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Ovakva paralelna događanja potvrđuju kako je naš skup prepoznat u regiji kao značajno godišnje okupljanje poljoprivrednika, znanstvenika stručnjaka i gospodarstvenika koji uz unapređivanje poljoprivredne proizvodnje žele i sačuvati našu nezamjenjivu i krhku prirodu ravnotežu. Održivi razvoj je jedina moguća opcija daljnjeg napretka.

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Svim nazočnima želim koristan i nadasve ugodan boravak u Vukovaru.

Ivan Šimić,

predsjednik organizacijskog odbora

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Remedying water-logged soils by means of adaptable tillage

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Abstract

The extreme climate phenomena that wreaked havoc in the Pannonian region in 2010 had very negative impacts on soils as well and this study contains an assessment of some of the consequences of the stress caused by precipitation on soils. The relatively rapid regeneration of chernozem soils damaged by hail was encouraged by consistent organic matter conserving tillage. Soil settlement along with the damage of the soil structure in the top 50 mm layer was monitored in a long term experiment, applying six different types of tillage techniques, in an environment characterised by 651 mm annual precipitation, from the time of the sowing of maize in the layer loosened by tillage. The best chances of minimised damage were observed in the case of the production of wide-row crops where the soil contained no compact layer and where about 30 % of the soil surface was covered. Loosening in the case of tillage carried out in the summer on moist soil occurred only where less heavy damage had been caused, under a minimum of a 40-45 % soil surface cover. The value of the relevant studies was increased by the enabling of the recovery of damaged soils and our recommendations were summed up in 18 points.

Key words: water-logging, rain stress, soil, remedy, tillage

Introduction

The Pannonian (or Carpathian) basin accommodates the whole or parts of the territory of as many as nine countries. This region is Europe's largest intermountain basin complex formed through geomorphic inversion during the Miocene, by the rising of the Carpathians and the subsiding of the areas in between and finally by the drying out of the Pliocene's Pannonian sea. The basin is dominated by the combined effects of oceanic, Mediterranean and continental climates and it is exposed to climate extremes (Bada and Horváth, 1998). Authors have long been preoccupied with climate extremes having adverse impacts on agricultural production (e.g. Balás, 1888; Milhoffer, 1897, Cserháti, 1900). Climate and its change have come to be frequently dealt with in scientific studies as well as the media in general. Opinions vary on the issue of climate change but the frequency of extreme weather phenomena has been undis-

putedly increasing. Year 2010 saw an outstanding number of adverse climate-related events across the region. In the middle of the Pannonian basin – in Hungary – the total precipitation was 969 mm, 71 % more than the average of the period between 1971 and 2000 (Kovács et al. 2010). Significant differences were also observed, e.g. in the SE, in the region of the town of Mezőhegyes, the total precipitation was 904 mm (60 % over the average), in Belvárdgyula – at a distance of 70 km from Osijek – 933 mm (55 % more), in Hatvan-Józsefmajor 951 (61 % more than the average) precipitation was measured. In the region of Daruvar near the southern edge of the basin the total precipitation was 1177 mm (32 % more than the average), in the region of Osijek 784 mm (12 % more) and in the NW part of the basin, in the region of Zabcice (24 km from the town of Brno in the Czech Republic) only 15 % more precipitation (541 mm) was recorded. Problems were caused not only by the quantity of precipitation but also by the extremes of its distribution, in some places in the region up to 150-160 mm rain fell in a matter of 4-6 days. In May and in June as well as in the late summer the region was hit by floods causing major damage. Moreover, a considerable part of the precipitation came in the form of storms and hail which, besides destroying part or the whole of the crops, damaged the soils as well. The rising of the groundwater table caused heavy damage by waterlogging as a result of which some 1 million hectares may be lost to cropping (O Horváth, 2011). Waterlogging appears in the form of water accumulating in plains from time to time, affecting large areas, originating directly from rain or snow and/or from the elevation of the groundwater level (Pálfai, 2000). Surface run-off and the stagnation of water on the surface depends on the soil mechanical composition and structure, on the soil original moisture content, the surface condition and cover, the soil water permeability and conductivity and on the quantity and intensity of the precipitation (Mattyasovszky, 1957, Várallyay and Farkas, 2008). Mattyasovszky noted that water intake that is characteristic of an adequately loose soil may decrease in a compact soil by 20-30 % in a matter of 10-30 minutes. At the same time, surface run-off increases, up to as much as 40-160 mm h^{-1} after the passage of 60-90 minutes, depending on the heaviness of the texture of the soil. Such conditions and this phenomenon were observed very frequently in 2010 since the soil water conductivity in a given soil is determined by its layer of the lowest conductivity capacity. This is why the presence of such a layer can make a world of difference. The soil has the greatest capacity as a natural water reservoir which, under ideal circumstances, can take in and store about two-thirds of the annual precipitation. In the majority of cases this storage capacity is utilised only to a certain extent owing to natural and human impacts (Várallyay and Farkas, 2008). In soils of a heavy mechanical composition with high proportions of clay and swelling clay mineral contents (*Gleyic Chernozems, Phaeozems, Stagnosols, Solonetz*) the water storage capacity of the top 1 meter soil layer is lost to their natural attributes and to their state modified by farming.

This study contains a discussion of certain consequences of precipitation and moisture surplus that can be measured in soils and a description of the possible remedies that should be applied to soils so damaged.

Materials and methods

Measurements taken in chernozem soil damaged by hail, as well as the findings of a relevant long term *soil quality - climate* experiment (Várallyay and Farkas, 2008; Birkás, Kisic et al., 2010), as well as in a *stubble - climate* experiment are evaluated in this study. Damage was caused by hail on 18 June 2010 at Mezőhegyes where a downpour of hail consisting of pieces of ice, of sizes between that of a walnut and a tennis ball, were falling for about 20 minutes, destroyed the vegetation in an area of about 10,000 hectares. The hail storm was followed by

an extremely heavy rain, some 70 mm falling in about an hour. The soil was damaged to varying degrees underneath the destroyed densely sown plants (wheat and rape), and in places where there was no cover (maize, sunflower). Only 10-40 cm stumps were left of the wide row crops that had been 50-80 cm tall at the time and since the torn leaves were piled up by the strong wind around the stumps, much of the soil was left without cover. In the areas concerned the soils' physical type is loam. On day two after the damage we checked the settlement of the top soil (0-50 mm) as well as the changes in the soil structure, where the soil moisture content was in the 0.32-0.36 m^3m^{-3} range. The findings were compared to the data taken from measurements carried out on 21 April 2010. The ratio of the depth of the settled soil to the original soil depth was used for establishing the settlement index.

The long term *soil quality - climate* experiment was set up in 2002 in the region of the town of Hatvan (47°41'N, 19°36'E) on Chernic Calcic Chernozem soil (by WRB 2006) with a clay loam texture developed on loam, a soil of medium sensitiveness to compaction. The soil OM content in the 0-40 cm top layer was 2.84 (2003) and 3.00 (2009), its clay content varied between 34 and 36 %, with ample nutrient supply. Further attributes of the soil (Várallyay and Farkas, 2008) included saturated water conductivity in the 15-20 cm layer and in the 45-50 cm layer was 17-31 and 26.7-33.5 mm day^{-1}, respectively. The saturated water content in the 15-20 cm layer and in the 45-50 cm layer was 0.40-0.52 m^3m^{-3} and 0.37-0.46 m^3m^{-3}, respectively. In the corresponding layers the field moisture capacity was 0.36-0.38 m^3m^{-3} and 0.34-0.35 m^3m^{-3}, respectively. The average annual total precipitation is 580 mm (during the growing season: 323 mm). The various years' precipitation figures are as follows: average (2002, 2006), dry (2003: -138 mm, 2004: -101 mm) and rainy (2005: +125 mm, 2008: +152 mm, 2010 +371 mm). Years 2007 and 2009 were dry only during the growing season. The experiment was focused on a single factor, arranged in strips at random, with four repetitions. Six treatments were applied, including direct drilling (DD), disking (15 cm, D), shallow and medium-deep tillage with cultivator (15 cm SC, 22 cm C), ploughing (32 cm, with surface forming, P), and loosening (40 cm, L). The surface cover ratios after sowing were, P:0, L, C, SC: 25 %, D: 20 %, DD: 35 %. In the wake of the Lumax treatment in mid-June, the weed-mulch ratios were: P: 2, L: 38, C: 34, DD: 33, SC, D: 32 %. The primary tillage treatments were carried out on 22.10.2009, and maize was sown on 4 May 2010 as had been planned. After sowing a total of 182 mm rainfall had been measured, with a total precipitation of 651 mm up to harvest. The following measurements were taken in the experiment in relation to the subject matter of the experiment: the degree of settlement in the tilth, changes in compaction (in the P, and D treatments), changes in the soil agronomical structure in the top 50 mm layer, evaluation as prescribed in the applicable standards (Sváb, 1981; Várallyay and Farkas, 2008). The measurements were taken between 22.03.2010 and 29.10.2010. The effects of the tillage carried out in wet soil were studied in the *stubble - climate* experiment. The treatments applied included control: no stubble stripping after wheat, soil surface covered with chopped straw and the tillage treatments: flat plate disk (FD, 6-8 cm), cultivator (C, 8-10 cm), conventional disking (CD, 8-10 cm). The measurements were taken between 20.07.2010 and 24.10.2010.

Results and discussion

Impacts of adverse climate phenomena on the soil

2010 was a disastrous year for soils which were hit by climate extremes in several waves. According to the continuous soil condition studies the following types of soil condition damage were observed and proven by measurements: *settlement* (in the wake of steady rains, and hail), *aggravation of compaction* (as dust and clay colloids are washed down as well as in the

wake of traffic on and tillage of wet soil), *structure degradation* as a result of steady rainfalls, beating by hail, tillage of wet soils and water stagnation). Both the crops and the soils were hit hard by the storms and hail. The soils that had been silted by heavy downpours became crusty and then cracked during the hot days. The rains caused shortage in the crop stands by washing nitrogen fertilisers down to deeper layers. Water-logging turned into a permanent damage in the fields from the spring on. Some of the threats had been caused by farming (tillage pan near the soil surface, traffic-induced compaction), others originated from natural causes (as a result of the rising of the groundwater table). About 12-15 % of the total area damaged by water was hit by floods, some 45-47 % was affected only by natural causes, 13-15 % was a result of wrong farming techniques while areas where the latter two were observed together, accounted for 25-27 % of the damaged area. Owing to the surface water cover large areas remained unsown from spring until autumn and after the early autumn rains even the newly sown seedlings were killed off. The soils sensitiveness (high, moderate or low, Várallyay and Leszták, 1989) was one of the key factors in the settling of the soils. In soils that had been found to be sensitive, the unfavourable weather patterns aggravated the damage caused by unreasonable land use. Under adverse climate conditions (as in 2010) however, even soils that are moderately sensitive to settling, become endangered. The Calcic Chernozem of Mezőhegyes is less sensitive to settling. The depth recorded at the time of ploughing in the autumn – 32.0 - 32.5 cm – and at the time of seedbed preparation (21.04). By the 2nd day after the hail the depth of the loosened layer decreased by 9-11 %. Settling was most prominent in the top 50 mm layer. Under the large amount of wheat straw or rape stalks beaten down by the hail however, 0-0.2 % settlement was measured (n: 32). The agronomical structure of the soil also changed in a particular way (Fig. 1). In the top 50 mm of the ploughed soil at Mezőhegyes there is usually a 78 % crumb ratio (Mh - usual), while in April 2010 it was as high as 79.4 %. In bare areas beaten down by the hail it decreased by 30-31 % (June, NC), while in areas covered by destroyed vegetation it dropped by 0-3 % (June, C). It should be noted that in the damaged soils (August, NC) some 70 % crumb ratios were found after the passage of two

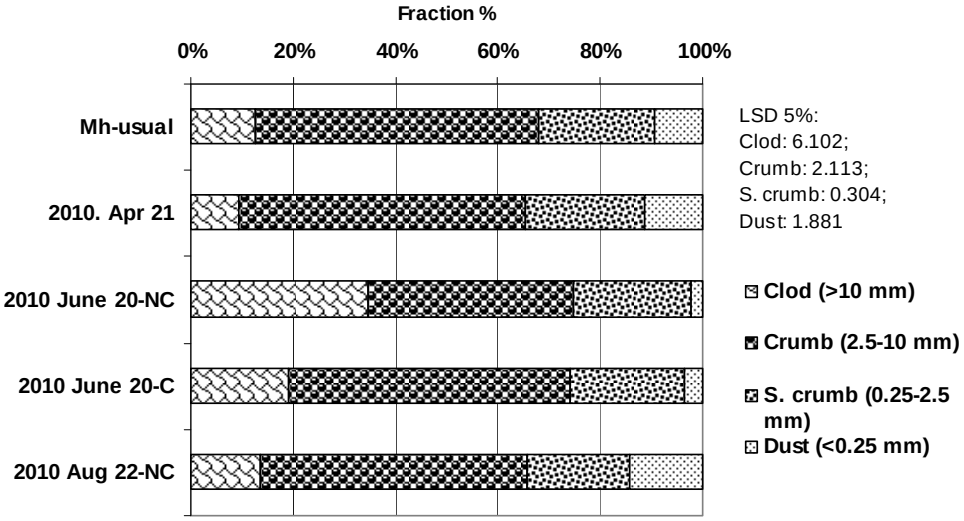

Figure 1. Trends in the agronomical soil structure in a Calcic Chernozem soil at Mezőhegyes (2010).
Note: NC-non covered, C: covered; n: 24-32

months, despite the continued rains. The generally favourable crumb ratio and the relatively modest damage was due to the continuous organic matter and structure preserving tillage (the biomass of the dead plants had been incorporated in the soil by 2-3 mixing treatments by the month of September, instead of removing it as had been done by other farms hit by the hail where the crumb ratio remained below 30 % until the autumn tillage season).

The tasks to be carried out after the damage had been done were chosen with a view to preserving the looseness of the soil and to improving the damaged structure. New sowing could be planned after the desiccation of the soil only in uncovered areas. The damaged top soil layer dried into a hard crust, thus sowing was possible after the crumbling of this hardened layer. The requirement of soil structure preservation was met by applying combinator assemblies without rolls, which made it possible to improve the soil's crumb structure during the two months after the hails (Fig 1.).

The impacts of the rain and surplus moisture stress on the soils

In the long term experiment after sowing we measured the depth of the loosened layer that had been created by the primary tillage carried out in the autumn (n: 16/treatment), and the depth measured after DD was also favourable (Fig. 2.), thanks to the preceding 10 years of OM-conserving land use. Between the sowing time and the date of the next measurements (10 June) a total of 207 mm of rains had been recorded, and the compacting impact of which – since at that time there had not been any vegetation cover – had also been detected. Besides the depth of the loosened layer the settlement of the soil was affected by the ratio of surface coverage as well. The settlement ratios at that time in the order of the P–L–C–SC–D–DD treatments were 14, 5, 1, 10, 30 and 6 % respectively, while the corresponding ratios at the end of the growing season were 15, 9, 5, 15, 36 and 13 % (n: 8/variant). The early rains had the greatest settling impact on bare ploughed or disked (slightly covered) soils. The greater settlement of the disked soil is partly explained by the disk pan developed below a depth of 15 cm. This was confirmed by the puddles of water on the top of the soil between 18 and 23 June, after another 100 mm rainfall. The 37.2 mm disk pan measured at the time of sowing increased to 40.5 mm after just one month. The thickening of the compact layer had probably been caused by the washing down of the dust fraction of the top layer to the compact layer. The thickness of the plough pan grew from 33.0 mm to 35 mm. This phenomenon has also been dealt with in the literature (Triphati et al., 2005; Birkás et al., 2009; Várallyay and Farkas, 2010). Further consequences of the temporary stagnant water layer on the soil surface included reduced plant height (45-51 cm), shorter corn cobs and an 8-9 % yield loss in comparison to the average of the plots.

The soil's top 50 mm layer was particularly heavily affected by rain stress. After primary tillage in October 2009 a total of 281 mm precipitation was recorded up to end-March and the proportion of crumbs dropped from the ratio measured in the preceding autumn. The favourable impacts of seedbed preparation were offset by the subsequent rains by early June but a mathematically reliable difference was found between the different treatments (Fig. 3). The degradation of the crumbs was particularly conspicuous in soil with bare surface at P or with little cover at D, just like the relatively less damage that was characteristic of the DD. From the middle of the growing season crumb forming improved thanks to the growing surface cover but the trends in the soils under the treatments marked P and D differed from the others. The authors noted the adequate organic matter content of the soil as the prerequisite for crumb forming and the regeneration of the crumbs (Cook et al., 2007; Kalmár et al., 2007; Várallyay,

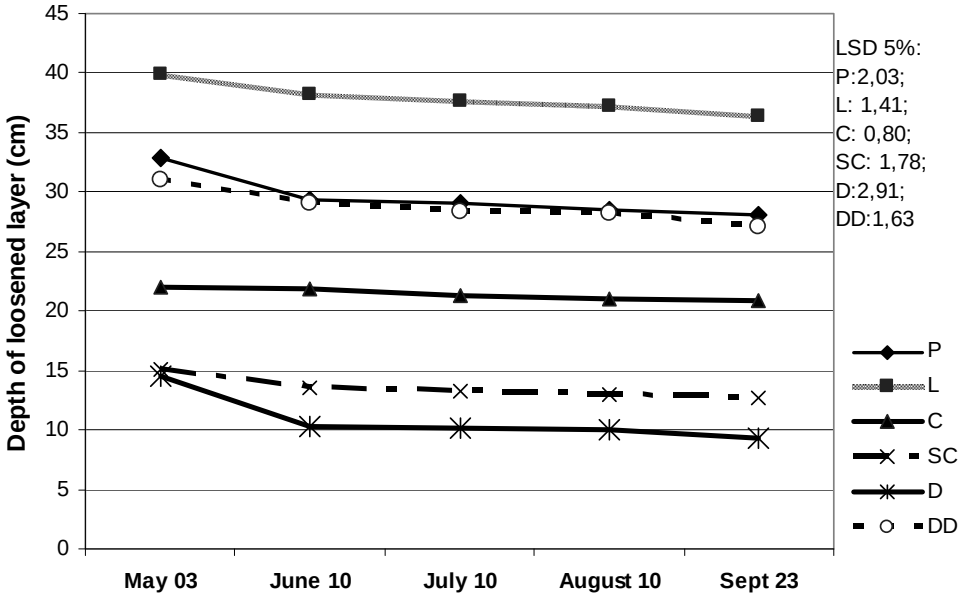

Figure 2. Settlement of soils after different tillage treatments in a rainy growing season (Hatvan, 2010)

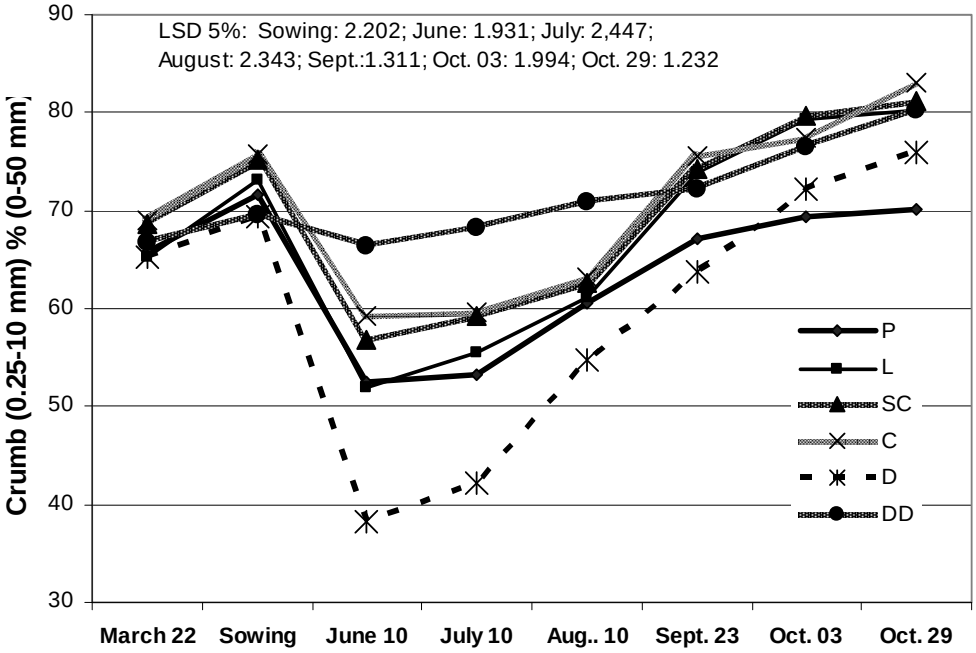

Figure 3. Trend of the crumb ratio in a rainy growing season under maize (Hatvan, 2010)

2010; 2011). The beneficial effects of high OM content had been found earlier as well (Birkás, Kisic et al., 2010). Maize began to have a material protective effect when its height reached 120 cm, around 10 July. The residues of the preceding crop afforded some protection to the soil up to mid-summer (except for treatment P) while the residues of the dead weed plants protected the soil up to the end of the growing season. The next task was to reduce the soil stress that is entailed by harvest and primary tillage. On 28 October the average moisture content of the top 30 cm layer was 0.16 m^3m^{-3} (in the deeper layers it was 0.33 m^3m^{-3}), which was adequate therefore the soil did not need to be allowed to rest underneath the chopped stalks.

In the case of the treatments (P, L, C, SC) the tillage depth was increased by 20 mm, in contrast to the customary practice, to prevent pan forming. In the case of treatment D the tillage depth was not increased, the disk pan was as thick as 40.5-41.0 mm. In the tilled layer the structure was found to be generally favourable (Fig. 3). Before the winter the surface cover ratios were 0.5, 29.75, 18.25, 24.75, 24.50 and 100 % in the following order: P-L-C-SC-D-DD. The necessity of surface protection is regarded to have been proven by the 195 mm precipitation recorded up to the end of February 2011.

The timeliness of the *stubble - climate* experiment was based on the studying of the effects of the tillage of the top 10 cm soil layer in wet soil (0.26 m^3m^{-3}) in the summer (Kalmár et al. 2011). The soil was compact below 12 cm underneath a layer of chopped wheat straw (S, 3.25 MPa), which did not deteriorate by flat plate disks (FD) or the cultivator (C), but which grew a lot worse by conventional disk (3.7 MPa, Fig. 4.). The shallow tillage did not, of course, break up the disk pan. In the order of S-FD-C-CD the surface cover rates were 90, 40, 40 and 20 %, respectively. A total of 273 mm precipitation was recorded during the period under review, i.e. the surface cover proves to have been necessary. At the end of the experiment (on the 96th day) the compact layer was found to be loosened and crumbled by the tools causing less stress to wet soil (flat plate disk, FD, and cultivator (C). A smaller degree of loosening was observed in the soil tilled with conventional disks (CD).

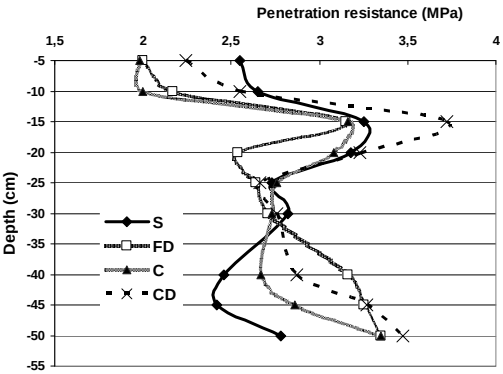

Figure 4. Typical soil resistance at the beginning of the experiment (July 20)

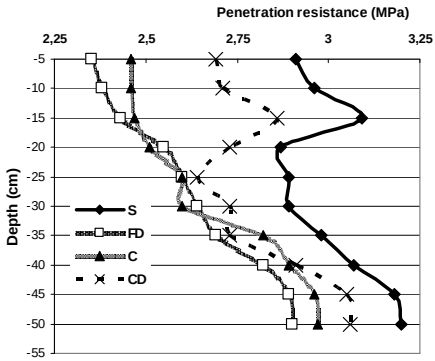

Figure 5. Typical soil resistance at the end of the experiment (Oct. 24)

At the beginning of the experiment the crumb ratios were found to be 67, 73, 73 and 69 % in the S-FD-C-CD order of variants, i.e. tillage improved the original 67 % ratio. At the end of the trial the crumb ratios were 68, 81, 81 and 76 % in the above order, i.e. tillage treatments causing less damage (FD, C) were more favourable not only than the treatment causing heavier soil

damage but also than leaving the soil undisturbed (S). The ratio of soil that has been damaged by rain stress and that has not recovered (on a per m^2 basis) during the experiment period may be an important indicator: S: 11, FD, C: 9, CD: 17 %.

The views taken of the different types of stubble treatment vary in time, e.g. during the early 1900s as well as during the early 1980s most people found a stripped soil surface without crop residues to be the most favourable condition. This approach has been changing gradually since the mid-1990s and a field covered by chopped crop residues after harvest is considered to be more acceptable (Kalmár et al., 2007). Strangely enough, the variability of the climate conditions has contributed to the change in the approach taken by most people, since in the dry summers of 2000, 2003, 2007 and 2009 the soil best retained its workability under an at least 30 % coverage. In those years people assumed that during a rainy summer period there is no need for a cover layer in the wake of tillage after harvest because there is a sufficient amount of moisture in the soil even without such a layer. The soil structure degradation observed after the occasional downpours however, calls for increased protection. The duration of the surface cover is also important, and during the middle of the summer a higher while towards the end of the season a smaller rate of cover will do. It is confirmed that in the summer of 2010 the settling and crumb degrading impacts of the frequent heavy rains, often coming in the form of rain storms, could be alleviated only by increased surface cover. The indicators of the impacts of soil cover included soil loosening or settlement, crumb forming or silting and the earthworm counts. In our experiment the soil without stubble stripping was covered by a 90 % chopped straw layer. In this case only 10 % of the soil surface was damaged by the rains. Within the plot the straw mulch: soil ratios varied between 70:30, 75:25, 80:20, 85:15, 90:10, 95:5 and 100:0 % (Table 1). The cover ratios (straw % / soil %) were thus 2.33, 3.00, 4.00, 5.66, 9.00 etc (that is, >2). At the end of the rainy season in question a 70-80 : 30-20 % straw mulch : soil ratio was found to be most favourable, at least 15-25 % of which was made up of killed plant residues (as secondary protective materials). Disturbed soil is particularly in need of protection therefore the minimum cover ratio was set at 40 %.

Table 1. Coverage (%) of tilled fields after harvest in different seasons

Season	Optimal	Adequate	Poor	Positive impacts of optimum surface cover
Rainy	40 – 50	25 – 35	< 15	Less soil structure deterioration and settling, improved straw decomposition and earthworm activity
Average	30 – 45	15 – 25	< 10	Maintaining soil workability and earthworm activity
Dry	45 – 55	25 – 35	< 25	Good moisture retention, crumbling, earthworm activity and straw decomposition

In dry seasons higher cover layers (45-55 %) were found to provide improved protection (Kalmár et al., 2007; Birkás, Bottlik et al., 2010). After the tillage treatments the straw mulch : soil ratios were 40:60 (FD, C), and 20:80 (CD), while in the FD and C plots even ratios as high as 45:55, 50:50, 55:45 were found, i.e. the cover ratios were, in favourable cases, as high as 0.67, 0.82, 1.00 and 1.22 respectively, while under the CD treatment it was as low as 0.25. Where the soil was not covered, its surface layer was beaten into silt by the rains, which was followed by crusting during the hot dry days. Under such circumstances the process of the regeneration of the crumbs has begin before the end of the season. The originally existing favourable surface cover layer gradually decreases as a result of microbial decomposition, as required for the

tillage treatments to be carried out later on. The rainy summer of 2010 was highly favourable for weed and volunteer crop emergence but no strong growth of weeds or volunteer crops is considered to be desirable in any season. Towards the end of the season, before the primary tillage treatments, a 30-35 % surface cover ratio was found to be most advantageous, bulk of which (50-60 %) was made up of mulch consisting of eradicated vegetation. In this case the cover ratios were found to vary between 0.43 and 0.53.

Remedying soils damaged by water surplus

Our proposals are based on findings derived from long term experiments and from monitoring on soils that are typical in our region (Birkás et al., 2010; Jug et al., 2010):

1. Actions on a national or large regional level:

- Surplus water to be found even today in water-logged fields should be drained and stored in a safe and reliable way.
- The areas damaged by water need to be mapped and documented – specifying those severely, moderately and less seriously damaged areas – for the required remediation plans to be worked out.
- The alleviation of water-logging, traffic- and tillage-induced damage carried out under the force of necessity should be developed into an annual programme.
- The remediation programme's tasks pertaining to soils should be specified: these should include organic matter conservation, the application of tools causing less damage to wet soils and the provision of financial assistance for the purchasing of such tools.

2. Tasks relating to farmers:

- Recognition of factors increasing climate damage (bad soil condition, wrong cropping practices) is required in order for the remedial actions to be worked out.
- Possibilities of soil remediation in the spring: e.g. where primary tillage could not be carried out in the autumn, techniques limiting the soil recovery (such as ploughing and disking) should be avoided in soils of clay contents exceeding 35-40 % and in gleyic soils.
- Application of stubble tillage techniques encouraging the recovery of the soils, making use of the protection afforded by surface cover (40-50 % of the straw).
- Encouraging the microbial activity required for soil recovery by mixing crop residues (50-60 % of the straw) into the soil.
- Exploiting the soil regenerating effects of the application of green manure (producing more manageable masses instead of aiming at producing large green masses).
- Exploiting the effects of stubble treatment encouraging weed emergence and the weed controlling effects of stubble treatment. The mulch covering the soil after chemical weed killing supplements the available surface protection.
- The traffic-induced damage caused in 2010 can be alleviated by loosening, with reduced energy input in fields after stubble stripping.
- Loosening the layer impeding water transport in the soils damaged by disk pan forming in the autumn of 2010 (deepening the biologically active layer).
- Application of deeper loosening with longer lasting effects where the layer concerned – 35-45-50 cm – is dryer.

- Extending the period of surface protection until after primary tillage leaving a mulch (with cultivator), without creating a compact water-impermeable layer.
- To improve the bearing capacity of the soils and to prevent crumb degradation, organic matter preserving should be prioritised, particularly in the case of primary tillage.
- To maintain the soil recovery processes ploughing wet soils in the summer and/or in the late autumn is not recommended.
- Good decisions require knowledge of the soil state across the entire field, to enable accurate assessment of the damage caused by the time after harvest in 2010, and to be able to critically analyse the whole year's soil remedial treatments after sowing.

Conclusions

Our studies were aimed at helping the recovery of soils damaged by water. In the areas damaged by hail, besides the devastation of the entire vegetation the damage caused to Calcic Chernozem soils in the case of large dead masses of vegetation the soil looseness and structure remained more or less intact, while without crop cover both factors deteriorated. The need for the soil recovery highlights the necessity of continuous and consistent organic matter and structure conserving tillage.

In Chernic Calcic Chernozem soil where a total precipitation of 651 mm was recorded during the growing season, six different tillage treatments were found to result in resistance to climate damage in the following order: DD=C>SC>L>P>D. In the case of wide row crops the best chance of minimising the damage was observed where no compact layer in the soil and some 30 % of the soil was covered during much of the growing season but a shallow loose layer and the presence of a tillage pan resulted in temporary waterlogging.

The protection of the soils after summer harvest is necessitated by the frequency of climate extremes. Undisturbed and disturbed soils were found to have different needs of protection. The former were found to require 70-90 % cover rates while the recommended cover rates for tilled soils was between 40 and 50 %. The required cover rates were established separately in every season. Our proposals for the remedying of damaged soils were listed in two main points and in 4+14 sub-points.

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Sažetak

Popravak privremeno poplavljenih tala uporabom prilagodljive obrade tla

Ekstremni klimatski događaji koji su se obrušili na panonsku regiju 2010 godine imali su vrlo negativan utjecaj na tlo, te ova studija sadrži procjenu nekih posljedica stresa uzrokovanog oborinama na tlo. Relativno brza regeneracija černozemnih tala oštećenih ledotučom bila je potpomognuta obradom tla kojom je konzervirana organska tvar u tlu. Slijeganje tla skupa s oštećenjem strukture tla u gornjih 50 mm tla promatrana je u dugogodišnjem pokusu, gdje je primijenjeno šest različitih tipova obrade tla, u okolišu kojeg inače odlikuje 651 mm oborina tijekom godine, od vremena sjetve kukuruza u tlo razrahljeno obradom. Najmanja oštećenja bila su uočena u slučaju širokorednih usjeva gdje tlo nije sadržavalo zbijeni sloj i gdje je oko 30% površine tla bilo pokriveno. Rahljenje u slučaju obrade vršene tijekom ljeta po mokrom tlu bilo je uspješno samo na manje teško oštećenim tlima, ispod minimalno 40-45% pokrivenosti površine tla. Vrijednosti relevantnih istraživanih parametara povećane su kroz omogućavanje oporavka oštećenih tala i date su preporuke za popravljanje u 18 točaka.

Ključne riječi: privremena poplavljenost, kišni stres, tlo, popravak, obrada

Pregledni rad / Review paper

Control of soil processes for environment protection

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Abstract

The three most important *»life quality criteria«* are: healthy and good-quality food, food-security; clean water; pleasant environment. All three are closely related to the sustainable use, proper management and efficient control of natural resources: the geological strata–soil–water–biota–vegetation–near surface atmosphere continuum. Soils are the most important *conditionally renewable natural resources* in the Carpathian Basin, having three unique properties: fertility/productivity; resilience and multifunctionality. Consequently, rational land use and soil management are indispensable elements of sustainable development, including multipurpose biomass production, rural development and environment protection. The natural conditions are generally and relatively favourable in the Pannonian Plains, but show high (and according to climate change forecasts increasing) spatial and time variability, irregular (consequently hardly predictable), often extremes and sensitively react to natural or human-induced stresses. The most significant environmental threats are soil degradation processes; extreme hydrological events and unfavourable changes in the biogeochemical cycles of elements. Their proper control, formulated in a comprehensive **Soil Conservation Strategy** should be the *priority* task both of sustainable (agricultural) development and environment protection.

Keywords: sustainable soil management; multifunctionality; soil degradation; extreme hydrological events; biogeochemical cycles of elements.

Introduction

Sustainable development is the management and conservation of the natural resource base, and the orientation of technological and institutional changes in such a manner as to ensure the attainment and continued satisfaction of human needs for *present* and *future* generations. *Sustainable agricultural development* includes efficient *biomass production* for food, fodder, industrial raw material and alternative energy, using environment-friendly, energy- and material saving technologies paying special attention to quality, and a socially acceptable rural development, simultaneously (Várallyay, 2003). Each society wishes to create favourable living conditions for its members. In spite of the fact that *»life quality criteria«* are formulated in different ways by various societies and individuals (depending on many factors, mainly on the given socio-economic conditions) there is full agreement in three elements:

– healthy, good quality food and food security;
– clean water;
– pleasant environment.

All three are closely related to the sustainable use, proper management and efficient control of natural resources: the geological strata–soil–water–biota–vegetation–near surface atmosphere continuum. **Soils** are the most important **conditionally renewable natural resources** in the Carpathian Basin, having three unique properties:

☼ fertility/productivity: soil can satisfy – to a certain extent – the main ecological requirements (air, water, nutrients) of the biota, natural vegetation and cultivated crops;

☼ resilience: soils may recover after a certain stress (Greenland & Szabolcs, 1993);

☼ multifunctionality: the primary media for multipurpose biomass production; reactor, transformer and integrator of other natural factors; environmental functions as storage, buffer, detoxication, biota habitat, etc.

Consequently, the rational use and protection of soil resources, maintaining their favourable *»quality«* and desirable *multifunctionality* are primary tasks of sustainable biomass production, rural development, environment protection and nature preservation (Láng et al., 1983, 2004; Várallyay, 2010b).

Soil functions and environment protection

The most important **soil functions** are as follows (Várallyay, 2003, 2010b):

(a) Conditionally renewable natural resource.

(b) Reactor, transformer and integrator of the combined influences of other natural resources, place of »sphere-interactions«, creating »life media« and habitat for biota and »land site« for natural vegetation and cultivated crops.

(c) Medium for biomass production, primary food-source of the biosphere.

(d) Storage of heat, water and plant nutrients, as well as wastes from various sources.

(e) High capacity buffer medium, which may prevent or moderate the unfavourable consequences of various environmental stresses.

(f) Natural filter and detoxication system, which may prevent the deeper geological formations and the subsurface waters from various pollutants.

(g) Significant gene-reservoir, an important element of biodiversity.

(h) Conserver and carrier of the heritage of natural and human history.

These functions are – theoretically – equally important, but society has used them in different ways (rate, method, efficiency) throughout history, depending on the given natural conditions and socio-economic circumstances. In the last decades the **environmental functions** (d, e, f, g) have gotten more and more significance. In many cases the character (spatial and time variability, changeability–stability–controllability, boundary conditions, limitations) of a certain function has not been (properly or adequately) taken into consideration during the utilization of soil resources. In such cases the misguided management resulted in over-exploitation, decreasing efficiency of one or more soil functions, and – over a certain limit – serious environmental deterioration (Láng et al., 2004; Várallyay, 2009).

Natural conditions and environmental threats in the Carpathian Basin The natural conditions (climate, water, soil and biological resources) of the Carpathian Basin (particularly the lowlands and plains) are **generally favourable for rainfed biomass production** (Láng et al., 1983; National Atlas of Hungary, 1989; Várallyay, 1985, 2010). These conditions, however, show high and *irregular,* consequently hardly predictable spatial and temporal *variability,* often *extremes* and sensitively react to various natural or human-induced *stresses* (Várallyay, 1989, 2006).

The Carpathian Basin is a greatly **»water-dependent« region** (Figure 1), where the soil–water relationships considerably influence, sometimes determine the type and rate of weathering, soil formation and soil degradation processes; the moisture and substance regimes; soil fertility/productivity; the yields and yield fluctuation of crops and environmental conditions (Várallyay, 1985, 1989, 2006, 2009, 2010c).

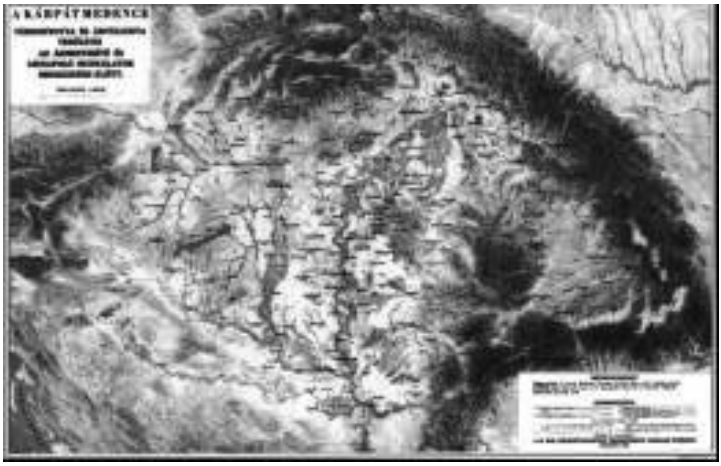

Figure 1. The Carpathian Basin

The generally favourable agro-ecological potential is mainly limited by three soil factors:

(1) Soil degradation processes (Várallyay, 1989, 2002, 2006, 2009).

(2) Extreme moisture regime: simultaneous hazard of flood, waterlogging, over-moistening and drought sensitivity. (Várallyay, 2010a,c).

(3) Unfavourable changes in the biogeochemical cycles of elements, especially of plant nutrients and environmental pollutants (Láng et al., 2004).

Rational land use and soil management may react to these limitations in two different ways:

– *adaptation* to the given conditions by rational »site-specific« land use, proper cropping pattern and adequate agrotechnology;

– *modification* (mitigation) of the unfavourable conditions by soil reclamation and amelioration, including the development of proper infrastructure, water management and soil conservation practices.

The comprehensive *assessment* and efficient *control* of these phenomena are the primary tasks of multipurpose biomass production, environment protection and sustainable rural development (Németh et al., 2005).

Limiting factors of soil multifunctionality, soil degradation processes

The main *limiting factors of soil multifunctionality* in Hungary are shown in Figure 2 (Szabolcs & Várallyay, 1978).

Soil degradation is usually a complex process in which several features can be recognized that contribute to

- unfavourable changes in soil processes and soil properties;
- loss or decrease of soil fertility and productive capacity;
- limitations in normal soil functions; and/or to
- serious environmental deterioration.

Soil degradation may be the result of natural factors and/or human activities (FAO, 1979).

Recognizing the world-wide importance of the prevention, control and »management« of soil degradation processes UNEP initiated a world programme for the GLobal Assessment of SOil Degradation (GLASOD). In the Programme a 1:5M scale GLASOD World Map and a series of larger scale (1:1M, 1:500 00) regional GLASOD maps were compiled and their territorial data were summarized, indicating the extension, degree, rate and the main reason of various types of soil degradation (Oldeman et al., 1990).

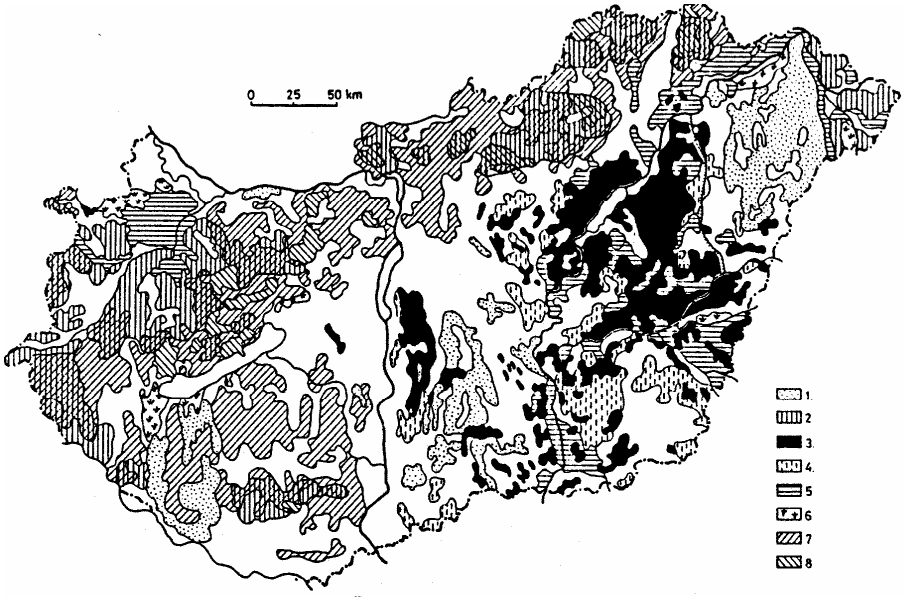

Figure 2 Map of the limiting factors of soil multifunctionality in Hungary.
1. Extremely coarse texture (8% of the total area of Hungary). 2. Acidity (12.8%). 3. Salinity and/or sodicity (8.1%). 4. Salinity and/or sodicity in the deeper layers (2.6%). 5. Extremely heavy texture (6.8%). 6. Peat formation (1.7%). 7. Erosion (15.6%). 8. Shallow depth (2.3%).

In the **EU Soil Conservation Strategy** 8 main *soil threats* have received priority attention, which are the most important soil degradation processes in the Carpathian Basin, as well: Figure 3 (Soil Atlas of Europe, 2005; Várallyay, 2005b).

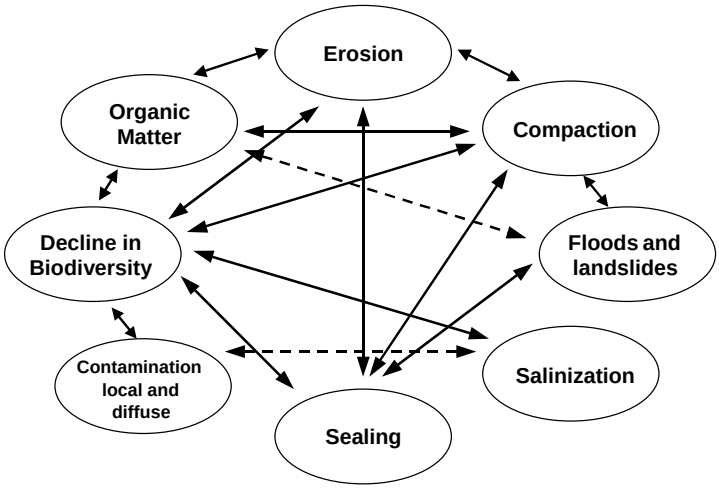

Figure 3. the main soil degradation processes in Europe and in the Carpathian Basin

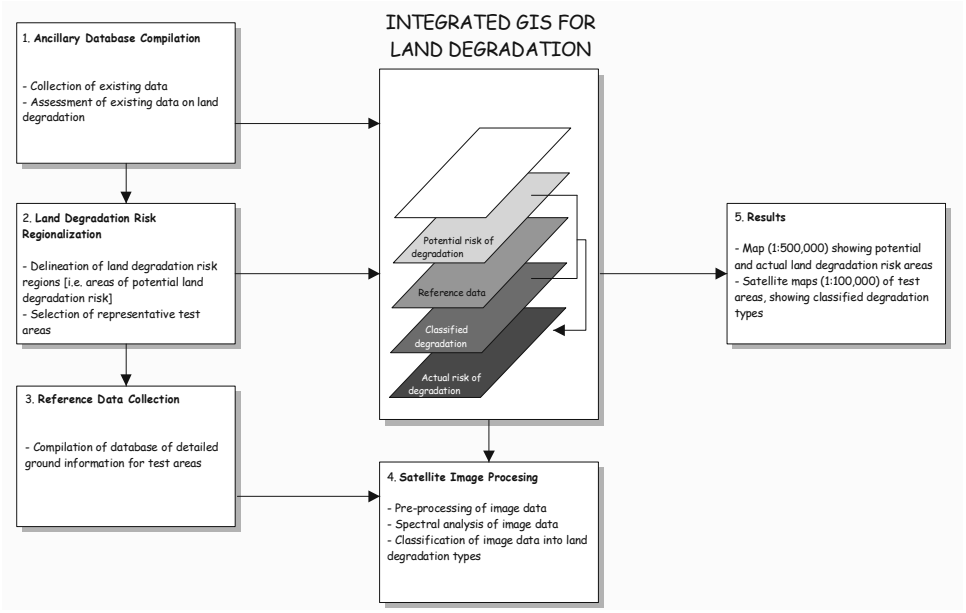

Figure 4. »Flow-chart« of the PHARE MERA Land Degradation Subproject

In spite of the large and increasing extension of degraded lands in all continents, it can be stated that soil degradation is not an unavoidable consequence of intensive (but rational!) agricultural production and social development! Most soils are resilient to a certain extent, consequently, most of the **soil degradation processes and their consequences can be efficiently prevented, eliminated or at least moderated.** But it needs permanent control measures and widely adopted soil (and water) conservation technologies, which are the indispensable elements of sustainable (agricultural) development and up-to-date **site-specific precision soil management** (Németh et al., 2005; Várallyay, 2005a, 2006).

In the last years the revolutionary development of in situ and laboratory analytics, remote sensing, informatics, computer technology, GIS/GPS applications, etc. have given *opportunity* for the *control* (prevention, elimination or at least moderation) of the unfavourable *soil degradation processes* on the basis of an up-to-date comprehensive environment/*soil database*. This was the aim of the GLASOD, the PHARE-MERA programmes, the European and the Hungarian Soil Conservation Strategy. The »flow chart« of the PHARE-MERA Soil Degradation Subpro9ject is shown in Figure 4 (Final Report, 1996; Szabó et al, 1998).

Extreme hydrological situations and soil moisture regime

It can be predicted with high probability that in future *water* will be the determining (hopefully not limiting) factor of food security and environmental safety in the Carpathian Basin. Consequently, the risk reduction of extreme hydrological events and soil moisture regimes, the **increase of water use efficiency** will be one of the key issues of water management, biomass production, rural development and environment protection, and *soil moisture control* will be an imperative task without any other alternatives (Várallyay, 2010c).

The **water resources are limited** and an increasing water demand must be satisfied from these limited resources.

The average 500–600 mm annual **precipitation** in the Pannonian Plains shows **extremely high territorial and temporal variability** – even at micro-scale. Under such conditions a considerable part of the precipitation is lost by surface runoff, downward filtration and evaporation. Precipitation will not be more in the future. On the contrary, it might be less according to the climate change forecast, assuming increasing temperature and aridity. Its greatly variable territorial and time distribution will not turn better. An opposite tendency has been forecast: **increasing risk** (frequency, intensity) **of extreme weather events** (high intensity rains, droughts etc.) with their hydrological (flood, waterlogging, over-moistening), ecological (droughts, crop damages, yield reduction) and environmental (erosion–sedimentation, infrastructure damages, landscape destruction) consequences.

The available quantity of **surface waters** (rivers) will not increase, particularly not in the critical low-water periods.

A considerable part of the **subsurface waters** (especially in the poorly drained lowlands) is of poor quality (high salinity, alkalinity, sodicity), threatening with harmful salinisation/sodification processes (Várallyay & Rajkai, 1989). Another part of the groundwater cannot be utilized because its over-exploitation may result in serious environmental deterioration: the water table sinks → capillary transport decreases or stops → drought sensitivity increases → serious »desertification symptoms« appear Várallyay, 2010a)..

Under such conditions it is an important fact that **soil is the largest potential natural water reservoir** (water storage capacity) in the Carpathian Basin. The 0–100 cm soil layer may store

about half of the average annual precipitation and about 50% of it is »available moisture content« (Várallyay, 1985, 2010a; Várallyay et al., 1980).

In many cases, however, this huge *potential* water storage capacity is not utilized because:

– the soil pores are saturated by a pervious water source;
– the infiltration is limited by a frozen or seriously compacted »impermeable« layer on or near to the soil surface;
– the storage capacity is limited by poor water retention.

As a consequence of these limitations the risk/hazard of **extreme hydrological/soil moisture events** (as flood, waterlogging, over-moistening vs. droughts) are characteristic features in the Carpathian Basin and occur with increasing frequency and intensity, often in the same year on the same area (Várallyay, 2006, 2009, 2010c).

Unfavourable changes in the biogeochemical cycles of elements

Water as solvent, reactant and transporting agent plays an important (sometimes decisive) role in physical and chemical weathering (abiotic and biotic transport and transformation phenomena), soil formation and soil degradation processes (Várallyay, 2010c).

The soil moisture regime strongly influences, sometimes determines other soil ecological conditions, such as air, heat and nutrient regimes, biological activity; the environmental sensitivity and tolerance limits of soil against various natural and human-induced stresses, including point source or quasi point source and diffuse soil pollution; and the soil technological indices for soil tillage and other agrotechnical operations (Figure 5) (Birkás, 2008; Farkas et al., 2009; Láng et al., 2004; Várallyay, 2010a).

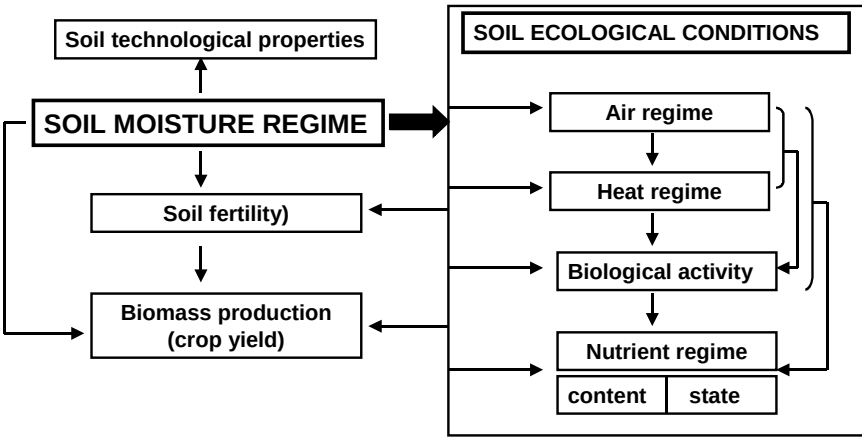

Figure 5. Relationships between soil moisture regime and soil ecological conditions

Control of soil processes

Soil *functions* are determined by the integrated influences of soil *properties*, which are the result of soil *processes* (mass and energy regimes; abiotic and biotic transport and transformation processes; phase interactions) under the influence of soil forming *factors* (Figure 6).

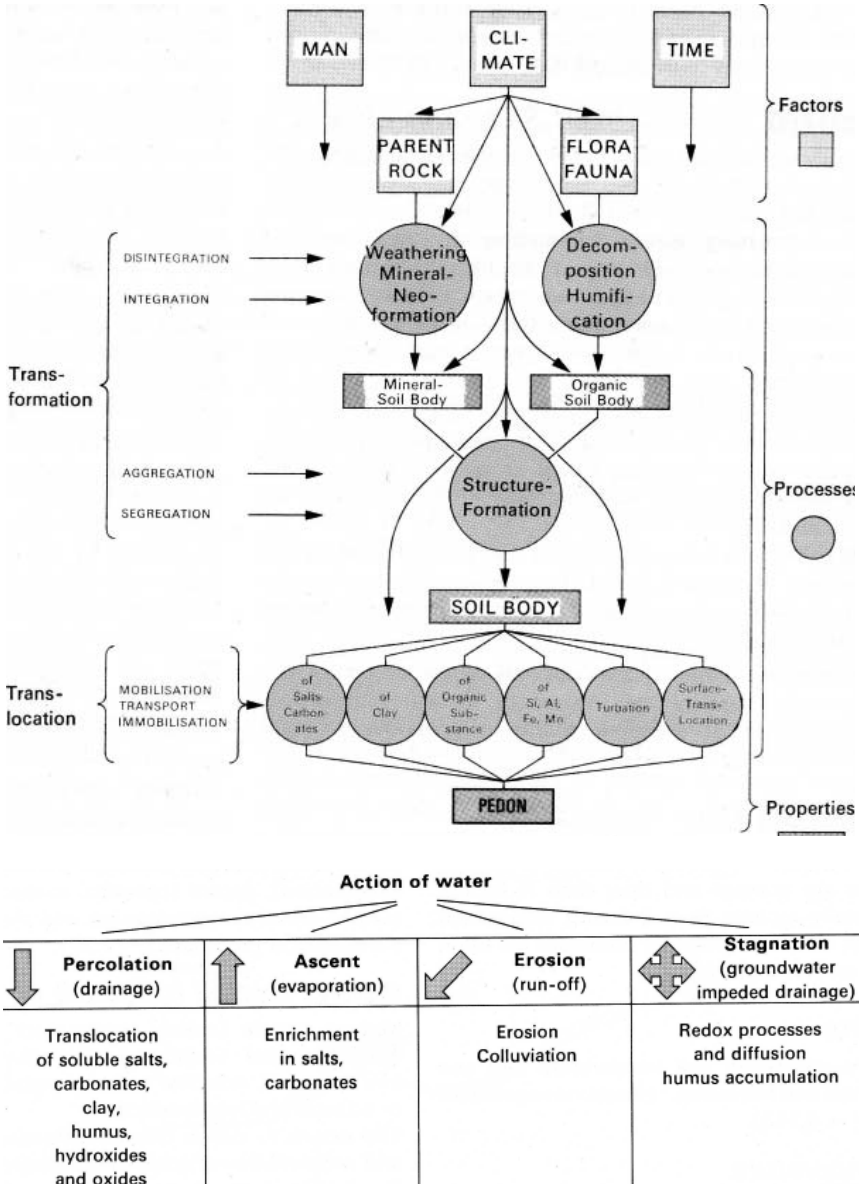

Figure 6. Soil forming factors, soil processes and soil properties

Their control is the main task of up-to-date, modern soil science, presenting a solid scientific basis for rational, efficient and sustainable land use and soil management.

The schematic »flow-chart« of the control of soil processes, indicating the logical sequence of the necessary steps is shown in Figure 7 (Soil Atlas of Europe, 2005; Várallyay, 2005b, 2010b; Várallyay et al., 2010).

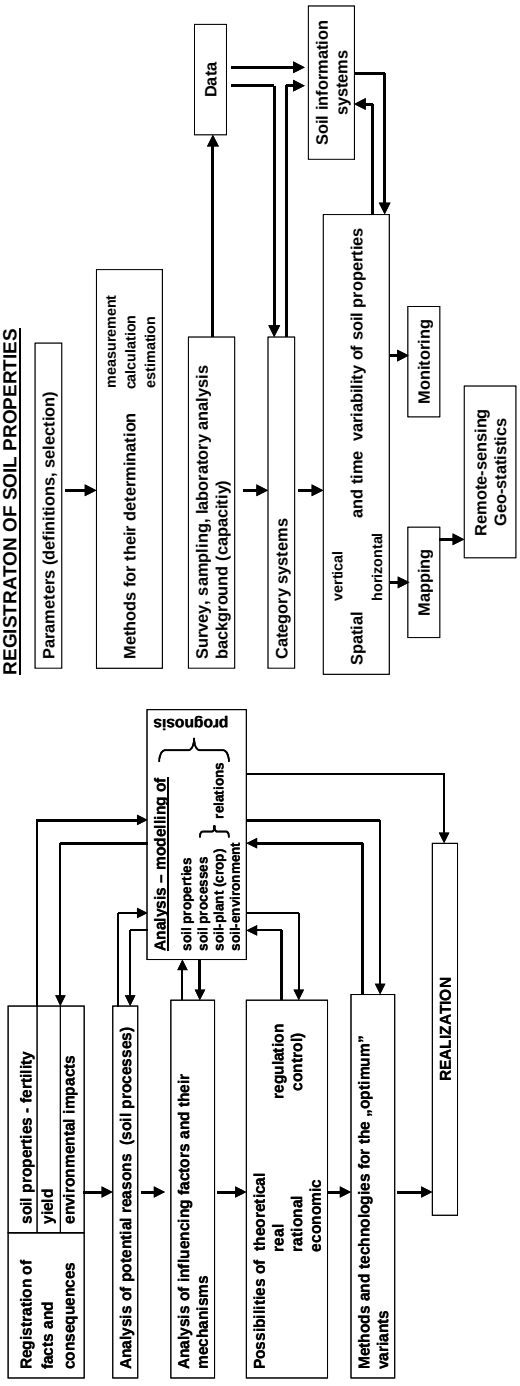

Figure 7. Necessary steps for the control of soil processes

For efficient soil/land degradation control comprehensive, reliable, exact and quantitative **information** are required on the existing and potential degradation processes, on their influencing factors and mechanisms and on their predictable consequences.

The key words in the system are: *prognosis and prevention*, and it should be based on a comprehensive:

– *sensitivity analysis,* evaluating the susceptibility/vulnerability of soils against various soil degradation processes;

– *impact analysis,* evaluating the »positive« and »negative« impacts of various human activities.

In the last years the revolutionary development of in situ and laboratory analytics, remote sensing, informatics, computer technology, GIS/GPS applications, etc. give opportunity for up-to-date database development, including a comprehensive assessment of soil sensitivity/susceptibility/vulnerability against various natural or human-induced stresses (Szabó et al., 1998; Várallyay, 2005a; Várallyay et al., 2010). An example of successful international cooperation in this field was the PHARE-MERA Project. The land degradation mapping methodology involved is summarized in Figure 4.

In Table 1 the main natural and human-induced reasons of the four most significant soil degradation processes and the possibilities of their control are summarized. As most of these processes are closely related to (are reasons and/or consequences of) the field water cycle and soil moisture regime, the aims and methods of their control are presented in Table 2, indicating that most of these »actions« are – at the same time – efficient environment control measures (Láng et al., 2004; Várallyay, 1989, 2006, 2009).

Table 1. The main reasons of soil degradation processes and possibilities of their control

Main reasons		Possibilities of control
Natural factors	Human activities	
1. Soil erosion a) water erosion		
Strong surface runoff - heavy rainfall - steep slope - uncovered surface (lack of permanent dense vegetation) - limited infiltration	- irrational land use, cropping pattern (deforestation, overgrazing, etc.) - too large farming plots - inadequate agriculture	Reduction of surface runoff - reduction of slopes (levelling; terracing: contour ploughing) - establishment of permanent and dense plant cover (rational land use, cropping pattern) - help infiltration (deep-loosening) - surface drainage
Erodability of soil		Reduction of soil erodability (mulching; chemical reclamation; soil conditioning) Proper infrastructure (layout of roads, canals; optimum-size plots)

b) wind erosion		
- strong wind - lack of permanent dense vegetation cover - dry and loose (non-stable) soil surface - lack of good soil structure	- as in part (a) - lack of windbreaks	- forest shelter belts (windbreaks) - establishment of permanent and dense plant cover (rational land use, cropping pattern, crop rotation) - stable soil surface (surface stabilization; irrigation; soil conditioning)
2. Acidification		
- acidic (non-calcareous) parent material - decomposition of plant residues (leading to CO_2, acidic substances - leaching (high precipitation + low water retention)	- acidic depositions, air pollution (urban, industrial, etc.) - improper fertilizer application (form, dosage)	- rational (adequate) fertilization system (form; dosage; Ca fertilizers) - chemical amendments (lime; alkaline substances) - air pollution control
3. Salinization/sodification		
- salt accumulation from local weathering surface subsurface waters seepage - improper drainage vertical horizontal - migration of soil solution	- salt accumulation from: irrigation water groundwater with rising water table due to human activities (unlined canals and reservoirs; poor irrigation practice; improper drainage) applied chemicals (fertilizers, amendments) - alkalization due to applied chemicals	- prevention of salt accumulation good quality irrigation water (on the field) groundwater control (horizontal drainage) - lowering of groundwater - prevention of table rise of saline seep control - amelioration reduction of alkalinity (amendments) $Na^+ \rightarrow Ca^{2+}$ ion exchange - Ca-containing amendments (solubility) - mobilization of soil-Ca acids, acidic materials) leaching (leaching requirements + vertical drainage /deep ploughing horizontal drainage
4. Physical degradation of soils *Structural damage, soil compaction*		
- lack of structure-forming and stabilizing agents: - inorganic and organic colloids - cementing agents - biological components (roots; microbial and earthworm activity) - natural structure destruction - heavy raining - surface runoff, flood, water-logging - chemical properties (e.g. alkalinity, etc.)	- mechanization (heavy machinery; combined operations; overtillage - tillage in improper moisture conditions - poor moisture-control practice - irrigation (intensity; method) - drainage - unfavourable changes in organic matter regime (chemical soil properties; biological degradation; improper recycling; lack of organic fertilizers)	- proper agrotechnics - tillage (time; moisture content; accuracy, »quality" and number of operations) ← technical background - cropping pattern, crop rotation - organic matter recycling - irrigation (moisture regime control) - chemical amelioration (improvement of acidic and salt-affected soils, sands, etc.) - soil conditioning

Table 2. Elements and methods of soil moisture control with their environmental impacts

Elements		Methods	Environ-mental impacts*
Reducing	surface runoff	Increase in the duration of infiltration (moderation of slopes; terracing contour ploughing; establishment of permanent and dense vegetation cover; tillage; improvement of infiltration; soil conservation farming system)	1,1a 5a, 8
	evaporation	Helping infiltration (tillage, deep loosening) Prevention of runoff and seepage, water accumulation	2,4
	feeding of groundwater by filtration losses	Increase in the water storage capacity of soil; moderation of cracking (soil reclamation); surface and subsurface water regulation	5b, 7
	rise of the water table	Minimalization of filtration losses (↑); groundwater regulation (horizontal drainage)	2,3 5b,5c
Increasing	infiltration	Minimalization of surface runoff (tillage practices, deep loosening) (↑)	1,4,5a, 7
	water storage in soil in available form	Increase in the water retention of soil; adequate cropping pattern (crop selection)	4,5b,7
Irrigation		Irrigation; groundwater table regulation	4,5c,7,9,10
Surface Subsurface } drainage		surface subsurface } moisture control (drainage)	1,2,3,5c, 6,7, 11

Favourable environmental effects	Unfavourable environmental effects
Prevention, elimination, limitation or moderation of: – water erosion (1) – sedimentation (1a) – secondary salinization, alkalization (2) – peat formation, waterlogging, overmoistening (3) – drought sensitivity, cracking (4) – plant nutrient losses by: – surface runoff (→ surface waters eutrophication) (5a) – leaching (→ subsurface waters) (5b) – immobilization (5c) – formation of phytotoxic compounds (6) – »biological degradation« (7) – flood hazard (8)	– overmoistening, waterlogging, peat and swamp formation, secondary salinization/ alkalization (9) – leaching of plant nutrients (10) – drought sensitivity (11)

Conclusions

The *control of soil processes* is a challenge to up-to-date soil science for sustainable development: rational land use, proper soil and water management, rural development and environment protection. The maintenance or improvement of the three most important properties of soil (fertility/productivity; resilience; multifunctionality) require continuous actions. This permanent control may *prevent, eliminate* or at least reduce undesirable soil processes and their harmful economical/ecological/environmental/social consequences; and may satisfy the conditions for the »quality maintenance« of this »conditionally renewable« natural resource.

Control – with priorities of *preventive actions* – can be efficient only on the basis of comprehensive database, risk assessment, impact analysis and prognosis.

The measures for the control of soil processes formulated in a modern *Soil Conservation Strategy* are indispensable elements of sustainable development for multipurpose biomass production, for the adaptation to or mitigation of predicted climate change and for environment protection, ensuring »quality life« for each member of the society. Consequently, it requires permanent care and priority attention.

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Sažetak

Kontrola procesa u tlu radi zaštite okoliša

Tri najvažnija »kriterija kvalitete života" su: zdrava i kvalitetna hrana, sigurnost hrane, čista voda, ugodno okružje. Sva tri su usko vezana za održivo korištenje, pravilno gospodarenje i efikasno upravljanje prirodnim resursima: geološki slojevi-tlo-voda-biota-vegetacija-prizemna atmosfera čine kontinuum. Tla su najvažniji uvjetno obnovljivi prirodni resurs Karpatske kotline, s tri jedinstvena svojstva: plodnost/produktivnost, prilagodljivost i multifunkcionalnost. Slijedom toga, racionalno korištenje zemljišta i gospodarenja tlom su neophodni elementi održivog razvoja, uključujući i biomasu za višenamjensko korištenje, ruralni razvoj i zaštitu okoliša. Prirodni uvjeti su uglavnom i relativno povoljni u Panonskoj ravnici, ali pokazuju visoku (i prema prognozama klimatskih promjena sve veću) prostornu i vremensku varijabilnost, nepravilnost (dakle teško predvidljivost), sve češću ekstremnost i osjetljivost reakcije na prirodne ili antropogeno-inducirane stresove. Najznačajnije prijetnje okolišu su procesi degradacije tla, ekstremni hidrološki događaji i nepovoljne promjene biogeokemijskih kruženja elemenata. Njihova pravilna kontrola, formulirana u sveobuhvatnoj **Strategiji Konzervacije Tla,** trebala bi biti *prioritetni* zadatak i za održivi (agrikulturni) razvoj i zaštitu okoliša.

Ključne riječi: održivo gospodarenje tlom, multifunkcionalnost, degradacija tla, ekstremni hidrološki događaji, biogeokemijsko kruženje elemenata

Izvorni znanstevni rad / Original scientific paper

Maize landraces as a natural source of beneficial traits

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Abstract

Maize breeding of today, as well as in the near future, depends upon genetic sources of desirable traits, maintained within existing gene bank germplasm. The MRI maize gene bank has a considerable number of local landraces collected from all agroecological regions of former Yugoslavia, classified according to their morphological traits, origin and evolution into 18 agroecological groups. The entire MRI gene bank landraces collection was evaluated on field testing under severe drought conditions in Egypt, as well as under moderate climate conditions in Zemun Polje and Skopje. After two-year studies of drought tolerance at three locations, a total of 20 ex Yugoslav ladraces were selected as potential source for alleles for drought tolerance. Low phytate maize offers major environmental and nutritional benefits. Analysis of 54 maize landraces was conducted to identify genotypes that had either low or high concentration of phytate. Populations beloging to group Derived flints have the lowest phytate content while populations from group Flinty dents have the highest phytate content. Populations from group Montenegrin flints have the highest average oil content and protein content, and the lowest starch content. Local landraces are natural source of alleles for tolerance to abiotic stress, low antinutritional components content as phytate or a large grains content of proteins, oil or starch that can be used for the infusion with genes of adaptability to particular environment conditions.

Keywords: maize, breeding, landrace, drough tolerance

Introduction

Maize was introduced into Europe at the end of the 15th century and due to different climate needed to adapt to cooler climate condotions. Dissemination from Spain, associated transmission over the old continent from different parts of America, and subsequent maize exploitation during the next five centuries contributed to the establishment of native maize genetic diversity in Europe. Alleles specific to European populations also emerged during adaptation to the local climate and environment (Rebourg *et al*. 2003). The first introduction of maize to the territory of the former Yugoslavia consisted of the flint races. The next introduction of new flint genotypes from Mexico increased the variability of the existing germplasm through crosses with the formely introduced flint types. The new flint race from North America were brought in the thrid introduction wave created local flints of unique genetic

bases, better adapted to cooler conditions. Dent types from North America, especially Corn Belt dent, spreed rapidly after intorduction at the end of 19th century.Contrasting climate, soils, agronomical practices, and breeder's effort created landraces progressively cultivated in favourable regions. After World War Two traditional local maize landraces were progressively replaced by agronomically improved hybrids. At the same time there were efforts to preserve landraces and collections of maize genetic resources were established in different countries. Landraces are considered to be the most significant as they represent original genetic material created by the process of natural selection and adapted to local growing conditions.

The MRI maize gene bank has a considerable number of landraces (2217) collected from all agroecological regions of former Yugoslavia. The accessions are classified according to their morphological traits, origin and evolution into 18 agroecological groups: Montenegrin flints, Bosnian early dents, Kosmet flinty dents, Macedonian flints, Eight rawed corn type of North eastern America, Derived flints, Mediterranean flint, Small-kernelled flints, Eight rowed soft dents, Romanian flints, Large-earted flints, White flinty dents Moravac, Dent type of USA corn belt dents, Derived dents, Dent type of southerneast USA, Serbian dents, Flinty dents, Denty flints (Pavlicic and Trifunovic, 1966; Radovic et al., 2000).

With their reserve of ancestral genes, maize landraces are real sources of genetic diversity and variability for maize improvement programs. Landraces can obtain specific characteristics: tolerance to abiotic and biotic stress, tolerance to herbicides, low antinutritional components content as phytate or a large grains content of proteins, oil or starch with implications in the productions improvement on the whole that can be used for the infusion with genes of adaptability to particular environment conditions.

Expectations of global climate changes for XXI century are towards higher temperatures, greater evapotranspiration and increased appearance of drought. Drought is a multidimensional stress affecting plants as a decrease in photosynthesis and growth (Yordanov *et al*., 2000). Environments under drough stres are characterised by wide fluctuations in precipitation, in quantity and distribution within and across seasons. It is believed that no other environmental factor limits global crop productivity more severely than water deficit (Fischer & Turner, 1978; Boyer, 1982). Drought is one of the most important abiotic stresses that seriously decreases final grain yield in maize. Stress can be alleviated either by management practices or by modifying the plant so that the impact of the causal factor on plant grain yield is reduced (Tollenaar & Wu, 1999). In temperate region, the aim is development of drought tolerant maize hybrids, with stable yields under conditions of the optimum water supply as well as under drought (Frova et al., 1999). **Increased crop production through improvement is expected if the adapted local genotypes possess variability for drought adaptive traits.**

In most commercial agriculture, non-ruminant livestock such as swine and poultry are fed mainly grains such as soybeans and maize. Phytate from these grains is unavailable for absorption, because they lack the digestive enzyme phytase, the unabsorbed phytate passes through the gastrointestinal tract, elevating the amount of phosphorus in the manure. Excess phosphorus excretion can lead to environmental problems such as eutrophication. Many of the problems associated with P in maize grain is due the fact that the most of phosphorus is bound in phytate (Raboy, 2001). Therefore, increasing of amount of available P and reduction the amount of phytate would be desirable. One approach would be to develop a selection program designed to decrease phytate and increase Pi simultaneously. The success depends on the ability to differentiate germplasm by the measurement of traits in a high-throughput, inexpensive, and precise manner that can be incorporated into normal breeding operations.

Among the traits that may add commercial value to maize those related to nutritional quality, specially protein and oil content, are of great interest to the feed industry, as well as starch for industrial purpose, specially bioethanol production. Kernels quality depends on outward factors influenced by the environment, weather, soils, temperature, rainfall as well as the management technology used during crop growth and development aimed to obtain economically sustainable yieldings (Fabrianac *et al*., 2006, Radosavljević and Milašinović, 2008, Harrelson *et al*., 2008, Idikut *et al*., 2009, Raymond *et al*., 2009). The aim of this study was screening of MRI landraces collection and identification of potential sources of favorable traits as drought tolerance, low phytate content, higher protein, oil and starch content.

Material and methods

Preliminary screening for drought tolerance was performed on 2217 landreces from MRI genebank at the Setz station of The Agricultural Research Centre, Egypt. There is no precipitation in the vicinity of the Setz station during the vegetative period and, as far as the water supply is concerned, the only uncontrolled factor is the level of the underground water. The material were estimated visually before harvesting and the best of them were recorded, by scoring staygreen (on the 1-5 scale, where 5 was the highest rate), and total appearance of the genotype (on the 1-8 scale, where 8 was the highest rate). Also, tasseling and silking data of each accession were recorded and their difference (ASI) was calculated. The material was selected on the basis of ASI (4 or less), % of barrenness, % of seed set (80%) and % of grain filing (80%). 167 local population out of 2217 was selected according to reported criteria for the further testing on two locations in moderate climate conditions in Macedonia/Skopje and Sebia/Zemun Polje under rainfed. Accessions were estimated visually before harvesting and the best of them were recorded, by scoring staygreen and total appearance of the accession. Also, tasseling and silking data of each accession were recorded and their difference (ASI) was calculated.

A set of 54 landraces from Maize Research Institute Genebank, was grown in a randomized complete block design (RCBD) with two replications at Zemun Polje. The populations were allowed to open pollinate, and both rows were hand-harvested to estimate yield and collect grain samples. To determine phytate and Pi, the method of Latta and Eskin (1980), modified by Sredojevic (2009) was employed. Kernel oil, protein, and starch concentrations were measured as percentage using Infratec 1241 Grain analyzer, (Foss Tecator, Sweden) and reported as percent (%).

Results and disscussion

Usually, studies of drought tolerance are performed in the managed stress environments (MSE). These locations have little or no precipitation at all during the growing season and maize is supplied by water only through irrigation. Selection based on performance in multi-environment trials (MET) has increased grain yield under drought through increased yield potential and kernel set, rapid silk exertion, and reduced barrenness, though at a lower rate than under optimal conditions. Maize is most susceptible to stress at flowering, when silk growth, pollination, and kernel set occur. Water stress slows ear growth, and consequently silk emergence, more than tassel growth or anthesis, resulting in a widening interval between anthesis and silking (ASI). According to the result of this investigation 20 ex Yugoslav landraces were selected on the basis of previously observed traits including ear, cob and kernel weight (Table 1 and 2).

ASI varied between 0 to 4 in both locations. Population 2101 has ASI 0 in Skopje and 1 in Zemun Polje. Yield, under stress at flowering, shows a strong dependency on kernel number per plant, barreness and ASI in tropical maize (Bolanos and Edmeades, 1996). Population 2217 has the highest kernel weight and no barren plant in location Skopje as well high kernel weight and 1 barren plant in location Zemun Polje. Chosen genotypes will serve as genetic pool in establishing *core* collection for drought tolerance and will be used in maize breeding programs.

Genetic variability in phytate contents of 54 landraces was observed, with values ranging from 1,147 (216) to 4,13(641) and averaged 2,91 g kg-1, (Table 3). Populations beloging to group Derivate flint have the lowest phytate content (1,95) while populations from group Flinty dents have the highest phytate content (3,43).

Table 1. The most drought tolerant maize landraces tested in Skoplje

No.	ASI	No.plant	No barren plants	Ear no.	% seed set	% grain filing	Ear weight	Cob weight	Kernal weight
10	0	12	4	8	90	80	0,23	0,08	0,15
13	2	18	0	19	100	100	0,79	0,14	0,65
104	0	20	0	21	95	95	0,96	0,20	0,75
1961	1	19	1	18	95	95	1,52	0,30	1,21
2033	1	20	1	19	95	95	1,84	0,37	1,47
2101	0	19	1	18	100	100	0,92	0,16	0,75
2228	2	20	3	17	100	100	1,37	0,29	1,08
2236	1	17	2	15	80	90	1,41	0,38	1,03
169	2	15	0	15	90	90	0,69	0,16	0,52
87	3	17	3	14	80	70	0,71	0,2	0,51
244	4	16	2	14	75	80	0,39	0,36	0,03
632	3	18	0	18	95	90	1,69	0,35	1,34
1513	3	15	0	15	90	90	1,49	0,37	1,11
1720	1	18	0	18	95	95	1,50	0,29	1,21
2005	4	13	5	8	70	75	0,87	0,28	0,59
2006	3	15	0	16	100	90	1,59	0,34	1,25
2012	3	12	1	11	90	90	0,83	0,17	0,66
2013	2	18	0	18	85	80	1,84	0,34	1,50
2217	3	18	0	21	95	95	2,94	0,65	2,28
1855	3	11	0	12	95	95	1,62	0,41	1,20

Populations from group Mediterranean flint have the lowest Pi content (0,46) and populations from group Dent type of southerneast USA, (0,82) the highest. Pi concentration varies between 0,27 in landrace 770, beloging group Flinty dents and 1,10 in landrace 262, from group Dent type of southerneast USA and averaged 0,63 g kg-1. The lower genetic variability in phytate content, in relation to Pi, was in accordance with results of Lorenz *et al* (2008) and Vancetovic *et al* (2010). Population 216 was determined to have the lowest phytate concentration of 1,14 g kg-1, a Pi concentration 30% greater than Pi mean. Population 216 will be used for further breeding genotypes with low phytate content and good agronomic traits. Dent type landraces have a little bit lower phytate content (3,0) and higher Pi content (0,66) than

flint type landraces 3,03 and 0,63, respectively. Because this study included only one environment, we can make only limited conclusions on the relative performance of these populations.

The protein, oil and starch content varies according to genotype (Lorenz *et al*., 2007, Drinic *et al*., 2009) and group (Table 3). The protein content ranged from 10,10 (376) to 14,85% (558), averaged 12,34%. The avaraged protein content were different beetween groups. The highest average protein content, 14.05%, has populations from group Montenegrin flints and the lowest one populations from group Derived dents (10,75%). Twenty six population has higer protein content than average. Landraces belonging to flint types have higher protein content than landraces of dents type. Populations have oil content between 3,30% (902) and 5,3% (891, 914), averaged 4,21%. Populations from groups Montenegrin flints and Macedonian flints have the highest average and second highest average oil content, 4,8% and 4,75%, respectively. The lowest average oil content has popualtions from group Large-earted flints, 3,63%. Twenty one populations have oil content higher than average. Flints has higher oil content than oil content of dents type.The starch is the largest single components in maize grain and the primary energy source. The starch content of maize landraces ranged from 66,35% (909) to 71,50% (190), averaged 68,61%. Twenthy one popualtion had starch content higher than average. The lowest one had populations from group Montenegrin flints, 67,53% and the highest populations from group Derived flints, 70,43%. It can be said that many tested landraces show an exceptional kernel quality based on their oil, protein and starch content, which makes them more than suitable to be used for futher breeding improvment programs.

Table 2. The most drought tolerant maize landraces tested in Zemun polje

No.	ASI	no. plant	no.barren plants	Ear no.	% seed set	% grain filing	Ear weight	Cob weight	Kernal weight
10	2	19	2	15	0	0	0,48	0,08	0,40
13	2	18	2	15	0	escape	0,68	0,09	0,59
104	1	19	3	19	100	100	1,13	0,17	0,96
1961	1	19	3	17	0	0	1,30	0,22	1,08
2033	3	20	1	18	100	100	1,96	0,33	1,63
2101	1	20	0	21	escape	escape	1,40	0,15	1,24
2228	1	19	0	19	100	100	2,13	0,31	1,82
2236	2	20	0	20	95	100	2,76	0,47	2,29
169	1	20	4	17	0	0	1,29	0,19	1,10
87	0	21	2	20	95	100	2,02	0,46	1,56
244	4	20	5	17	0	0	1,85	0,29	1,56
632	3	20	3	16	-	0	1,83	0,30	1,53
1513	1	20	2	17	95	100	1,69	0,27	1,42
1720	1	19	2	20	90	100	2,15	0,35	1,80
2005	2	20	1	19	90	85	2,41	0,47	1,94
2006	1	19	1	18	100	100	2,13	0,31	1,82
2012	1	17	3	14	100	100	1,63	0,25	1,38
2013	1	20	2	17	90	100	2,06	0,30	1,76
2217	1	19	3	17	90	100	2,38	0,46	1,92
1855	4	17	5	15	90	100	1,95	0,33	1,62

Table 3. The variation of phytate, Pi content, protein, oil and starch content of 54 landraces

Group and population No ()	Pi gkg-1	Phytate gkg-1	oil	proteins	strach
Montenegrin flints (4)	0,984	2,609	4,80	13,05	67,75
Montenegrin flints (20)	0,568	2,564	4,60	14,50	67,45
Montenegrin flints (408)	0,622	3,363	4,80	14,60	67,40
Montenegrin flints (average)	**0,724**	**2,845**	**4,73**	**14,05**	**67,53**
Bosnian early dents (128)	0,693	2,69	4,40	12,55	67,80
Bosnian early dents (477)	0,831	3,376	4,10	12,40	69,30
Bosnian early dents (485)	0,669	3,407	4,40	11,15	69,80
Bosnian early dents (average)	**0,731**	**3,157**	**4,30**	**12,03**	**68,96**
Kosmet flinty dents (33)	0,746	3,291	4,05	14,60	67,10
Kosmet flinty dents (419)	0,348	4,138	4,25	13,50	68,10
Kosmet flinty dents (641)	0,690	2,502	4,45	12,80	68,80
Kosmet flinty dents (average)	**0,594**	**3,310**	**4,25**	**13,63**	**68,00**
Macedonian flints (103)	0,752	2,717	4,95	12,35	68,75
Macedonian flints (588)	0,586	3,170	4,00	13,00	68,80
Macedonian flints (891)	0,450	3,705	5,30	13,80	67,25
Macedonian flints (average)	**0,596**	**3,197**	**4,75**	**13,05**	**68,26**
Eight rawed corn type of NE America (132)	0,727	1,780	4,40	11,80	69,60
Eight rawed corn type of NE America (606)	0,658	3,520	4,20	12,20	68,60
Eight rawed corn type of NE America (785)	0,412	2,924	4,05	13,35	68,25
Eightrow corn type of NE America (average)	**0,599**	**2,741**	**4,22**	**12,45**	**68,81**
Derived flints (79)	0,565	2,591	4,75	12,80	68,85
Derived flints (186)	0,736	1,698	4,15	10,90	70,95
Derived flints (190)	0,963	1,573	3,40	10,65	71,50
Derived flints (average)	**0,7547**	**1,954**	**4,10**	**11,45**	**70,43**
Mediterranean flint (850)	0,576	3,211	4,55	11,60	69,35
Mediterranean flint (902)	0,377	3,195	3,30	12,55	68,55
Mediterranean flint (921)	0,433	3,06	3,55	11,70	68,95
Mediterranean flint (average)	**0,462**	**3,153**	**3,80**	**11,95**	**68,95**
Small-kernelled flints (121)	0,755	2,685	3,95	13,65	69,00
Small-kernelled flints (558)	0,473	3,492	4,90	14,85	66,65
Small-kernelled flints (900)	0,686	3,436	4,75	12,55	68,25
Small-kernelled flints (average)	**0,638**	**3,204**	**4,53**	**13,68**	**67,96**
Eight rowed soft dents (754)	0,505	2,754	3,85	12,05	68,80
Eight rowed soft dents (794)	0,709	2,893	4,50	13,15	68,60
Eight rowed soft dents (807)	0,572	3,001	3,90	12,40	69,05
Eight rowed soft dents (average)	**0,595**	**2,882**	**4,08**	**12,53**	**68,82**
Romanian flints (676)	0,557	2,64	3,75	11,45	67,85
Romanian flints (690)	0,806	4,058	3,55	12,45	67,00
Romanian flints (692)	0,638	3,461	3,60	12,25	68,50
Romanian flints (average)	**0,667**	**3,386**	**3,63**	**12,05**	**67,78**

Large-earted flints (138)	0,77	1,488	3,85	12,10	69,25
Large-earted flints (832)	0,598	3,297	3,65	12,00	69,10
Large-earted flints (984)	0,366	3,132	3,85	10,30	70,40
Large-earted flints (average)	**0,578**	**2,639**	**3,78**	**11,46**	**69,58**
White flinty dents Moravac (90)	0,608	2,681	4,70	11,65	68,80
White flinty dents Moravac (802)	0,692	2,646	3,65	12,40	70,25
White flinty dents Moravac (887)	0,738	3,086	4,15	11,25	67,55
White flinty dents Moravac (average)	**0,679**	**2,804**	**4,16**	**11,77**	**68,87**
Dent type of USA corn belt dents (216)	0,868	1,147	4,00	11,55	69,65
Dent type of USA corn belt dents (268)	0,678	1,734	4,30	10,25	70,85
Dent type of USA corn belt dents (559)	0,626	3,174	4,65	13,00	66,75
Dent type of USA corn belt dents (average)	**0,724**	**2,018**	**4,32**	**11,60**	**69,08**
Derived dents (376)	0,856	3,686	4,30	10,10	69,55
Derived dents (965)	0,508	3,195	4,05	11,55	68,20
Derived dents (968)	0,638	3,334	3,80	10,60	70,60
Derived dents (average)	**0,667**	**3,405**	**4,05**	**10,75**	**69,45**
Dent type of southerneast USA (909)	1,103	1,497	3,90	12,75	66,35
Dent type of southerneast USA (914)	0,610	3,285	5,30	10,85	68,30
Dent type of southerneast USA (262)	0,749	3,177	4,45	12,55	68,85
Dent type of southerneast USA (average)	**0,820**	**2,653**	**4,55**	**12,05**	**67,83**
Serbian dents (280)	0,749	1,492	4,35	11,05	68,35
Serbian dents (674)	0,522	3,187	3,60	11,45	66,85
Serbian dents (710)	0,607	2,817	3,40	12,90	68,75
Serbian dents (average)	**0,626**	**2,498**	**3,78**	**11,80**	**67,98**
Flinty dents (399)	0,486	4,013	4,85	13,80	67,30
Flinty dents (770)	0,273	2,978	4,15	12,15	70,15
Flinty dents (826)	0,643	3,288	4,60	14,05	66,55
Flinty dents (average)	**0,467**	**3,426**	**4,53**	**13,33**	**68,00**
Denty flints (707)	0,464	3,403	4,80	13,10	67,80
Denty flints (709)	0,484	2,969	3,75	10,55	71,10
Denty flints (937)	0,500	3,020	4,25	13,70	67,30
Denty flints (average)	**0,506**	**3,130**	**4,27**	**12,45**	**68,73**

Conclusion

The studied landraces have shown a significant difference according analyzed traits. Twenty most drought tolerant landraces were selected for futher breeding programme aimed to broaden the genetic base of the elite breeding material. European landraces could be a source of variability for the objectives of diversification and preservation of environment: source of drought tolerance, low phytate, grain quality. The landraces are valuable autochthonous source of potentially useful traits and allels for improvment of the exisitng modern varieties.

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Sažetak

Sorte kukuruza kao prirodni izvor željenih nasljednih svojstava

Oplemenjivanje kukuruza danas, kao i u bliskoj budućnosti, ovisi o genetskim izvorima poželjnih svojstava, održavanih kroz postojeće gen-banke germplazme. MRI banka gena kukuruza ima znatan broj lokalnih sorti skupljenih iz svih agroekoloških regija bivše Jugoslavije, klasificiranih u skladu s njihovim morfološkim svojstvima, podrijetlu i evoluciji u 18 agroekoloških grupa. Cijela kolekcija sorti u MRI gen-banci bila je ocijenjena u poljskim pokusima u izraženoj suši u Egiptu, kao i u umjerenom klimatu Zemun-Polja i Skopja. Nakon dvogodišnjih istraživanja otpornosti na sušu na tri lokaliteta, ukupno 20 sorti s prostora bivše Jugoslavije bilo je odabrano kao potencijalni izvor alela za tolerantnost na sušu. Kukuruz s niskim fitatima nudi glavne okolišne i nutritivne pogodnosti. Analiza 54 sorte kukuruza provedena je da bi se identificiralo genotipe koji su imali niske ili visoke koncentracije fitata. Populacije koje su pripadale grupi izvedenih tvrdunaca imale su najniži sadržaj fitata, dok su populacije iz grupa poluzubana imale najviši sadržaj fitata. Populacije iz grupe crnogorskih tvrdunaca imale su najviši prosječni sadržaj ulja i bjelančevina, te najniži sadržaj škroba. Lokalne sorte su prirodni izvor alela za toleranciju na abiotske stresove, sadržaj niskih nehranjivih komponenti kao što su fitati ili veliki sadržaj bjelančevina u zrnu, ulja ili škroba koji mogu biti korišteni za infuziju gena za adaptibilnost određenim uvjetima okoliša.

Ključne riječi: kukuruz, oplemenjivanje, sorte, tolerantnost na sušu

Izvorni znanstveni rad / Original scientific paper

The effect of a plant arrangement pattern and hybrids on weediness of a maize and soya bean intercropping system

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Abstract

The maize and soya bean intercropping resulted in the decrease in parameters of weediness, especially in the number of perennial weed species and fresh biomass per area unit. The intercropping system in alternate rows expressed greater efficiency in weed control (number of species, number of plants per species and weed biomass) in comparison to both, the intercropping system in strips and maize monocorps. In soya bean, both intercropping systems were more advantageous than soya bean monocrops. The smallest number and the lowest biomass of weeds in the summer aspect were recorded in the latest maturity hybrid (FAO 700), not only in monocrops, but also in intercrops. Differences in numbers of weed plants per species, as well as in fresh and air dried weed biomass observed among maize hybrids were not statistically significant. In the two years of investigation (2004 and 2005), the plant arrangement pattern in strips was more efficient in relation to the alternate rows. Intercropping affected more favourably maize than soya bean crops in which, the positive effect was the most observable in 2005, especially in strips and it mainly related to the number of weed plants per species.

Key words: maize, soya bean, intercrops, monocrops, weeds

Introduction

Maize weed community in Serbia is very rich in species and according to many surveys it amounts to over 150 species. Weed in soya bean is lower than in maize, but it is important that the common types of weeds, are regular followers of both interrow crops. One of the advantages of intercropping system of these two crops in crop production is better and more successful control of weeds, especially the perennial ones. Reducing the number and weight of weeds in intercropping by comparison with monocrops of maize and soya bean, was expressed in spring (Dolijanović et al., 2008), but much more in the summer aspect of the weed community, owing to the increased cover of soil and higher competitive ability of crop plants (Dolijanović et al., 2007a). Wilson, 1988., believes that in organic production after the critical period, weeds do not have to cause direct damage to crops, but they do make seeds, thus increasing the potential infestation by leaving seed reserves in the soil. This, of course, affects the economic characteristics of this production, because chemical substances for weed

control (herbicides) are often very expensive. Hence the great interest in methods of weed control that allow the reduction of pesticide use, non-chemical methods, organic production, intercropping (Vandermeer, 1989), as well as the use of genetically modified crops tolerant to herbicides. Of course, the efficacy of different methods of weed control can be improved by understanding the mechanisms of competition between plants (Dolijanović, 2008). While earlier research focused on the calculation of yield loss as a result of weed competition, more modern approaches relating to the management of the processes of competition among plant species, using a broad knowledge within the environmental science and biology.

Depending on the density of breeding, development of habitat and coverability, changing external field crops and soil conditions, water and light regime in the soil, thus creating a specific fitomicroclimate (Dolijanović, 2008). Resulting microclimate changes affect the differences in the structure and floristic composition of weed communities of individual crops depending on the method of cultivation and selection of hybrids. In previous studies, Dolijanović et al., 2007a showed that the presence of a small number of weeds in intercropping maize and soya bean in relation to their monocrops, especially during the summer aspect.

The intercropping system, as a true non-chemical method, is one possibility of reducing the problems with weeds (Baumann et al., 2001). These authors have found that intercrops of leek and celery result in a significant increase in light interception compared to monocrops of these cultures, and thus in a significant decrease of the competitive impact of weeds in the system of intercrops. The increase in light interception in intercropping reflects faster, horizontal growth of leaf area, increasing the coverage and competition towards weeds, particularly in relation to the leek.

They tracked the biomass of the weed *Senecio vulgaris* L. in intercropping and monocrops of leek and celery, on the 38th day after the planting of this weed in the crops of celery and leek as well as on the 90th after the establishing of the crop. The resulting biomass was the highest in leek monocrop and the lowest in the intercrops in the beginning, and later in the monocrop of celery. This is particularly important in the later period of vegetation and reduction of weeds in the summer aspect. However, the alleged interception of light, and competition with weeds in intercropping depends on other factors, primarily on water and nutrients in the soil.

Examining the influence of plant density of wheat and legumes in intercropping on weediness, Bulson et al., 1997 have stated the presence of the following weed species: *Fumaria officinalis, Ranunculus repens, Rumex spp, Cirsium arvense, Papaver rhoeas, Polygonum persicaria, Galium aparine, Poa annua, Poa trivialis* and *Elymus repens*. Regarding the biomass of weeds (g/m^2) in intercropping, it decreased with increasing density of wheat and legumes. In addition to plant density, important factors in competition of mixed crops and weeds are the relative ratio of the mixture of species and their spatial distribution. Other factors, such as hybrids / varieties, production characteristics of the soil, water regime, diseases and pests also have an important role in explaining the competition of crops and weeds.

In addition to the numerous advantages of such systems of breeding, farmers usually opt for pure breeding of crops, primarily due to the fact that small opportunities for improvement, especially in high technology and machinery are designed mainly for monocrops.

The aim of this study is to determine the effect of intercropping maize and soya bean in alternate rows and strips of weed infestation in the summer aspect of the monocrops of these species. It is also important to determine which of the tested hybrids (FAO 500, 600 or 700) most favourably influence the number and mass of weeds, both in the intercrops and monocrops.

Material and Methods

Two-year trials were carried out on chernozem in the experiment field of the Maize Research Institute, Zemun Polje, in the vicinity of Belgrade. The four-replicate plot was set up according to the randomised block design. The elementary plot size amounted to 21 m^2. The following factors were included into the studies performed under rainfed conditions: **(A)** - Spatial maize-soya bean intercrop patterns: alternate rows (A_1) and strips (A_2) and **(B)** - experimental prolific maize hybrids of different maturity groups: EPH2-FAO 500 (B_1), EPH4-FAO 600 (B_2) and EPH11-FAO 700 (B_3).

Soya bean cultivar Nena (II maturity group) were used as materials. The additive series intercropping system was applied. The distance spacing between maize and soya bean rows was 70 cm. The distance spacing between maize plants in the row was 40 cm (monocrops) and 20 cm (intercrops), while the corresponding distances in soya bean were 3.60 cm and 1.80 cm. Hence, the plant density in monocrops and intercrops amounted to 35.962 maize plants ha^{-1} and 400.000 soya bean plants ha^{-1}.

Winter wheat was a preceding crop. After wheat harvest, stubbles were shallow ploughed down to the depth of 10 cm. Fertilising with NPK fertilisers was done in autumn prior to primary tillage (ploughing) that was performed to the depth of approximately 25 cm. Each year, a total of 500-600 kg NPK fertilisers (16:16:16 or 15:15:15) per hectare (approximately 80 kg a.i. N, P_2O_5 and K_2O) was incorporated in the soil. Spring seedbed preparation was done by a combined implement - a seedbed conditioner, 10-15 days prior to sowing. Furthermore, each year, a total of 200 kg Urea per hectare (approximately 90 kg a.i. N) was incorporated with the seedbed preparation. Both crops, maize and soya bean, were sown by hand: on April 22, 2004, i.e. on April 28, 2005.

The number of species, the number of plants per species, fresh and air dried weed biomass in monocrops and maize-soya bean intercrops were analysed in this study. All stated parameters in weeds were determined by the one square meter area method. The weed infestation estimation was performed on July 13-14, 2004 and June 30, 2005. The estimation time was determined on the basis of the actual crop performance that was particularly affected by weather conditions during the years of investigation. Following the estimation, hoeing was done with the aim of suppressing the weeds in monocrops and intercrops.

Obtained data were statistically processed by the analysis of variance, in which plant arrangement patterns and hybrids were factors, while LSD test was applied for the individual comparisons.

Meteorological conditions

Table 1 presents the basic meteorological data of the wider region during the trial performance in 2004 and 2005. The first year of investigation sufficient precipitation amounts, their favourable distribution and optimal air temperatures characterised the year 2004. That is why in this year a greater number of individuals was established but a smaller number of species and lower weight of weeds compared to the year of 2005, both in the intercrops and monocrops of maize and soya bean. The second year of study, regarding the meteorological conditions, was similar to the previous one and the difference was in slightly lower air temperatures at the beginning of the growing season of the crop species and increased rainfall in August, which had a negative impact on yield, but not on the weediness of maize and soya bean.

Table 1. Meteorological conditions in Zemun Polje during the period of investigation

Month	Temperature (°C)		Precipitation (mm)	
	2004	2005	2004	2005
March	8,1	6,0	18,4	32
April	13,5	13,1	69	53
May	16,2	17,7	62,8	48
June	20,7	20,2	107,1	94
July	23,0	22,9	93,7	90
August	22,3	21,4	88,1	145
September	17,7	18,9	45,8	56
Average-Sum	17,4	17,2	484,9	518

Results and discussion

Representative conclusions about the effects of spatial pattern arrangements of plants and various maize hybrids on the number of species and specimens, fresh and air dried weight of weeds in monocrops and intercrops of maize and soya bean are obtained by the insight into the results shown in Tables 2, 3 and 4.

Unlike the weediness of intercrops and monocrops in the spring aspect (Dolijanović et al., 2008), summer aspect of maize and soya bean weed communities is significantly poorer in species, which was also found by Momirović et al., 1997, Milena Simic, 2003. This aspect is fully developed after the application of cultural practices (hoeing in this case) and after closing the row and forming of the characteristic pattern of crops. The most abundant weed species in the summer aspect of monocrops and intercrops of maize and soya bean were *Sorghum halepense* L. Pers., *Solanum nigrum* L. and *Amaranthus retroflexus* L., and significant places in weed synusia were taken up by *Amaranthus albus* L., *Datura stramonium* L., *Convolvulus arvensis* L., *Chenopodium hybridum* L, and *Hibiscus trionum* L. The greatest number of species in monocrops and intercropping was declared in maize hybrids FAO 700, but among the species present in the hybrids, the least was occupied by perennial species. Only two perennial species were noted in soya bean monocrops, but due to their significant development in this crop, received fresh weight of weeds was higher compared to all the monocrops of maize. A number of species and weed plants, and lower fresh weight of weeds in crops was declared maize monocrops in 2004, while in 2005, all the parameters had higher values for weeds in soya bean crops.

The greatest number of weed species was declared in intercropping in 2005, and most weed plants and the highest fresh weight of weeds, both in monocrops and intercropping, owing to favourable weather conditions in 2004. Thus, favorable meteorological conditions are suitable for growth and development, both endangered, and all other species in agrofitocenosys.

Table 2. Weediness of maize - and soya bean monocrops (summer aspect)

Weed parameters	2004				
	B_1	B_2	B_3	Average	Soya bean
Number of weed species	11	10	11	**10.7**	10
Number of weed plants per species	29.50	27.0	27.0	**27.8**	26.8
Number of annual weeds	7	6	7	**6.7**	8
Number of perennial weeds	4	4	3	**3.7**	2
Weed fresh weight (g)	1925.0	1945.0	1805.0	**1891.7**	2285.0
Air dry weight (g)	508.4	567.4	501.1	**525.6**	718.3
	2005				
Number of weed species	10	11	9	**10**	15
Number of weed plants per species	12.2	14.8	13.3	**13.4**	17.0
Number of annual weeds	7	8	7	**7.3**	12
Number of perennial weeds	3	3	2	**2.7**	3
Weed fresh weight (g)	326.9	420.3	391.1	**379.4**	450.2
Air dry weight (g)	73.2	98.3	91.9	**87.8**	107.8

B_1-FAO 500, B_2-FAO 600, B_3-FAO 700.

The intercropping system in 2005, based on data on weeds in Tables 2 and 3, led to the decrease in number of species, the number and fresh weight of weeds per unit area compared to monocrops of maize and soybeans. And if given differences, by analysis of the maize crops, are not statistically significant, this decrease of weed parameters certainly has an impact on growth and development of maize and soya bean (Table 4). Observing specifically intercropping systems, very small differences can be noticed in view of measured parameters of weeds. Statistical analysis also revealed that regarding tested hybrids, the number of weeds, the hybrid FAO 700 was the best, and in terms of weight of the weed, it was the hybrid FAO 600th. This statement is consistent with the previous studies that these two hybrids have an advantage over the hybrids FAO 400 and 500 (Dolijanović et al., 2006., Dolijanović et al., 2007b).

Differences in measured parameters of weediness depending on the weed hybrids were not statistically significant for both crops, which is the logical consequence of similar morphological characteristics of hybrids of FAO groups 500, 600 and 700 (Table 4).

Observing the two spatial arrangements pattern in intercropping in both years, based on data in Table 3, we see a number of weed species, weed plants and especially higher values in the fresh weight of weeds in the strip in relation to the alternate rows. Thus, the intercropping system in alternate rows is more favorable in terms of reducing the number of species, number of individuals, especially in terms of fresh weight of weeds.

Table 3. Effects of plant arrangement pattern and hybrids on weedines of maize-soya bean intercrops (summer aspect)

Weed parameters	2004							
	A_1				A_2			
	B_1	B_2	B_3	Average	B_1	B_2	B_3	Average
Number of weed species	10	10	11	**10.3**	13	10	12	**11.7**
Number of weed plants per species	26.0	27.5	25.8	**26.4**	28.5	33.8	38.8	**33.7**
Number of annual weeds	8	8	8	**8**	9	8	10	**9**
Number of perennial weeds	2	2	3	**2.3**	4	2	2	**2.7**
Weed fresh weight (g)	1875.0	1810.0	1905.0	**1863.3**	2190.0	1950.0	2430.0	**2190.0**
Air dry weight (g)	536.3	427.9	539.4	**501.2**	648.9	580.1	663.2	**630.7**
	2005							
Number of weed species	11	12	11	**11.3**	12	11	13	**12**
Number of weed plants per species	12.8	13.0	12.2	**12.7**	14.8	12.5	12.0	**13.1**
Number of annual weeds	8	10	8	**8.7**	9	7	10	**8.7**
Number of perennial weeds	3	3	3	**3**	3	4	3	**3.3**
Weed fresh weight (g)	349.5	334.6	281.2	**321.8**	339.8	271.0	369.8	**326.9**
Air dry weight (g)	85.6	76.1	60.9	**74.2**	74.9	60.3	90.6	**75.3**

A_1-alternate rows, A_2- strips

Table 4. Statistical analysis of observed weed parameters in maize and soya bean (p level)

Crops	Year	Number of weed plants per species		Weed fresh weight (g)		Air dry weight (g)	
		A	B	A	B	A	B
Maize	2004	0.112	0.779	0.331	0.827	0.195	0.814
	2005	0.858	0.773	0.468	0.985	0.526	0.964
Soya bean	2004	0.064	0.596	0.158	0.693	0.0056	0.514
	2005	0.0003	0.571	0.0164	0.838	0.030	0.835

$p<0.01$ very significant (**); $p<0.05$ significant (*); $p>0.05$ no significant (ns);

By statistical analysis of the results using the F test, a certain difference was found between the analysis of maize and soya bean crops (Table 4). In fact, when analyzing the maize crop, we note that none of the studied factors (plant arrangement pattern and hybrids) did not achieve a statistically significant effect on the studied parameters of weeds, whereas in soya bean, tested weeds parameters significantly changed under the influence of plant arrangement pattern, especially in the second research year. These differences are the result of large differences in the examined parameters between soya bean monocrops and intercrops studied, and significant influence of maize in intercropping on the decrease of the number and particularly the weight of weeds. This confirms the earlier mentioned fact that the efficiency of intercrops in terms of the number of weed species is not significant, but is larger and more significant in terms of number of weed plants and their fresh weight, which is, considering competition for essential growth factors, important.

Literature data on the activities of intercrops to control weeds is of a small scale. For example, Ayeni et al., 1984. state that during the study in Nigeria they found that intercropping of maize and pea failed to significantly reduce the infestation in earlier phases of vegetation, and later it did. Liebman, 1986, states that the effect of intercrops on weed control generally has an advantage compared to monocrops of individual components in the mixture. Increasing the number of plants per unit area, as in intercropping, leads to a reduction in the biomass of weeds (Bulson et al, 1997).

Conclusion

Based on results obtained effects of the plant arrangement pattern and maize hybrids on weed infestation of intercrops and monocrops of maize and soya bean grown on chernozem under rainfed conditions, the following can be concluded:

The weed community was composed of a relatively small number of weed species – 10.7 (maize) and 10 (soya bean) in monocrops and eleven in intercrops in 2004, and 10 and 15 in monocrops and 11.3 in intercrops in 2005. Dominant species that determined the community were as follows: annuals - *Solanum nigrum* L. and *Amaranthus retroflexus* L. and perennials - *Sorghum halepense* L. Pers. and *Convolvulus arvensis* L.

The intercropping system in alternate rows expressed greater efficiency in weed control (number of species, number of plants per species and weed biomass) in comparison to both, the intercropping system in strips and maize monocrops. In soya bean, both intercropping systems were more advantageous than soya bean monocrops.

Differences in the number of weed plants per species, as well as in fresh and air dried weed biomass obtained among observed maize hybrids were not statistically significant.

The system of maize-soya bean intercrops under rainfed conditions expressed significant advantage in weed control particularly in troublesome perennial species in relation to maize and soya bean monocrops.

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Sažetak

Utjecaj rasporeda unutar sklopa i hibrida na zakorovljenost kukuruza i soje u združenom uzgoju

Združeni uzgoj kukuruza i soje rezultira smanjenjem parametara zakorovljenosti, posebno u broju višegodišnjih korovnih vrsta i svježe biomase po površini. Združeni uzgoj u naizmjeničnim redovima daje veću efikasnost u kontroli korova (broj vrsta, broj biljaka iste vrste i biomasa korova) u usporedbi sa združenim uzgojem u trakama i samostalnoj sjetvi kukuruza. U slučaju soje, oba sustava združenog uzgoja bila su bolja od samostalne sjetve soje. Najmanja brojnost i najniža biomasa korova tijekom ljeta bila je zabilježena kod hibrida najduže vegetacije (FAO 700), ne samo u samostalnoj sjetvi, nego i kod svih združenih usjeva. Razlike u broju korova u svakoj vrsti, kao i u svježoj i suhoj biomasi korova zabilježenoj kod različitih hibrida nije bila statistički značajna. U dvije godine istraživanja (2004 i 2005), prostorni raspored usjeva u trake bio je učinkovitiji nego izmjenični redovi. Združeni uzgoj imao je bolje učinke na kukuruz nego soju, kod koje su pozitivni učinci bili vidljiviji 2005. godine, posebno u trakama, te su se uglavnom odnosili na broj korova unutar vrste.

Ključne riječi: kukuruz, soja, združena sjetva, sjetva samostalne kulture, korovi

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Maize hybrids productivity under different spatial arrangements

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Abstract

The more favourable sowing pattern provided by closer rows enhances a maize growth rate that led to a higher radiation use efficiency and a greater grain yield. The three maize hybrids of different maturity groups were grown in three spatial arrangements with and without herbicide application, during 2005-06 at Zemun Polje, Belgrade, Serbia. The aim was to estimate if the different spatial arrangements of maize plants in a combination with the herbicide application influenced the hybrids height, aboveground biomass productivity and the grain yield. The highest plant height, as well as, the aboveground biomass productivity, on the average for all observed hybrids, were achieved in the spatial arrangement of the inter-row distance of 50 cm x the distance between the plants in the row of 35 cm (SP2). The grain yield of studied maize hybrids did not significantly differ over spatial arrangements during the years of investigation. Recently developed hybrids better respond to changes in spatial arrangements of plants. The higher values of the plant height, productivity and the grain yield of studied hybrids were recorded when herbicides were applied in the recommended rate and half the recommended rate than in the untreated control. Growing maize hybrids in the adequate plant pattern and with the application of herbicides at lower rates provides the advantage to the crop over weeds with the simultaneous environmental protection.

Key words: maize, spatial arrangements, competition, biomass productivity, yield

Introduction

The possibility of maize growing in the altered spatial arrangement, first of all. the decreased inter-row distance is considered together with the development of new generations of hybrids that can be grown in greater densities. Decreasing the distance between neighbouring rows at any particular plant population has several potential advantages. It reduces competition among plants within rows for light, water and nutrients due to a more equidistant plant arrangement (Olson and Sander, 1988; Porter et al., 1997). The more favourable sowing pattern provided by closer rows enhances the maize growth rate early in the season (Bullock et al., 1988), leading to a better interception of sunlight, a higher radiation use efficiency and a grea-

ter grain yield (Westgate et al., 1997). Sunlight penetration to the soil surface was the greatest in the hybrid ZP 578, as a result of the smallest index leaf angle (Radenović et al., 2008).

The long-term studies carried out in the USA show that the further yield increase in maize can be more easily achieved by increasing the number of plants per area unit than by increasing the yield per plant. In regard to this, new generations of maize hybrids are characterised by better ability of plants to be grown in a denser stand, as they were selected under such conditions. The higher density results in the appearance modification of the maize genotype plant. Older generations of maize hybrids selected in lower densities have, as a rule, more robust plants and less erect top leaves. Newer generations of maize hybrids selected in higher densities (60-100,000 plants ha^{-1}), have less robust plants, lower placed ears, while the angle of top leaves in relation to the stalk is smaller. Moreover, nowadays producers have a broad spectrum of herbicides available, which makes chemical control more effective and reduces labour and need to modify cultivators and equipment for enhanced sowing patterns (Paszkiewicz, 1996).

Row spacing narrower than conventional derived from early canopy closure decreases the potential for weed interference, especially for shade intolerant species (Teasdale, 1995; Johnson et al., 1998). Maize grown at high populations and in narrow rows could suppress weeds and increase the consistency of weed control by herbicides applied at reduced rates (Forcella et al., 1992; Teasdale, 1995). The role of the genotype in weed suppression has received attention over the past 30 years (Forcella, 1987; Mohler, 2001; Simić et al., 2009). The possibility of weed suppression on the basis of the increased competitive activity of crops by growing high yielding hybrids that »endure" a greater density, depends on the genotype properties, environmental conditions and growing regions (Lindquist and Mortensen, 1999; Farnham, 2001).

Growing maize hybrids in the adequate plant pattern and with the application of herbicides in lower amounts provide the advantage to the crop over weeds with the simultaneous environmental protection. The aim of this study was to estimate if the different spatial arrangements of maize plants in combination with the herbicide application influenced hybrids height, productivity and grain yield.

Material and Methods

The field experiment was conducted on slightly calcareous chernozem at the Maize Research Institute, Zemun Polje, during 2005–2006. The three-replicate experiment was set up according to the split-split plot RCB design. Main plots encompassed the following spatial arrangements of maize: SP1 row space of 70 cm and 25 cm between plants in the row; SP2 row space of 50 cm and 35 cm between plants in the row and SP3 row space of 35 cm and 50 cm between plants in the row. The maize population density was the same at all spatial arrangements (57,143 plants ha^{-1}). The subplots included a pre-emergence application of isoxaflutole (Merlin 750-WG, WG, 750 g a.i. kg^{-1}, Bayer) + acetochlor (Trophy-EC, EC, 768 g a.i. L^{-1}, Dow AgroScience) at three herbicide rates: T1 - the full rate (101,25 g ha^{-1} + 1536 g ha^{-1} a.i.), T2 - half the rate (50,625 g ha^{-1} + 768 g ha^{-1} a.i.) and a T3 - control variant without the herbicide application. Sub-subplots included different maize maturity group hybrids: H1 - ZPSC 434 (FAO 400), H2 - ZPSC 578 (FAO 500) and H3 - ZPSC 735 (FAO 700). The maize hybrids aboveground plant biomass for three plants per replication was measured on June 14 and July 7 in 2005 and 2006. The plant height was also measured on July 7 in both years and calculated as an average of ten plants. The maize hybrids aboveground biomass productivity was calculated as a difference of two biomasses (Sarić et al., 1986):

$$C = dW / (dt \times P)$$

where C is aboveground biomass productivity in kg/ha/day
dW is a difference between two successive measurements of aboveground biomass, and
P is a land area to which aboveground biomass productivity refers

The maize hybrid grain yield was measured at the end of a growing cycle and calculated to 14% of moisture. The data were processed by the analysis of variance, while differences between treatments were tested by the LSD-test.

Meteorological conditions during the investigated years were optimal according to monthly air temperatures during the maize growing season. The precipitation sum was insufficient the in both years, while the precipitation distribution was unfavourable for the maize production in 2006, Table 1.

Table 1. Average monthly temperatures and precipitation sum during maize growing seasons in 2005/06

		April	May	June	July	Aug.	Sept.	Average/ Sum
Temperature (°C)	2005	12.4	17.6	20.1	22.4	20.6	19.5	18.8
	2006	13.4	16.9	20.0	17.5	21.1	19.7	18.1
Precipitation (mm)	2005	28.2	3.2	65.0	44.0	64.0	21.4	225.4
	2006	19.4	15.2	57.8	6.2	113.1	17.7	229.4

Results and Discussion

The height of studied maize hybrids significantly varied in dependence on the spatial arrangement in which they were grown in both years, 2005 and 2006 (Tables 2 and 3). The highest height (178.51 cm) of maize hybrids in 2005, on the average over variants in which herbicides were applied, was recorded in the spatial arrangement SP2, while the lowest height (165.93 cm) was in the spatial arrangement SP3. In 2006, the highest height (190.90 cm) was determined in the spatial arrangement SP3, while the lowest height (182.20 cm) was recorded in the spatial arrangement SP1. The differences in plant heights among hybrids were very significant, which was predetermined by their genetic properties and their maturity group. Regardless of the spatial arrangement of plants, the maize hybrid heights were always the lowest in the variant in which herbicides were not applied, especially in 2006. However, weeds had an advantage on areas where herbicides were not applied under conditions of the uneven precipitation distribution and also put weed pressure on the crop was high, hence maize hybrids heights were lower in untreated variants in 2006 than in the same areas in 2005.

Although maize hybrids differently responded to observed spatial arrangements, their two-year average height was the highest when they were grown in SP2 (inter-row distance of 50 cm and the distance between plants in the row of 35 cm), while their height was the lowest in SP3, Figure 1. The lowest, i.e. the highest two-year average height was recorded in the hybrid H3, i.e. H2, respectively.

Table 2. Maize hybrids heights (cm) in dependence on the spatial arrangement in 2005

Hybrid	SP1			SP2			SP3			Mean
	T1	T2	T3	T1	T2	T3	T1	T2	T3	
H1	197.8	197.4	117.1	212.2	201.5	125.9	187.2	194.3	104.7	170.9b
H2	207.9	212.1	113.0	201.5	206.9	131.5	199.3	208.5	111.9	176.95a
H3	186.3	199.9	134.3	199.1	193.6	134.4	189.1	189.7	108.7	170.56c
Mean	197.3	203.1	143.3	204.3	200.7	130.6	191.9	197.5	108.4	172.78
	173.98a			**178.51a**			**165.93b**			**$LSD_{0.05}$ = 0.20**
	$LSD_{0.05}$ = 6.46									

Values followed by the same letter are not significantly different (P= 0.05) according to the LSD test.

Maize hybrids aboveground biomass productivity expressed over the gain of aboveground biomass from two different developmental stages, indicates that maize hybrids responded the best to the spatial arrangements SP2 and SP1 in both years, Tables 4 and 5. Hybrid productivity was greater in 2005 than in 2006. The greatest aboveground biomass productivity (1197.5 kg/ha/day) was recorded in SP2, i.e. in the inter-row distance of 50 cm. Hybrids had the greatest productivity in this spatial arrangement in both variants, treated and untreated. Realised productivity statistically significantly differed over spatial arrangements and hybrids.

Table 3. Maize hybrids heights (cm) in dependence on the spatial arrangement in 2006

Hybrid	SP1			SP2			SP3			Mean
	T1	T2	T3	T1	T2	T3	T1	T2	T3	
H1	234.2	232.2	92.7	240.5	234.0	92.0	227.8	227.8	123.0	189.36b
H2	232.0	235.5	98.0	247.3	245.3	95.3	233.3	238.8	105.2	192.24a
H3	224.8	228.0	89.8	223.5	231.5	91.7	222.8	215.8	123.7	183.45c
Mean	230.3	231.9	93.5	237.1	236.9	93.0	228.0	227.5	117.3	188.35
	182.20c			**188.90b**			**190.90a**			**$LSD_{0.05}$ = 0.13**
	$LSD_{0.05}$ = 0.56									

Values followed by the same letter are not significantly different (P= 0.05) according to the LSD test.

Table 4. Maize hybrids aboveground biomass productivity (kg/ha/day) in dependence on the spatial arrangement in 2005

Hybrid	SP1			SP2			SP3			Mean
	T1	T2	T3	T1	T2	T3	T1	T2	T3	
H1	1102.0	1309.8	616.2	1307.4	1325.8	802.3	1367.0	1542.0	523.1	1099.5c
H2	1207.9	1400.0	651.4	1584.2	1133.5	904.5	1448.7	1607.0	624.0	1173.5b
H3	1617.9	1455.2	679.7	1438.5	1355.4	925.7	1418.3	1375.1	531.2	1199.7a
Mean	1309.3	1388.3	649.1	1443.4	1271.6	877.5	1411.3	1508.0	559.4	1157.6
	1115.6c			**1197.5a**			**1159.6b**			**$LSD_{0.05}$ = 0.41**
	$LSD_{0.05}$ = 2.55									

Values followed by the same letter are not significantly different (P= 0.05) according to the LSD test.

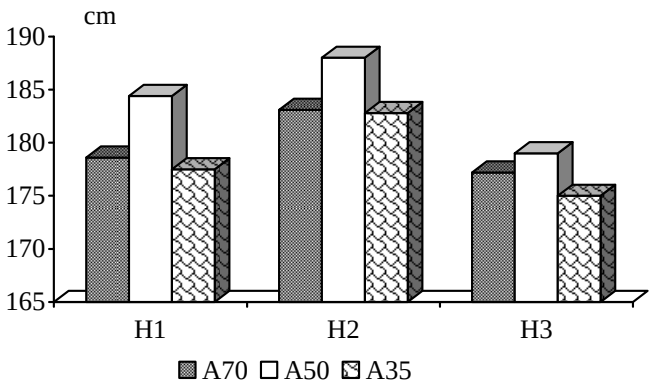

Figure 1. The maize hybrids height (cm per plant) in different spatial arrangements (2005-06)

In 2006, the greatest maize hybrids aboveground biomass productivity was realised in the spatial arrangement SP1 and amounted to 494.9 ka/ha/day. Hybrids productivity was statistically significantly lower in other two spatial arrangements. Realised productivity significantly differ over maize hybrids and as in 2005 it was the highest in the hybrid H3.

Table 5. Maize hybrids aboveground biomass productivity (kg/ha/day) in dependence on the spatial arrangement in 2006

Hybrid	SP1			SP2			SP3			Mean
	T1	T2	T3	T1	T2	T3	T1	T2	T3	
H1	653.6	542.3	191.6	525.2	653.2	194.3	594.4	593.0	158.9	456.3c
H2	682.4	692.1	200.5	562.5	595.2	168.3	565.1	595.9	224.4	476.3b
H3	676.3	622.5	192.8	653.5	661.5	150.5	653.0	552.8	169.0	481.2a
Mean	670.8	619.0	195.0	580.4	636.6	171.0	604.2	580.6	184.1	471.3
	494.9a			**462.7b**			**456.3c**			**$LSD_{0.05}$ = 0.09**
	$LSD_{0.05}$ = 2.16									

Values followed by the same letter are not significantly different (P= 0.05) according to the LSD test.

According to obtained results, hybrids differently responded to the growth in studied spatial arrangements. On the average for two years, the greatest productivity was recorded in the hybrid H3 (FAO maturity group 700) when grown in a common spatial arrangement of 70 x 25 cm. The change in the spatial arrangement, i.e. the reduction in the inter-row distance resulted in the reduction of productivity of this hybrid, and the lowest productivity was recorded in the spatial arrangement SP3 (inter-row distance of 35 cm). The lowest, significantly greater and the greatest productivity of the hybrid H1 was realised in the spatial arrangements SP1, SP3 and SP2, respectively. The hybrid H2 also favourably responded to the change in the spatial arrangement, first of all to the inter-row distance and its greatest productivity was realised in SP3.

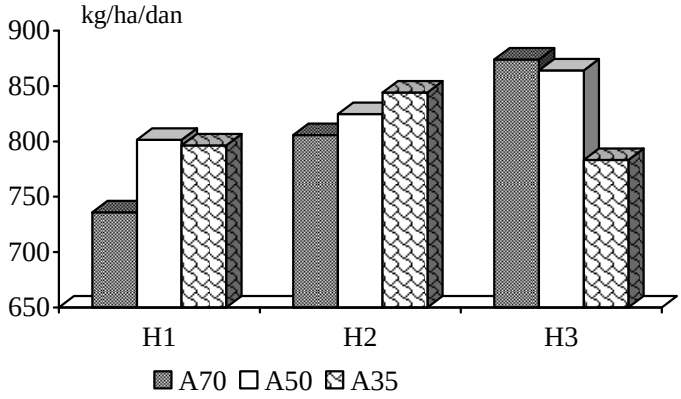

Figure 2. The maize hybrids productivity (kg/ha/day) in different spatial arrangements (2005-06)

The maize grain yield was also affected by investigated parameters. An inter-row distance had a positive effect on maize production in 2005 and the highest grain yield on the average was observed in the spatial arrangement SP3 (11.8 t/ha), although the differences in grain yield between evaluated space arrangements were not significant, Table 5. The hybrid H3 had the highest yield on the average (11.10 t/ha).

The 2006 yield was lower in all trial variants than the 2005 yield, which was probably a result of the unfavourable precipitation distribution and a dry spell in July 2006 with only 6.2 mm rain per month. The highest grain yield (10.80 t/ha), on the average, of all three hybrids was achieved in the spatial arrangement SP3 in 2006, while differences in grain yield were not statistically significant over spatial arrangements, Table 6. The highest average grain yield of 10.00 ha/t, significantly higher than in remaining two hybrids, was recorded in the hybrid H1.

The significantly higher grain yield was observed in the variant with the herbicide application in both years of investigation, Table 5 and 6.

Table 6. Maize hybrids grain yield (t/ha) in dependence of spatial arrangement in 2005.

Hybrid	SP1			SP2			SP3			Mean
	T1	T2	T3	T1	T2	T3	T1	T2	T3	
H1	12.6	11.9	8.9	12.4	11.8	7.3	13.1	13.7	7.6	11.0ns
H2	12.3	13.5	7.3	12.1	11.9	7.3	11.6	14.1	8.2	10.9ns
H3	12.7	7.5	7.3	12.3	12.5	10.1	14.6	14.6	8.5	11.1ns
Mean	12.2	11.0	7.8	12.3	12.1	8.2	13.1	14.1	8.1	11.0
	10.4ns			**10.9ns**			**11.8ns**			**$LSD_{0.05}$ = 0.26**
	$LSD_{0.05}$ = 1.56									

ns - not significant

Table 7. Maize hybrids grain yield (t/ha) in dependence on the spatial arrangement in 2006

Hybrid	SP1			SP2			SP3			Mean
	T1	T2	T3	T1	T2	T3	T1	T2	T3	
H1	11.5	11.9	5.9	11.6	11.4	5.4	12.3	12.1	8.3	10.0a
H2	10.5	10.0	5.1	11.1	10.9	4.2	12.1	11.4	8.0	9.3b
H3	9.81	10.6	5.7	9.4	10.0	6.8	10.9	10.4	12.0	9.5ab
Mean	10.6	10.8	5.6	10.7	10.8	5.5	11.8	11.3	9.4	9.6
	9.0 ns			**9.0 ns**			**10.8 ns**			**$LSD_{0.05}$ = 0.60**
	$LSD_{0.05}$ = 4.85									

On the average for the 2005-2006 period, the highest grain yield of all hybrids was observed in the spatial arrangement SP3, Figure 3. The spatial arrangement SP2, i.e. SP1 was the least favourable for hybrids H1 and H2, i.e. H3, respectively.

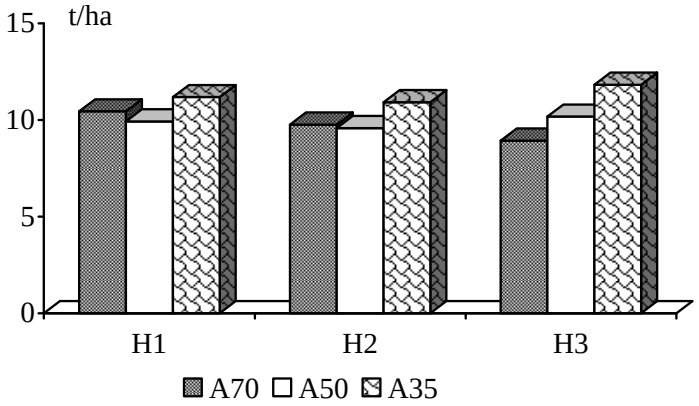

Figure 3. The maize hybrids grain yield (t/ha) in different spatial arrangements (2005-06)

According to gained results, the hybrid H3, although belongs to the FAO late maturity group, was characterised by a longest growing period in all variants of the spatial arrangement on the average for both years of investigation. The reason is probably the affiliation to the older generation of hybrids that were earlier developed and hence this hybrid is not adapted to the cultivation in the altered spatial arrangement. Unlike the hybrid H3, hybrids of a newly developed generation H1 and H2 more favourable responded in regard to the plant height in dependence on the growing system, first of all on the inter-row distance. The plants of the hybrid H2 were the tallest at the end of season in both years even though they did not grow fastest during the growing period (Simić et al., 2009).

The density and the plant arrangement patterns according to which certain hybrids are grown have the different effects on their morphological and productive properties (Sarlangue et al., 2007). Bullock et al. (1988) showed that crop growth rate was higher early in the season when maize was grown in an equidistant pattern in 38-cm rows than when grown in rectangular

pattern in 76-cm rows. Teasdale (1995) found that the leaf canopy of maize grown in 38-cm rows closed one week earlier than maize grown in 76-cm rows. Westgate et al. (1997) suggested also, that hybrids with a grater capacity of altering leaf display angles or with a whorled leaf display might be better suited for efficient light interception in narrow rows. Results of our studies also indicate that the increase of maize density from 42.000 to almost 99.000 plants per hectare significantly affected the increase of a leaf area per plant and leaf area index of maize from 2.85 to 6.26 or by 54.5%, as well as, the decrease of fresh weed biomass (Simić et al., 2003). The genotype height is its essential trait that contributes to a greater competitiveness in relation to weeds (Schnieders et al., 1999). Maize hybrids cultivation at an increased density and a narrower inter-row distance could reduce weediness and increase efficiency of herbicides, hence their lower rates could be applied (Teasdale, 1995).

Potential increases in maize aboveground biomass production and grain yield led many producers to consider using narrow maize rows (Sangoi et al., 2001), even though some studies showed no positive impact on grain yield of sowing maize in narrow rows (Teasdale, 1995; Westgate, 1997). Obtained results indicate that it is possible to grow maize hybrids successfully and achieve higher biomass productivity and grain yield under conditions of the altered spatial arrangements with the herbicide application at recommended or even lower rates. On the average for two years, the greatest productivity was recorded in the hybrid H3 (FAO 700) in which the alternation of the spatial arrangement in relation to the conventional one resulted in a lower productivity. On the other hand, the hybrid H2 very favourable responded to the change in the spatial arrangement and had the highest productivity, on the average for both years, in SP3. Results obtained by Widddicombe and Thelen (2002) also pointed out to significant differences among hybrids in their response to the decrease in the inter-row distance. The full-season leafy hybrid had a dray matter increase of 1.4 and 2.8 Mg ha^{-1} when a row width was narrowed to 56 and 38 cm, respectively. Conversely, the shorter-season leafy hybrid did not respond to changes in the row width.

Both, aboveground biomass and grain yield of maize differed over spatial arrangements and rates of applied herbicides. The two-year highest average grain yields of hybrids was recorded in the spatial arrangement SP3. Similarly, the yield was increased when maize was grown in 50-cm than in 76-cm rows and the biomass of mixed annual weeds was reduced (Murphy et al., 1996; Simić and Stefanović, 2007). The row distance reduction from 100 to 50 cm linearly increased the number of kernels per ear, grain weight and maize grain yield (Sangoi et al., 2001). The greater distance between adjacent plants within rows obtained with the use of narrow rows also enhanced maize ability to convert the intercepted solar radiation to grain production.

Maize hybrids grown under enhanced spatial arrangements with the herbicide application made maize plants more productive and competitive, and contributed to the environmental protection.

Conclusion

Based on the results of this research following conclusions were drawn:

– maize hybrid cultivation in the observed spatial arrangements resulted in significant differences in the plant height and hybrid aboveground biomass productivity
– the highest plant height, as well as, the greatest aboveground biomass of maize, on the average for both years of investigation and all studied hybrids were realised with the 50-cm spatial arrangement and the 35-cm distance of plants within the row (SP2)

- grain yield of observed maize hybrids did not significantly differ among three different spatial arrangements in any of years of investigation
- hybrids of newly developed generation better responded to the changes in the growing system, i.e. in the plant spatial arrangement
- all observed parameters of maize hybrids (plant height, aboveground biomass productivity and grain yield) had higher values in the variants with the herbicide application in full and half a recommended rate than in the untreated control
- obtained results point out that the ZP maize hybrids can be grown in the altered spatial arrangement with a decreased inter-row distance under agroecological conditions of Zemun Polje, in order to increase their competitiveness and decrease of herbicide rates, by which the environment is protected.

Acknowledgement

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Sažetak

Produktivnost hibrida kukuruza uslijed različitog prostornog rasporeda

Poželjniji sjetveni rasporedi, koji se dobiju smanjenjem međurednog razmaka, poboljšavaju brzinu rasta kukuruza, što rezultira boljom efikasnošću iskorištavanja zračenja i višeg uroda zrna. Tri hibrida kukuruza različite grupe dozrijevanja uzgajani su u tri različita prostorna rasporeda, sa i bez uporabe herbicida, tijekom sezone 2005-06 u Zemun Polju, Beograd, Srbija. Cilj je bio procijeniti da li je različiti prostorni raspored biljaka u kombinaciji sa i bez aplikacije herbicida utjecao na visinu hibrida, nadzemnu masu i prinos zrna. Najviše biljke, kao i nadzemna masa, u prosjeku za sve hibride, bile su na tretmanu međurednog razmaka od 50 cm u kombinaciji s unutar-rednim razmakom od 35 cm (SP2). Urod zrna promatranih hibrida nije se signifikantno razlikovao između tretmana prostornog rasporeda tijekom godina istraživanja. Nedavno stvoreni hibridi bolje su reagirali na promjene prostornog rasporeda biljaka. Više vrijednosti visine biljaka, produktivnosti i uroda zrna proučavanih hibrida zabilježene su pri primjeni punih doza i polovičnih doza herbicida u odnosu na netretiranu kontrolu. Uzgoj hibrida kukuruza u adekvatnom rasporedu i aplikaciji nižih doza herbicida osigurava prednost usjevu u odnosu na korove pri usporednoj zaštiti okoliša.

Ključne riječi: kukuruz, prostorni raspored, kompeticija, produkcija biomase, urod

Section I

farming of the future

bilinogojstvo budućnosti

chairmen / moderatori

1. Danijel JUG
2. Bojan STIPEŠEVIĆ
3. Snežana DRINIĆ MLADENOVIĆ

Sažetak / Abstract

Uvođenje ekološke proizvodnje u funkciji eliminacije loših izbora u poljoprivredi Republike Hrvatske

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Sažetak

Brzi porast svjetskog stanovništva i prenaglašena komercijalizacija potiču intenziviranje poljoprivredne proizvodnje, koja uz prebrzo uvođenje tehnoloških inovacija te globalne klimatske promjene rezultira vrlo često proizvodima upitne kakvoće. Zaostajanje za svjetskim trendovima u Republici Hrvatskoj (RH) ima za posljedicu i neke pozitivne karakteristike. Nažalost, od tradicionalne proizvodnje je uglavnom ostao i dalje uzak izbor kultura, predstavljen stranim sjetvenim materijalom, vrlo često neprilagođenim lokalnim agroekološkim čimbenicima. Zbog manjih i vrlo često raštrkanih posjeda, te loše poljoprivredne orijentacije, mala je efikasnost i teško je ostvariti očekivani prihode. Međutim, relativno nezagađeno tlo i voda u RH mogu biti dobra podloga za intenziviranje ekološke proizvodnje. Ona uz bolju organizaciju, te uvođenje klasterske proizvodnje u cijelom proizvodnom lancu, može omogućiti poljodjelcima puno radno vrijeme i dugoročno održivu proizvodnju.

Ključne riječi: tradicionalna poljoprivreda, efikasnost, ekološka proizvodnja

Abstract

The introduction of organic farming in the function of elimination of bad choices in agriculture of the Republic of Croatia

The rapid growth of the world population and overemphasized commercialization are encouraging intensification of agricultural production, which, with fast introduction of technical innovation and global climatic changes, results very often with products of dubious quality. The lagging behind world's trends in Republic of Croatia (RC) has for the consequence also some positive characteristic. Alas, from traditional production only remains are very scarce choice of crops, represented very often with foreign seed material, unfit for local agroenvironmental factors. Due to small and scarce properties, in combination with bad agricultural orientation, the efficiency is low and it is hard to accomplish expected income. In contrary, relatively unpolluted soil and water in RC can be good base for intensification of organic agriculture. It can, with better organization in combination with cluster production, provide to farmers full working hours and long term sustainability of their production.

Keywords: traditional agriculture, efficiency, organic agriculture

Izvorni znanstveni rad / Original scientific paper

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Sažetak

Proizvodnja sjemenske i merkantilne soje u Hrvatskoj radi se u velikoj mjeri na konvencionalan način, dok druge zemlje primjenjuju reduciranu i no-tillage tehnologiju. Svaka od navedenih tehnologija ima svoje prednosti, neke u vidu manjih troškova i brzine obavljanja pojedinih faza radova, a neke nedostatke zbog sabijanja tla i stvaranja nepropusnog sloja na konačan financijski rezultat. Cilj ovog istraživanja je pokazat opravdanost primjene ovih tehnologija u našim uvjetima proizvodnje. Istraživanja su provedena na lokaciji Čokadinci 2009. i 2010. godine. Pokus je postavljen u 4 ponavljanja po slučajnom rasporedu na obiteljskom poljoprivrednom gospodarstvu. Varijante obrade su: standardna obrada (oranje na 30 cm), jesensko tanjuranje na 15 cm i no-tillage tehnologija.

Ključne riječi: Soja, konvencionalna obrada, reducirana obrada i no-tillage

Uvod

Prema FAO podacima u Hrvatskoj postoji trend povećanja površina zasijanih sojom (FAOSTAT, 2008.). Tako je u 2001. godini soja bila zasijana na 41621 ha, a danas ima tendenciju rasta do 60000 ha. Soja se uzgaja skoro na svim tipovima tala i od svih leguminoza najtolerantnija je na izbor tla (Jurić, 1986.). Generalno se uzima da traži tla kao i kukuruz. Na našim prostorima soja se proizvodi na konvencionalan način što znači da se vrši duboko jesensko oranje na 30 cm, proljetno tanjuranje i predsjetvena priprema. Upravo na konvencionalan način dokazana je rentabilnost proizvodnje soje u istočnoj Hrvatskoj (Jukić i sur., 2007.). Soja se komercijalno uzgaja no-tillage varijantom u SAD već dvadesetak godina (Kapusta i Krausz, 1993.). Zbog sve većih površina koje se siju pod sojom na obiteljskim poljoprivrednim gospodarstvima reducirana obrada i no-tillage tehnologija pokazuju se kao dobar način da se usjevi posiju na vrijeme i da proizvođači smanje troškove. Reduciranom i no-tillage varijantom sjetve vraća se prirodna ravnoteža tla, popravljaju se vodozračni odnosi, mikrobiološka karakteristika tla (Birkas, 2002.). Reduciranje zahvata obrade tla ne znači, ujedno, i reduciranje prinosa, a posebice ako se uzme u obzir i ekonomska kalkulacija isplativosti različitih sustava obrade tla u uzgoju soje (Jug, 2005.). Sjetva no-tillage varijantom soje postala je uobičajena metoda u SAD-u (Touchton and Johnson, 1982.). Cilj istraživanja je pokazati opravdanost primjene novih tehno-

logija na našim prostorima, odnosno da li postoji razlika u prinosu između konvencionalne, reducirane i no-tillage tehnologije.

Materijal i metode rada

Pokus je postavljen u Čokadincima i to u četiri ponavljanja slučajni blok raspored na eutrično smeđem tlu na Obiteljskom poljoprivrednom gospodarstvu. sa tri varijante obrade tla u 2009. i 2010. godini. Veličina osnovne parcele iznosila je 1100 m^2 (22 X 50). Prema klasifikaciji tala (Škorić, 1991.) u 2009. godini ph-KCL bio je 6,6 (neutralne reakcije), a u 2010. godini 5,6 (slabo kisele reakcije). Postotak humusa, Al-P_2O_5 i AL-$_{K2O}$ bio je u istraživanim godinama u sličnom omjeru. Rezultati provedene analize uzoraka tla sa svih lokacija prikazani su u Tablici 1. U zaštiti od korova, za sve godine i varijante, primijenjena je split metoda, kod prve troliske primijenjen je prvi split sa Laguna (60 gha^{-1}) + Harmony (4 gha^{-1}) + okvašivač Trend (02 lha^{-1}), a nakon dva tjedna drugi split Laguna (60 gha^{-1}) + Harmony (4 gha^{-1}) + okvašivač Trend (02 lha^{-1}). Prije cvatnje protiv uskolisnih korova primjenjen je focus ultra (1,5 lha^{-1}) + okvašivač Trend (02 lha^{-1}). U svim godinama istraživanja za varijantu no-tillage je prije sjetve izvršeno prskanje totalnim herbicidom Boom efect (6 lha^{-1}). Analiza varijance za godinu, varijantu i ponavljanja izračunata je pomoću Mstat programa.

Žetva je izvršena malim kombajnom Deutz-Fahr 33.70 Farm Liner širine hedera 2,65 m, a uzorci za svaku varijantu i repeticiju su se vagali na pisti obiteljskog poljoprivrednog gospodarstva na digitalnoj vagi.

Tablica 1. Rezultati analize uzoraka tla

	pH-HOH	pH-KCL	Humus	Al-P_2O_5	AL-$_{K2O}$
2009.					
Čokadinci	6,8	6,6	1,7	21,0	25,2
2010.					
Čokadinci	6,1	5,6	1,9	20,2	27,1

Postavljene su tri varijante: konvencionalna, reducirana i no-tillage.

Konvencionalna varijanta podrazumijevala je jesensko duboko oranje na 30 cm, jednokratno tanjuranje vučenom tanjuračom zahvata 3,3 m (razmak tanjura 21 cm), a u proljeće zatvaranje zimske brazde teškom klinastom drljačom 3 m, sa dva reda valjaka.

Sjetva je obavljena no-till sijačicom Tye Acres 4,4 m, sa 22 reda na razmak redova od 20 cm.

Reducirana varijanta podrazumijeva dva prohoda teškom tanjuračom u jesen (tanjuranje u pravcu i dijagonali na dubinu od 15 cm), a u proljeće zatvaranje zimske brazde teškom klinastom drljačom sa dva reda valjaka.

No-tillage varijanta podrazumijeva samo sjetvu bez ikakvih prohoda.

Sorta koja je korištena za pokus u istraživanim godinama je Podravka 95 (grupa 0-1) koja je uz sortu Ika najzastupljenija u sjemenskoj i merkantilnoj proizvodnji u Hrvatskoj. Planirani sklop bio je 600 000 biljaka/ha, a sjetva je obavljena na dubinu od 3 – 4 cm i to: 26. travnja 2009. i 01. svibnja 2010. godine. U 2010. godini sjetva se nije mogla ranije obaviti zbog velike vlažnosti tla na lokaciji Čokadinci. Kao predusjev za sve varijante i godine uzgoja bila je ozima pšenica, a gnojidba za sve varijante i godine je iznosila 74 kg N, 80 P_2O_5i 12 kg K2O/ha.

Prema meteorološkim podacima, vidljivo je da su se istraživane godine jako razlikovale prema količini oborina u odnosu na višegodišnji prosjek (Tablica 2). Količina oborina tijekom vegetacijskog perioda 2009. godine bila je manja za 185,1 l od višegodišnjeg prosjeka, dok je 2010. godina bila viša za 70,1 l od višegodišnjeg prosjeka i to prvenstveno kod početnog porasta (od klijanja do pojave prve troliske)

Tablica 2. Količina oborina tijekom vegetacijskog razdoblja u 2009. i 2010 godini.

Vegetacijska godina 2009 i 2010./ Vegetation years 2009 and 2010			
Mjesec /Month	Višegodišnji/prosjek/Average	2009	2010
V	56,2	39,6	80,2
VI	84,8	83,8	175,8
VII	68,5	8,4	19,8
VIII	74,9	33,4	57,8
IX	73,3	7,4	94,2
Ukupno/ Total	357,7	172,6	427,8

Rezultati i rasprava

Dobiveni podaci prinosa soje pod utjecajem različitih varijanti obrade tla prikazani su u Tablici 3. Sklopovi soje u 2009. godini na konvencionalnoj varijanti bili su 600 000 biljaka/ha, reduciranoj 570 000 biljaka/ha, a na no-tillage 500 000 biljaka/ha. U 2010. godini sklopovi su bili znatno manji nego prethodne godine. Na konvencionalnoj varijanti bili su 570 000 biljaka/ha, na reduciranoj 510 000 biljaka/ha, a na no-tillage 430 000 biljaka/ha. Razlog ovim nižim sklopovima može se pripisati izrazito velikim količinama oborina nakon sjetve, a što je rezultiralo propadanju sjemena i mladih biljaka prvenstveno kod no-tillage varijante (Tablica 2). Prema rezultatima analize varijance u prosjeku za obje godine konvencionalna varijanta i varijanta reducirane obrade tla imale su statistički vrlo značajno veći prinos od no-tillage varijante (Tablica 3). Analizom varijance dobiveni koeficijent varijacije od 2,64% upućuje na odličnu izvedenost pokusa.

Tablica 3. Prinos zrna soje (t/ha) tijekom 2009. i 2010. godine

Godina/ Year	2009	2010	Prosjek prinosa t/ha/ Average yeald t/ha
Konvencionalna/ Conventional	3,65	3,15	3,40
Reducirana/ Reduced	3,25	2,78	3,01
No-tillage/ No-tillage	2,89	1,54	2,21
Prosjek godine/ Year average	3,26	2,48	
F-test za godine/ For year			** P<0,01%
LSD prinos/ Yield	0,05		0,082
	0,01		0,114
LSD interakcija/ Interaction	0,05		0,117
	0,01		0,162

Prema rezultatima analize varijance F-test za godine istraživanja pokazuje statističke visoko opravdane razlike (P<0,01%), u 2009. godini ostvaren je prosječan prinos od 3,26 t/ha, a u 2010. godini 2,48 t/ha (Tablica 3). Najveći prinos u godinama istraživanja ostvarila je konvencionalna varijanta 3,40 t/ha, zatim reducirana varijanta 3,01 t/ha, a no-tillage varijanta imala je svega 2,21 t/ha. Slične podatke dobili su Jug i sur. (2009.) gdje su najveći prinosi ostvarivani na konvencionalnoj obradi s dvogodišnjim prosjekom od 2.60 t/ha, zatim na varijanti rahljenje i tanjuranjem s prinosom od 2.54 t/ha, slijedi višekratno tanjuranje s prinosom od 2.48 t/ha, te signifikantni niži jednokratno tanjuranje s prinosom od 1.89 t/ha i no-tillage s prinosom od 1.82 t/ha. Za sve godine istraživanja varijanta konvencionalne (3,40 t/ha) obrade tla po prinosu ostvarila je statistički značajne razlike (P<0,01%) u odnosu na reduciranu (3,01 t/ha) i no-tillage varijantu (2,21 t/ha). Razlika varijante reducirane obrade tla (3,01 t/ha) po prinosu u godinama istraživanja bila je statistički značajna (P<0,01%) u odnosu na no-tillage varijantu (2,21 t/ha).

Prema rezultatima analize varijance F-test za interakciju godina x varijanta pokazuje statistički visoko opravdane razlike (P<0,01%), zbog toga što je 2010. godina izrazito nepovoljno utjecala na no-tillage varijantu. Kod konvencionalne varijante došlo je do 13,7 % smanjenje prinosa u odnosu na 2009., kod reducirane 14,5 % smanjenja prinosa, a kod no-tillage varijante došlo je do smanjenja prinosa za 46,7 %. Niski prinosi soje u 2010 godini posljedica su vrlo nepovoljnih vremenskih prilika (Tablica 2) koje su vladale tijekom cijele sezone, a prvenstveno od klijanja pa do pojave prve troliske. Kod no-tillage varijante zbog velikih količina oborina došlo je do površinskog zadržavanja oborinske vode, što je rezultiralo gušenjem i propadanjem mladih biljaka, smanjenjem sklopa i prinosa sjemena. Dvogodišnji prosječni prinos soje bio je pod vrlo značajnim utjecajem godine, obrade tla i njihove interakcije.

Zaključci

Na temelju provedenih istraživanja obavljenih na eutrično smeđem tlu u Čokadincima za varijante konvencionalne, reducirane i no-tillage varijante na prinos sjemena soje u 2009. i 2010. godini možemo zaključiti:

Najveći prinos za sve godine istraživanja ostvaren je na konvencionalnoj varijanti sjetve i statistički je značajan (P<0,01%) u odnosu na reduciranu i no-tillage varijantu.

Reducirana varijanta sjetve ostvaruje manji prinos nego konvencionalna varijanta, ali su i manji troškovi proizvodnje tako da ova varijanta sjetve može biti prihvatljiva za proizvođače sjemena.

No-tillage varijanta u svim godinama istraživanja ostvarila najmanji prinos i on je statistički niži (P<0,01%) u odnosu na konvencionalnu i reduciranu varijantu.

U godinama sa velikim količinama oborina tijekom vegetacijskog perioda no-tillage varijanta sjetve ne ostvaruje prinos sjemena koji može pokriti troškove proizvodnje, te je zbog toga neprihvatljiva.

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Abstract

Effect of soil tillage on soybean yield

Soybean seed production in Croatia it is largely in the conventional manner, while other countries apply reduced and no-tillage technology. Each of these technologies has its advantages, some in the form of lower costs and speed the performance of certain phases of work, and some disadvantages due to soil compaction and the creation of impervious layer in the final financial result. The aim of this research is to show justification for the application of these technologies in our production conditions. Investigations were carried out on site Čokadinci 2009 and 2010. year. The experiment was set up in 4 replicates in a randomized assignment to the family farm business. Tillage were: conventional tillage (plowing to 30 cm), autumn harrowing at 15 cm and no-tillage technology.

Key words: soybean, conventional tillage, reduced tillage and no-tillage

Izvorni znanstveni rad / Original scientific paper

Prinos kukuruza u ovisnosti o gustoći usjeva sa i bez navodnjavanja

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Sažetak

Tehnologiju proizvodnje kukuruza, i gustoće usjeva kao njen sastavni element, neophodno je prilagoditi potrebama biljaka u uvjetima navodnjavanja. Obavljena su dvogodišnja istraživanja u poljskim pokusima na pokusnom polju Naučnog instituta za ratarstvo i povrtlarstvo Novi Sad, u Rimskim Šančevima, u 2005. i 2006. godini u cilju utvrđivanja efekta gustoće biljaka na prinos kukuruza u uvjetima sa i bez navodnjavanja. Ispitivan je hibrid NS 6010, grupe zrenja FAO 600, u pet gustoća sjetve (50000 bilj./ha-G1, 60000 bilj./ha–G2, 70000 bilj./ha–G3, 80000 bilj./ha–G4 i 90000 bilj./ha–G5) sa međurednim razmakom od 70 cm. Navodnjavanja su obavljena orošavanjem pri poljskoj vlažnosti od 60% od PVK, koja odgovara lentokapilarnoj vlažnosti. Također je bila i kontrola bez navodnjavanja. Povećanje prinosa navodnjavanjem bilo je skromno, do 15,96%, zbog povoljnih vremenskih uvjeta u toku vegetacije kukuruza. Sa povećanjem sklopa do 60000 - 70000 bilj./ha, u uvjetima navodnjavanja, prinos kukuruza se povećavao, a sa daljim povećanjem sklopa prinos je stagnirao. U uvjetima bez navodnjavanja, povećanje sklopa usjeva preko 50000 biljaka/ha nije uticalo na povećanje prinosa.

Ključne riječi: kukuruz, navodnjavanje, sklop biljaka, prinos

Uvod

Proizvodnja kukuruza u Srbiji odvija se na oko 1.200.000 ha sa prosječnim prinosom ispod svjetskog prosjeka. Na teritoriji Vojvodine stanje je nešto bolje, ali daleko ispod mogućnosti i proizvodnih potencijala ovog podneblja. Od ratarskih biljaka kukuruz se uzgaja na najvećim površinama (preko 40 % oraničnih zemljišta Vojvodine). Prosječan prinos u proteklih deset godina varira od 3,4 t/ha do 6,5 t/ha (Statistički godišnjak Srbije) i u velikoj mjeri zavisi od vremenskih uvjeta, prvenstveno količine i rasporeda padavina.

Na području Vojvodine je teško organizirati uspješnu biljnu proizvodnju u uvjetima prirodne opskrbe vodom. Prinos i ukupna proizvodnja kukuruza varira u zavisnosti od agroekoloških uvjeta, nivoa primijenjene tehnologije uzgoja i posebno hibrida. Noviji hibridi, pored većeg genetskog potencijala rodnosti, odlikuju se i većom tolerancijom prema stresnim uvjetima proizvodnje, racionalnije koriste hraniva i raspolažu vodom, te podnose gušću sjetvu. U suvre-

menoj tehnologiji uzgoja hibrida kukuruza visoki i stabilni prinosi mogu se postići samo ako se svakoj biljci osigura optimalan oblik i veličina vegetacijskog prostora. Sklop je »vječito« pitanje koje u sušnim godinama posebno dolazi do izražaja. Navodnjavanje je jedina mjera kojom se uspješno rješava problem suše i omogućuje postizanje prinosa na genetskom i fitoklimatskom nivou (Stojaković i sur., 1996., Bošnjak, 1997., Živanović i sur., 2006., Ivanović i sur., 2008.).

Materijal i metode

Pokus je postavljen na pokusnom polju Instituta za ratarstvo i povrćarstvo, Novi Sad, u Rimskim Šančevima, na tlu tipa černozem, u 2005. i 2006. godini. Korišten je hibrid NS 6010, FAO 600. Pokus je postavljen po metodi blok sistema prilagođen uvjetima navodnjavanja umjetnom kišom. Primijenjena je suvremena tehnologija proizvodnje, agrotehničke mjere su obavljene u optimalnim rokovima. Kukuruz je posijan 11.04. u 2005. godini i 22.04. u 2006. godini. Sjetva je obavljena sa međurednim razmakom od 70 cm, dok je razmak u redu variralo u zavisnosti od varijante. Istraživanje je obuhvatilo varijantu sa navodnjavanjem (N – 60% od poljskog vodnog kapaciteta, PVK) i kontrolnu varijantu bez navodnjavanja (Ø). Vrijeme navodnjavanja je određivano prema vlažnosti tla. Navodnjavanja su obavljena pri poljskoj vlažnosti od 60% od PVK, koja odgovara lentokapilarnoj vlažnosti. U toku vegetacije praćena je dinamika vlažnosti tla termogravimetrijskom metodom sušenja uzoraka u sušnici na 105 – 110 °C. Uzorci tla su uzimani po slojevima od 10 – 20 cm do 60 cm dubine svakih 7 – 10 dana, a po potrebi i u kraćem periodu vremena. Tokom vegetacionog perioda 2005. godine izvršena su dva navodnjavanja 08.06. i 24.06., u 2006. godini tri 04.07., 17.07. i 28.07., sa normom od 60 mm. Berba je obavljena u tehnološkoj zrelosti, sa osnovne parcele 14 m^2, u obje godine u drugoj dekadi listopada, prinos je preračunat po hektaru sa 14 % vlage. Vlažnost zrna u berbi određena je metodom sušenja uzoraka u sušnici. Podaci o temperaturama i količinama padavina, uzeti su sa meteorološke stanice Rimski Šančevi. Statistička obrada rezultata urađena je analizom varijance dvofaktorijalnog pokusa i primjenom LSD testa.

Rezultati i rasprava

Tijekom predvegetacijskog perioda 2005. godine formirane su povoljne rezerve vlage. U vrijeme sjetve vlažnost tla iznosila je 22,49 mas %. Česte padavine u travnju i svibnju, iako male po količini, kao i predvegetacijske rezerve vlage u tlu bile su dovoljne da osiguraju optimalno snabdijevanje biljaka vodom. Povoljna vlažnost tla održala se sve do početka lipnja, kada je obavljeno i prvo navodnjavanje. Nakon navodnjavanja pala je obilna kiša, 113 mm za dva dana, pri čemu se javio višak vode koji se procijedio u dublje slojeve. Zatim je uslijedio beskišni period i javio se drugi deficit vode u zoni aktivne rizosfere. Navodnjavanje je obavljeno krajem lipnja i vlažnost tla dostigla je nivo poljskog vodnog kapaciteta. Do kraja vegetacije kukuruz je bio optimalno snabdjeven vodom, vlažnost tla bila je iznad tehničkog minimuma.

U predvegetacijskom periodu 2006. godine formirane su značajne rezerve vlage u tlu. Sjetvu je pratio vlažan period sa visokom vlažnosti tla, 22,12 mas %. Kišni period nastavljen je u svibnju i lipnju kada je kukuruz bio snabdjeven lakopristupačnom vodom, a vlažnost tla se kretala u intervalu od 19 mas % do 24 mas %. Prvi deficit vode bio je početkom srpnja, obavljeno je prvo navodnjavanje i vlaga u tlu dostigla nivo poljskog vodnog kapaciteta. Visoke temperature u srpnju i male količine padavina (30 mm) utjecale su na pojavu suše, kada su obavljena dva navodnjavanja sredinom i krajem lipnja. Na kontrolnoj varijanti bez navodnjavanja vlažnost tla se spustila ispod tehničkog minimuma, a sredinom srpnja čak ispod početne vlažnosti venuća. U takvim uvjetima biljke su koristile vodu iz dubljih slojeva tla, što je rezultiralo smanjenjem prinosa. Tek krajem prve dekade kolovoza, nakon češćih kiša, vlažnost tla se poboljšala. Do kra-

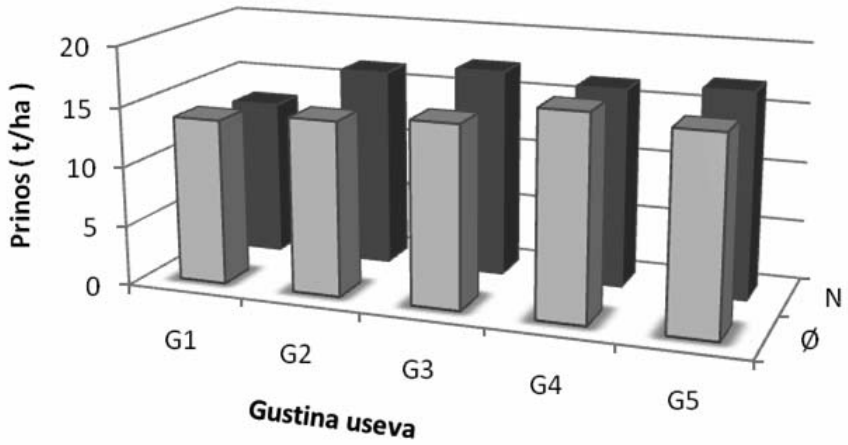
ja vegetacije na navodnjavanoj varijanti biljke kukuruza su bile optimalno snabdjevene vodom, u granicama iznad tehničkog minimuma.

Vremenske prilike u 2005. i 2006. godini bile su povoljne za proizvodnju kukuruza, o čemu svjedoče i veći prosječni prinosi u Vojvodini, 6,5 i 5,9 t/ha (Statistički godišnjak Srbije). Količine padavina bile su veće, a temperature više od višegodišnjeg prosjeka za vegetacioni period. U prvoj godini istraživanja navodnjavanje je povećalo prinos kukuruza za 5,03 %. Da je godina bila povoljna za proizvodnju kukuruza svjedoče i visoki prinosi postignuti na varijanti bez navodnjavanja preko 15 t/ha. Ostvareni prinos na tretmanu sa navodnjavanjem iznosio je 16,09 t/ha, povećanje prinosa je vrlo skromno, iznosi samo 0,77 t/ha i nije statistički značajno. U drugoj godini istraživanja prinos na varijanti bez navodnjavanja iznosio je 12,95 t/ha, što je za 2,07 t/ha manje od prinosa u uvjetima navodnjavanja (15,02 t/ha). Efekt navodnjavanja u ovoj godini bio je statistički značajno veći, i veći nego u prethodnoj i iznosio je 15,96 %.

Rezultati o efektu navodnjavanja na prinos kukuruza se slažu sa rezultatima Bošnjaka i Pejića (1997), koji su utvrdili da je u pojedinim godinama efekt navodnjavanja na povećanje prinosa kukuruza bio različit, u povoljnim godinama je izostao ili je bio vrlo skroman, a u izrazito sušnim godinama bio je vrlo visok do tri puta veći nego u kontroli bez navodnjavanja.

U povoljnoj 2005. godini u kontrolnoj varijanti bez navodnjavanja prinos zrna kukuruza bio je veći sa povećanjem broja biljaka. Razlike su značajne između G1 i G3 dok između većih sklopova G3, G4 i G5 kao i između G2 i G3 nema statističkih razlika. U uvjetima navodnjavanja najveći prinos je ostvaren pri sklopku od 70000 bilj/ha. Visoko signifikantno je veći prinos pri sklopu G3 u odnosu na G1, dok između sklopova G2, G3, G4 i G5 nema statistički značajnih razlika.

Slične rezultate dobili su Latković i sur. (2008) koji navode da je najviši prinos ostvaren kod sklopka od 89000 bilj./ha, ali bez značajnijih razlika kod manjih sklopova. Isti autori smatraju da, uzimajući u obzir sve činioce, prije svega količinu i raspored padavina u vegetaciji, preporučuju sklop od 54 – 68000 bilj./ha za srednje kasne hibride kukuruza.

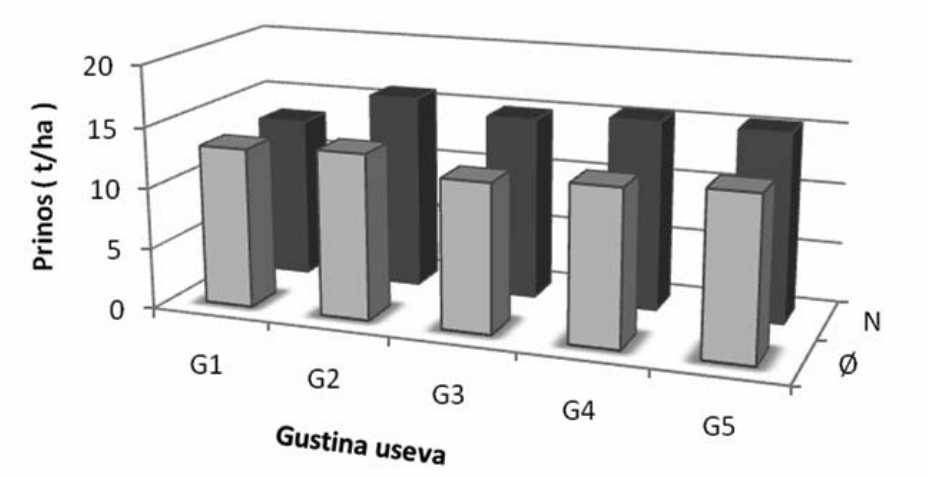


Graf. 1. Prinos kukuruza (t/ha) u zavisnosti od gustoće usjeva u uvjetima sa i bez navodnjavanja u 2005. godini

U 2006. godini u uvjetima bez navodnjavanja nije utvrđen efekt gustoće usjeva na prinos kukuruza, odnosno nisu utvrđene statistički značajne razlike između različitih sklopova. U uvjetima navodnjavanja najveći prinos je postignut sa sklopkom od 60000 bilj./ha. Visoko signifikantno je veći na G2 u odnosu prema G1, dok nema statistički značajnih razlika između G2, G3, G4 i G5.

Slične rezultate navodi i Norwood (2000., 2001.), koji zaključuje da je optimalan broj biljaka po hektaru za područje Kanzasa 60000 bilj./ha, odnosno 57000 - 69000 bilj./ha u uvjetima navodnjavanja za Kolorado (Al-Kaisi i Yin, 2003.). Larsen i Clegg (1999.), Norwood (2001.) zaključuju da u optimalnim uvjetima vlažnosti tla kukuruz na području Nebraske treba gajiti pri sklopu 85000 biljaka po hektaru, ali da se taj broj smanjuje na 45-65000 u nepovoljnim uvjetima.

U prosjeku za obje godine istraživanja u uvjetima bez navodnjavanja nije utvrđen efekt povećanja sklopa na prinos. U uvjetima navodnjavanja, maksimalan prinos se postiže sjetvom od 60000 do 70000 biljaka/ha. Pri manjem sklopu biljaka prinos kukuruza je značajno manji, a sa povećanjem sklopa biljaka prinos kukuruza ostaje na istom nivou.



Graf. 2. Prinos kukuruza (t/ha) u zavisnosti od gustoće usjeva u uvjetima sa i bez navodnjavanja u 2006. godini

Prema Starčeviću i Latković (2004.) optimalna sklop nije stalna veličina već varira iz godine u godinu. U sušnim godinama najbolji sklop je 47000 biljaka po hektaru, a u godinama sa povoljnim količinama i rasporedom padavina optimalni sklop je 57000 biljaka po hektaru, što se slaže sa našim rezultatima.

Zaključak

Navodnjavanje je skromno povećalo prinose zrna kukuruza u povoljnoj 2005. godini 5,03% i u 2006. godini 15,96 %. Obe godine su bile povoljne za uzgoj kukuruza posebno se to odnosi na količine i raspored padavina. U uvjetima navodnjavanja najveći prinosi zrna kukuruza postignuti su pri sklopu od 60.000 do 70000 biljaka po hektaru, a sa daljim povećanjem broja biljaka prinos je ostao na istom nivou. Na kontrolnoj parceli bez navodnjavanja sa povećanjem broja biljaka, prinos nije značajno rastao iznad 50.000 biljaka po hektaru.

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Abstract

Maize yield depending on various plant densities in irrigated and nonirrigated conditions

Technology of corn production, as well as plant density as its constitutive element, should be adjusted to plant needs in irrigated conditions. A two year field trials were carried out at Institute of Field and Vegetable Crops, Novi Sad, in Rimski Sancevi, in 2005-2006. The main goal of the study was to determine the effect of plant density on yield in conditions with and without irrigation. Hybrid NS 6010, FAO 600 was used at five plant densities (50000 plants per hectar – G1, 60000 plants per hectar – G2, 70000 plants per hectar – G3, 80000 plants per hectar – G4 i 90000 plants per hectar – G5) depending on a variant with 70 cm between row. Sprinkler irrigation was applied at pre-irrigation soil moisture 60 % of the field water capacity, which is equal to lentocapilary moisture. The control non-irrigated plot was also included. Yield increase by irrigation was modest, up to 15.96 %, due to favorable weather conditions during corn vegetation. Plant density increase up to 60000 - 70000 plants per hectare, in irrigated conditions, increased the yield, but with further plant density increase, corn yield stagnates. In non-irrigated conditions increase of plant density above 50000 plans per hectare does not affect the yield.

Key words: corn, irrigation, plan density, yield

Izvorni znanstveni rad / Original scientific paper

Novi genotipovi graška zrnaša – značajan čimbenik proizvodnje bjelančevina i energije za domaće životinje

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Sažetak

Cilj rada je bio prikazati proizvodnost zrna, sirovih bjelančevina i nedušičnih ekstraktivnih tvari (NET) kod novostvorenih genotipova graška Poljoprivrednog fakulteta u Osijeku i Poljoprivrednog instituta Osijek. Prinosi zrna novih genotipova graška zrnaša su na svim ispitivanim lokacijama i godinama bili veći od standarda, a na većini lokacija i godina statistički značajno veći. Prinos zrna novih genotipova je ovisno o lokaciji i godini dostizao vrijednosti i veće od 6 t/ha (na bazi 14 % vlage). Koncentracija bjelančevina u suhoj tvari zrna je bila 22,4 %, a koncentracija NET-a 66,6 %. Utvrđeno je da novi genotipovi graška zrnaša imaju visok potencijal proizvodnje zrna, bjelančevina i nedušičnih ekstraktivnih tvari po jedinici površine čime se omogućuje da ovaj usjev postaje sve važniji čimbenik u proizvodnji bjelančevina i energije za domaće životinje.

Ključne riječi: grašak, prinos zrna, bjelančevine, energija

Uvod

Suho zrno graška (*Pisum sativum* L.) su mnogi autori ocijenili kao koncentrirano bjelančevinasto-energetsko krmivo prikladno za hranidbu svih vrsta i kategorija domaćih životinja (Hickling, 2003.) s prosječnim sadržajem bjelančevina oko 23 %, škroba oko 46 % i niskim sadržajem antinutritivnih tvari, prikladnim za korištenje bez termičke obrade. Samodostatnost, smanjenje emisije CO_2 i potrošnje fosilnih goriva, smanjenje emisije pesticida u okoliš, izbjegavanje sirovina porijeklom iz GMO usjeva i oslanjanje farmi na vlastite inpute prepoznati su kao važni ciljevi kako od strane tvoraca agrarne politike tako i od samih gospodarskih subjekata u poljoprivredi. Pri postizanju takvih ciljeva grašak zrnaš može dati višestruki doprinos, a Marohnić (2006.) ga smatra budućim bjelančevinastim krmivom Europe zbog više razloga: 1) veća domaća proizvodnja graška smanjila bi potrebu za uvozom sojine sačme iz predjela gdje prevladavaju GMO usjevi; 2) grašak usvaja simbiotki fiksiran N za svoje potrebe i ostavlja u tlu za naredne usjeve; 3) grašak dospijeva za žetvu početkom srpnja kada je rijetko potrebno trošiti energente za dosušivanje zrna prije skladištenja; 4) zrno nije potrebno termički obrađivati prije korištenja u ishrani pa se isključuje potrebu za investicijama u dodatnu opremu; 5) prinosi zrna graška u

Europi su viši i s manjim varijacijama među godinama u odnosu na soju; 6) grašak zrnaš ima jednostavnu agrotehniku koju može usvojiti svako gospodarstvo. Navednom je potrebno dodati i da se vegetacija graška odvija u hladnijem dijelu godine u odnosu na soju uslijed čega je znatno manja pojava ljetnih tzv. tvrdih korova (*Abuthilon theophrastii, Xanthium strumarium, Datura stramonium*) i posljedično je lakša i jednostavnija zaštita graška od korova i manja emisija herbicida u okoliš.

Na prinos zrna utječe genotip, okolina i interakcija genotipa i okoline. Stoga je od velike važnosti odabir sorata prilagođenih lokalnim agroekološkim uvjetima. Veliki je broj ispitivanja o utjecaju čimbenika okoline, tipa tla i kultivara na prinos zrna (Biarnes-Dumoulin, 1996., Siddique i sur., 2001., Čupić i sur., 2003. i 2008., Gantner i sur., 2008.). Iz toga proizlazi i radna hipoteza da su sorte najbolje prilagođene okolinama u kojima su stvorene. U svim uzgojnim područjima graška u svijetu, razvijaju se vlastiti oplemenjivački programi, tako i u Republici Hrvatskoj ima više oplemenjivačkih programa graška. Cilj rada je prikazati proizvodnost zrna, sirovih bjelančevina i nedušičnih ekstraktivnih tvari (NET) kod novostvorenih genotipova graška Poljoprivrednog fakulteta u Osijeku i Poljoprivrednog instituta Osijek.

Materijal i metode

U radu su prikazana ispitivanja dva seta genotipova. Prvi set se sastojao od novog genotipa »PF-G1« (kreacija Poljoprivrednog fakulteta u Osijeku i Poljoprivrednog instituta Osijek, u postupku priznavanja) i standarda - sorte »Santana«, ispitivanih na tri lokacije (Osijek, Kutjevo, Zagreb) tijekom 2007., 2008. i 2009. godine, po slučajnom bloknom rasporedu u pet ponavljanja. Pri tome su analizirana gospodarska svojstva: prinos zrna (preračunat na 14% vlage), vlaga zrna u žetvi, koncentracija sirovih bjelančevina u zrnu (množenjem koncentracije dušika dobivene po Kjeldahl metodi koeficijentom 6,25, samo u 2008. godini na lokaciji Osijek) i koncentracija NET u zrnu (kao NET% = 100% - koncentracija bjelančevina % - koncentracija pepela % - koncentracija sirovih vlakana %, utvrđenih standardnom metodom po AOAC, također samo u 2008. godini na lokaciji Osijek). Statistička obrada vrijednosti prinosa provedena je analizom varijance. Značajnost razlika među prosječnim prinosima utvrđena je LSD testom. Drugi set genotipova sastojao se iz sedam novostvorenih genotipova (G-09-1 do G-09-7, kreacije Poljoprivrednog fakulteta Osijek i Poljoprivrednog instituta Osijek) i standarda – sorte »Gold«, koji su ispitivani u Osijeku tijekom 2008. i 2009. godine po slučajnom bloknom rasporedu u tri ponavljanja. Veličina pokusne parcelice je bila 5 m^2 (5m×1m). Analizirano je svojstvo prinosa zrna, metodom analize varijance, a značajnost razlike prosjeka prinosa novih genotipova u odnosu na standard testirana je LSD testom (Vasilj, 2000.).

Rezultati i rasprava

Kod trogodišnjeg trolokacijskog ispitivanja novi genotip »PF-G1« je ostvario visoku proizvodnost zrna po jedinici površine, u opsegu od 2,97 t/ha u nepovoljnoj okolini do 6,05 t/ha u povoljnoj okolini (Tablica 1.). Prosječni prinos genotipa »PF-G1« je bio uvijek veći od standarda »Santane«, a statistički značajno veći je bio na svim lokacijama i godinama osim na lokaciji Kutjevo u 2008. i Zagreb 2009.

Kod dvogodišnjeg ispitivanja sedam novih genotipova (G-09-1 do G-09-7) sa standardom »Gold« na lokaciji Osijek, novi genotipovi ostvarili su prosječne prinose zrna u opsegu 3,44 do 5,48 t/ha (Tablica 2.). Prosječni prinosi zrna novih genotipova su bili iznosom veći od standarda u obje godine ispitivanja. U 2008. godini značajno veći prinos zrna u odnosu na standard imali su svi novi genotipovi osim G-09-7, a u 2009. godini svi osim G-09-5 i G-09-7.

Tablica 1. Prosječni prinosi novog genotipa »PF-G1« u odnosu na standard »Santanu« u trogodišnjem trolokacijskom pokusu

Šifra	Godina	Lokacije						Prosjek (t/ha)
		Osijek		Kutjevo		Zagreb		
»Santana«	2007	3,896		4,547		4,438		4,294
	2008	4,524		4,961		4,809		4,765
	2009	3,644		5,362		2,855		3,953
	Prosjek	4,021		4,957		4,034		4,337
»PF-G1«	2007	4,087	**	5,109	*	5,021	**	4,739
	2008	6,015	**	5,201	ns	5,783	*	5,666
	2009	3,967	*	6,048	**	2,969	ns	4,328
	Prosjek	4,690		5,453		4,591		4,911
LSD 2007	LSD 5%	0,087		0,527		0,342		
	LSD 1%	0,132		0,798		0,518		
LSD 2008	LSD 5%	0,518		0,750		0,841		
	LSD 1%	0,785		1,136		1,274		
LSD 2009	LSD 5%	0,311		0,276		0,352		
	LSD 1%	0,471		0,418		0,534		

Ostvareni prinosi zrna novih genotipova u oba pokusa bili su u skladu s rezultatima Čupića i sur. (2003.), Stjepanovića i sur. (2006.), i Gantnera i sur. (2008.).

Tablica 2. Prosječni prinosi novih genotipova u odnosu na standard »Gold« na lokaciji Osijek u dvogodišnjem pokusu

	Prosječni prinos t/ha	
Šifra	2008	2009
G-09-1	5,48**	3,86*
G-09-2	5,37**	3,75*
G-09-3	4,85*	3,97*
G-09-4	4,97*	3,87*
G-09-5	4,81*	3,49 ns
G-09-6	4,92*	3,98*
G-09-7	4,58 ns	3,44 ns
»Gold«	3,96	3,06
$LSD_{0,05}$	0,67	0,73
$LSD_{0,01}$	0,93	1,02

Prema rezultatima analize kvalitete zrna, novi genotip »PF-G1« imao je koncentraciju bjelančevina 22,36 % i NET-a 66,6 % u suhoj tvari zrna, što je bilo slično standardnoj sorti »Santana« (Tablica 3.). Koncentracije bjelančevina i NET-a u suhoj tvari zrna bile su u skladu s rezultatima brojnih istraživanja (Hickling, 2003.), dok su Stjepanović i sur. (2006.) utvrdili znatno veću koncentraciju bjelančevina kod sorte »Gold«, 27 % u suhoj tvari zrna. Ovakva razlika je vjerojatno proizašla iz povoljnih okolinskih uvjeta tijekom 2005. godine što je pogodovalo nakupljanju bjelančevina u zrnu.

Sadržaj vlage u zrnu kod novog genotipa »PF-G1« u vrijeme žetve bio je 12,6 % što je bilo niže od standardne sorte. Sadržaj vlage i kod genotipa »PF-G1« i kod standarda »Santane« bio je povoljan za skladištenje zrna bez dosušivanja i u skladu je s podacima Marohnića (2006.).

Tablica 3. Svojstva kvalitete zrna graška (Osijek, 2008.)

Šifra	Vlaga zrna %	Bjelančevine u ST %	NET u ST %
»Santana«	13,13	22,83	66,79
»PF-G1«	12,60	22,36	66,58

Uz ostvarene visoke prinose zrna novih genotipova ovisno o godini i lokaciji, s pripadajućim koncentracijama bjelančevina i NET-a u suhoj tvari zrna, moguće je ostvariti visoke prinose sirovih bjelančevina (563 do 1216 kg/ha) i NET-a (1634 do 3356 kg/ha) po jedinici površine. Na osnovu utvrđenih vrijednosti prinosa zrna, bjelančevina i NET-a i već poznatih prednosti vezanih uz očuvanje okoliša možemo tvrditi da će rasti važnost graška kao visokovrijednog usjeva u proizvodnji bjelančevina i energije za hranidbu domaćih životinja u Republici Hrvatskoj.

Zaključak

Prosječni prinosi zrna novih genotipova graška zrnaša kretali su se u opsegu 2,97 do 6,05 t/ha i na svim ispitivanim lokacijama i godinama bili su veći od standarda, a na većini ispitivanih lokacija i godina bili su statistički značajno veći od standarda. Koncentracija bjelančevina u suhoj tvari zrna kod novog genotipa »PF-G1« bila je 22,4 %, a koncentracija NET-a 66,6 %, što je bilo slično standardu. Istraživanjem je utvrđeno da novi genotipovi graška zrnaša imaju visok potencijal proizvodnje bjelančevina i nedušičnih ekstraktivnih tvari po jedinici površine, što uz brojne prednosti vezane uz očuvanje okoliša upućuje na potrebu veće zastupljenosti ovog usjeva u proizvodnji bjelančevina i energije za ishranu životinja.

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Abstract

New dry pea genotypes – the valuable contribution to protein and energy production for feeding livestock

Aim of the work was to present the grain, protein and nitrogen-free extract (NFE) yield of new dry pea genotypes created at the Faculty of Agriculture in Osijek and Agricultural Institute Osijek. Grain yields of all new genotypes were greater than yield of standard variety at all investigated locations and years, and at most of them were significantly greater. New genotypes have reached the grain yields greater than 6 t/ha (based on 14 % grain moisture) at certain locations and years. Achieved crude protein concentration was 22,4 %, and NFE 66,6 % in grain dry matter. The high grain, protein and NFE production potential of new genotypes was approved, what brings this crop to an increasingly important contributor to protein and energy production for feeding livestock.

Key words: dry pea, grain yield, protein, energy

Izvorni znanstveni rad / Original scientific paper

Grain yield and stability parameters of ZP maize hybrids

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Abstract

The Maize Research Institute, Zemun Polje, has been conducting macro trials since 2002 in different agroecological regions in Serbia. Productivity of hybrids belonging to the maturity groups FAO 300-700 was observed in these trials. Five hybrids were tested in 14 locations in Serbia for a period of two years, in order to determine yield potential and stability of the tested hybrids. In 2008 and 2009, the highest average grain yields were recorded in the following hybrids: ZP 505 (9.888 t ha^{-1}) and ZP 434 (9.775 t ha^{-1}). The highest yields were achieved in the areas of Srem and Bačka with ZP-505 performing best in both mentioned areas, while yields in Central Serbia and Banat were slightly lower. In less favourable regions, the best results were detected in ZP 434. Values of the regression coefficient indicate a good adaptation of high yielding hybrids to favourable growing conditions.

Key words: maize hybrids, grain yield, stability

Introduction

Maize is grown on approximately 60% of arable fields (1,200,000 ha) in Serbia. In contrast to sunflower and soya bean whose areas vary over years, maize, due to its economic importance, is cultivated on established areas.

The aim of each breeder is to develop maize with a high genetic potential of yield. Grain yield depends on genetic constitution of hybrids, and even more on the ability of hybrids to »resist" limiting environmental factors (Stojaković et al., 2002). However, genetic yielding potential is used with 30-45% in dependence on a hybrid and a maturity group. In order to provide a stable and more qualitative maize production, an adequate selection of maize hybrids for certain locations is necessary (Jovin et al., 2002).

Genotype-by-environment (GE) interaction presents the response of genotypes evaluated under different environmental conditions. This is a complex phenomenon as it involves environmental (agro-ecological, climatic and agronomic) conditions and all physiological and genetic factors that determine the plant growth and development (Mohammadi, 2009).

The objective of the present study was to determine via production trials the highest and most stable yields of ZP hybrids in different agroecological maize growing regions of Serbia. Based

on performed trials it is possible to reliably determine a regular regional distribution of ZP hybrids over different production regions.

Material and Methods

Five maize hybrids of different FAO maturity groups were used in this study (ZP-341: FAO 350, ZP-434: FAO 400, ZP-505: FAO 500, ZP-544: FAO 550, ZP-684: FAO 650). All of these hybrids are commercial and widely grown in Serbia.

Macro trails set up in 14 locations were carried out during the two-year period with no replication. Selected locations represent main maize production areas in Serbia. The elementary plot size was 0.1 ha. Sowing and harvesting were mechanised. Samples for the moisture content analysis were drawn during the harvest. Hybrids were sown at different densities: FAO 300-400: 70,000 plants per hectare, FAO 500: 65,000 plants per hectare and FAO 600: 60,000 plants per hectare. Grain yield data converted to t ha^{-1} at a 14% moisture level are presented in this paper.

Stability parameters were estimated by models of Eberhart and Russel (1966).

As described by Eberhart and Russell (1966), the behaviour of the cultivars was assessed by the model $Y_{ij} = m + b_i I_j + d_{ij} + e_{ij}$, where Y_{ij} = observation of the i^{th} (i = 1, 2, ..., g) cultivar in the j^{th} (j = 1, 2, ...n) environment, m = general mean, b_i = regression coefficient, I_j = environmental index obtained by the difference among the mean of each environment and the general mean, d_{ij} the regression deviation of the i^{th} cultivar in the j^{th} environment and e_{ij} = effect of the mean experimental error (Scapim et al., 2000).

The regression coefficient (bi) measures the response of genotypes to environments. When b_i=1 there is an average stability and adaptability to both, poor and good environments; when b_i>1 genotypes give above average stability only in good environments. Whereas, b_i<1 indicates that genotypes are better adapted to poor environments (Aremu et al, 2009).

Results and Discussion

According to the two-year results, it can be concluded that both years had good conditions for the maize production although a lower level of precipitation was recorded compared to the multi-year average. In 2009, recorded yields were greater than those recorded in the previous year.

The average grain yield per year ranged from 8.967 t ha^{-1}in 2008 to 9.914 t ha^{-1} in 2009 (Table 1).

Table 1: Grain yield of observed hybrids during the two-year period in 14 locations in Serbia

Hybrid	2008	Rank	2009	Rank
ZP-341	8.653	5	9.912	3
ZP-434	9.187	2	10.364	2
ZP-505	9.372	1	10.404	1
ZP-544	8.742	4	9.605	4
ZP-684	8.879	3	9.283	5
Average	8.967		9.914	

The main two-year grain yield of hybrids ranged from 9.081 t ha^{-1} (ZP-684) to 9.888 t ha^{-1} (ZP-505). Early to medium maturity hybrids ZP-341 and ZP-434 had very good grain yields, better than late maturity hybrid ZP-684 and medium maturity hybrid ZP-544 (Table 2). Better performance of the earlier maturity hybrids can be explained by their shorter vegetation period. These hybrids go earlier through critical periods of their growth and are able to escape the periods of drought.

Table 2: Two-year grain yield of observed hybrids obtained in different areas in Serbia

Hybrid	Bačka	Srem	Banat	C. Serbia
ZP-341	9.880	10.095	7.747	8.729
ZP-434	10.306	10.696	8.609	9.213
ZP-505	10.731	11.059	8.234	8.888
ZP-544	9.767	9.570	8.093	8.564
ZP-684	9.788	9.615	7.642	8.069
Average	10.094	10.207	8.061	8.693

Maize yields varied over growing areas. During the two year period, the highest yields were recorded in the areas of Srem (10.207 t ha^{-1}) and Bačka (10.094 t ha^{-1}). The greatest performance was achieved by the ZP 505 hybrid. In the growing areas of Banat and Central Serbia, due to less favourable growing conditions, average yields were slightly lower with ZP 341 achieving highest yields in both areas (Table 2.).

Table 3: Average grain yield for the 2008-2009 period and stability parameters for observed hybrids

Hybrid	Grain yield	Rank	bi	Rank
ZP-341	9.283	3	0.99	1
ZP-434	9.775	2	1.03	3
ZP-505	9.888	1	1.04	4-5
ZP-544	9.174	4	0.98	2
ZP-684	9.081	5	0.96	4-5
Average	9.440		1.00	

Values of the regression coefficient b_i indicates that the highest performing hybrids (ZP 505 and ZP 434) have a high level of adaptation to favourable growing conditions but didn't express highest stability. ZP 341 expressed the most stable yields, while later maturity group hybrids showed better adaptability to less favourable growing conditions. These results are not in agreement with the results obtained by Pavlov et al. (2011) who determined better adaptability of the later maturity group hybrids to favourable growing conditions.

Conclusion

Based on the results gained in this study it can be concluded that in years with optimal weather conditions mid-early to mid-late hybrids will generate the highest yield.

Both years, in which trials were conducted, had favourable growing conditions.

Trial results show that the average yields varied over production regions and a recommendation for an appropriate choice of hybrids should be given for each area.

The application of statistical models for assessing yield stability can be useful when giving recommendations for growing certain hybrids.

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Sažetak

Urod zrna i parametri stabilnosti ZP hibrida kukuruza

Institut za kukuruz Zemun Polje provodi od 2002. godine makropokuse u različitim agroekološkim regijama Srbije. Produktivnost hibrida koji pripadaju grupi zriobe FAO 300-700 bili su praćeni u ovim pokusima. Pet hibrida bilo je testirano na 14 lokaliteta u Srbiji tijekom razdoblja od dvije godine, s ciljem determinacije potencijala uroda i stabilnosti testiranih hibrida. Tijekom 2008. i 2009. godine najviši prosječni prinos zrna zabilježen je na slijedećim hibridima: ZP 505 (9.888 t ha^{-1}) i ZP 434 (9.775 t ha^{-1}). Najviši prinosi bili su postignuti na područjima Srijema i Bačke s hibridom ZP-505 koji se pokazao najboljim u oba spomenuta područja, dok su prinosi u centralnoj Srbijij i Banatu bili nešto niži. U slabije pogodnim područjima, najbolji rezultati bili su zabilježeni za hibrid ZP 434. Vrijednosti koeficijenta regresije ukazuju na dobru adaptibilnost visokoprinosnih hibrida u uvjetima koji su pogodni za rast.

Ključne riječi: hibridi kukuruza, urod zrna, stabilnost

Izvorni znanstveni rad / Original scientific paper

Soybean cultivars with reduced level of anti-nutritional factors in grain

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Abstract

The presence of protease inhibitors prohibits the utilization of the raw beans for food and feed. Breeding of soybean cultivars for reduced amount of anti nutritional factors at Maize Research Institute Zemun Polje resulted in development of two new Kunitz-free cultivars – Lana and Laura. In order to investigate changes of Kunitz trypsin inhibitor (KTI) content under the N-fertilization treatments, soybean KTI varieties Lana and Laura and variety Vojvodjanka (standard grain type) were evaluated for TI content in field trials. Nitrogen application which caused an increase in seed protein content resulted in TI concentration reduction. Feeding trials with pigs in different growth stages fed mixtures with raw and extruded standard and KTI-free soybean cultivars were aimed at estimating the nutritional value of new cultivars. The greatest improvement in growth performance was noted for the group fed extruded KTI-free soybean. New cultivars are suitable for thermal processing at lower temperatures and during a shorter period of time, which gives a new opportunity for saving energy and preserving valuable nutritional composition of soybean.

Keywords: soybean, Kunitz trypsin inhibitor, N-aplication, feeding trials

Introduction

The protease inhibitors in soybean - Kunitz trypsin inhibitor (KTI) and the Bowman–Birk inhibitor (BBI) constitute at least 6% of the protein present in soybean seed (Ryan, 1973) and with lectin, represent the main anti nutritional factors of soybeans. Approximately, 80% of the trypsin inhibition is caused by KTI (Brandon, 1993), which strongly inhibits trypsin, and therefore, reduces protein digestibility and food intake. Beside that, KTI is responsible for hypersecretion of pancreatic enzymes, leading to demands of sulphur-containing amino acids and alongside previous, resulting in growth depression in non ruminant animals. Due to this, row soybean can not be used for animal feeding and needs to be heat-processed to eliminate thermo-labile anti nutritional factors. Heat processing inactivates anti nutritional factors and modifies the structure of the proteins, making them more available for digestion. Despite the efficiency of thermal treatment to reduce protease inhibitors, residual inhibition (10-20%) is maintained (Carvalho et al., 1998). Furthermore, excessive heat treatments (uncontrolled temperature; long period of time) may decrease protein solubility and lower amino acid availability. Soybean lines with reduced protease inhibitor content could reduce or eliminate the

need for expensive heat treatments and lessen the chance of lowering amino acid availability. A part of the breeding program of Maize Research Institute »Zemun Polje« is aimed at developing soybean cultivars with reduced trypsin inhibitors content. As a result of breeding for this trait, two Kunitz-free (KTI free) varieties Lana and Laura were released. TI content in new cultivars was about 50% reduced as compared with the conventional cultivars (standard grain type). Like other quantitative seed quality characteristics, TI content is subject to considerable environmental variation and highly depends on fertilisation. Nitrogen application leads to an increase in seed protein content and reduction in TIA by about 15% as compared with the control (Vollman et al., 2003). Numerous studies investigated effect of soybean variety and processing on growth performance of pigs *(Cook et al., 1988, Palacios et al., 2004)* and demonstrated that inclusion of raw Kunitz-free soybean in diet was beneficial in terms of better growth performance compared with conventional cultivars, but still inferior to the growth performance obtained by soybean meal, where the KTI and other anti nutritional factors are inactivated by heating. Regarding previous issues, present study was carried out to 1. Get more insight into environmental variation of TI content and find out an appropriate agronomic management for new cultivars 2. Estimate the nutritional value of new cultivars in feeding trials with pigs and determine whether raw Kunitz-free soybean cultivars could be fed successfully to pigs in different stages of development.

Materials and method

Soybean Kunitz-free genotypes Laura and Lana, and cultivar Vojvođanka (standard grain type) were evaluated for trypsin inhibitor content depending on fertilization treatments. A trial was carried out on chernozem in the experimental field of the Maize Research Institute »Zemun Polje«, at Zemun polje, during 2008. The experiment was laid out in a split plot with five treatments: control, without fertilizer; P60K60 (60 kg ha^{-1} P_2O_5 and 60 kg ha^{-1} K_2O, T_1), N30P60K60 (30 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5 and 60 kg ha^{-1} K_2O, T_2), N60P60K60 (60 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5 and 60 kg ha^{-1} K_2O, T3), N90P60K60 (90 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5 and 60 kg ha^{-1} K_2O, T_4). The aim of the treatmens was to create different conditions in terms of nitrogen supply during plant growth and development. The content of trypsin inhibitors was estimated according to a *modified Erlanger method* (Hamerstrand et al., 1981). Seed protein contents were determined by near-infrared reflectance spectroscopy (NIRS) using Infratec 1241 Grain analyzer (Foss Tecator, Sweden). Relationship between protein and trypsin inhibitor content was determined with Spearman's rank correlation coefficient. During 2008 year, pig experiment was conducted at the »Stari Tamiš« farm, in order to evaluate effect of row soybean on growth performance and health of pigs in growth stage and fattening, and to determine differences in weight gain of animals fed mixtures formulated to contain: 20% grits made by extrusion of standard grain quality soybean (Mixture 1), 20% grits of extruded grain of Kunitz-free soybean cultivars (Mixture 2), 20% row Kunitz-free soybean cultivars (Mixture 3). Sample was consisted of 14 animals per each mixture, with beginning body weight 23 kg. Individual daily weight gain (DWG) of pigs was recorded in two stages: Stage 1 (body weight of feeders 56,35 kg, 55,60 kg and 52,12 kg, for Mixture 1, Mixture 2 and Mixture 3, respectively) and Stage 2 (finishing body weight 110,35 kg, 116,60 kg and 103,73 kg, for Mixture 1, Mixture 2 and Mixture 3, respectively).

Results and discussion

A considerable variation in seed protein content and trypsin inhibitor concentration depending on fertilization treatment is shown in Table 1. Protein content in seeds of analysed geno-

types progressively increased with increasing levels of nitrogen up to 60 kg N ha^{-1} which is in accordance with the results of similar studies (Kumawat et al., 2000).

Trypsin inhibitor content was clearly influenced by the treatments applied (Table 1). As expected, the lowest TI content was detected in Laura and Lana, KTI-free cultivars. Rank values showed TI concentration was affected by N-application identically in both Kunitz-free and standard grain type cultivars. The highest level of this inhibitor was found in control, whereas the lowest concentration was detected in N90 P60 K60 treatment, for all observed genotypes. This suggests that TI content could be reduced by nitrogen application up to the certain level. Decrease in inhibitor level can be explained as the dilution effect: while total protein content is increased owing to the availability of additional nitrogen, protease inhibitors are expressed on more constant level, and therefore TI content per unit of protein meal is reduced relatively (Vollman et al., 2003). In our study, Spearman's rank correlation coefficients (rs) between protein and TI content of three cultivars showed negative and strong correlation, according to the conclusion of previous study.

Table 1: Protein and TI content ranking of 3 soybean cultivars under different N-treatment.

Genotype	Treatments	N0 P60K60	N30 P60K60	N60 P60K60	N90 P60K60	control	rs*
Lana	Protein Content (%)	36,57	36,75	37,18	36,58	36,56	-0.7
	Rank	4	2	1	3	5	
	Trypsin inhibitor (mgg^{-1})	15,26	15,24	14,67	14,54	15,35	
	Rank	2	3	4	5	1	
Laura	Protein Content (%)	37,37	37,42	37,64	37,51	37,31	-0.9
	Rank	4	3	1	2	5	
	Trypsin inhibitor (mgg^{-1})	14,73	14,38	14,28	14,05	15,01	
	Rank	2	3	4	5	1	
Vojvodjanka	Protein Content (%)	36,49	36,57	36,89	36,77	36,02	-0.8
	Rank	4	3	1	2	5	
	Trypsin inhibitor (mgg^{-1})	31,04	30,07	29,9	29,37	31,21	
	Rank	3	2	4	5	1	

*rs: Spearman's rank correlation coefficient

Table 2: Daily weight gain (g) of three groups of pigs fed different mixtures

	Mixture 1 (extruded standard cult.)	Mixture 2 (extruded KTIfree)	Mixture 3 (raw KTI-free)
1 Stage	641	623	562
Index %	100,00	97,19	87,67
2 Stage	794	897	759
Index %	100,00	112,97	95,59
Sum	728	778	674
Index %	100,00	106,87	92.58

Growth performance data from the pig experiment showed that the best daily weight gain of pigs was achieved for the group fed mixture with extruded KTI-free soybean cultivar (Mix.2) in Stage 2. This group performed the best overall growth rates (Index=106,87%). Feeding raw KTI-free soybean (Mix. 3) to pigs depressed daily weight gain by 14,29% as compared with DWG achieved by pigs fed extruded KTI-free cultivar (Mix. 2). Growth depression could be explained by other heat-labile anti nutritional factors present in raw soybeans – Bowman-Birk trypsin inhibitor and lectin. Previous results suggest that simple removal of Kunitz inhibitor without any intervention upon Bowman-Birk inhibitor, although allowing a reduction of processing costs (Friedman et al, 1991) does not appear to solve a problem of direct livestock nutrition. On the other hand, DWG achieved by pigs fed raw soybean slightly depressed by 7,42% as compared with DWG of pigs fed extruded standard soybean (Mix.1). This suggests that Kunitz-free varieties may present good solution for small farms with direct feed production and animal growing, especially for the regions where the processing industry is not developed. Additionally, KTI free soybean can still offer nutritional advantages, since it needed a shorter heating time for inactivation of trypsin inhibitors (Friedman et al., 1991) and such varieties might be processed more economically into human foods, as well. Furthermore, DWG of pigs fed Mix. 1, Mix. 2 and Mix.3 differed in different stages of pig's development (Stage 1 and Stage 2), suggesting that the effect of Kunitz trypsin inhibitor is age dependant, and might be more harmful for young animals than for adults, which is in accordance with the results obtained by Baker, 2000.

Conclusion

Present results showed that nitrogen application have influenced protease inhibitor content leading to its reduction. This suggests that appropriate agronomic management could probably minimise the need for postharvest treatment of soybean grain and reduce the overall meat production costs. Although nutritional value of raw KTI-free soybean varieties is diminished by other heat-labile factors present in grain, such varieties might be processed more economically – shorter heating time and lower temperature, or utilized in extensive farming systems.

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Sažetak

Kultivari soje sa smanjenim sadržajem anti-nutritivnih faktora u zrnu

Prisutnost inhibitora proteaze sprječava korištenje sirovih zrna za ljudsku i stočnu ishranu. Oplemenjivanje kultivara soje na smanjenu razinu anti-nutritivnih faktora na Institutu za kukuruz Zemun Polje rezultiralo je razvojem dva nova »Kunitz-free« kultivara - Lana i Laura. U istraživanju promjena sadržaja Kunitz tripsin inhibitora (KTI) kod različitih tretmana gnojidbe dušikom, kod KTI sorti Lana i Laura te sorte Vojvođanka (standardni zrnati tip) ocjenjivan je sadržaj TI u poljskim pokusima. Primjena dušika koja je utjecala na povećanje sadržaja bjelančevina u zrnu rezultirala je u smanjenju sadržaja TI. Hranidbeni pokusi na svinjama u različitim stadijima uzrasta hranjenim s mješavinama sirovog i prerađenog standarda te bez-KTI kultivara soje služili su za procjenu nutritivne vrijednosti novih kultivara. Najveći napredak u rastu zabilježen je za grupu hranjenu prerađenom bez-KTI sojom. Novi kultivari su prikladni za termičku obradu pri nižim temperaturama i kraćim vremenom obrade, što daje nove prilike uštedi energije i očuvanju vrijednih nutritivnih sastojaka soje.

Ključne riječi: soja, Kunitz tripsin inhibitor, gnojidba dušikom, hranidbeni pokusi

Izvorni znanstveni rad / Original scientific paper

Evaluation of ZP maize hybrids as double crops

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Abstract

Double-crop systems have the potential to generate additional feedstocks for bioenergy and livestock utilization, and also to reduce NO3–N leaching relative to sole-crop systems. Four early maturity ZP maize hybrids was selected to evaluate the potential for grain and biomass production under double-cropping conditions. The dry matter production, grain yield and harvest index were investigated. The hybrid ZP172 has the highest total and biomass fresh weight as well as total and biomass dry matter. Harvest index differ between hybrids. The highest harvest index has hybrid ZP173 and this hybrid is good for grain, as well as hybrid ZP172 with the lowest harvest index is good for biomass production.

Keywords: maize, biomass, double cropping, harvest index

Introduction

Agriculturally derived biomass is a potentially abundant feedstock capable of providing a renewable supply of energy, fuels, and commodity chemicals with reduced greenhouse gas emissions relative to petrochemical alternatives (Perlack et al., 2005; Farrell et al., 2006). However, producing the enormous quantities of biomass beside maintenance adequate levels of food production, conservation of natural resources and preservation of environmental quality, is big challenge (Cassman and Liska, 2007). Therefore, one of the greatest obstacles confronting biomass production for industrial utilization is the development of cropping systems that balance the need for increased productive capacity with the maintenance of other critical ecosystem functions (Fales et al., 2007).

The second crops, planted mostly in the summer after winter crops are traditionally used for food, forage (grain, silage), green manuring and bee pasture, and more recently use to produce a biomass for energy. In such a system, two crops are harvested in a single year. Land by sowing of double crops is systematically exploited and in some way soil quality is build-up and the soil tilth is maintenance (Stipešević et al., 2005), as well as soil protection against environmental deterioration, soil nutrients and moisture accumulation and conservation (Karlen and Doran, 1991) and there is no overlap of use of agricultural land to meet the needs for food and bioenergy. Growing double crops ensures maximum utilization of productive capacities per area unit, and clearly involves a high level of growing technology.

Production of double crops requires the right choice of crops and production technology, as it relates to the part of the year when the lack of rainfall is frequent. Maize as one of the main

agricultural crops in regions is also a suitable raw materials for a bioethanol production (Drinic et al., 2011). Pejic (1994) points out that different hybrids FAO 100 and 200 from double cropping can enter the phase of full of wax maturity before the first autumn frosts. According to the same author, in some growing regions of our country, this phase of maturity can reach and some late maturity hybrids FAO 300. The aim of this study was to evaluate four early maturity ZP maize hybrids as double crop, planted after winter wheat, for production of biomass that further could be use as lignocelluloses raw material for ethanol production.

Material and methods

Immediately after harvest of winter wheat was carried out basic processing and preparing land for planting. Field plots were arranged in a randomized complete block design with three replications on chernozem in the experiment field of the Maize Research Institute, Zemun Polje, in the vicinity of Belgrade. The four early maturing hybrids ZP161, ZP172, ZP173, ZP196 was sown on July 8th. A total of 200 kg Urea per hectare (approximately 90 kg a.i. N) was incorporated with the seedbed preparation. The elementary plot size amounted to 8,06m^2. Planted density was 79,000 plants ha^{-1}. **At physiological maturity plants were harvested.** The samples were weight and oven-dried to determine DM. Crop yield data were presented in terms of biomass and grain components, where biomass includes all non-grain, lignocellulosic dry matter. Harvest index (HI) is defined as the ratio between ear DM and fodder DM. The obtained results were analyzed using analysis of variance (ANOVA). Linear regression was used for data analysis based on the evalution of correlation coefficients. Effects were considered significant in all statistical calculation if P-values < 0.05.

Results and discussion

To grow a successful maize crop in a double-cropping system, a hybrid must be chosen which will mature more quickly given the later planting as a second crop. Also, as conserving soil moisture is important a fast change between crops must be achieved. Double-cropping systems evaluated in our study included fall-seeded wheat succeeded by maize. Four early maturing hybrids were choosen ZP161 (dent type), ZP172 (semiflint), ZP173 (dent), ZP196 (semiflint).

Total fresh weight was between 928,3g in hybrid ZP161 to 1389,0 g in hybrid ZP172 (Table 1). Biomass fresh weight ranged from 351,4g (ZP161) to 760, 4g (ZP 172). The hybrid ZP172 has the highest total dry matter, 663,9 as well as biomass dry matter, 305,4 g. Hybrid ZP161 has the lowest total dry matter, 616,5 g, as well hybrid ZP196 has the lowest biomass dry matter, 209,7g. Two hybrids ZP161 and ZP173 have similar grain weight 5,56 kg and 5,95 kg, respectively. The lowest grain weight has hybrid ZP196, 4,38 kg and the highest one hybrid ZP172, 6,73 kg. Hybrid ZP172, also, has the highest biomass weight 10,83 kg, hybrid ZP196 has the lowest one 5,76kg and hybrids ZP161 and ZP173 have 7,16 kg and 7,5kg, respectively.

Table 1. Fresh and dry matter of four ZP maize hybrids, grain yield and harvest index

Hybrids	Total fresh weight, g	Total dry matter, g	Biomass fresh weight, g	Biomass dry matter, g	Grain yield t/ha	Harvest index
ZP161	928,3^{a}	616,5^{a}	351,4^{a}	238,1^{b}	5,79^{ns}	0,778 ^{ns}
ZP172	1389,9^{c}	663,9^{b}	760,4^{d}	305,4^{d}	6,59 ^{ns}	0,623 ^{ns}
ZP173	1039,0^{b}	618,7^{a}	494,9^{b}	245,7^{c}	6,16 ^{ns}	0,801 ^{ns}
ZP196	1237,9^{d}	624,6^{ab}	540,9^{c}	209,7^{a}	4,49 ^{ns}	0,759 ^{ns}

Means within a column followed by the same letter are not significantly different at $P < 0.05$

The physiological efficiency of maize plants to convert the total dry matter into grain yield is measured in the forum of harvest index value. The higher the harvest index value, the more will be the physiological effriciency of crops for converting the total dry matter into final grain yield. Heggenstaller et al. (2008) concluded that double crop corn has a lower harvest index compared to sole-crop corn. The high density as well as narrow row managment resulted in reduction of harvest index according to Shapiro and Wortemann, 2006. Hybrids study in our experiment exhibited different harvest indices. The hybrid ZP173 has the highest harvest index 0,801 and hybrid ZP172 the lowest one, 0,623. The high harvest index indicates higher grain content in the forage which increases maize forage palatability, energy level, and digestibility (Woody et al., 1983). The hybrid ZP 172 has good grain weight but in same time very high biomass production, the lowest proportion of grain compared to aboveground biomass, so it has the lowest harvest index. According to Widdicombe et al. (2002) the earlier maturing leafy hybrids produced a significantly lower harvest index than the full season leafy hybrids and the nutridense hybrids. The grain yield varied from 4,49t/ha (hybrid ZP196) to 6,59t/ha (ZP172).

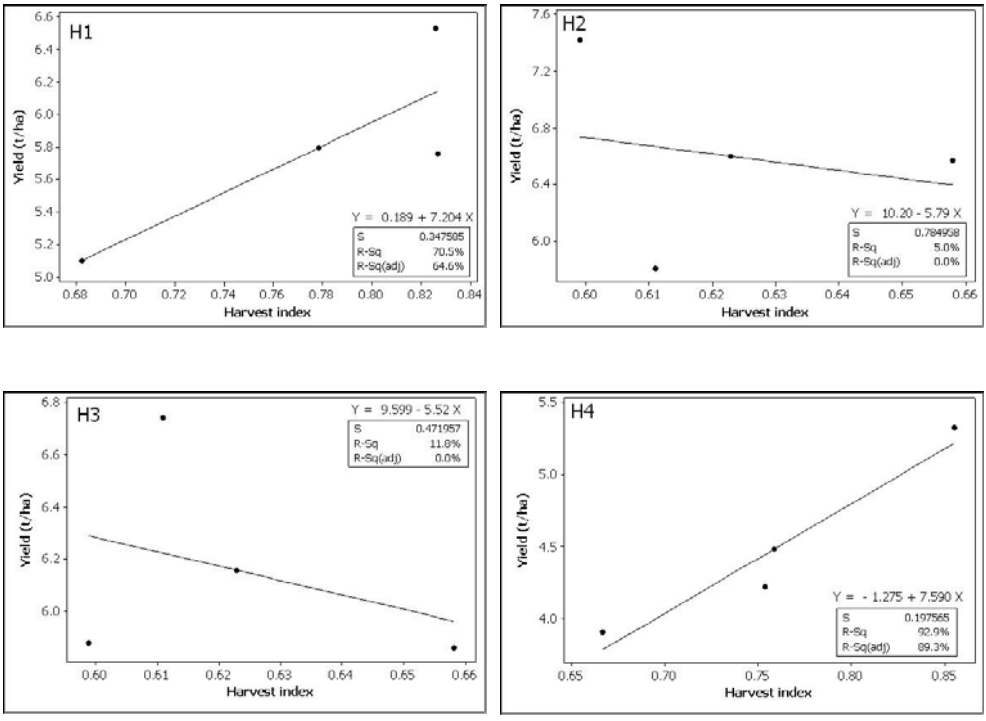

Fig. 1. Effect of harvest index on grain yield. H1 - ZP161, H2 -.ZP172, H3 - ZP173, H4 - ZP196

Regression and correlation analyses of harvest index and grain yield are presented in Figures 1 and Table 2. The response of grain yield to harvest index was linear. As harvest index increased grain yield showed a linear decrease in hybrids ZP 172 and ZP173 and a linear increase in hybrids ZP161 and ZP 196. The high positive correlation coeficient between grain yield and harvest index, r^2=0,9 was for hybrid ZP196. The correlation between grain yield and harvest index for hybrid ZP161 was positive but only moderate in magnitude (r^2 = 0.70).

Table 2. Regression equations for grain yield. Data were regressed against harvest index for four different maize hybrids

Hybrids	Regression equation	R^2
ZP161	y= 0,189x + 7,02	0,70
ZP172	y= 10,20x - 5,79	0,05
ZP173	y= 9,599x - 5,52	0,11
ZP196	y= -1,275x + 7,59	0,92

Conclusion

This is one year experiment so only limited conclusions can be given. The hybrid ZP173 is good for grain production. The hybrid ZP172 has the higest biomass production under double-cropping conditions and potentianally could be used as raw matherial for ethanol production. Given that grain yielding ability will obviously continue to be critical and high stover yield for energy markets might be desirable as well, total biomass yield of maize could be increasingly important and could replace grain yield as the primary trait for selection in some breeding programs.

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Sažetak

Evaluacija ZP hibrida kukuruza kao postrnih usjeva

Sistem postrne sjetve ima potencijal generirati dodatnu masu krme za ishranu stoke, kao i za bio-gorivo, te reduciranje ispiranja NO_3–N u odnosu na samostalni usjev. Četiri ranozrela ZP hribrida kukuruza odabrana su za evaluaciju proizvodnje zrna i biomase u sistemu postrne sjetve. Promatrali su se proizvodnja suhe tvari, urod zrna i indeksi žetve. Hibrid ZP172 je imao najviše ukupne i svježe biomase, kao i ukupnu i masu suhe tvari. Indeks žetve se razlikovao među hibridima. Najviši indeks žetve imao je hibrid ZP173 i ovaj hibrid je bio dobar za zrno, kao što je hibrid ZP172 s najnižim indeksom žetve dobar za proizvodnju biomase.

Ključne riječi: kukuruz, biomasa, postrni usjev, indeks žetve

Section II

feed the plant, protect the nature

hraniti biljku, čuvati prirodu

chairmen / moderatori

1. Irena JUG
2. Boris ĐURĐEVIĆ
3. Srđan ŠEREMEŠIĆ

Pregledni rad / Review paper

Sadržaj teških metala u zrnu uljarica

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Sažetak

Teški metali ne akumuliraju se jednakomjerno u zrnu, listu, stabljici i korijenu. Većina teških metala se više nakuplja u korijenu (Fe, Cr, Pb), stabljici i listu (Hg, Cd), nego u zrnu (Zn). Nakupljanje teških metala u zrnu uljarica može biti korisno kada se radi o metalima koji su esencijalni za ljudsku prehranu (Fe, Zn) ili štetno, kada se radi o metalima koji su toksični u niskim koncentracijama (Cd, Hg). Pravilnik o toksinima, metalima, metaloidima te drugim štetnim tvarima koje se mogu nalaziti u hrani (NN, 2003., 2004.) ističe da sjemenke uljarica smiju sadržavati 0,1 mg Hg kg^{-1}, 0,5 mg Pb kg^{-1} i 0,5 mg Cd kg^{-1} suhe mase. Pravilnikom je određena i maksimalna koncentracija Cd u zrnu soje od 0,2 mg Cd kg^{-1} suhe mase, što je skladu je s graničnim vrijednostima postavljenim Pravilnikom Europske Komisije (EC, 2001.). Nadalje, veće koncentracije toksičnih teških metala u tlu mogu biti fitotoksične i djelovati negativno na rast biljke (Ni, Pb, Cd, Zn).

Ključne riječi: suncokret, soja, zrno, teški metali

Uvod

U pedosferi se nalaze esencijalni teški metali koje biljke zahtijevaju u rastu i razvoju (Fe, Mn, Zn, Cu, Mo, Ni), korisni (Co) i teški metali toksični u niskim koncentracijama (Cr, As, Pb, Hg i Cd), koji remete određene procese u razvoju biljke (He i sur., 2005.). U svijetu se oko 3 milijarde ljudi susreće s problemom manjka esencijalnih teških metala (Fe i Zn) (Welch, 2002.). Procjenjuje se da je gotovo polovina tala na kojima se uzgajaju žitarice slabo opskrbljena sa Zn, što uzrokuje nedostatak Zn u prehrani u kojoj prevladavaju žitarice (Alloway, 2008.). S druge strane, urbanizacija i industrijalizacija, te upotreba mineralnih i organskih gnojiva i pesticida, u poljoprivrednoj proizvodnji dovode do onečišćenja vodnih resursa i zemljišta. Najčešće se kao elementi onečišćenja okoliša zajednički spominju toksični teški metali (Cd, Pb, Hg), te esencijalni (Cu, Zn, Fe, Mn), koji u većim koncentracijama mogu biti toksični. Posebno su štetni toksični teški metali koji akumulacijom u biljne organizme ulaze u hranidbeni lanac. Pristupačnost i bioakumulacija teških metala u biljku ovisi o prisutnosti kelata i drugih teških metala, sadržaju humusa, pH vrijednosti tla, salinitetu i ostalim ekološkim čimbenicima (Singh i sur., 2004.). U poljoprivrednoj proizvodnji, kontaminacija tala toksičnim teškim metalima je važan ograničavajući čimbenik produktivnosti i kvalitete usjeva. U našoj zemlji glavni usjevi za proizvodnju ulja su suncokret (*Helianthus annuus* L.), uljana repica (*Brassica napus* L.) i soja (*Glycine max* L., Merr.). Prema FAO statističkim podacima (2010.) desetogodišnjeg prosjeka proizvodnje u

Hrvatskoj (2000. – 2009.) požnjevene površine suncokreta prosječno iznose 30 617 ha, uz prosječan prinos 2,37 t ha^{-1}, soje 46 160 ha, uz prosječan prinos od 2,31 t ha^{-1} te uljane repice 15 880 ha uz prosječan prinos od 2,32 t ha^{-1}.

Cilj ovog rada je ukazati na problem akumulacije teških metala kod uljarica, posebice akumulacije toksičnih teških metala.

Raspodjela teških metala u biljci

Akumulacija teških metala u biljku ovisi o biljnoj vrsti i sorti, svojstvima tla, pH vrijednosti, organskoj tvari, kationskom izmjenjivačkom kompleksu i dr. Optimalne koncentracije esencijalnih teških metala u uljaricama prema Bergmann – u (1992.) prikazane u tablici 1.

Tablica 1. Optimalna koncentracija esencijalnih elemenata teških metala u suhoj tvari lista (ppm) u određenoj fazi razvoja (Bergmann, 1992.)

Mo	Cu	Mn	Zn
suncokret (vršni najrazvijeniji listovi, početak cvatnje)			
0,30 – 1,00	10 – 20	25 – 100	30 – 80
soja (potpuno razvijeni vršni listovi, bez peteljki, na kraju cvatnje)			
0,50 – 1,00	10 – 20	30 – 100	25 – 60
uljana repica (potpuno razvijeni listovi, početak cvatnje ili kada je biljka visine 30 – 50 cm)			
0,40 – 1,00	5 – 12	30 – 100	25 – 70

Akumulacija teških metala u sjemenu ovisi o sadržaju i usvajanju tih elemenata iz otopine tla, njihovoj translokaciji ksilemom iz korijena u stabljiku i translokaciji floemom iz izdanaka tijekom formiranja sjemena. Suncokret je kultura koja u usporedbi s žitaricama ima veću nadzemnu masu, dubok korijen s jakom usisnom moći, stoga i prirodno teži većoj akumulaciji teških metala. Utvrđeno je da suncokret uz lan, durum pšenicu (Li i sur., 1997.; Khoshgoftarmanesh i Chaney, 2007.) i soju (Sugiyama i sur., 2007.), prirodno teži većoj akumulaciji Cd, no rizik konzumacije u prehrani je relativno niži zbog manjeg udjela direktne konzumacije suncokreta i soje, u odnosu na pšenicu. Singh i sur. (2004) navode da suncokret pri usvajanju teških metala preferira redom Fe > Cr > Mn > Zn, te da je koncentracija akumuliranih metala najveća u korijenu suncokreta, zatim slijede izdanci, listovi te zrno. Vincenc i sur. (1997.) prema dvogodišnjem prosjeku šest lokacija u Češkoj ističu da se od teških metala u nadzemnom dijelu uljane repice najviše Zn akumulira u zrno (31,10 mg Zn kg^{-1}).

Toksični teški metali se razlikuju prema negativnom utjecaju na biljku, primjerice fitotoksičnost Pb, u usporedbi s drugim toksičnim elementima, je relativno niska, jer se većina usvojenog Pb u biljci zadržava u korijenovom sustavu (Murillo i sur., 1999.). Neki teški metali mogu reducirati rast biljke. Mukhtar i sur. (2010.) su hidroponskim uzgojem suncokreta uz aplikaciju Ni (0,15 mg L^{-1} i 30 mg L^{-1}) i Pb (0,15 mg L^{-1} i 30 mg L^{-1}) utvrdili da Ni smanjuje udio suhe tvari korijena za 38,4% i izdanaka za 55,1%, te da je aplikacija Pb dovela do smanjenja udjela suhe tvari korijena za 33,6% i izdanaka za 50,5%. Solhi i sur., (2005.) navode da tretiranje tla s DTPA (dietilentriaminpentaacetalna kiselina) povećava raspoloživost, a time i fitotoksičnost teških metala, što može reducirati rast i biomasu biljke. Autori navode da primjena 1,5 mmol DTPA kg^{-1} u tlo koje sadrži 182 mg kg^{-1} DTPA raspoloživog Zn i 29 mg kg^{-1} DTPA raspoloživog Pb, smanjuje masu suhe tvari uljane repice za 24%, dok istovremeno nema značajnog utjecaja na smanjenje suhe

mase suncokreta. Shute i Macfie (2006.) utvrđuju da visoke koncentracije Cd (100 mg Cd kg^{-1}) i Zn (2000 mg Zn kg^{-1}) u tlu reduciraju rast soje za 40, odnosno 55%.

Koncentracija teških metala u zrnu uljarica

Budući da toksični elementi negativno djeluju na organizam, donesena je regulativa o njihovim maksimalnim koncentracijama u zrnu uljarica. Prema Pravilniku o toksinima, metalima, metaloidima te drugim štetnim tvarima koje se mogu nalaziti u hrani (NN, 2003., 2004.) sjeme soje smije maksimalno sadržavati 0,2 mg Cd kg^{-1} suhe mase, dok je u sjemenkama ostalih uljarica postavljena granična vrijednost 0,5 mg Cd kg^{-1} suhe mase. Prema istom pravilniku sjemenke uljarica smiju sadržavati 0,1 mg Hg kg^{-1} i 0,5 mg Pb kg^{-1} suhe mase. Granična vrijednost za Cd u sjemenu soje (0,2 mg Cd kg^{-1}) u skladu je s graničnim vrijednostima postavljenim Pravilnikom Europske Komisije (EC, 2001.).

U usporedbi s žitaricama, uljarice akumuliraju veću količinu teških metala u zrno. Primjerice zrno soje prosječno sadrži 97 µg Fe i 43 µg Zn g^{-1} suhe tvari, dok pšenično zrno sadrži manje, 37 µg Fe, odnosno 31 µg Zn g^{-1} suhe tvari (Welch, 2002.). Utvrđeno je da je količina Cu i Zn u (oljuštenom) zrnu uljanog suncokreta gotovo 5, odnosno 2,5 puta veća od količine u zrnu pšenice (Škrbić i Cvejanov, 2011.).

Lavado i sur., (2001.) ističu kako se koncentracija teških metala u zrnu soje, pšenice i kukuruza (tablica 2) mijenja ovisno o načinu obrade tla (bez obrade i konvencionalna obrada).

Tablica 2. Koncentracija teških metala u zrnu soje, pšenice i kukuruza (mg kg^{-1}) ovisno o obradi tla: bez obrade (BO) i konvencionalna obrada (KO) (Lavado i sur., 2001.)

	Pb		Ni		Cu		Zn		Mo	
	BO	KO	BO	KO	BO	KO	BO	KO	BO	KO
soja	0,85	0,80	4,39	4,26	17,10	20,83	44,85	43,50	2,95	1,71
pšenica	0,74	0,70	2,68	1,76	11,0	5,80	36,87	37,65	2,02	1,21
kukuruz	0,80	0,98	0,87	0,90	10,30	7,33	19,09	22,60	1,52	1,41

Translokacija elemenata u zrno nije ista za sve teške metale. Rezultati istraživanja Mauk i Noodén (1992.) pokazuju da se Mo, Mg, Zn i Fe redistribuiraju iz listova i akumuliraju u sjeme soje, dok se B, Cu, Ca i Mn ne redistribuiraju iz listova u sjeme. Varga (2010.) iznosi da je koncentracija Cd u zrnu soje (0.141 mg kg^{-1}) gotovo jednaka koncentraciji Cd u listu soje (0,156 mg kg^{-1}) u vrijeme cvatnje, dok Murillo i sur. (1999.) navode da je koncentracija Pb u sjemenu suncokreta uzgajanom na tlu kontaminiranim toksičnim elementima bila 18 puta manja u odnosu na list suncokreta. Nadalje, Kim i sur. (2007.) navode da se manja količina Cu akumuliranog u listovima soje redistribuira i pohranjuje u sjeme soje, dok je Mo unutar biljke mobilniji te se akumulira u većoj količini u sjeme prilikom njegovog formiranja.

Problem akumulacije Cd

Kadmij je toksičan element za biljke, životinje i ljude te njegova akumulacija u biljke predstavlja određeni rizik za ljudsko zdravlje.

Često je prisutan problem povećane koncentracija Cd u tlu, koji jednim dijelom dospijeva u tlo putem mineralnih fosfornih gnojiva (He i sur., 2005.), te se na obradivim površinama dugo-

godišnjom aplikacijom fosfornih gnojiva, postupno povećala koncentracija Cd u tlu (Bergkvist i sur., 2003.). Ipak, u Hrvatskoj je 2009. godine potrošnja fosfornih mineralnih gnojiva bila za 23% manja u odnosu na četverogodišnji prosjek (2005. – 09.; Statistički ljetopis, 2010.). Teodorović i sur. (2009.) navode da tla istočne Hrvatske sadrže 0,2 do 1,3 mg Cd kg^{-1}. Ovisno o koncentraciji pristupačnog Cd u tlu, određena količina Cd se u konačnici akumulira u zrno te može biti čak i iznad dozvoljene granice (EC, 2001.), kao što primjerice Lončarić i sur. (2011.) iznose da kisela i nedovoljno kalcizirana tripleksom gnojena tla rezultiraju koncentracijom Cd u zrnu soje iznad dozvoljene koncentracije od 0,2 mg Cd kg^{-1}, propisane prema EC (2001.), te da istovremeno kalcizacija utječe na smanjenje koncentracije Cd u zrnu soje ispod dopuštene granice, za čak 49 %.

U SAD – u su Li i sur. (1997.) proveli skrining 200 genotipova proteinskog suncokreta s ciljem ispitivanja akumulacije Cd u zrno, ovisno o genotipu, te navode da se koncentracija Cd u zrnu kreće u rasponu od 0,31 do 1,34 mg kg^{-1} (Li i sur., 1997.). Sugiyama i sur., (2007.) navode da se kultivari soje razlikuju prema akumulaciji Cd, te da se kod kultivara koji akumuliraju manju količinu Cd u zrno, akumulirani Cd zadržava u korijenu.

Zaključak

Translokacija elemenata u biljci je različita. Toksični teški metali (Cr, As, Pb, Hg i Cd), imaju različitu fitotoksičnost. Toksičnost Pb u usporedbi s drugim toksičnim elementima je manja zato što se većina usvojenog Pb zadržava u korijenovom sustavu. Veće koncentracije Ni i Pb u tlu, smanjuju udio mase suhe tvari korijena, stabljike i listova suncokreta, dok veće koncentracije Cd i Zn reduciraju rast soje. Akumulacija teških metala se razlikuje ovisno o pojedinim dijelovima biljke. Kod uljarica se Zn i Mo prilikom formiranja sjemena translociraju iz listova i akumuliraju u sjeme. Uljarice u usporedbi s žitaricama akumuliraju veću količinu teških metala u zrno, što je s jedne strane pozitivno zbog povećanja koncentracije esencijalnih elemenata, posebice Fe i Zn čiji je nedostatak veliki problem u svijetu, dok s druge strane imaju afinitet ka većoj akumulaciji toksičnih elemenata kao što je Cd.

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Abstract

Heavy metals content in oil crops grain

Heavy metals accumulate unequally in the plant grain, leaf, stem and root. Most of heavy metals accumulate more in the root (Fe, Cr, Pb), stem and leaf (Hg, Cd) and than in the grain (Zn). On the one hand, accumulation of essencial heavy metals (Fe, Zn) in the grain of oilseed crop is advisable, and on the other hand accumulation of toxic heavy metals is noxiously (Cd, Hg). Regulation of toxins, metals, metalloids and other harmful substances that may be present in food (NN, 2003., 2004.) pointed out that oil crop grain may contain 0.1 mg Hg kg^{-1}, 0.5 mg Pb kg^{-1} and 0.5 mg Cd kg^{-1} dry weight. Regulations has determined the the maximum concentration of Cd in soybean grain, 0.2 mg Cd kg^{-1} dry weight, which is according with the limit values set out by Regulation of the European Commission (EC, 2001). Furhtermore, greater concentrations of toxic heavy metals in soil can be phytotoxic and have negative effect on plant growth (Ni, Pb, Cd, Zn).

Key words: sunflower, soybean, grain, heavy metals

Izvorni znanstveni rad / Original scientific paper

The effects of Vermicompost utilization in winter wheat production

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Abstract

The objective of this paper was to investigate the effect of the vermicompost application on grain yield and plant height of winter wheat. Experiment was conducted in semi-controlled conditions. Highest grain yield in soil with optimal fertility and in a low fertility was obtained with 900 g of vermicompost per pot 7.95 g and 7.47 g, respectively. However, statistical differences were not observed among soils of different fertility. Addition of 900 g vermicompost also resulted with statistically higher straw height (54.46 cm) at the optimal fertility soil compared with low fertility soil (49.87 cm). Foliar application of dissolved vermicompost showed that the greatest response of wheat yield was found after two spraying (5.13 g), conversely plant height showed highest values with three spraying (42.72 cm).

Key words: vermicompost, fertilization, winter wheat, grain yield

Introduction

The use of organic fertilizers of different origins both in the world and in our country is the basis for successful agricultural production. Among the organic fertilizer barnyard manure has the greatest importance. However, decrease in number of livestock, improper storage of manure, uneven application and inadequate doses can significantly reduce the effect of its utilization. Nowadays, the global rise in energy prices, striving to preserve the favorable properties of the soil through the use of organic fertilizers and the development of the sector of organic agriculture strongly affect the constant demand for high quality organic fertilizers.

Manure, garden waste, organic waste from the farms or agricultural residues can be used to obtain vermicompost (VC), very useful and ecologically balanced organic fertilizer (Milosev et al., 1998). Production of compost using earthworms is a type of bioreactor for efficient recycling of organic residues for its application in the production of different plant species (Padmavathiamma et al., 2008). Vermicompost obtained after biodegradation of substrates originating from animal excrement has a high content of nutritive elements in a form that is easily accessible to plants. Although the nutrient content can vary due to differences in a row material, period of the year or time of production an average VC nutrient concentration is 2-3% N, 0.4-2.9% P, 1.7-2.5% and 1.9-9.5 K (Edwards, 1998).

Verimcompost utilization is similar to the barnyard manure, and therefore VC could have a significant role in a range of sustainable cropping methods. However, due to smaller quantities,

compost from earthworms is mainly used as fertilizer in intensive methods of production such as the production of vegetable, horticulture or sold as a soil conditioner. Although there are numerous literature data on the use of VC as organic fertilizers (Edwards and Arancón, 2004), its application in the form of aqueous solution for foliar treatments of plants in various stages of growth and development has been studied to the lesser extent, for which there is scant literature data. Some authors elucidate that vermicompost contain different active ingredients (plant hormones) as a result of the transformation of organic matter by earthworms and the presence of groups of microorganisms which positively affect the growth and development of plants (Atiyeh et al., 2002; Arancón et al., 2006).

The aim of this study was to determine the possibility of improving the production of winter wheat by adding VC as a basic organic and foliar fertilizer in the form of aqueous solution.

Materials and methods

The trial was set up in semi-controlled condition of vegetation shed for a period of two years 2007/08. To perform the experiment Mitscherlich pots were filled with soil from the longtrem experiment. The vermicompost investigation was conducted in three replicates, and the influence of three treatments was investigated: (i) soil originated from the unfertilized and fertilized two-year rotation (factor A); (ii) different doses of VC introduced in soil as organic fartilizer (factor B) and (iii) foliar application as aqueous solution (Factor C).

Mitscherlich pots were filled with 7 kg of substrate composed of soil and sand in a 3:1 ratio. The chemical composition of the used soil as a substrate and VC are shown in Table 1. Soil substrate was amended with different amount of VC according to experiment plan: control-no VC (BO), 300 g per pot (B1), 600 g per pot (B2) and 900 grams per pot (B3). The moisture content in VC before entering the soil was adjusted to 45.4 vol%. Foliar application was made by hand, spraying plants in different growth stages. The aqueous solution application plan foresees that the experiment is done in a different number of repeating: control-no treatment (CO), one (C1), two (C2) and three treatments (C3). The first spraying was conducted in tillering 06th March (C1), the second spraying in booting 05th April (C2) and third spraying (C3) 04th May in the flowering stage. For foliar treatment 5% solution of VC was used in corresponding water volume in which 100 grams of the VC was dissolved. At the time of optimal term for sowing, 30 seeds of winter wheat Europa 90 were sown per pot, and the surface of the pot was covered with a thin layer of sand to prevent the creation of crust. In March, thinning was done at the final number of 15 plants per pot. The moisture of soil substrate was maintained by watering at an optimal level, between 70-80% of the water retention capacity of land in pot. The harvest is in full maturity of plants was made by cutting the stem to the ground surface. The data reported was assessed by analyses of variance (ANOVA). The analyses were conducted using the statistical software package Statistica 8.1. (StatSoft Inc., USA).

Table 1. Chemical properties of soils and vermicompost

	pH		$CaCO_3$ %	Humus %	Total N %	AL-P_2O_5 mg/100g	AL-K_2O mg/100g
	KCl	H_2O					
Unfertilized soil	7,03	8,39	2,12	2,09	0,06	7,4	18,2
Fertilized soil	6,81	7,89	0,34	2,93	0,146	60,0	39,5
Vermicompost	7,67	7,99	1,43	27,6	1,526	382,5	195,7

Results and discussion

Different levels of soil fertility did not affect significantly the yield of winter wheat (Table 2). However, it was found that the amount of VC applied before sowing wheat in the form of organic fertilizer, led to the manifestation of a statistically significant difference comparing different treatments (BØ, B1, B2 and B3). Obtained results are in accordance with previous research in which VC application as organic fertilizer has significantly affected chemical, microbiological and physical properties of soil that resulted in increasing the yield (Molnar et al., 1988; Milošev et al., 2009). In the soil from the unfertilized two-year crop rotation the highest yield of wheat (7.47 g per pot) was obtained with a maximum quantity of VC added (900g) with statistically significant differences compared to the B2, B1 and BØ. The lowest grain yield (3,02 g) was found with 300 g VC per pot and was significantly different compared to the B3 and B2, whereas compared to the control showed no statistical difference. In the soil from fertilized two-year rotation the highest yield of wheat was measured at the B3 variant (7.95 g), with the statistical significant differences compared with other treatments, while the lowest grain yield was found in the control (2.61 g). The results are in line with previous studies of Milosev et al. (1990) in which doses greater than 600 g per pot VC affected the yield and yield components of wheat, as well as research McClintock (2004) who found that the optimal VC content in the substrate is 10-20% of its total volume. Winter wheat yield improvement with vermicompost appliaction was also observed by Suthar (2006).

Table 2. Effect of vermicompost application on winter wheat grain yield per pot (g)

Soil fertility (Factor A)	Vermicompost incorporation (Factor B)	Vermicompost foliar (Faktor C)				Average Factor B	Average Factor A
		CØ	C1	C2	C3		
Unfertilized	*BØ*	2.49	3.4	3.68	4.27	**3.46bc**	**4.54**
	B1	2.58	2.90	3.4	3.27	**3.02c**	
	B2	3.8	4.11	4.8	4.15	**4.21b**	
	B3	6.59	7.3	8.2	7.8	**7.47a**	
Fertilized	*BØ*	2.28	2.55	2.50	3.10	**2.61d**	**4.59**
	B1	3.10	3.26	3.81	3.46	**3.40c**	
	B2	3.29	4.03	5.47	4.93	**4.43b**	
	B3	6.80	7.5	9.20	8.20	**7.95a**	
Average Factor C		**3,86d**	**4.38bc**	**5.13a**	**4.88b**	**40.87**	

Spraying wheat plants with VC aqueous solution, showed statistically significant differences between treatments (Table 2). Foliar application VC exerted a positive effect on wheat yield, which was based on a high concentration of N and humic acids in aqueous solution originating from earthworms activity (Tomate et al., 1988). The highest grain yield (5,13 g) of wheat was obtained after two treatments with a VC solution (C2). Yield increase was not observed with the treatment carried out in May (the flowering phase) and statistically C3 was less effective compared with the C2. On the other hand, there is a statistically significant difference between the yield obtained in control (CØ) and the other treatments. Positive effects of vermicompost extracts on cereal yield have been also found in Gamaley et al. (2001) in two agricultural regions in Russia.

Vermicompost application had influenced the plant height of winter wheat (Table 3). Addition of VC increased production potential of soil with lower fertility, but the optimal soil fertility also responded to the added VC. Comparing the height of the wheat plants in different soil fertility statistically significant differences was obsrerved. Unlike grain yield per plants, plant height showed a greater response on the fertility of the soil substrate which was used in this experiment. At low soil fertility (unfertilized) lowest plant height were measured in the control variant (34.34 cm), while the plant height was highest (49.87 cm) with a maximum VC added (B3). There was an expression of statistically significant differences between treatments B3 and other treatments.At soil with high fertility adding VC in the pots as organic fertilizer resulted with significant influence on the individual differences between treatments. Significantly highest (54.46 cm) among wheat plants were fertilized treatment with the highest amount of VC (B3), and the lowest were fertilized plants in the control variant without VC.

Foliar application of the VC had a positive effect on stem height in wheat (Table 3). The plants that were treated three times with a solution (C3) were significantly highest in stem (42,72 cm) at the time of harvest in comparison with other plants. This could be explained with N originating from VC solution that replaced N which was translocated in spike and grain. Unlike grain yield per plant, greater number of treatments with solution increased the plant height. The study of Sing et al. (2010) confirmed that leachates derived from composting processes have potential use as foliar fertilization for strawberry.

Table 3. Effect of vermicompost application on winter wheat plant height (cm)

Soil fertility (Factor A)	Vermicompost incorporation (Factor B)	Vermicompost foliar (Faktor C)				Average Factor B	Average Factor A
		CØ	C1	C2	C3		
Unfertilized	*BØ*	32.10	33.50	35.55	36.23	**34.34cd**	**39.94b**
	B1	33.40	34.68	36.50	36.50	**35.27c**	
	B2	38.30	39.67	40.60	40.80	**39.84b**	
	B3	45.30	51.33	51.37	51.49	**49.87a**	
Fertilized	*BØ*	32.80	32.50	34.47	38.00	**34.44d**	**41.80a**
	B1	39.67	34.73	35.83	38.37	**37.15c**	
	B2	40.43	39.67	41.63	42.86	**41.14b**	
	B3	49.27	55.77	55.30	57.53	**54.46a**	
Average Factor C		**38,90c**	**40.23bc**	**41.40b**	**42.72a**	**40.87**	

Conclusion

Vermicompost as a organic fertilizer in soil of different fertility did not showed statistically significant effect on grain yield per plant, while plant height was influenced by this factor. The highest values of the observed parameters were obtained by adding the maximum amount vermicompost. Foliar treatment of vermicompost positively affected the yield and plant height of wheat. The highest winter wheat yield was obtained after two treatments, whereas plant height of wheat was highest with three treatments. Application vermicompost as an organic fertilizer in combination with foliar treatment in wheat production can significantly affect the yield and height of winter wheat plants.

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Sažetak

Utjecaj primjene vermikomposta u uzgoju ozime pšenice

Cilj rada bio je istražiti utjecaj primjene vermikomposta na prinos zrna i visinu biljaka ozime pšenice. Istraživanje je provedeno u polu-kontroliranim uvjetima. Najveći prinosi zrna ostvareni su na optimalno gnojenom tlu (7.95 g.) i na tlu slabe plodnosti 7.47 g.), uz dodatak 900 g. vermikomposta po loncu. Između istraživanih tala, različite plodnosti, nisu utvrđene statistički značajne razlike u visini ostvarenog prinosa. Dodatak od 900 g. vermikomposta rezultirao je statistički značajnim razlikama u visini biljaka, između optimalno gnojenog tla (54.46 cm) i tla slabije plodnosti (49.87 cm). Folijarnom primjenom otopine vermikomposta, najveći je prinos ostvaren na tretmanu s dva prskanja (5.13 g), a najveće vrijednosti visine biljaka zabilježene su tri prskanja (42.72 cm).

Ključne riječi: vermikompost, gnojidba, ozima pšenica, prinos zrna

Izvorni znanstveni rad / Original scientific paper

The influence of foliar fertilization on growth, soluble protein's status and yield of maize inbred plants

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Abstract

The significance of nitrogen cycling in plant is well known. A direct supply of amino acids, by foliar fertilization facilitates protein synthesis and plant growth. The aim of this study was to examine the effects of foliar fertilizer with amino acids on growth, content of soluble proteins in leaves in three different phases (48 h after spraying, 21 day after spraying and during anthesis) and yield of five ZP maize inbred lines.

The parallel increase of fresh matter and decreasing of soluble proteins during vegetation varied upon inbred. The results of dry matter pointed fluctuation during vegetation, independently on applied treatment or inbred. The application of Activeg fertilizer induced slight increase of fresh matter 48 h after application, but control plants had higher fresh matter, up to anthesis. Moreover, Activeg induced decrease in soluble proteins content. The grain yield of ZP maize inbreds also varied over genotypes and the application of foliar fertilizer induced the increase of yield up to 21%, on average. However, achieved increase of grain yield of all inbreds and particularly of those with lower dry matter content, indicated different paths of plant green matter and seed matter biosynthesis, as well as the influence of Activeg fertilizer on biosynthesis.

Key words: maize inbred lines, Activeg, soluble proteins, growth, yield

Introduction

The significance of nutrition in plant growth and yielding is well known. Discrete importance is given to nitrogen and its cycling in plant methabolism. Cycling of mineral nutrients, i.e. retranslocation in the phloem from shoot to roots, and translocation of cycled nutrients back to the shoot in the xylem, is important for plant growth, especially under stress conditions (Marschner et al., 1997). Niu et al (2007) ascertained that the nitrogen amount, cycling within the plant at the low nitrogen level was higher in genotypes with better nitrogen efficiency, together with more intensive transpiration, as well as better water using efficiency. Additionally, the total xylem-transported nitrogen in genotype with better nitrogen efficiency was several times more than that in genotype with poor nitrogen efficiency. A model of total N flow in castor bean (*Ricinus conmunis*) showed that the exported N from leaves moved downwards

to the root rather than directly feeding younger leaves higher up the shoot (Jeschke and Pate, 1991). It has been reported that over 60 % of the amino-N flux in the xylem was cycling in young wheat and rye plants (Cooper and Clarkson, 1989). Perez Leroux and Long (1994) ascertained high positive correlation between N supply and growth rate in maize plants, too. Meanwhile, Simova-Stoilova et al (2001) established that barley genotype with lower soluble proteins content in leaves give higher grain yield. The role of nitrogen, i.e. proteins in plant metabolism and photosynthesis is well known. Nitrogen deficiency had only a small effect on the quantum yield of CO_2 assimilation but a large effect on the light-saturated rate of photosynthesis (Khamis et al, 1990).

Ammo acids are basic nutrients and building blocks for proteins. They are essential for all living organisms. During the stress periods, the plants energy is not used to form proteins but to synthesize different amino acids (Mertz et al, 1952). Consequently, a direct supply of amino acids facilitates protein synthesis and plant growth. Foliar feeding, provides nutrients through the foliage of the plant which has the ability to absorb and translocate certain minerals within plant tissues.

The aim of this study was to examine the effects of foliar fertilizer with amino acids on growth, content of soluble proteins in leaves and yield of five ZP maize inbred lines.

Material and methods

Field experiment was conducted during 2010 at the Maize Research Institute, on a slightly calcareous chernozem soil type. Winter wheat was used as a preceding crop. Effects of the foliar fertilizer Activeg (12:4:6 + 0,2 MgO + ME + aminoacids), applied in doze of 4 l ha^{-1} on the 5 ZP maize inbred lines was examined. The main plots encompassed one 10 m row of each inbred line in 4 replications, while subplots included a treatment and a control, without the application of fertilizer. Inbred lines were sown manually on April 26-27, while fertilizer was applied in the 4-6-leaf stage of maize.

The samples for fresh matter (FM) determination of shoots (3 plants per replication) were collected: 48 hours (phase I, May 21) and 21 days (phase II, June 11) after the foliar fertilizer application, while leaves from whole plant were collected during anthesis period (phase III, 13 July for L1, 19 July for L2, 28 July for L3, 26 July for L4 and 22 July for L5). The dry matter (DM) of shoots and leaves was determined after drying at 40 °C in ventilation dryer. The content of soluble proteins was determined from dry matter, by the method of Lowry et al (1951). The grain yield was measured at the end of a growing cycle and calculated with 14% of moisture.

Obtained data were statistically processed by the standard deviation, while grain yield was processed by the analysis of variance (ANOVA), while differences of means were determined by the LSD test at the 0.05 probability level.

Results and discussion

The increase of fresh matter from phase I (2 days after fertilizer spraying) to phase II (21 days after spraying) varied upon inbred (Figure 1): it had the highest average value at L3 (from 1.04 to 21.03 g) while it was lowest at L1 (from 0.81 to 7.16 g). The observed trend continued up to phase III (anthesis) where lowest average fresh matter of leaves was observed at L1 (42.21 g), while the highest value was at L4 (127.65 g). Furthermore, the application of Activeg fertilizer induced slight increase of fresh matter in phase I (up to 0.6 g, present at L4), what is in accordance to relative short period after fertilizer application. Ahmed Magda et al (2010); Hassan et

al (2010) and Shaheen et al (2010) are underlining positive effect of amino acid foliar fertilizers on plant fresh matter accumulation. The increase of fresh matter, under influence of foliar fertilizer was better displayed in phase II, where difference between treatment and control was highest at L5 (9.58 g), while negative influence of fertilizer was observed at L2, with decrease of fresh matter of 5.58 g. Such trend was drawn out to anthesis period, where higher fresh matter of leaves was noticed at control plants, particularly at L3 (42.48 g).

The results of dry matter pointed fluctuation during vegetation, independently on applied treatment or inbred (Figure 1), where average values were double lower in phase II (12-13 %), in relation to phase I (19-23 %) and then increase to phase III, with values similar to phase I (22-26 %). The differences between fertilizer treatment and control were negligible in general. The only differences were noticed in phase I, where in treatment of L2, L4 and L5, the average DM was higher to 6 %, in relation to control. Similar to upper results Ahmed Magda et al (2010) and Shaheen et al (2010) depicted increase of dry matter, as well as growth parameters of fenugreek and onion plants, sprayed with increased doses of amino acid foliar fertilizers.

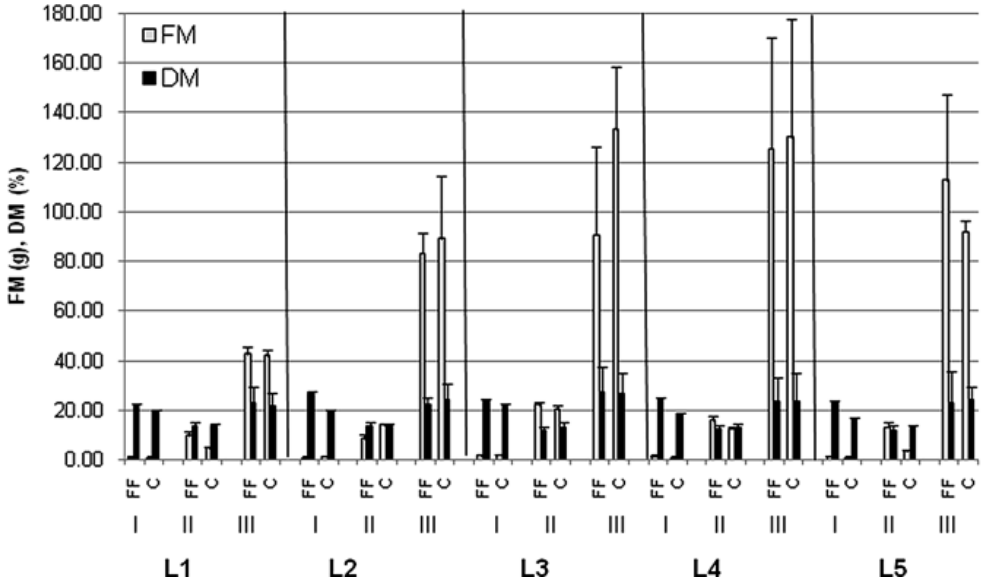

Figure 1. The effects of Activeg foliar fertilizer on the fresh (FM) and dry matter (DM) of maize shoots; FF – treatment with foliar fertilizer, C – control; I – 48 h after fertilizer application, II – 21 day after fertilizer application, III – pollination; L1-L5 – maize inbreds

Parallel to fresh matter increase (Figure 1), the average content of soluble proteins decreased to anthesis period (Figure 2): it was lowest at leaves of L4 (77 mg g^{-1}) and highest at leaves of L3 (112 mg g^{-1}). It was interesting to underline that inbreds with lowest average proteins content: L3 and L4 had the highest average fresh matter production, evidencing about high negative correlation between these two parameters (R = -0.83). Moreover, the spraying with foliar fertilizer induced decrease in content of soluble proteins, in comparison to control: in phase I it was lowest in leaves of L5 (4.40 mg g^{-1}) and it was highest in leaves of L1 (47.91 mg g^{-1}); as well, in phase III it was lowest in leaves of L5 (2.98 mg g^{-1}) and highest in leaves of L2 (30.84 mg g^{-1}). The observed trend, of protein decreasing in maize leaves by spraying with Activeg was not

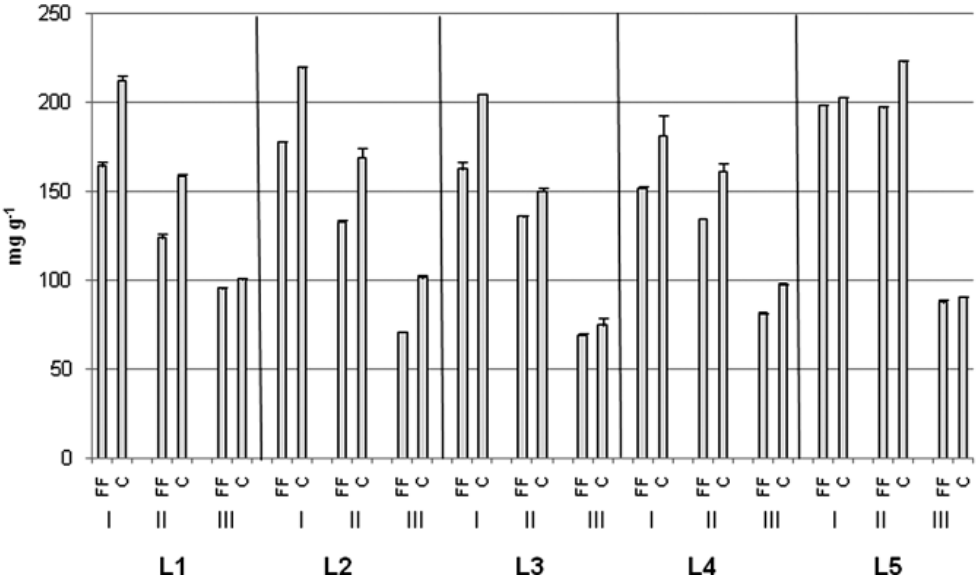

Figure 2. The effects of Activeg foliar fertilizer on the content of soluble proteins in maize shoots; FF – treatment with foliar fertilizer, C – control; I – 48 h after fertilizer application, II – 21 day after fertilizer application, III – pollination; L1-L5 – maize inbreds

in accordance with results of Ahmed Magda et al (2010) and Shaheen et al (2010), observed on fenugreek and onion sprayed with amino acids fertilizer, too, since the authors were represented total protein amount. The lowest difference in soluble proteins content between plants treated with foliar fertilizer and control was present in L5, inbred which maintained almost the same level of proteins from phase I to phase II (200.14 and 209.86 mg g^{-1}, respectively), with highest drop of 88.89 mg g^{-1}, to phase III.

Table 1. The effects of Activeg foliar fertilizer on the grain yield; L1-L5 – maize inbreds

	L1	L2	L3	L4	L5	**Average**
Grain yield (t ha^{-1})						
Foliar fertilizer	1.63	2.99	7.38	6.82	4.64	4.69
Control	0.96	2.96	6.79	5.83	1.98	3.70
Average	1.29	2.97	7.08	6.32	3.31	
LSD 0.05	Genotype 0.96		Treatment 0.19		Interaction 1.01	

The grain yield of ZP maize inbreds also varied over genotypes (Table 1). Differences in average yield were significant with exception present at L2 and L5. The highest average yield was observed at L3, inbred with highest average fresh matter present in phases I and II and highest dry matter present in phase III (Figure 1). The lowest yield was gained at L1, inbred with lowest fresh matter content during all three examined phases and highest protein content in phase III (Figure 2). As well, the application of foliar fertilizer induced the increase of yield up to 21%, on

average, in relation to control. Similarly, Hassan et al (2010) ascertained that foliar fertilizers containing amino acids are increasing plum yield and fructification. The highest yield achieving by application of Activeg fertilizer was at L1 and L5, increasing grain yield up to 41 and 57%, respectively. Similar results was obtained by Simova-Stoilova et al (2001) on barley genotype with lower soluble proteins content in leaves, which gave higher grain yield, irrespective that dynamics of soluble proteins during vegetation differed in barley plants, compared to maize.

Conclusion

Based on obtained results it could be concluded that increase of fresh matter of ZP maize inbreds was followed by fluctuations in dry matter content, as well as decrease in soluble proteins content, up to anthesis. The application of Activeg foliar fertilizer induced decrease of fresh matter and soluble proteins content, as well as slight increase of dry matter in maize shoots, i.e. leaves in all three phases. However, foliar fertilizer induced significant increase of grain yield of all inbreds and particularly of those with lower dry matter content of leaves, evidencing about different paths of green matter and seed matter biosynthesis.

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Sažetak

Utjecaj folijarne gnojidbe na rast, status topivih bjelančevina i urod samooplodnih linija kukuruza

Značaj kruženja dušika u biljci je dobro poznat. Direktna opskrba aminokiselinama folijarnom gnojidbom poboljšava sintezu bjelančevina i rast usjeva. Cilj ovog istraživanja bio je istražiti utjecaj folijarnog gnojiva s aminokiselinama na rast, sadržaj topivih bjelančevina u lišću u tri faze (48 h nakon prskanja, 21 dan nakon prskanja i tijekom metličanja) i urod pet samooplodnih linija ZP kukuruza.

Usporedno povećanje svježe tvari i smanjenje topivih bjelančevina tijekom vegetacije variralo je između linija. Rezultati suhe tvari istakli su fluktuacije tijekom vegetacije, neovisno o primijenjenom tretmanu ili liniji. Primjena Activeg gnojiva inducirala je blagi porast svježe tvari 48 h nakon primjene, no kontrolne biljke su imale višu svježu tvar sve do metličanja. Nadalje, Activeg je inducirao smanjenje sadržaja topivih bjelančevina. Urod zrna samooplodnih ZP linija je također varirao između genotipova i primjena folijarnog gnojiva je povećala prinos preko 21% u prosjeku. Bilo kako bilo, postignuta povećanja uroda kod svih linija, posebno kod onih s manjim sadržajem suhe tvari, ukazala je na različite sinteze biljnog lisnog tkiva i zrna, kao i na utjecaj Activeg gnojiva na biosintezu.

Ključne riječi: samooplodne linije kukuruza, Activeg, topive bjelančevine, rast, prinos

Izvorni znanstveni rad / Original scientific paper

Potencijal organske gnojidbe na prirod i kakvoću ploda jabuka (*Malus domestica* Borkh)

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Sažetak

Gnojidba jabuka organskim gnojivom jedna je od osnovnih mjera u ekološkom uzgoju jabuka. Cilj ovoga rada bio je istražiti potencijal organskog (svinjskog) gnojiva u usporedbi sa mineralnim gnojivom (KAN-a) na prirod i kakvoću plodova jabuke sorte Idared. Istraživanje je provedeno 2009. godine u voćnjaku na OPG Lačić u Donjoj Vrbi (Slavonski Brod). Utvrđeno je da gnojidba KAN-om značajno povećala broj plodova I. klase i prirod po stablu I. klase, a najveća masa plodova dobivena je u tretmanu s organskim gnoidbom. Statistički značajna razlika u tvrdoći ploda uočena je između kontrole i ostalih provedenih tretmana. Svi ostali analizirani parametri kvalitete nisu se statistički razlikovali između provedenih tretmana. Iz ovih rezultata je vidljiv veliki potencijal organske gnojidbe u ekološkom, kao i u održivom voćarstvu jer ona nije ugrozila ni prirod ni kvalitetu plodova jabuke u odnosu na mineralno gnojivo.

Ključne riječi: gnojidba, jabuka, prirod, kakvoća, Idared

Uvod

Tip tla i klimatski uvjeti određenog područja, različite sorte, podloge i uzgojni oblici, te intenzitet njege i održavanja tla u voćnjaku su čimbenici koji određuju vrstu i potrebnu razinu gnojidbu. Uporaba gnojiva u svrhu postizanja visokih prinosa, visoke kvalitete plodova te ravnoteže u razvoju vegetativnih i generativnih organa jedan je od osnovnih pomotehničkih zahvata u suvremenom uzgoju jabuka. Uporabom novih tehnologija u proizvodnji jabuka, a koje uključuju kvalitetnu i dobro uravnoteženu gnojidbu, godišnji prirodi mogu doseći vrijednosti iznad 100 t×ha^{-1} (Ernani i sur., 2002.). Same voćke za rast i razvoj plodova i vegetativnih organa iznose velike količine hranjiva iz tla, koje je zatim potrebno svake godine nadomjestiti, a sve u cilju stabilne i redovite rodnosti. Rast i prirod su dobri indikatori ishranjenosti voćke, odnosno primjenjene gnojidbe, a u istu svrhu može se koristiti i kontrola kvalitete plodova (Gliha, 1978.). Pozitivan utjecaj gnojidbe, posebno gnojidbe dušikom, ogleda se u povećanom postotku plodova I. klase, većem broju plodova po stablu te povećanju priroda kao rezultatu

raspoloživog dušika u tlu. Stanisavljević navodi da je veća opskrbljenost lista dušikom omogućila veći promjer, dužinu i svježu masu ploda, čime je došlo do » efekta razrjeđenja« , odnosno u tkivu krupnijih plodova je bio manji sadržaj dušika nego kod manjih plodova (Stanisavljević i sur., 2008.). Ahad i suradnici (1992.) su utvrdili da tretiranje stabla sa 2 kg NPK povećanje vegetativnih dijelova voćke, ukupnog broja plodova i njihove svježe mase. Na osnovi višegodišnjih istraživanja (Tojnkoi sur., 1997.) ustanovljeno je da sorta Idared postiže najveći prirod pri gnojidbi s 45 kg N/ha. Obilna gnojidba dušikom uzrokuje slabiju obojenost plodova, kasniju zriobu, niži sadržaj šećera i kiselina, nedovoljnu čvrstoću ploda i slabije skladišne sposobnosti (Gliha, 1978.). Utjecaj dušika se očituje i kao važan čimbenik u povećanju zametnutih cvjetnih pupova i produžetku vremena oplodnje (Petri, 2002.). Dodatak organskih gnojiva u voćnjaku pozitivno utječe na poboljšavanje strukture tla i sadržaja humusa u tlu. Velike doze organskih gnojiva mogu rezultirati povećanom slanošću tla te s tim povezanim povećanim trošenjem dušika i smanjenju priroda (Stamatiadis i sur., 1999.).

Cilj ovoga rada bio je istražiti potencijal organske gnojidbe u usporedbi sa mineralnom gnojidbom odnosno njihov utjecaj na kakvoću i prirod plodova jabuke sorte Idared.

Materijal i metode rada

Istraživanje je obavljeno 2009. godine u voćnjak na OPG Lačić u Donjoj Vrbi (Slavonski Brod). Voćnjak je posađen 1991. Godine. Pokus je obavljen na stablima jabuke sorte Idared koje su cijepljene na podlogu MM 106. Voćke su formirane u obliku modificirane jednoetažne palmete s vretenastim nastavkom krošnje. Posađene su na razmak od 3 m unutar reda i 4,5 m između redova, što čini sklop od oko 700 stabala po ha. Tlo je srednje duboki teški pseudoglej razvijen na diluvijalnim ilovinama pleistocena. U voćnjaku je zadnja obavljena gnojidba bila 2004. godine s 800 kg mineralnog gnojiva NPK (7:20:30) po hektaru. Tlo u voćnjaku je zatravljeno, prostor između redova se obrađuje strojno, a između voćaka ručno košenjem. Voćnjak je smješten na blago povišenom platou na nadmorskoj visini od 118 metara južne ekspozicije u humidnoj klimi.

Istraživanje o utjecaju gnojidbe na prirod i kvalitetu plodova jabuke sorte Idared obavljeno je na 4 stabla (jedna kombinacija) za svaki tretman gnojidbe i kontrole, u četiri repeticije po metodi split plot. Promatrana stabla odabrana su prema sličnosti vanjskog habitusa, TCSA (poprečni prosjek stabla) i zdravstvenog statusa. Gnojidba je provedena u dva termina tijekom vegetacije - 1.04.2009. i 19.05.2009.

Tretmane su bili sljedeći:

a) Gnojidba KAN-om (KAN) sa 700 kg/ha

b) Gnojidba organskim (svinjskim) gnojem (SG) sa 3 t/ha

c) kontrola (KO) – bez gnojidbe.

Berba jabuka je obavljena 30.09.2009. godine. Analiza tla obavljena je nakon berbe 2009. godine. Analiziran je gornji sloj tla (0-30 cm) (Tablica 1).

Tablica 1. Kemijska svojstva tla

Svojstva tla na 0-30cm dubine				
Tretmani		Koncentracija (mg/kg) u 0-30cm dubine tla		
	%	pH	pH	Hy
	Humus	H_20	KCl	Cmol*kg^{-1}
KAN	1,90	5,45	4,69	6,17
SG	1,68	5,34	3,99	6.87
KO	1,59	5,33	4,05	6,34

Kako bismo dobili stvaran uvid u opravdanost mineralne i organske gnojidbe na prirod i kakvoću plodova po berbi analizirali smo:

a) ukupan prirod (kg/stablo i t/ha),
b) ukupni prirod (kg/stablo) I. Klase,
c) udio plodova I. klase,
d) broj plodova I. Klase po stablu,
e) ukupan broj plodova po stablu,
f) masa ploda

Određivanje kvalitete plodova uključivala je sljedeće analize:

a) tvrdoća plodova (penetrometra Effegi, FT 327, sondom promjera 11 mm. Uzorak je sadržavao 10 plodova po kombinaciji),
b) topiva suhe tvari (refraktometar Atago tip A-297. Uzorak je sadržavao 10 podova. Vrijednosti mjerenja su izraženevne u ° po Brixuu u 2 ponavljanja,
c) jodno-škrobni test (indeks) – uzorak je sadržavao 10 plodova po konbinaciji. Jodno-škrobni indeks utvrđen je prema tablici (Blanpied i Silsby, 1992.),
d) Streifov indeks (Streif, 1996.) – matematički izračunati Streifov indeks (*Si*) na temelju osnovnih pokazatelja zrelosti ploda (*T*-tvrdoća, *TST*-topiva suha tvar i *Ši*-škrobni indeks) po formuli: $Si = \frac{T}{TST \cdot Ši}$. Streifov indeks zrelosti je brza i sigurna metoda određivanja zrelosti plodova (Unuk i sur., 2007.) na osnovu kojeg se može zaključiti da li su plodovi ubrani u optimalnom roku berbe. Dr. Streif je razvio indeks zbog smanjenja mogućnosti pogrešnih prognoza i procjena optimalnog roka berbe na osnovi samo jednog parametra zrelosti (uzorak 10 plodova),
e) ukupne kiseline (mol/dm^3) – određivane se titracijskim postupkom s 0,1 M otopinom NaOH uz fenolftalein kao indikator (uzorak 10 plodova).

Podaci su statistički obrađeni koristeći ANOVA i LSD test, pomoću PC aplikacija Microsoft Excel i Origin 7.0.

Rezultati i rasprava

Ukupan prirod (kg/stablo) povećao se gnojidbom. Analizom ukupnog priroda vidi se da je prirod najmanji kod kontrole, nešto je veći kod gnojidbe svinjski gnojem, a najveći je pri gnojidbi

dušičnim gnojivom. Statističke značajne razlike u prirodu između provedenih tretmana nije bilo (Tablica 2). Čmelik i Tojnko kroz višegodišnje praćenje utjecaja gnojidbe na prirod sorte Idared zaključuju da ista nema velike potrebe za gnojidbom (Čmelik i Tojnko, 2005.). Pri udjelu I. klase i broju plodova po stablu nije bilo statističkih značajnih razlika (Tablica 2). Statistički značajna razlika između provedenih tretmana uočena je kod broja plodova I. klase i priroda plodova I. klase po stablu (Tablica 2). Najveći broj polova I. klase bio je pri dušičnoj gnojidbi, dok je najmanji broj plodova bio pri gnojidbi svinjskim gnojem, isto kao i kod priroda plodova I. klase po stablu. Nije bilo statistički značajnih razlika u masi plodova između provedenih tretmana.

Tablica 2. Utjecaj gnojidbe na prirod plodova jabuke sorte Idared

Tretmani	Prirod po stablu (kg)	Ukupan prirod (t/ha)	Udio podova I. klase (%)	Broj plodova po stablo	Broj plodova I. klase po stablu	Masa ploda (g)	Prirod po stablu plodova I. klase (kg)
KAN	54,51 a	40,34 a	62,6 a	376 a	233,25 b	145,75 a	35,25 b
SG	40,38 a	30,80 a	58,8 a	271,75 a	156 a	168,25 a	23,06 a
KO	39,06 a	28,91 a	61,5 a	282,5 a	174 a	138,75 a	23,94 a

* razlike između vrijednosti s istim slovom nisu značajne na 1%-tnoj razini

Tvrdoća plodova bila je najveća pri tretmanu dušičnom gnojidbom, a najmanja u kontroli sa statistički značajnim razlikama između provedenih tretmana i kontrole (Tablica 3).

Dobiveni rezultati sadržaja topive suhe tvari upućuju na vrlo slične podatke kod sva tri tretmana s malim oscilacijama i bez statistički značajne razlike (Tablica2). Bulatović-Danilović (2005.) navodi da je sadržaj topive suhe tvari za sve sorte jabuka odličan ako je iznad 13° Brix-a. Tvrdoća plodova postupno se smanjuje tokom zrenja, a postotak topive suhe tvari je relativno visok, te se može pretpostaviti da su plodovi ubrani u užitnoj zrelosti jer je iz rezultata vidljivo da je konverzija škroba u šećer uznapredovala, a tvrdoća ploda je bila manja od preporučene za berbu (Benković-Lačić i sur., 2009.). Nije bilo statistički značajnih razlika u vrijednostima jodno-škrobnog indeksa između provedenih tretmana. Najveća pretvorba škroba u šećer bila je kod tretmana sa svinjskim gnojem, a najniža kod tretmana sa dušičnom gnojidbom (Tablica 3). Masa plodova jabuke pri tretmanu sa svinjskim gnojem bila je najveća, a ti su plodovi sadržavali najviše škroba. Rezultati Streifovog indeksa nisu pokazali statistički značajnu razliku između provedenih tretmana. Prema rezultatima testa zrelosti plodovi su bili ubrani u užitnoj zrelosti (Tablica 3). Ukupne kiseline u plodovima različitih tretmana nisu se statistički razlikovale. Najveći sadržaj kiselina imali su plodovi u tretmanu sa svinjski gnojem (Tablica 3.), a sa plodovima s najvećom prosječnom masom povezana je i najveća koncentracija ukupnih kiselina (Unuk i sur., 2007.).

Tablica 3. Utjecaj gnojidbe na kvalitetu plodova jabuke sorte Idared

Tretmani	Tvrdoća (kg/cm^2)	Topiva suha tvar (° Brix)	Jodno -škrobni test (1-8)	Streifov indeks	Ukupne kiseline (mol/dm^3)
KAN	5,27 b	15,6 a	3 a	0,113 a	0,123 a
SG	5,23 b	15,6 a	4 a	0,084 a	0,165 a
KO	4,64 a	15,2 a	3,25 a	0,095 a	0,145 a

* razlike između vrijednosti s istim slovom nisu značajne na 1%-tnoj razini

Zaključak

Prinos jabuka između organske i mineralne gnojidbe nije se statistički razlikovao osim u većem broju plodova I. klase po stablu i priroda po stablu I. klase na stablima tretiranim mineralnom gnojidbom dušikom. Analizom kvalitete plodova nije bilo utvrđeno značajnih razlika između provedenih tretmana osim u tvrdoći plodova koja se statistički razlikovala između kontrole i provedenih tretmana, a ukazuje na mogućnosti korištenja organskog gnojiva pri očuvanju tvrdoće plodova. Temeljem nitratne direktive (12.12.1991.) želi se smanjiti onečišćenje okoliša uzrokovano ili potaknuto nitratima iz poljoprivrede, pa štetnost mineralne gnojidbe kao i visoka cijena ne opravdavaju njegovo korištenje. Iz ovih rezultata je vidljiv veliki potencijal organske gnojidbe u ekološkom, kao i u održivom voćarstvu jer ona nije ugrozila ni prirod ni kvalitetu plodova jabuke u odnosu na mineralno gnojivo. Potrebna su daljnja istraživanja.

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Abstract

Potential of organic fertilization at yield and quality of apple (*Malus domestica* Borkh)

Fertilization of apele with organic fertilizer is one of the basic measures in ecological apple growing. The aim of this study was to explore the potential of organic (pig) manure compared with mineral fertilizers (KAN) on yield and fruit quality of apple varieties Idared. The study was conducted 2009th in an orchard on the family farm »Lačić« in Donja Vrba (Slavonski Brod). It was found that fertilization KAN significantly increased the number of first class fruit per tree. A statistically significant difference in fruit firmness was observed between control and performed treatments. All other analyzed quality parameters were not statistically different between conducted treatments. From these results it is evident the great potential of using organic manure in organic and sustainable orchards growth because it did not endanger either the yield or quality of apple fruit in relations to mineral fertilizers.

Key words: fertilization, apple, yield, quality, Idared

Izvorni znanstveni rad / Original scientific paper

Are there any useful effects of wastes in the crop production?

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Abstract

Nowadays, one sugar factory remained in decreased capacity in Hungary. So, the absence of lime-sludge forces the agriculture to find other liming materials. The metallurgy lime sludge contains 278,400 mg kg^{-1} from calcium (Ca). The amount of calcium is 50% in sugar factory lime sludge. Calcium has very important role in amelioration of acidic soils. The pH of sugar factory originated lime sludge is 10.8- 11.2 pH, this value is 10.77 pH the metallurgy lime sludge. The experimental plants were sunflower (*Helianthus annus L. cvs. Arena*). The nutrient solution-plant system was examined. The examined material was added to the nutrient solution in different quantities: 0.17 g dm^{-3}, 1.7 g dm^{-3}, 17 g dm^{-3}. The content of elements of metallurgy lime sludge was measured with ICP. Dry matter accumulation of shoots and roots, relative chlorophyll contents, absolute chlorophyll a, b and carotene contents also were measured. The root dry weights were increased at all treatments. The contents of absolute chlorophyll a, b and carotene increased when 17 g dm^{-3} was added to the nutrient solution. The dry matter accumulation of roots increased when metallurgy lime sludge was applied. Same increase was observed at shoots. On the other hand, the application of metallurgy lime sludge can be limited because of its heavy metal contents.

Keywords: acidic soils, crop production, land use, lime sludge

Introduction

Liming is the oldest and most widely applied metal immobilizing, and pH regulating soil treatment. Its primary incentive is the suppression of Al and Mn phytotoxicity in acidic arable soils, but it also can limit the mobility and uptake of the other metals (Pierzynski and Schwab, 1993; Chlopecka and Adriano, 1996). Several mechanisms have been attributed to the lime-induced immobilization of metals (Hamon et al., 2002; Bolan et al., 2003): 1. increase in negative charges on soil components, 2. formation of hydroxy metal groups with strong sorption behaviour, 3. precipitation of metals as hydroxides or carbonates, and 4. metal sequestration due to enhanced microbial activity. A disadvantage associated with liming in the context of in situ metal

immobilization is the gradual reduction of its effect over the course of time due to dissolution and leaching of the liming agent, an effect which for long-term phytostabilization purposes, and provides little guarantee for a permanently safe crop production on metal contaminated agricultural soils. Therefore, a stronger immobilization effect than the one obtainable by liming may be describes.

Even if the duration of a satisfactory immobilization treatment is dependent on several parameters, such as, land use, treatments costs and periodicity of a treatment and the stronger the metal binding, the higher will be its acceptance for use in practice.

Materials and Methods

Sunflower *(Helianthus annus L. cvs. Arena)* was used in the experiments. The seeds were surface-sterilized with 18% hydrogen peroxide, and then washed in distilled water. Then they were germinated on moistened filter paper at 25 °C. The seedlings were transferred to continuously aerated nutrient solution, when the hypocotyl was 2,5-3,0 cm. The composition of nutrient solution as follows: 2.0 mM $Ca(NO_3)_2$, 0.7 mM K_2SO_4, 0.5 mM $MgSO_4$, 0.1 mM KH_2PO_4, 0.1 mM KCl, 1µM H_3BO_3, 1µM $MnSO_4$, 0.25 µM $CuSO_4$, 0.01 µM $(NH_4)_6Mo_7O_{24}$. Iron was added to the nutrient solution as Fe-EDTA at a concentration of 10^{-4}M. 0.17, 1.7 and 17 g dm^{-3} were added to the nutrient solution from lime sludge. The seedlings were grown under controlled environmental conditions (light/dark regime 10/14 h at 24/20 °C, relative humidity of 65–70 % and a photosynthetic photon flux of 300 µmol $m^{-2}s^{-1}$). The contents of elements were measured with ICP, the relative chlorophyll contents with SPAD 502 (Minolta). The absolute chlorophyll a, b, and carotene were measured with Meterek SP 80 Spektrometer by Moran and Porath's method (1980). The number of laboratory readings for ICP was the mean of three samples, and SPAD 502 was 60. The samples were dried at 85 Cº, the dry matter of shoots and roots of 12 plants were measured.

The lime sludge originated from the Ore, Mineral and Waste Recycling Works of Borsod Private Company Limited by Shares (BÉM Zrt.).

Results and discussion

The Recycling Law says that in the interest of the utilization of material and energy present in waste we should aim to recycle the litter as much as possible. Utilization can also means, that where possible, we should try to recycle waste instead of extracting raw materials, which prevents the exploitation and destruction of our natural environment. By the way of priority the law reinforces the re-utilization of wastes occurring from within its own materials instead of the traditional waste disposal technologies and other treatments, which make the waste non-hazardous.

The contents of some elements in lime sludge (Table1).

Table 1. Contents of some elements in the lime sludge (mg kg^{-1})

Al	Ca	Cr	Fe	K	Mg	Zn
3,440.00	278,400.00	169.00	118,500.00	1,010.00	5,055.00	106.00

Metal toxicity is usually connected with low soil pH in cultivated plants. Acidity increases the availability of aluminium, manganese, and iron which are abundant in mineral soils. The pH of lime sludge is very alkalic (10.77) therefore it is applicable for increasing the soil pH.

The toxic effects of aluminium are primarily root-related (Taylor, 1988). The root system becomes stubby as a result of inhibition of elongation of the main axis and lateral roots (Klotz and Horst, 1988). The severity of inhibition of root growth is a suitable indicator of genotypic differences in aluminium toxicity (Foy et al., 1967). Aluminium toxicity is therefore often expressed simultaneously in two ways, namely induced deficiency of mineral nutrients, such as magnesium, and inhibition in root elongation (Tan et al., 1992).

Iron deficiency is a worldwide problem in crop production on calcareous soils. It is the major responsible factor for so-called lime-induced chlorosis. The critical toxicity contents are above 500 mg Fe kg^{-1} leaf dry weight, but its dependence is high on other factors, such as content of other mineral nutrients (Yamauchi, 1989). Iron toxicity may also play a role under dry land conditions and is probably an early event of drought-induced damage in photosynthetic tissue caused by iron-catalyzed formation of oxygen free radicals in the chloroplasts (Price and Hendry, 1991).

The plants can uptake these elements originating from wastes, and may cause different effects on their development and growth. The dry matter accumulation of shoots and roots are shown in Table 2.

Table 2. Effects of different quantities lime sludge on the dry matter accumulation of shoots and roots of sunflower seedlings (g $plant^{-1}$) n=12± s.e.

treatments	roots	shoots
control	0.1218± 0.02	0.7573± 0.12
0.17	0.1393± 0.02	0.8075± 0.14
1.7	0.1995± 0.03	0.9924± 0.07
17	0.1531± 0.01	0.7097± 0.09

The application of lime sludge increased the dry matter accumulation. The dry matter of roots increased with 14%, when the lime-sludge was applied at the 0.17 g dm^{-3} concentration, 25% at the 17 g dm^{-3} concentration, and approx 64% at the 1.7 g dm^{-3} treatment.

The dry matter accumulation of shoots was higher at the 0.17 and 1.7 concentration than at the control. This value increased with 15% at the 0.17 and 31% at the 1.7 g dm^{-3} treatments. Dry matter of shoots decreased with 7% at the 17g dm^{-3}.

Low chlorophyll contents affect photosynthetic activities. The decreasing dry matter accumulation can be explained by the lower level of the chlorophyll contents (Table 3).

Table 3. Relative chlorophyll contents of the 1st and 2nd leaves of sunflower on the measurement of 10th, 13th and 15th days (Spad Units) n=60± s.e.

relative chlorophyll contents of the 1st leaves of sunflower (Spad Units)			
treatments	on 10th day	on 13th day	on 15th day
control	37.59± 2.12	41.37± 1.59	42.92± 2.16
0.17	38.41± 2.27	41.98± 2.19	42.69± 1.38
1.7	38.92± 2.08	42.44± 2.25	42.98± 2.53
17	40.20± 2.91	43.60± 2.56	45.03± 2.35

relative chlorophyll contents of the 2nd leaves of sunflower (Spad Units)			
treatments	on 10th day	on 13th day	on 15th day
control	33.77± 1.85	37.65± 2.16	40.01± 2.10
0.17	35.29± 1.68	38.76± 1.77	38.81± 1.82
1.7	33.31± 2.75	38.08± 2.02	38.16± 1.29
17	35.03± 1.84	39.53± 1.91	40.23± 1.15

The relative chlorophyll contents increased at the 17 g dm^{-3} treatment in the first and second leaves on the 10th, 13th and 15th days. The relative chlorophyll contents increased in the first leaves effecting by all treatments or all concentration.

The most favourable concentration is the 1.7 g dm^{-3} according the dry matter accumulation. The relative chlorophyll content was the highest at the 17g dm^{-3}.

The amount of photosynthetic pigments was measured. The results are shown in Table 4.

The chlorophyll a, b and carotene contents were lower when 0.17 and 1.7g were added to the nutrient solution than at the control in the 1st leaves. The chlorophyll and carotene increased when 17g dm^{-3} treatment was applied. These values deceased at all cases on the second leaves of sunflower.

Table 4. Contents of chlorophyll a, b and carotin of 1st and 2nd of sunflower leaves (mg g^{-1})

1st leaves of sunflower			
treatments	chlorophyll a	chlorophyll b	carotene
control	13.00± 1.12	3.97± 0.65	7.89± 0.96
0.17	12.89± 0.29	3.83± 0.23	7.87± 0.47
1.7	12.15± 0.70	2.58± 0.38	7.17± 0.84
17	13.14± 0.67	3.93± 0.12	8.67± 1.16
2nd leaves of sunflower			
control	14.34± 1.26	4.77± 0.23	9.99± 0.69
0.17	13.53± 1.21	4.10± 0.87	9.31± 0.95
1.7	12.36± 0.61	3.54± 0.65	8.21± 0.37
17	13.95± 0.65	4.19± 0.31	9.49± 0.77

Conclusion

The application of metallurgy lime sludge had not got disadvantageous effects on the growth and development of sunflower. The dry matter accumulation did not decrease significantly moreover these values increased when 0.17 and 1.7 g were given to the nutrient solution.

The relative chlorophyll contents increased at the 17 g dm^{-3} treatment in the first and second leaves on the 10th, 13th and 15th days.

The amounts of photosynthetic pigments decreased in the second leaves at all treatments. The absolute chlorophyll-a, and carotene increased in the first leaves when 17g was used.

These results suggest the potential possibility of application of lime sludge as soil amendments instead of sugar factory lime sludge.

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Sažetak

Da li postoje ikakvi korisni učinci otpada na proizvodnju usjeva?

Danas u Mađarskoj postoji još jedna jedina šećerana, a i ona sa sve manjim kapacitetom prerade. Dakle, odsustvo saturacijskog mulja prisiljava poljoprivredu da potraži druge izvore materijala za kalcizaciju. Troska iz metalurgije sadrži 278,400 mg kg^{-1} kalcija (Ca). Količina kalcija je 50% one od saturacijskog mulja iz šećerane. Kalcij ima vrlo važnu ulogu u amelioraciji kiselih tala. Reakcija saturacijskog mulja podrijetlom iz šećerana kreće se između 10.8- 11.2 pH, dok troska iz metalurgije 10.77 pH. Za pokusnu biljku korišten je suncokret (*Helianthus annus L. cvs. Arena*). Ispitivani su sustavi hranjivih otopina. Istraživani materijal bio je dodavan hranjivoj otopini u različitim količinama: 0.17 g dm^{-3}, 1.7 g dm^{-3} i 17 g dm^{-3}. Sadržaj elemenata u metalurškoj troski bio je određen ICP-om. Mjereni su također akumulacija suhe tvari u stabljici i korijenju, relativni sadržaj klorofila, apsolutni sadržaj klorofila a, b i karotenoida. Težina suhe tvari korijena povećan je kod svih tretmana. Sadržaj apsolutnog klorofila a, b i karotenoida povećan je kad je 17 g dm^{-3} dodano hranjivoj otopini. Akumulacija suhe tvari korijenja povećala se pri dodavanju metalurške troske. Neka povećanja uočena su u stabljikama. U drugu ruku, aplikacija metalurške troske može biti ograničena zbog svog sadržaja teških metala.

Keywords: acidic soils, crop production, land use, lime sludge

Izvorni znanstveni rad / Original scientific paper

Physiological responses of maize and cucumber to the biofertilizer treatment under alkaline condition

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Abstract

The aim of this study was to investigate the effect of high pH and bacteria based biofertilizer (Phylazonit MC®) on nutrient uptake and some other physiological parameters of maize and cucumber seedlings in laboratory experiments. According to our results the microorganisms containing fertilizer decreased the bicarbonate caused high pH and stimulated development of roots supporting larger availability of nutrients. In all the cases, the bicarbonate significantly decreased – by more than 50% – the content of investigated pigments, which was compensated by the application of biofertilizer. The biofertilizer (under 40 mM bicarbonate) could compensate – by 124% in chlorophyll-a, 80.9% in chlorophyll-b, 43.7% in carotenoids – the retardation effect of bicarbonate. It was observed, that the applied biofertilizer reduced the amount of excreted organic acids by the root of plants. The use of this biofertilizer can take the utilization of chemical fertilizers more effective and due to this process the production of crops are getting more successful.

Keywords: biofertilizer, pH, organic acids, photosynthetic pigments

Introduction

The soil is a complicated and complex system of different elements, compounds, respectively creatures. The environmental factors can influence the mobility and amount of nutrients, which important for plant (Wolf, 1999). The pH of soil, respectively rhizosphere determines the uptake of nutrients, which the plant can also modify by secreted organic acids and the microorganisms also can take part it. The changes in pH by excreted organic acids are in many cases responses of root to the nutritional status of plant (Marschner et al., 1987). The most important factor is the excretion of H^+, HCO_3^-, and OH^- in the induced soil pH changes by roots; which is in relation with the uptake of anion/cation. The microorganisms also can produce organic acids throw their metabolism. To apply bacteria (PGPB- *Plant Growth Promoting Bacteria*) as biofertilizer is getting become conspicuous, because the level of animal breeding and the utilization of organic fertilizer are dropping, thus the soil is getting poor in useful bacteria. One of the most important roles of PGRB is to enhance the formation of Fe-complex by excreted extracellular siderophores (Klopper et al., 1980).

Materials and methods

The experimental plants were maize (*Zea mays L. Dekalb DKC 4490*) and cucumber (*Cucumis stativum L. cv. Delicatess*). Monocot and dicot plants were chosen to investigate the effects of microorganisms, because they have different nutrient uptake mechanism (Marschner et al., 1986). The seeds were germinated on moistened filter paper at 25°C. The seedlings were transferred to a continuously aerated nutrient solution of the following composition: 2.0 mM $Ca(NO_3)_2$, 0.7 mM K_2SO_4, 0,5 mM $MgSO_4$, 0.1 mM KH_2PO_4, 0.1 mM KCl, 1µM H_3BO_3, 1µM $MnSO_4$, 0.25 µM $CuSO_4$, 0.01 µM $(NH_4)_6Mo_7O_{24}$. The nutrient solution of cucumber contains 10µM H_3BO_3. The pH was measured of the fresh nutrient solution (basic pH) and after 3 days also (changed pH). The replicates were 3.

The iron as Fe-EDTA was added to the nutrient solution in the concentration of 10^{-4}M. Bicarbonte was added to the nutrient solution in the form of $NaHCO_3$ in the following concentration: 10, 20, 40, 80 mM. In the case of cucumber, the plants died because of the high (80 mM) bicarbonate concentration. 1.25 g agar-agar mixed with 3 ml Bromcresol Purple indicator (*BCP-5',5"-dibromo-o-cresolsulfophthalein*), (in 100 ml) was used to visualize the pH changes by excreted organic acids by roots. The agar-agar mixed with indicator was set to pH 6.0 with NaOH and H_2SO_4 to show the negative or positive changes in pH.

The applied biofertilizer (1 $ml \cdot l^{-1}$) was PHYLAZONIT MC®, which contains two bacteria: *Bacillus megatherium var. phosphoricum* and *Azotobacter chroococcum*. The pH of nutrient solution was measured with Optima 200A (USA). Root differentiation and its excreted organic acids were investigated with special agar-agar method. The contents of photosynthetic pigments (chlorophyll-a,-b, total carotenoids) were analysed with METEREK SP-830 spectrophotometer. The seedlings were grown under controlled environmental conditions (light/dark regime 16/8 h at 20-25 °C, 65–75% relative humidity and a photosynthetic photon flux density 300 µmol $m^{-2}s^{-1}$).

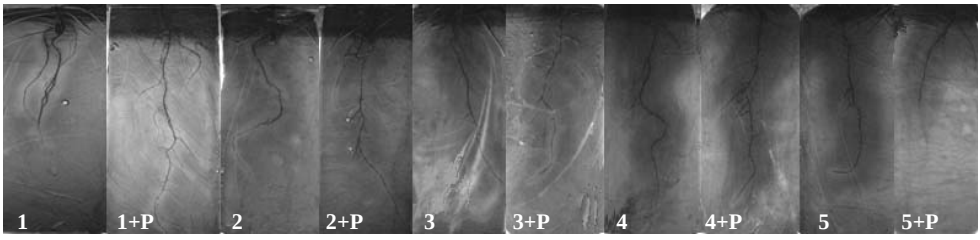
Table 1. The effect of treatments on nutrient solution's pH in the case of maize seedlings (n=3±s.e.). Significant difference comparison to the control: *p <0.05, **p<0.01, ***p<0.001. Significant difference comparison to the fresh pH: [a]p<0.05, [b]p<0.01, [c]p<0.001. Biofertilizer: Phylazonit MC®

Treatments	2nd day		8 th day	
	basic pH	changed pH	basic pH	changed pH
	in 0th hour	**in 72th hour**	**in 0th hour**	**in 72th hour**
control	7,06±0,23	6,44±0,16	4,86±0,06	7,04±0,24[c]
control+ biofertilizer	6,94±0,45	5,75±0,12	4,85±0,03	7,01±0,45[c]
10mM $NaHCO_3$	6,50±0,43	8,08±0,50***[c]	6,86±0,14***	7,53±0,15
10mM $NaHCO_3$+ biofertilizer	6,43±0,42	7,71±0,46**	6,84±0,10***	7,53±0,03
20mM$NaHCO_3$	7,89±0,09*	8,08±0,03***	7,74±0,03***	8,23±0,63*
20mM $NaHCO_3$+ biofertilizer	7,81±0,08	8,06±0,34***	7,70±0,06***	8,18±0,32
40mM $NaHCO_3$	8,21±0,07***	8,65±0,38***	8,09±0,01***	8,31±0,04**
40mM $NaHCO_3$+ biofertilizer	8,20±0,07***	8,03±0,34***	8,06±0,04***	8,25±0,17*
80mM $NaHCO_3$	8,22±0,02***	8,70±0,10***	8,36±0,03***	8,96±0,31***
80mM $NaHCO_3$+ biofertilizer	8,18±0,21***	8,43±0,31***	8,33±0,07***	8,80±0,52***

Results and discussion

The solubility and mobility of nutrient are determined by the pH of soil. The effects of bicarbonate and biofertilizer treatments were investigated on the pH of nutrient solution (Table 1.).

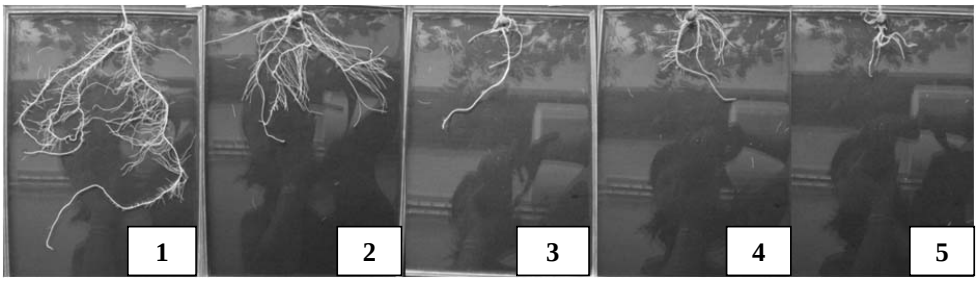
The application of bicarbonate affected the pH of nutrient solution, as a result of it the pH significantly increased in the cases of basic and changed nutrient solution as well. This effect depended on the concentration of bicarbonate; higher bicarbonate concentration caused higher pH. The high pH (pH 8.0) can decrease the solubility of most important macro-, and micronutrient – e. g. Fe, Zn – which can reduces the growth and several metabolism processes, because the alkaline condition inhibits the solubility of element and therefore the uptake of nutrient as well (Terbe, 2009). When biofertilizer was added into the nutrient solution the bicarbonate caused high pH decreased. The secreted organic acids by microorganisms decreased the pH and could help to make soluble the nutrients (Bowen and Rovira, 1991). The released organic acids by roots play an important role in reduction of unfavourable environmental condition – e.g. alkaline pH – and the mobilization of nutrients. The effects of applied treatments were measured on the amount of excreted organic acids by monocot maize and dicot cucumber (Picture 1.).



Picture 1. The demonstration the effects of treatments on secreted organic acids by 5-day-old cucumber seedlings after 24 hour. Treatments: 1: control, 2: 10 mM $NaHCO_3$, 3: 20 mM $NaHCO_3$, 4: 40 mM $NaHCO_3$, 5: 80 mM $NaHCO_3$; +P: Phylazonit MC®.

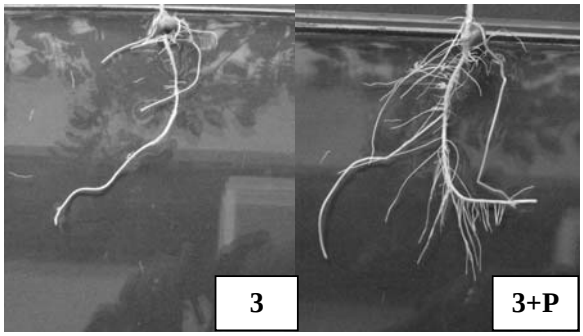
The Bromocresol Purple indicator shows the changes in pH. By the bluish (dark) discolouration of Bromocresol Purple indicator demonstrates the pH increasing effect of bicarbonate, which depended on the bicarbonate concentration. In the case of maize the roots secreted organic acids (until treatment 20 mM $NaHCO_3$, above treatment 40 mM $NaHCO_3$) had a negligible changes in pH, as a results of the applied extreme high concentration of bicarbonate (data not shown). The cucumber was more sensitive than the monocot maize. The agar with indicator showed pH changes in case of cucumber roots treated with 10 mM $NaHCO_3$ and above 40 mM $NaHCO_3$ only the root tips released a few organic acids. The biofertilizer Phylazonit MC® decreased the pH and the amount of secreted acids by the root of plants. The microorganisms can relieve the plants and the plant can preserve bigger part of the photosynthetically produced organic matter for better production.

Several differences among root morphology of experimental plants were observed under alkaline conditions (Picture 2. and Picture 3.).



Picture 2. The effects of treatments on the morphology of root (maize seedlings). Treatments: 1: control, 2: 10 mM $NaHCO_3$, 3: 20 mM $NaHCO_3$, 4: 40 mM $NaHCO_3$, 5: 80 mM $NaHCO_3$.

The bicarbonate decreased the development and growth of roots parallel with its increasing concentration. Above pH 7.8-8.0 (treatment 3) there were no or less secondary roots and root hairs were experienced, which have a main role in absorbing water and nutrients from the soil. The application of biofertilizer improved the growth of secondary roots and as a result of it the uptake of nutrient as well; under high pH (Picture 3.).



Picture 3. The effects of bicarbonate and biofertilizer treatments on the morphology of maize root. Treatments: 3: 20 mM $NaHCO_3$; +P: Phylazonit MC®.

In the case of treatment 20 mM $NaHCO_3$ bicarbonate induced the roots to secrete the highest amount of organic acid comparison to the other treatment including control. The bacteria contents biofertilizer helped the plant to reduce the amount of own secreted organic acids; therefore the microorganisms could help the development of roots. Similar results were observed in the case of cucumber, but the responses of this dicot plants were more sensitive to the alkaline pH, because plants were lost after 4 days in case of treatment 4 and 5. The bicarbonate also reduced the length and growth of the roots under increasing bicarbonate treatments. The application of Phylazonit MC® could compensate the bicarbonate caused stress via its useful bacteria, which release organic acids and decrease the pH and make the nutrient more available for the plants.

The high pH also induced iron-chlorosis of leaves, therefore the effects of bicarbonate and biofertilizer were also examined on contents of photosynthetic pigments such as chlorophyll-a, chlorophyll-b and carotenoids (Table 2.).

Table 2. The effects of bicarbonate and biofertilizer on the concentration of chlorophyll-a, chlorophyll-b and carotenoids in cucumber's 2nd leaves. (mg·g^{-1}) (n=3±s.e.) Significant difference comparison to the control: *p <0.05, **p<0.01, ***p<0.001. Significant difference comparison to the treatment without biofertilizer: [a]p<0.05, [b]p<0.01, [c]p<0.001. Biofertilizer: Phylazonit MC®

Treat.	chl-a	chl-b	car	chl-a/ chl-b	chl-a/car	total chl/car
1	13.72±2.42	5.25±1.16	3.96±0.76	**2.64**	**3.47**	**4.79**
1+P	12.34±0.35*	4.34±0.23*	3.40±0.11*	**2.84**	**3.63**	**4.91**
2	11.29±1.84	3.55±0.38***	3.08±0.23**	**3.22**	**3.65**	**4.82**
2+P	12.15±0.63	4.72±0.25*[a]	3.45±0.17*	**2.58**	**3.52**	**4.89**
3	10.02±0.40*	3.61±0.37***	2.83±0.23***	**2.79**	**3.54**	**4.82**
3+P	12.79±1.50[a]	4.96±0.70[b]	3.63±0.54[b]	**2.59**	**3.54**	**4.89**
4	4.59±1.36***	1.78±0.47***	2.31±0.24***	**2.48**	**1.94**	**2.76**
4+P	10.29±0.77**[c]	3.22±1.31***[a]	3.32±0.98*[a]	**3.23**	**3.07**	**4.07**

The bicarbonate caused high pH significantly reduced the contents of investigated pigments. In the case of maize the 80 mM bicarbonate treatment decreased the content of chlorophyll-a by 62%, the chlorophyll-b by 68% and the carotenoids by 63%. The response of dicots was similar in lower bicarbonate treatments; they have a different nutrient uptake mechanism which take them more sensitive to the pH (Marschner et al, 1986). In the case of cucumber the highest concentration of bicarbonate was 40 mM, which caused reduction in the contents of all the measured pigments: chlorophyll-a (67%), chlorophyll-b (66%), carotenoids (42%). The favourable effect of biofertilizer Phylazonit MC® was observed. The control treatment with biofertilizer increased – by 1.5%, 0.7%, 4.7% – the contents of chlorophyll-a, -b and carotenoids in the case of maize comparison to the control, respectively. However, the biofertilizer did not increase the contents of pigments in cucumber. The highest (40 mM) bicarbonate treatment of cucumber with Phylazonit MC® significantly compensated – by 124% in chlorophyll-a, 80.9% in chlorophyll-b, 43.7% in carotenoids – the retardation effect of bicarbonate. However, the added biofertilizer in the case of the 80mM bicarbonate treatment could not compensate the effect of high pH in maize seedlings.

Conclusion

According to our result the bicarbonate caused alkaline conditions modified the solubility and mobility of nutrient and as a result of it the development of roots were retarded. The amount of released organic acids increased under alkaline condition in the case of maize and cucumber as well. The alkaline condition influenced the nutrient uptake and caused serious retardation in contents of photosynthetic pigments in order to decrease the photosynthesis. The application of microorganisms containing biofertilizer could enhance the uptake of nutrients by secreted own organic acids, which reduced the bicarbonate caused high pH and decreased the retardation effect of bicarbonate on root morphology and the contents of photosynthetic pigments.

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Sažetak

Fiziološka reakcija kukuruza i krastavaca na tretman biognojivom u alkalnim uvjetima

Cilj ovog istraživanja bio je utvrditi utjecaj visokog pH i bakterijskog biognojiva (Phylazonit MC®) na usvajanje hraniva i određene fiziološke parametre klijanaca kukuruza i krastavaca u laboratorijskim uvjetima. U skladu s našim rezultatima gnojidba s mikroorganizmima snizila je bikarbonate, što je povisilo pH i stimuliralo razvoj korijenja, poboljšavajući tako veću pristupačnost hraniva. U svim slučajevima, bikarbonati su značajno smanjili – za više od 50% - sadržaj praćenih pigmenata, što se kompenziralo kroz primjenu biognojiva. Biognojivo (s 40 mM bikarbonata) može kompenzirati - do 124% klorofil-a, do 80,9% klorofil-b, te do 43,7% karotenoide – retardacijski učinak bikarbonata. Uočeno je da primjena biognojiva reducira količinu izlučenih organskih kiselina iz korijenja biljaka. Uporaba ovog biognojiva može poboljšati usvajanje i efikasnost mineralnih gnojiva i na taj način unaprijediti proizvodnju usjeva.

Ključne riječi: biognojivo, pH, organske kiseline, fotosintetski pigmenti

Izvorni znanstveni rad / Original scientific paper

The effect of N-P-Zn fertilization on the yield, zinc content and uptake of ryegrass

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Abstract

The effect of nitrogen, phosphorus and zinc fertilization on the yield, Zn content and Zn uptake of ryegrass was studied in a greenhouse experiment. The treatment combination was set according to Box-Wilson method. Performing multiple regression analysis, the yield, the zinc content and uptake were described as a function of fertilizer doses by a polynomial of second degree. The R^2 values were the following: $R^2 = 0.863$ (for the yield), $R^2 = 0.936$ (for the Zn content) and $R^2 = 0.968$ for the Zn uptake. Based on the regression equation we calculated the optimal fertilizer doses, these are N = 120, P_2O_5 = 89 and Zn = 2.8 mg kg^{-1}. Among N, P and Zn the N and Zn doses increased the zinc content and uptake significantly (P = 0.1%) in the studied range.

Keywords: zinc, Box-Wilson, greenhouse

Introduction

The appropriate nutrient supply is one of the most important factors of the success for intensive plant production. Beside, the three most important macroelement (NPK) fertilization, the micronutrient replacement is also of great importance. In Hungary 40-45% of agricultural areas is Zn deficient (Elek and Patócs, 1984). Our aim was to study the direct effects and the interactions of the N-P-Zn fertilizers.

Using a traditional method for the set of a multivariate experiment a high number of samples are to be applied, because the number of combinations increases exponentially with the factors. For example if we examine the effect of three factors in five rates, 5^3 samples are required for the experiment. The Box-Wilson (1951) experiment designing method reduces the number of combinations by simultaneously changing the factors. Using Box Wilson method for the above experiment only 64 samples are required. Due to these advances we chose Box-Wilson method for the study of N-, P- Zn interactions. The experiment was designed and the results were evaluated according to Kafarov (1976) by using the computer program of Biczók et al. (1994).

Based on our earlier experiences (Loch, 1971) we supposed that the effects are not linear and we chose the following three variable quadratic polynomial for the description of the relations.

$Y = b_0 + b_1 \cdot (N) + b_2 \cdot (P) + b_3 \cdot (Zn) + b_{12} \cdot (N) \cdot (P) + b_{23} \cdot (P) \cdot (Zn) + b_{13} \cdot (N)(Zn) + b_{11} \cdot (N)^2 + b_{22} \cdot (P)^2 + b_{33} \cdot (Zn)^2$.
(eq.1)

Where:

Y = yield or zinc content or zinc uptake

(N), (P), (Zn) = nutrient doses

b_0, b_1, b_2, b_3, = linear regression coefficient

b_{12}, b_{23}, b_{13} = regression coefficient of interactions

b_{11}, b_{22}, b_{33} = coefficients of quadratic effects

Table 1. NPZn treatments

Treatment	N	P_2O_5	Zn
	[mg kg^{-1}]		
1	120	120	6
2	40	120	6
3	120	40	6
4	40	40	6
5	120	120	2
6	40	120	2
7	120	40	2
8	40	40	2
9	160	80	4
10	0	80	4
11	80	160	4
12	80	0	4
13	80	80	8
14	80	80	0
15	80	80	4

Materials and methods

A pot experiment was conducted using a meadow chernozem soil. The soil was zinc deficient due to its high calcium-carbonate content. The phosphate-P and total nitrogen content of the initial soil was determined from 0.01 M $CaCl_2$ extract according to Houba (1990). The soluble zinc content was measured from DTPA-$CaCl_2$-TEA extract (Lindsay, 1978). The main soil characteristics of the initial soil are the following:

Clay content (%) = 20.62, Humus content = 2.66%, pH_{H2O} = 7.9 , total nitrogen content (0.01M $CaCl_2$) = 39.5 mg kg^{-1}, phosphate-P content (0.01M $CaCl_2$) =1.28 mg kg^{-1}, Zn_{DTPA} = 0.55 mg kg^{-1} $CaCO_3$ content = 7.8%. The Zn content of plant was determined by cc. HNO_3 digestion applying AAS apparatus.

Pots were filled with 2500g air-dry soil. N, P, Zn and K treatments were applied using NH_4NO_3, KH_2PO_4, KCl and $ZnSO_4 \cdot 7H_2O$ solutions mixed into the soils. The K rate was 150 mg K_2O kg^{-1} soil in every pot, while the N, P and Zn rates varied. The NPZn treatment combinations are shown in Table 1. Each element was applied in five doses. The number of the treatments was 15. Treatments 1 -14 were applied in four replicates, while treatment 15 was applied in eight replicates. This was the medium treatment and the statistical analysis required more replicates by this treatment than the others.

The experimental plant was ryegrass (*Lolium perenne* L.). 1.7 g seeds were sown in the soils per pots on April 20. The harvest was on May 21 (32 days after sowing). Soils were kept at constant moisture at 75% of field water capacity, by daily irrigation.

Results and discussion

Dry matter

The yield of ryegrass is presented in Table 2. The dry matter production ranges from 8.5 to13.9 g pot^{-1}. The relation between the yield and the treatments can be described with the following equation:

$$Y = 7.00 + 0.08 \cdot (N)^{***} + 0.03 \cdot (P) - 0.37 \cdot (Zn) + 9.96 \cdot 10^{-5}(N) \cdot (P) - 7.24 \cdot 10^{-4} \cdot (N) \cdot (Zn) + 3.51 \cdot 10^{-4}(Zn) \cdot (P) - 3.87 \cdot 10^{-4} \cdot (N)^{2***} - 2.34 \cdot 10^{-4} \cdot (P)^{2*} - 6.1 \cdot 10^{-2}(Zn)^2$$

(eq.2)

*** P= 0.1%, *P = 5%

The goodness of fit is characterised by R^2 = 0.863. The regression equation shows that yield is influenced by the N doses to the largest extent. The linear component and the quadratic component are highly significant (P = 0.1%). The quadratic effect of P is slightly significant (P = 5%).

Neither the effect of Zn nor the interaction of the tested elements can be confirmed statistically. The optimums of the doses were calculated from equation 2. These are N = 120, P_2O_5 = 89 and Zn = 2.8 mg kg^{-1} and the maximum yield was 13.97 g pot^{-1}.

Zn content

The zinc content of ryegrass is presented in Table 3. It ranges from 14.3 to 49.5 mg kg^{-1}. The relation between the Zn content and the treatments can be described with the following equation:

$$Y = 19.062 + 0.078 \cdot (N)^{***} - 0.168 \cdot (P) + 2.305 \cdot (Zn)^{***} + 1.50 \cdot 10^{-4}(N) \cdot (P) -$$

$$- 5.8 \cdot 10^{-3} \cdot (N) \cdot (Zn) + 3.71 \cdot 10^{-3}(Zn) \cdot (P) + 1.044 \cdot 10^{-4} \cdot (N)^2 + 9.833 \cdot 10^{-4} \cdot (P)^2 -$$

$$- 0.0121 \cdot 10^{-2}(Zn)^2$$

(eq.3)

*** P= 0.1%

Table 2. The dry matter production of ryegrass

Nr.	N	P_2O_5	Zn	Dry matter production (g pot^{-1})				
	mg kg^{-1}			1	2	3	4	mean
1	120	120	6	12.7	12.8	12.8	13.1	12.85
2	40	120	6	10.6	10.5	10.3	10.9	10.58
3	120	40	6	12.3	12.0	11.9	12.6	12.20
4	40	40	6	10.4	10.9	10.7	10.7	10.68
5	120	120	2	13.4	13.0	13.0	12.9	13.08
6	40	120	2	10.6	10.8	10.8	10.6	10.70
7	120	40	2	12.5	12.7	12.9	12.6	12.68
8	40	40	2	10.9	10.5	10.8	11.0	10.80
9	160	80	4	13.9	13.3	13.3	12.8	13.33
10	0	80	4	8.5	9.0	8.6	9.5	8.90
11	80	160	4	12.4	12.4	12.4	12.6	12.45
12	80	0	4	12.0	11.3	12.1	11.5	11.73
13	80	80	8	11.1	11.7	11.9	12.0	11.68
14	80	80	0	12.0	14.3	13.7	14.2	13.55
15.	80	80	4	13.7	13.1	12.8	13.6	13.27
	80	80	4	13.2	13.9	12.5	13.3	

The goodness of fit is characterised by $R^2 = 0.936$ .The regression equation shows that Zn content is influenced by Zn and N doses to the largest extent. The linear components of N and Zn doses are highly significant (P = 0.1%). By the examined P doses the negative effect P was not experienced. Data presented in Table 3 correspond with the above results.

Data in line 9 and 10 of Table 3 show the effect of N doses related to the mean P, Zn treatment. By 160 mg kg^{-1} of applied N the mean Zn content was much greater (37.7 mg kg^{-1}), than by 0 mg kg^{-1} of applied N (24.5mg kg^{-1}). Nitrogen promotes the uptake of other elements.

In line 11 and 12 Zn content in ryegrass can be seen in case of the largest (160 mg- kg^{-1} P_2O_5) and the smallest P (0 mg kg^{-1} P_2O_5) doses by middle P and Z doses. The differences are not significant (36.3 mg kg^{-1} and 35.6 mg kg^{-1}). The largest difference in Zn content occurred as an effect of Zn treatment. . By 8 mg kg^{-1} of applied Zn the mean Zn content was 43.3 mg kg^{-1}, whereas by 0 mg kg^{-1} of Zn application it was only15.6 mg kg^{-1} by middle NP doses.

Table 3. The zinc content and uptake of ryegrass (mg kg^{-1})

Nr.	zinc content (mg kg^{-1})					zinc uptake (mg)				
	1	2	3	4	mean	1	2	3	4	mean
1	39.0	36.7	43.4	41.8	40.2	0.25	0.23	0.28	0.28	0.26
2	32.0	32.0	32.4	32.8	32.3	0.13	0.13	0.13	0.15	0.14
3	49.5	44.6	40.6	40.6	43.8	0.29	0.26	0.23	0.26	0.26
4	31.6	29.7	30.8	31.2	30.8	0.13	0.13	0.13	0.13	0.13
5	36.3	29.7	28.1	29.3	30.8	0.25	0.20	0.18	0.19	0.21
6	22.8	19.5	19.1	21.3	20.7	0.10	0.09	0.09	0.09	0.09
7	31.2	33.2	31.6	30.1	31.5	0.19	0.22	0.21	0.19	0.20
8	22.8	24.3	24.7	26.2	24.5	0.10	0.10	0.11	0.12	0.11
9	37.9	35.1	41.0	36.7	37.7	0.29	0.25	0.29	0.24	0.27
10	21.3	24.3	25.1	21.0	22.9	0.05	0.06	0.05	0.06	0.06
11	33.5	43.8	34.3	33.5	36.3	0.20	0.25	0.20	0.21	0.22
12	35.9	38.2	34.7	33.5	35.6	0.20	0.19	0.20	0.18	0.19
13	44.2	43.8	43.4	41.8	43.3	0.22	0.24	0.24	0.23	0.23
14	15.4	15.0	17.6	14.3	15.6	0.09	0.09	0.09	0.09	0.09
15	27.8	32.8	32.8	27.8	29.7	0.15	0.16	0.14	0.15	0.15
	29.3	27.0	32.8	27.4		0.15	0.16	0.14	0.14	

Zn uptake

The relation between the Zn uptake and the treatments is the following:

$Y = 0.103 + 6.21 \cdot 10^{-4}$ (N) *** - $1.58 \cdot 10^{-3}$ (P) + $1.48 \cdot 10^{-3}$(Zn)*** + $9.77 \cdot 10^{-7}$(N) · (P)

$+7.42 \cdot 10^{-5} \cdot$ (N) · (Zn) + $2.73 \cdot 10^{-5}$(Zn) · (P) + $2.44 \cdot 10^{-6} \cdot (N)^2 + 9.08 \cdot 10^{-6} \cdot (P)^{2+} -$

$9.76 \cdot 10^{-4}(Zn)^2$

(eq.4)

*** P= 0.1%, +P = 10%

The goodness of fit is characterised by $R^2 = 0.968$. The results are similar to that of Zn content. N and Zn treatment had a highly significant increasing effect (P = 0.1%).

The quadratic side of P treatment was very slightly significant (P = 10).

Conclusion

Applying Box-Wilson experimental design the effect and the interaction of N, P and Zn doses can be studied more effectively than by the traditional methods.

By means of the applied method optimal nutrient doses and ratio can be calculated under greenhouse circumstances. In our experiment the optimal N, P and Zn doses are the following: N =120, P_2O_5= 89 and Zn = 2.8 mg kg^{-1}, thus the N : P_2O_5 : Zn ratio is 1: 0.75 : 0.023.

In the studied range N and Zn treatment had highly significant increasing effect (P = 0.1%) for the Zn content and the zinc uptake by the plant. The effect of P was not confirmed statistically. In this experiment the P-Zn antagonism can not be observed, which can be contributed to the fact that maximum of P dose was not greater than 160 mg kg^{-1}.

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Sažetak

Učinak N-P-Zn gnojidbe na prinos, sadržaj cinka i usvajanje hraniva kod engleskog ljulja

Učinci gnojidbe dušikom, fosforom i cinkom na urod, sadržaj Zn i usvajanje Zn od strane engleskog ljulja praćeni su u stakleničkom pokusu. Kombinacija tretmana bila je postavljena po Box-Wilson-ovoj metodi. Kroz izvođenje višestruke regresijske analize prinos, sadržaj cinka i usvajanje bili su opisani kao funkcija količine gnojiva s polinomijalnom funkcijom drugog stupnja. Vrijednosti R^2 bile su slijedeće: R^2 = 0.863 (za prinos), R^2 = 0.936 (za sadržaj Zn) i R^2 = 0.968 za usvajanje Zn. Na osnovi regresijske jednadžbe izračunate su optimalne doze gnojiva, koje iznose N = 120, P_2O_5 = 89 i Zn = 2.8 mg kg^{-1}. Između N, P i Zn dušik i cink su povećali sadržaj Zn i usvajanje signifikantno (P = 0.1%) u proučavanom rasponu.

Ključne riječi: cink, Box-Wilson, staklenik

Izvorni znanstveni rad / Original scientific paper

Effects of ammonium-nitrate and bacterial fertilizer on the yield and nutrient content of maize (*Zea mays L.)*

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Abstract

The greenhouse pot experiment was performed to study the effects of NH_4NO_3, wheatstraw, NH_4NO_3+wheatstraw treatments with or without application of Phylazonit MC bacterial fertilizer on the dry matter production and nutrient content of maize (*Zea mays* L.). Bacterial fertilizer was applied in two different doses. NH_4NO_3 enhanced the growth of plant, while the straw treatment decreased. The lower dose of bacterial fertilizer increased the dry weights compared to control, but decreased when it was applied with straw. The higher dose of Phylazonit MC did not alter or decreased the dry matter accumulation when it was combined with straw. We measured the lowest plant nitrogen in the control and the highest one in straw+higher dose of biofertilizer combined treatment. Phylazonit MC enhanced the plant nitrogen. The P and K contents of plant decreased due to the application of NH_4NO_3 and NH_4NO_3+straw compared to control. In pots, treated with straw, we measured improved P and K values. Phylazonit MC mostly did not alter the P and K contents of plant, but when high dose was applied to straw an enhanced P and K values appeared. We measured the lowest P and K contents in the pots with NH_4NO_3 treatment and the highest ones in straw+high dose of Phylazonit combined treatment.

Keywords: nitrogen, phosphorus, potassium, bacterial fertilizer, maize

Introduction

In the sustainable agricultural system, it is important to maximize the ecological benefits and minimize the environmental hazards. Not balanced use of chemical fertilizers may cause environmental pollution, ecological damage (Kádár et al., 2007).

For reducing application of chemical fertilizers, an alternative method must be developed. In recent years, biofertilizers have emerged as an important component of the integrated nutrient supply system. The bacterial fertilizers are products containing different types of microorganisms (Vessey, 2003). Application of biofertilizers may help to avoid environmental hazards for plants, animals and human beings and may hold a great promise to improve yield trough better nutrient supply (Malboobi, 2009).

Allocation of an organic material into the soil may influence net mineralization or immobilisation processes of soil. Organic materials with high C/N ratio may cause microbial immobilisation

and besides may retard plant growth (Azam, 1989). Bacterial fertilizers may contain cellulolytic microorganisms also, and might cause a relatively rapid turnover of organic matter and a smaller net immobilization processes.

In Hungary few studies were performed on the effect of the bacterial fertilizer application (Kincses et al., 2008). Therefore there has been a growing need to support the applicability of different biofertilizers on the basis of scientific results.

The major objective of our greenhouse pot experiment was to evaluate the effects of ammonium-nitrate, wheat straw, Phylazonit MC bacterial fertilizer and their combined application on dry matter accumulation and nutrient uptake of maize (*Zea mays L.*).

Materials and methods

The greenhouse pot experiment was performed using marshy meadow soil. Experimental soil was collected from the upper layer (0-30 cm) of an agricultural farm at Demecser (in north-east region of Hungary). The soil had the following parameters: $CaCO_3$ (%) = 30; K_A = 47 (Plasticity index according to Arany); Hu% = 3.8; AL-P_2O_5 (mg kg^{-1}) = 210.8; AL-K_2O (mg kg^{-1}) = 346.7.

10 kg soil was weighed into Mitscherlich type pots. Ion exchanged water was added to all pots to keep the soil at constant moisture (60% of the water-holding capacity). The indicator plant was maize (*Zea mays*). The bi-factorial trials were arranged in a randomized complete block design (Table 2.) with three replications.

Table 2. Scheme of treatments applied

treatment code	NH_4NO_3 (g pot^{-1})	wheat straw (g pot^{-1})	Phylazonit MC*** bacterial fertilizer (cm^3 pot^{-1})
1. (control)	-	-	-
2.	0.690	-	-
3.	0.690	18	-
4.	-	18	-
5.	-	-	20
6.	0.690	-	20
7.	0.690	18	20
8.	-	18	20
9.	-	-	40
10.	0.690	-	40
11.	0.690	18	40
12.	-	18	40

***: Phylazonit MC was deluted 500-fold

Nitrogen was ensured as NH_4NO_3. The 0.690 g NH_4NO_3 pot^{-1} was the recommended 200 kg ha^{-1} NH_4NO_3 dose. Before sampling soil for our experiment, 150 kg ha^{-1} N:P:K complex fertilizer has been dispersed in early spring, that is why at the beginning of our experiment we has not ensured further P an K nutrients.

18 g pot^{-1} dose of wheat straw was equivalent of 7 t ha^{-1} dose. The N, P and K content of straw were 0.44% and 0.10%, 0.60%, the C/N ratio was 93:1.

The applied biofertilizer was Phylazonit MC, which contains carboxi-methyl-cellulose (CMC), *Azotobacter croococcum*, *Bacillus megatherium* soil bacteria, microelements, heteroauxin, gibberelin and vitamin B. Before application, Phylazonit was diluted 500-fold and was applied with two doses. A lower dose (20 cm^3 pot^{-1}) was equivalent of 10 l ha^{-1} and a higher one (40 cm^3 pot^{-1}) was equivalent of 20 l ha^{-1}.

On 29th April fifteen seeds of maize per pot were sown into the soil and after emergence, ten plants per pot were left to grow. On 4th June five plants, on 25th June three plants pot^{-1} were cut in order to analyse them. Two plants were left to grow until 10th July. On 10th July plant were collected for further analysis. The plant samples were first air-dried and than dried at 60C° until reaching constant mass. The biomass production was determined by weighing. In this paper we present the dry matter production and nutrient content of plant samples grown until 10 July. The total nitrogen analysis was performed by dry combustion method (Nagy, 2000). P was determined colorimetrically using the molybdenum blue colorimetric method (Tahmm et al., 1968), while potassium was quantified by atomic emission spectroscopy.

Analysis of variance was carried out on the data in order to provide a statistical comparison between the treatment means. The least significant difference (LSD) test was used to detect differences between means at probability level $P \leq 0.05$.

Results and discussion

Dry matter yield and heights of maize

Fig. 1., 2. show the influence of ammonium-nitrate, wheat straw, their combination (NH_4NO_3+straw) and two different doses of bacterial fertilizer on the dry weights and heights of maize.

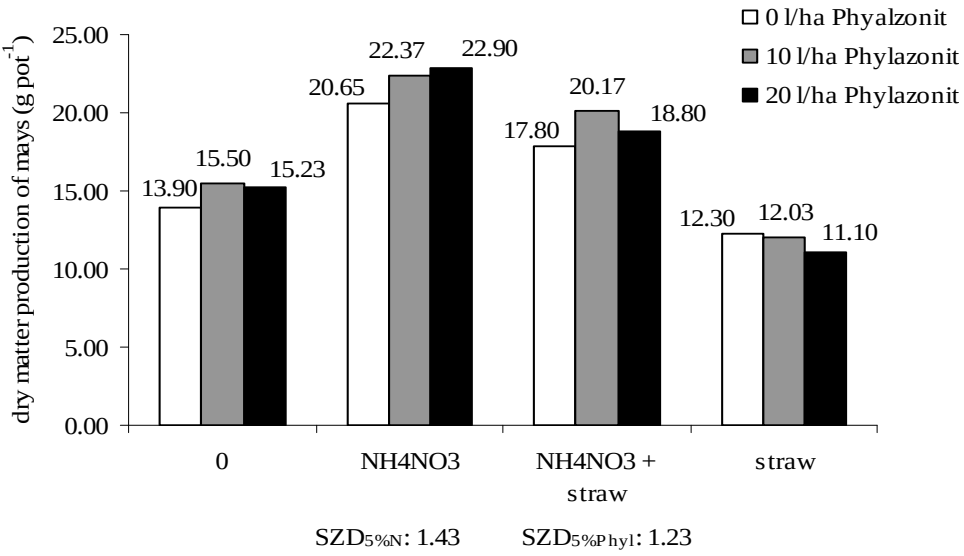

Fig. 1. Changes in the dry matter yield of maize as influenced by different treatments

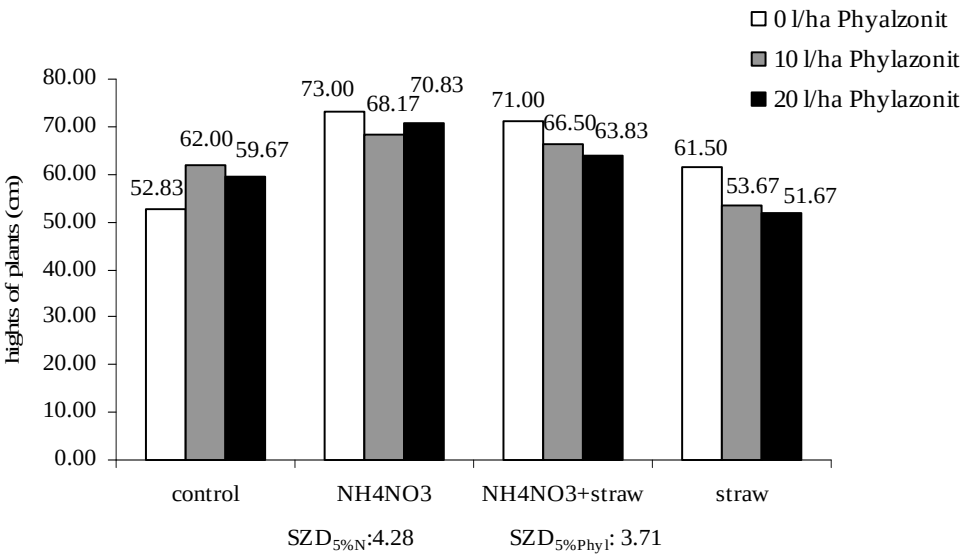

Fig. 2. Changes in the heights of maize as influenced by different treatments

In the treatment with NH_4NO_3 the dry matter production was the highest (20.65 g/pot) and with straw treatment the yield value was lower (12.30 g/pot) than in the control (13.9 g/pot). Ammonium-nitrate enhanced the growth of plant, while the straw treatment might cause nitrogen immobilization and decreased the growth of plant. It can also be seen that the lower dose of bacterial fertilizer increased the dry matter accumulation of maize significantly compared to control plants. Increased values appeared also, when low dose of Phylazonit MC was applied with NH_4NO_3 compared to NH_4NO_3 treatment. When bacterial fertilizer was combined with straw the dry matter a little bit decreased compared to straw treatment. Higher dose of Phylazonit MC did not enhanced the dry matter values, moreover a little bit decreased them when it was combined with straw.

The highest plants (73 cm) were measured in the pots with NH_4NO_3 treatment and the lowest ones (52.83 cm) in the control. Low dose of bacterial fertilizer increased plant hights compared to control, but decreased values appeared when Phylazonit was combined with NH_4NO_3 and with straw, compared to appropriate treatment (NH_4NO_3, straw) without bacterial fertilizer application. Higher dose of bacterial fertilizer (compared to the effect of lower dose) did not alter the hights of plants any longer.

Nitrogen, phosphorus and potassium content of maize

The N, P, and K nutrient contents of maize as influenced by N fertilizer, wheat straw, their combined treatment and different doses of bacterial fertilizer are given in Table 3.

Table 3. Nitrogen, phosphorus and potassium content (%) of maize as influenced by different treatments

treatments	Phylazonit doses (dm^3 ha^{-1})			mean	$LSD_{5\%(N)}$
	0	10	20		
N%					
control	**0.758**	0.790	0.773	*0.774*	0.039
NH_4NO_3	0.809	0.775	0.799	*0.794*	
NH_4NO_3+straw	0.810	0.842	0.875	*0.842*	
straw	0.991	1.010	**1.066**	*1.022*	
mean	*0.842*	*0.854*	*0.878*	*0.858*	
$LSD_{5\%(phyl.)}$		0.034			
P%					
control	0.268	0.251	0.236	*0.252*	0.015
NH_4NO_3	**0.178**	0.196	0.193	*0.189*	
NH_4NO_3+straw	0.229	0.210	0.219	*0.219*	
straw	0.303	0.302	0.327	*0.311*	
mean	*0.245*	*0.240*	*0.244*	*0.243*	
$LSD_{5\%(phyl.)}$		0.013			
K%					
control	1.97	1.80	1.80	*1.85*	0.161
NH_4NO_3	**1.42**	1.59	1.48	*1.50*	
NH_4NO_3+straw	1.70	1.81	1.89	*1.80*	
straw	2.13	2.27	**2.39**	*2.26*	
mean	*1.80*	*1.87*	*1.89*	*1.85*	
$LSD_{5\%(phyl.)}$		0.140			

Changes in the nitrogen content of plant showed a statistically significant increasing tendency with all treatments compared to control. With increasing N supply, the nitrogen content of plant increased. The straw decreased the dry matter yield of plants and that is why caused higher nitrogen content. Low dose of Phylazonit MC did not alter the N values, but the higher doses in most cases caused enhanced nitrogen content of plant.

We measured the lowest plant nitrogen in the NH_4NO_3 treatment and the highest ones in straw treatment with combination of higher doses of biofertilizer.

The phosphorus and potassium contents of plant decreased by the NH_4NO_3 and NH_4NO_3+straw applications compared to control. As the growth rate increased the nutrient content decreased due to dilution brought about by the higher production of plant material. In pots, treated with straw, we measured improved P and K values because of lower production of plant and due to the mineralization of straw.

Phylazonit MC did not alter the P and K contents of plant, but it is worth to mention, when high dose of Phylazonit was applied to straw an enhanced P and K contents of plant appeared. We measured the lowest P and K contents in the NH_4NO_3 treatment and the highest ones in straw+high dose of Phylazonit combined treatment.

Conclusion

Ammonium-nitrate enhanced the growth of plant, while the straw decreased the dry matter accumulation. The lower dose of bacterial fertilizer increased the dry weights compared to control, but decreased these values when Phylazonit MC was applied with straw. Higher dose of bacterial fertilizer did not enhanced the dry matter values, moreover a little bit decreased them when it was combined with straw.

We measured the lowest plant nitrogen in the control and the highest one in straw+higher dose of biofertilizer combined treatment. Phylazonit MC enhanced the plant nitrogen. The P and K contents of plant decreased by the application of NH_4NO_3 and NH_4NO_3+straw compared to control. This change might be because of the »dilution effect«. In pots, treated with straw, we measured improved P and K values.

Phylazonit MC mostly did not alter the P and K contents of plant, but it is worth to mention, when high dose of bacterial fertilizer was applied to straw an enhanced P and K contents of plant appeared. We measured the lowest P and K contents in the NH_4NO_3 treatment and the highest ones in straw+high dose of Phylazonit combined treatment.

Finally it can be concluded, that the lower dose of Phylazonit MC (10 l ha^{-1}) enhanced the dry matter accumulation and heights of plant and resulted a little bit higher N content of plant, but did not decreased the nitrogen immobilization process appearing as a result of the straw application. The higher dose of Phylazonit MC (20 l ha^{-1}) a little bit decreased dry matter accumulation and heights of plant when it was combined with straw and that is why caused enhanced P and K contents of plant.

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Sažetak

Utjecaj amonij-nitrata i biognojiva na visinu uroda i sadržaj hraniva u kukuruzu (*Zea mays L.)*

Proveden je pokus u stakleniku u loncima da bi se proučio utjecaj tretmana NH_4NO_3, pšenična slama, te NH_4NO_3+pšenična slama, s ili bez primjenebiognojiva Phylazonit MC na produkciju suhe tvari i sadržaj hraniva u kukuruzu (*Zea mays* L.). Biognojivo bilo je primjenjeno u dvije doze.

NH_4NO_3 je poboljšao rast biljaka, dok ih je tretman slamom usporavao. Niža doza biognojiva povećala je suhu masu u usporedbi s kontrolom, ali ju je smanjila u kombinaciji sa slamom. Viša doza Phylazonit MC u kombinaciji sa slamom nije promijenila ili smanjila akumulaciju suhe tvari. Najniži sadržaj N u biljci bio je zabilježen na kontrolnom tretmanu, dok je najviši zabilježen u tretmanu slama+viša doza biognojiva. Phylazonit MC je povećao N u biljkama. Sadržaj P i K u biljkama smanjen je uslijed tretmana s NH_4NO_3 i NH_4NO_3+slama u usporedbi s kontrolom. U loncima tretiranima sa slamom izmjerene su povišene vrijednosti P i K. Phylazonit MC većinom nije mijenjao sadržaj P i K u biljci, no, primjenom više doze i slame pojavile su se više vrijednosti P i K. Najniže P i K vrijednosti izmjerene su u loncima s NH_4NO_3 tretmanom a najviše kod tretmana slama+viša doza Phylazonit biognojiva.

Ključne riječi: dušik, fosfor, kalij, biognojivo, kukuruz

Izvorni znanstveni rad / Original scientific paper

Nutritional aspects of organic apple growing in East Hungary

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Abstract

Recent interest to avoid use of agrochemicals in fruit growing and to safeguard environmental and human health has stimulated interest in organic fruit production (OFP) as environmental friendly fruit growing system all over the world. Despite of frequented usage and increasing role there are only less information is available about its nutritional aspects, mostly in Eastern Europe. Therefore the aim of our three-year study was to investigate the nutrient status in organic apple management system and the impact of nutrition on nutrient uptake and environment as well. For leaf and fruit analysis seven traditional and resistant cultivars were selected. To realize the effect of this environmental sound production system on environment and nutrient uptake, soil and leaf analysis was used. It was found that the availability of studied nutrients was less stable in the organic handling due to the strict fertilization requires and maintenance. The low nutrient content of soil and also the generally poorer uptake of nutrients resulted higher production risk in the organic apple orchards compared with conventionally or integrated ones. This indicates that a more efficient nutrient supply is needed for the OFP to achieve good quality and profitable yield.

Keywords: organic growing, apple, nutrition management

Introduction

In the last two decades the worldwide demand for organic food products continues to expand rapidly. Therefore the sustainable and environmentally-benign productions become major principles in the whole fruit growing sector in Europe (Sansavini, 1990; Sansavini, 1997; Morris and Winter, 1999) and Hungary as well. However the organic production requires a holistic approach to agricultural ecosystem management.A major component of organic production is providing organic sources of nutrients to promote plant growth as well as sustain soil quality. Organic **nutrition** of plants can present opportunities and challenges to the grower (Rosen and Allan, 2007).Organic orchards should be sited on land with superior soils and preplant soil preparation to increase organic matter and correct any sub-optimal soil characteristics. Soil and leaf chemical analysis has important role to achieve successful organic fruit growing

because soil and leaf analysis provide the basis for correcting mineral nutrient deficiencies or imbalances in organic production.

It may be necessary to use a number of strategies to supply mineral nutrients over the life of the orchard. The slower, natural methods applied require a management approach that is simultaneously patient and dynamic. Moreover, organic production system strives towards sustainability by minimizing environmental degradation and improving soil quality, while maximizing productivity as well as economic returns (Reganold et al., 2001).

Materials and methods

Characteristics of examined apple orchard

The study was performed at the orchard Fruit Research Station (University of Debrecen), at Debrecen-Pallag during 2002-2004. The 1 ha orchard was planted in 1997 with 39 apple cultivars, grafted on M26 rootstock. Spacing between and within rows was 4 x 1.5 m. Cultivars were planted in 7-tree plots and replicated three times in organic management system, which consists of 8 rows, labelled from A to L per line. Selected seven cultivars (cv. 'Jonagold', 'Mutsu', 'Idared', 'Red Elstar', 'Egri piros', 'Remo' 'Reka') were positioned by randomize way. Only organic manuring was used in the organic orchard part. Stable manure, 30 t ha^{-1} were applied to the soil in 2001 and 2003.

Soil sampling and preparation

Soil was sampled from each 7-tree plot of examined apple cultivars. Three samples were taken from each plot, one from the middle and one from both edges of the plots by leaving 1 m at both sides. As the root system was most intense in the upper layer of the soil, soil samples were taken from 0-20 cm layers of the soil by using a manual soil sampling equipment according to Jackson, 1958 and Hungarian standard (MSZ-08 0202-77). Sampling was performed at the beginning and the end of the vegetation period in April and October in 2002 and 2003, respectively.

The soil samples were dried, sieved, homogenized and stored in plastic boxes until the examination. Soil pH was determined from soil solution made by 0.01 M $CaCl_2$. Plasticity index (K_A) and humus content was measured according to Hungarian guideline (MSZ 20135:1999). Nitrogen forms of each soil sample were quantified according to Houba et al., 1986. For extracting the available P and K content of soils, ammonium-lactate solution (so called AL extractant) was used, then the amount of phosphorus was quantified colorimetrically with the phospomolybdovanadate method (MSZ 20135:1999).

Potassium was quantified by flame atom emission spectrophotometry method (MSZ 20135:1999). For determining Ca, Mg, Mn, Cu and Zn contents of soil Lakanen-Erviö solution (LE) was used (Lakanen Erviö, 1971). Soil Ca, Mg, Mn, Cu and Zn contents were quantified by flame atomic absorption spectrophotometry (MSZ 20135:1999).

Plant sampling and preparation

The selected cultivars form the same 7-tree plots were used for plant sampling as for soil sampling. Leaves were taken from all trees of each 7-tree at the standard sampling time (second half of July). For sampling 8-10 healthy leaves were taken from the mid-third portion of extension shoots current year were collected in each selected tree, following the international and Hungarian plant sampling guidelines for fruit orchards (Stiles and Reid, 1966; MI-08 0468-81).

Leaf samples were dried, finely grounded and homogenized. Samples were then stored in paper bags in a dark and dry place until use.

Nitrogen content of leaves was determined from homogenized samples directly using the dry combustion method according to Nagy (2000).

For determining phosphorus and potassium contents of leaves, first homogenized leaf samples were digested with cc. 5 ml H_2SO_4 and 5 ml H_2O_2 in a heating block digestor.

Then leaf P was quantified colorimetrically with the phospomolybdovanadate method using a spectrophotometer (Metertech VIS SP-850 Plus; Metertech Inc., Taipei, Taiwan).

Leaf K was determined by flame atom emission spectrophotometry and Ca, Mg, Mn, Cu and Zn contents of leaves were quantified by flame atomic absorption method as described for soil samples.

Results and discussion

Results of soil examination

Orchard soil type was brown forest soil with alternated layer of clay (»Kovárvány«), being relatively poor in colloids, macronutrients and humus content (Table 1).

The plasticity index according to Arany (K_A) was 28. Total carbon and nitrogen content was 0.34 and 0.043 % (dm.) Salinity of soil was approx. 0.002%. The pH of soil was slightly acidic.

Table 1. Soil analytical results of examined organic orchard part (2002-2004, averages)

K_A*	28
pH (0,01 M $CaCl_2$)	5.13
Humus (%)	0.75
NO_3^--N (0,01 M $CaCl_2$) (mg/kg)	1.00
NH_4^+-N (0,01 M $CaCl_2$) (mg/kg)	0.81
Organic N (0,01 M $CaCl_2$) (mg/kg)	2.90
PO_4^{3-} (0,01 M $CaCl_2$) (mg/kg)	4.76
K (0,01 M $CaCl_2$) (mg/kg)	168
Ca (LE) (mg/kg)	451
Mg (LE) (mg/kg)	87.4
Mn (LE) (mg/kg)	62.3
Cu (LE) (mg/kg)	3.48
Zn (LE) (mg/kg)	1.78

* - Plasticity index according to Arany (this value relate to plasticity of soil, connection with clay content of soil, using in Hungary)

Humus content and nitrogen forms, like nitrate and ammonium nitrogen and soluble organic nitrogen in the soil were low, which was accordance with the results of yields. Significant amount of easily soluble organic nitrogen fraction was pointed out that organic production can be

use in sandy soils provided that the efficiency of nutrients should be increased by improving soil properties.

Easily soluble and available phosphorus and potassium content of soil were low also due to the soil properties (Table 1). Micronutrient contents were very low in the soil of organic orchard except copper. This is probably due to more frequent copper uses (as a fungicide) in an organic orchard than in integrated one.

Our data indicated that highly significant differences between the two management systems ($P < 0.001$) for magnesium, copper, and zinc; while significant differences between the two management systems was at $P = 0.007$ for calcium. Years had no significant effect for any soil elements and manganese data indicated no significant differences among years, management systems.

Results obtained indicated that seasonal variability of available elements in the soil was high in the organic orchard (data not shown). The obtained data on micronutrient contents correspond to the values characteristic to sandy soil with low humus content and pH value.

Soil analytical results corresponded to the nutrient maintaining of organic fruit production. Data obtained pointed out that organic farming under unfavourable conditions could not based on simply organic fertilization. Required yield can be received only soil improving nutritional management.

Results of leaf examination

Based on leaf diagnostic results established that studied growing ways not affected the dynamics of macro and microelement uptake of examined seven cultivars (data not shown). N and K contents of leaves were slightly lower than optimal values (Table 2).

Whereas leaf phosphorus, calcium and magnesium contents were near optimal.

S and Cu content of leaves was in the 'optimal' range of nutrient supply category which can be explained by the relatively high Cu content of soil follows from the frequent use of copper sprays ($CuSO_4$) against diseases and pests (Holb et al., 2009).

Table 2. Nutrient contents in apple leaves
(Pallag, 2002-2004, averages of cultivars at standard sampling time)

N (%)	2.14
P (%)	0.20
K (%)	1.14
Ca (%)	1.46
Mg (%)	0.41
S (%)	0.21
Mn (mg/kg)	73.12
Zn (mg/kg)	23.23
Cu (mg/kg)	6.88

Beside absolute element concentrations binary ratios of them were also investigated. Our assumption is that these ratios can provide a better indication of nutritional status than conventional sufficiency range approaches. It has been suggested that using these ratios minimize the effects of dilution or concentration due to dry matter and age factors and better evaluates possible nutritional interactions. The most frequently used ratios (N/K, N/P, N/Ca, K/ Ca, K/ Mg, Ca/Mg and Cu/Zn/Mn) were calculated (Table 3).

Nutrient ratios were sometimes unfavourable in organic orchard, which pointed out the balanced and harmonic nutrient supply conditions in this orchard part (Table 3).

Direct evidence was found that the applied plant protection practice have an effect on nutrient uptake and following of this the ratio of nutrient in leaves. Due to the higher leaf Cu content in organic apple leaves, the Cu:Zn:Mn triple ratio was close to the optimal value.

Table 3. Nutrient ratios in apple leaf
(Pallag, 2002-2004, averages of cultivars at standard sampling time)

Nutrient ratios	Organic	Optimal
N/K	2.01	1.76
N/P	11.20	14.40
N/Ca	1.56	1.53
K/Ca	0.79	0.87
K/Mg	2.80	3.90
Ca/Mg	3.62	4.50
Cu/Zn/Mn	~1:3:11	~1:3:10

Conclusions

In conclusion, based on our results obtained leaf analytical results depended on cultivars.

Our results suggested that mobility and available of nutrients in studied organic orchard where only natural nutrient sources are allowed, was hindered. This study also demonstrated that the lower nutrient content of soil and also the generally poorer uptake of N, P and K nutrients in organic apple orchards resulted in higher production risk in the organic apple orchards compared with conventionally or integrated ones. This indicates that a more efficient nutrient supply is needed for the organic management system to achieve good quality and profitable yield.

Moreover, from results it is very hazardous to state that organic fruits provide greater health benefits than integrated or conventionally ones but we suggest that these comparison studies should be expand. The real benefit of these studies is that they will recognize and establish the production input weakness and strengths that affect nutrition, so that changes can be made to improve both organic and integrated fruit growing produce.

Acknowledgements

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Sažetak

Nutritivni aspect ekološki uzgojenih jabuka u Istočnoj Mađarskoj

Recentni interes izbjegavanja uporabe agrokemikalija u voćarstvu zbog očuvanja okoliša i ljudskog zdravlja potakao je interes za ekološkom proizvodnjom voća, kao prijateljskim sistemom za očuvanje okoliša diljem cijelog svijeta. Unatoč čestoj uporabi i rastućoj ulozi, nedostaje informacija o nutritivnim aspektima, većinom u Istočnoj Europi. Stoga je cilj ovog trogodišnjeg istraživanja bio istražiti status hraniva u ekološkom uzgoju jabuka kao i utjecaj na ishranu i okoliš. Odabrano je sedam tradicionalnih i otpornih kultivara za analizu listova i plodova. Otkriveno je da je pristupačnost praćenih hraniva manje stabilna u ekološkom uzgoju zbog strogih zahtjeva prema uporabi gnojiva kao i njezi bilja. Nizak sadržaj hraniva u tlu te općenito slabije usvajanja hraniva rezultiralo je višim proizvodnim rizikom u ekološkom uzgoju jabuka u odnosu na konvencionalni i integrirani uzgoj. Ovo indicira da je potrebna efikasnija opskrba hranivima za ekološku proizvodnju voća ne bi li se postigla dobra kvaliteta i profitabilan urod.

Ključne riječi: ekološki uzgoj, jabuka, način ishrane

Izvorni znanstveni rad / Original scientific paper

Role of groundcover technique in efficient resource nutrition management of sour Cherry

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Abstract

Preserving soil moisture as well as weed control are in focus of crop production all over the world. This statement is highly valid for fruit production, where the water availability of soil is a cardinal problem. It seems that the practise of ground cover is suitable to solve these problems simultaneously. Therefore, the aim of our study is to examine the effects of different groundcover methods on nutrient availability and uptake of sour cherry orchard. The experiment was carried out in the orchard of Research Station of Újfehértó, in Eastern Hungary. The orchard was set up on acidic sandy soil in the Nyírség region. It was established in the autumn of 2000, using 'Oblacsinszka' cultivar grafted on prunus mahaeb rootstock at a spacing of 5.0 x 2.5 m. The applied treatments were the following: cow manure, straw, sawdust, pine bark mulch, black foil and control as a check. The different matters were applied on the soil surface to test the effectiveness of these materials. From the results of plant chemical analysis it is stated that all used treatments increased leaf N, Mg and Ca content while decreased leaf P and K content. Consistent effect of treatment was not observed regarding to leaf micronutrient contents. However, the applied treatments increased leaf micronutrient contents usually.

Key words: floor management, mulching, sour cherry

Introduction

Worldwide research goals and concerns are to soil and soil water conservation and improve. This conception is mostly actual in horticulture. In modern (high-density) plantations the nutrient and water uptake is more intensive, so both the preservation of soil moisture and nutrient level are key factors in qualified fruit growing. On the other hand due to the climatic changes, the water supply of trees will be satisfied among worse conditions than some decades ago. Appearance of water supply problems and water stress is increased in fruit growing sector, where the number of corrections is limited anyway.

To solve these problems the practise of mulching is preferenced. Furthermore, floor management is a successful tool in weed management which causes many problems mostly for organic growers due to the prohibition of synthetic herbicides. Mulching with organic materials is highly beneficial in many orchard crops because it is a traditional weed control method that offers important potential benefits by maintaining a high quality soil environment (Hogue, 1998). Moreover, mulching has used generally in organic fruit farming all over the world due to benefits of it (Skroch and Shribbs, 1986). Mulches are not only highly effective in checking evaporation and in preventing weed growth, but also have influence on several processes in the soil. The benefits are variously attributed to the suppression of weed growth, to the conservation of moisture by reducing evaporation and run off, to protection from erosion, to increased infiltration of water, to the increase or decrease of soil temperature fluctuations, to the enhancement of mineral nutrient availability, to the enhancement of nitrification, to additional nutrients and organic matter derived from a decomposing mulch, or to the preservation or improvement of soil structure (Merwin et al., 1994). Moreover, mulching has a positive effect on nutritional and biological factors as well (Faust, 1989). On the one hand mulching produces an increase in the nutrient content of the soil by leaching of nutrients from the mulch, but at the same time the entire condition of nutrient availability may be modified for better or worse by changes induced by the mulch in the moisture and temperature regimes of the soil. On the other hand applying mulches increases root length density and brought the roots closer to the surface (Merwin and Stiles, 1994). In a review of orchard floor management, Skroch and Shribbs (1986) provide some general guidelines for several aspects, including soil quality, water relations, and microclimate.

Materials and methods

Characteristics of examined orchard

The experiment was carried out in the orchard of Research Station of Újfehértó, in Eastern Hungary, began in 2008. The orchard was set up on acidic sandy soil in the Nyírség region. It was established in the autumn of 2000, using 'Oblacsinszka' cultivar grafted on *Prunus mahaeb* rootstock at a spacing of 5.0 x 2.5 m. The orchard has been treated according to the Integrated Fruit Production guidelines. The orchard was not irrigated in the studied period.

The applied treatments were the following: cow manure, straw, sawdust, pine bark mulch and black foil. The different matters were applied on the soil surface to test the effectiveness of these materials. Each treatment plot consisted of 20 trees.

The layout of the groundcover matter was the same in all treatments. The line of trees was covered in 1.0m wide stripes along plots. So the covered area was 50 m^2 (Photo 1).

Soil samples were taken from three layers (0-30 cm and 30-60 cm) of each plot, from the middle of the section by using manual soil sampling equipment. Sampling was performed at the beginning of the vegetation period, in April, 2008, before applying groundcover matters. For the characterisation of the soil the most important soil parameters and nutrient status were determined. The applied treatments of the examined orchard part are indicated in Table 1.

Photo 1: Usage of black foil (P. T. Nagy – Újfehértó, 2008)

Table 1: Applied treatments

Treatments	Applied dose (m^3/plot)
Control	-
Straw	2.475
Sawdust	5.0
Pine bark mulch	2.5
Cow manure	1.65
Black foil	0.5 mm (thickness)

Soil sampling and preparation

The soil samples were dried, sieved, homogenized and stored in plastic boxes until the examination. Soil pH, plasticity index (K_A) and humus content was measured according to Hungarian guideline (MSZ 20135:1999). Nitrogen forms of each soil sample were quantified according to Houba et al., 1986. For extracting the available P and K content of soils, ammonium-lactate solution (so called AL extractant) was used, then the amount of phosphorus was quantified

colorimetrically with the phospomolybdovanadate method (MSZ 20135:1999). Potassium was quantified by flame atom emission spectrophotometry method (MSZ 20135:1999). For determining Mg, Mn, Cu and Zn contents of soil Lakanen-Erviö solution (LE) was used (Lakanen Erviö, 1971). Soil Mg, Mn, Cu and Zn contents were quantified by flame atomic absorption spectrophotometry (MSZ 20135:1999).

Plant sampling and preparation

Leaves were taken from all trees at the standard sampling time (after ripening) in 2008. For sampling 6-8 healthy, well developed leaves were taken from the mid-third portion of extension shoots current year per each tree, following the international and Hungarian plant sampling guidelines for fruit orchards (Stiles and Reid, 1966; MI-08 0468-81).

Leaf samples were dried, finely grounded and homogenized. Samples were then stored in paper bags in a dark and dry place until use.

Nitrogen and sulphur content of leaves was determined from homogenized samples directly using the dry combustion method according to Nagy (2000).

For digestion of leaf P and K cc. H_2SO_4 and H_2O_2 mixture was used. Then leaf P was quantified colorimetrically with the phospomolybdovanadate method. Leaf K was determined by flame atom emission spectrophotometry.

For digestion of leaf Ca, Mg, Mn, Cu and Zn cc. HNO_3 was used. Then the contents of leaves were determined by flame atomic absorption method.

To determine leaf B, the leaves were ashed then B content was measured by photometric method (Azomethin-H method).

Table 2: Results of soil analysis (Újfehértó, 2008)

Parameters	Depth (cm)	
	0-30	30-60
pH (KCl)	4,67	3,90
$CaCO_3$ %	-	-
Plasticity index (K_A)	25	25
Humus (%)	0,69	0,64
(NO_3+NO_2)-N (mg/kg)	1,6	1,1
NH_4^+-N (mg/kg)	1,2	6,1
P_2O_5 (mg/kg)	51	116
K_2O (mg/kg)	117	150
Mg (mg/kg)	69	50
Mn (mg/kg)	53	69
Cu (mg/kg)	2,1	8,7
Zn (mg/kg)	1,1	5,1

Results and discussion

Results of soil analysis

The results of soil sampling before the treatments were set up are showed in Table 2.

The pH of soil was strongly acidic. The physical category of soil was sandy without carbonate content. Soil P and K was low, but their amounts significantly increased by depth. Soil N was very low based on humus content and mineralized forms. The values of mineralized N forms correspond to the type of the examined soil. The nitrate and ammonium contents of soil were very low. Examined micronutrient contents of soil were low also followed from soil properties.

Results of leaf analysis

The effect of treatments on macronutrient contents of leaves are showed in Table 3.

From results it was evident that all applied treatments increased leaf N content but the effect was not significant in all cases. Opposite to those obtained leaf N, leaf P and K was deceased by treatments. Similarly to those stated leaf N, leaf Mg and Ca was increased by all applied treatments also.

Table 3: Results of leaf analysis (Macronutrients) (Újfehértó, 2008)

	N (%)	P %	K %	Mg (%)	Ca (%)
Control	2.52a	0.33c	1.67d	0.48a	1.64a
Straw	2.67bc	0.30b	1.37a	0.53b	2.06c
Sawdust	2.75c	0.31b	1.43b	0.56b	2.25d
Mulch	2.55a	0.32c	1.31a	0.54b	2.12d
Black foil	2.53a	0.34c	1.43b	0.49a	1.99c
Cow manure	2.63b	0.26a	1.49b	0.49a	1.75a
Mean	**2.61**	**0.31**	**1.45**	**0.52**	**1.97**

Different letters within columns denote significant differences (LSD 5%)

The effect of treatments on micronutrient contents of leaves are showed in Table 4.

Table 4: Results of leaf analysis (Micronutrients) (Újfehértó, 2008)

	S (%)	Mn (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	B (mg/kg)
Control	0.18a	46.20a	61.40bc	19.90a	49.47c
Straw	0.17a	48.90a	60.00b	18.80a	56.89d
Sawdust	0.19b	54.70c	55.40a	21.30b	55.12d
Mulch	0.18a	52.70c	56.20a	24.20d	50.88c
Black foil	0.20b	49.00b	62.40c	24.90d	54.06d
Cow manure	0.18a	47.10a	65.10d	20.30a	38.63a
Mean	**0.18**	**49.77**	**60.08**	**21.57**	**50.84**

Different letters within columns denote significant differences (LSD 5%)

Leaf S was slightly affected by treatments. Treatments usually increased leaf Mn and Zn, but the effect was not consistent sometimes. Similar inconsistent effect was observed at leaf Cu and B. Moreover increasing effect of treatments was not observed regarding these nutrients.

Conclusions

From the results of plant chemical analysis it is stated that all used treatments increased leaf N, Mg and Ca content while decreased leaf P and K content.

Consistent effect of treatment was not observed regarding to leaf micronutrient contents. However, the applied treatments increased leaf micronutrient contents usually.

Field observations supported that ground cover applications were favourable to keep soil moisture.

Further investigations needed to clear the effect of ground covering on the changes of available nutrient content of soil.

Acknowledgements

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Sažetak

Uloga tehnike pokrivanja tla u učinkovitom upravljanju izvorima hraniva za višnju

Konzervacija vlage u tlu kao i kontrola korova su u centru pažnje proizvodnje usjeva diljem svijeta. Ova izjava je naročito važna u voćarstvu, gdje je pristupačnost vlage u tlu kardinalni problem. Čini se da je praksa pokrivanja tla najpodobnija za simultano rješenje ovog problema. Stoga, cilj ovog istraživanja jest ispitati učinke različitih metoda pokrivanja tla na pristupačnost hraniva i usvajanje u višnjiku. Pokus je proveden u višnjiku Istraživačke stanice Újfehértó, na istoku Mađarske. Višnjik je podignut na kiselom pjeskovitom tlu Nyírség regije u jesen 2000. godine, koristeći kultivar »Oblačinska« cijepljen na podlogu rašeljke (Prunus mahaeb) na razmak od 5.0 x 2.5 m. Primjenjeni tretmani bili su slijedeći: goveđi stajski gnoj, slama, piljevina, malč od borove kore, crna folija i kontrola, bez ikakvog pokrova. Navedeni materijali bili su primjenjeni po površini tla da bi se utvrdila njihova efektivnost. Iz kemijske analize biljnog materijala može se ustvrditi da su svi korišteni tretmani povećali sadržaj u tkivu lista N, Mg i Ca, dok su smanjili P i K. Dosljedni učinci tretmana nisu bili uočeni glede sadržaja mikroelemenata u tkivu lista. Ipak , primjeneni tretmani obično bi povećali sadržaj mikroelemenata u listu.

Ključne riječi: upravljanje pokrovom, malčiranje, višnja

Izvorni znanstveni rad / Original scientific paper

The effect of increasing compost doses on the change of P and K contents of soil and yield of ryegrass *(Lolium perenne L.)*

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Abstract

Compost utilization experiment with 3 different composts was set in the greenhouse of the Institute of Agricultural Chemistry and Soil Science. Our aim was to study the effect of composts applied in different rates on dry matter production of plant and nutrient content of plant and soil. According to the yield data the 1st compost had the most favourable effect. The highest nutrient content was observed in the 2nd compost, but this had a moderate effect on yield. The low yields can be explained with the high nutrient contents. This effect is probably related to antagonism and not optimal nutrient proportions. The optimal application and dose of the three composts are different.

Keywords: compost ratio, nutrient content

Introduction

Satisfaction of the increasing needs of humanity causes large environmental load, so we have to satisfy our needs with the use of sustainable management. One of these environmental loads is the amount of wastes emitted in increasing volume. Public spaces of cities and agriculture are continuously forming waste materials and by-products in such a large amount, that their disposal in a landfill is inconceivable, so it have to be recycled (Simándi, 2008). A possible solution for this problem is composting. The compost is a nutrient source for plants and it has a positive effect on soil parameters and yield as well (Gigliotti et al., 1966; Kádár-Morvai, 2007; Keserű, 2007). Furthermore composting is the most cost-effective option of waste management (Araújo et al., 2010).

The reason of that we chose the more accurate cognition of compost utilization is to do more effective the site-specific nutrient supply. Our goal was to study and evaluate the effect of

composts applied in different rates on dry matter production of plant and nutrient content of plant and soil.

Materials and methods

The utilization experiment with 3 different composts under controlled conditions was set in the greenhouse of the Institute of Agricultural Chemistry and Soil Science. We received the 3 composts from one of the partners of University of Debrecen in 2009. Composts were sieved (< 2 mm), because degradation of the large particles in the pots is slow. Composts were mixed with acidic sandy soil in four proportions (5 %, 10 %, 25 % and 50 %), in four replications (Table 1). After the volumetric mixture we set up the pots randomised.

After one week maturation of wet compost-soil mixture we sowed perennial ryegrass *(Lolium perenne L.)*. The advantage of ryegrass is that it grows quite fast, tolerates the greenhouse conditions well and it indicates the effect of treatments well. After the shooting of ryegrass the water supply of the 2.5 kg pots was carried out at 60 per cent of field water capacity of soil. In our department previous researches confirmed that irrigation at 60 per cent of field water capacity is optimal in sandy soils (Loch et al. 1992).

Table 1: The compost-soil ratio of treatments

Treatments	Compost ratio (%)	Sandy soil ratio (%)
1.	0	100
2.	5	95
3.	10	90
4.	25	75
5.	50	50

After the harvest we measured the dry matter production of ryegrass. We investigated the 0.01 M dm^{-3} $CaCl_2$ and ammonium lactate – acetic acid (AL) extractable P-, K-contents of soils, and the total P-, K-contents of the plant.

Chemical analysis:

Soil samples from each pots were collected, air dried and sieved (< 2 mm) for further analysis. The easily available P- and K-contents of the soils were measured in 0.01 M $CaCl_2$ extractant (Houba et al., 1990) with 1:10 soil:solution ratio. Samples were shaken for two hours, than filtered (12-15 µm). We measured the P-, K-concentrations of filtrates with SKALAR Continuous Flow Analyzer and by the method of flame emission spectrophotometry (UNICAM SP95B AAS). We determined the P- and K-contents of the soil samples in ammonium lactate acetic acid (AL) solution with 1:20 soil:solution ratio (Egnér et al., 1960) as well. During the extraction, samples were shaken for two hours, and filtered (5-7 µm). We measured the P concentration of filtrate with a spectrophotometer (METERTEK SP-850), and K concentration with UNICAM SP95B AAS.

Plant samples were harvested and dried at 105 °C to constant mass. After grinding, 0.5 g plant samples were digested with 5 cm^3 of H_2SO_4 (96 %) and 5 cm^3 of H_2O_2 (30 %) at 280 °C. Digested samples were made up to 50 cm^3 with distillated water at room temperature. The filtered solutions were analyzed. The P content were measured by the method of Tahmm et al. (1968)

with spectrophotometer (METERTEK SP-850), and the K contents by flame emission spectrophotometer (UNICAM SP95B AAS).

Statistical analyses:

We used variance analyses for the processing of the data. All statistical analyses were performed with a Microsoft Excel Macro (Tolner et al., 2008; Vágó et al., 2008) according to Sváb (1981). With this program we determined the significance level of the treatment effect and significant differences at $P \leq 0.05$.

Results and discussion

The average dry matter production of ryegrass in different treatments (5 compost soil rates; 3 composts) is shown in Figure 1. As the data show composts had a significant effect ($P \leq 0.001$) on the dry mass of ryegrass, but the yield increasing effect of the three composts differed. The highest positive effect was observable in the case of 1st compost. If a 25 % rate of 1st compost was applied, the dry weight increased by nearly 4 g pot^{-1}. The additional dose of this compost didn't cause higher yield. It can be stated that the optimal compost: soil ratio is 25:75 %. The 25 and 50 % dose of 3rd compost increased significantly the yield. The yield increasing effect of 50 % compost rate was 1.5 g pot^{-1}. The 2nd compost had a moderate effect, but the 10 % compost rate increased significantly the dry weight of ryegrass. The recommended doses are different for each composts.

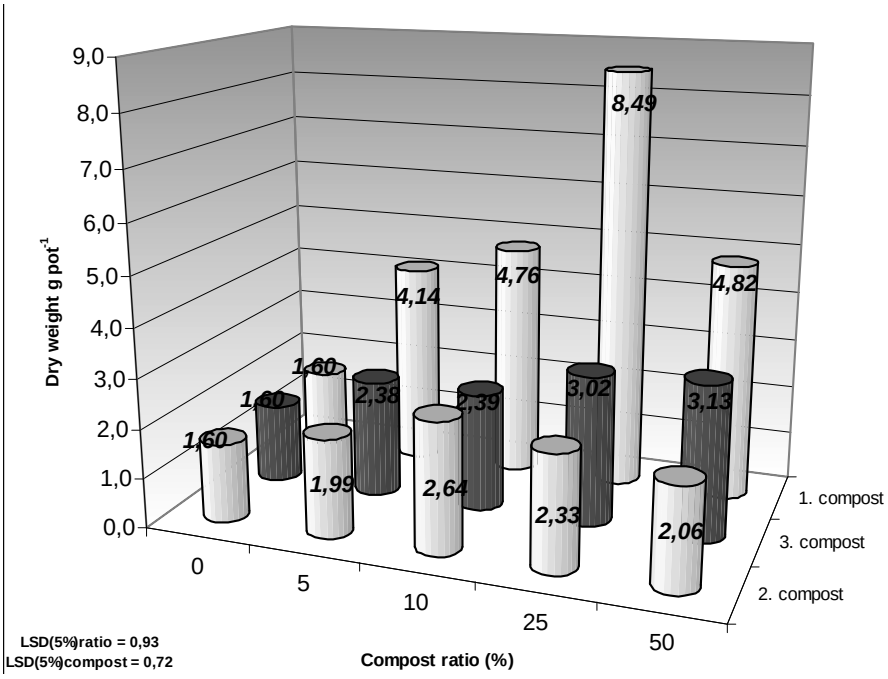

Figure 1: Dry matter production of ryegrass in each treatment (g pot^{-1})

The K- and P-content of the soil determined in AL extractant are represented in Figure 2 and 3. Each composts modified significantly ($P \leq 0.001$) the AL extractable nutrient contents.

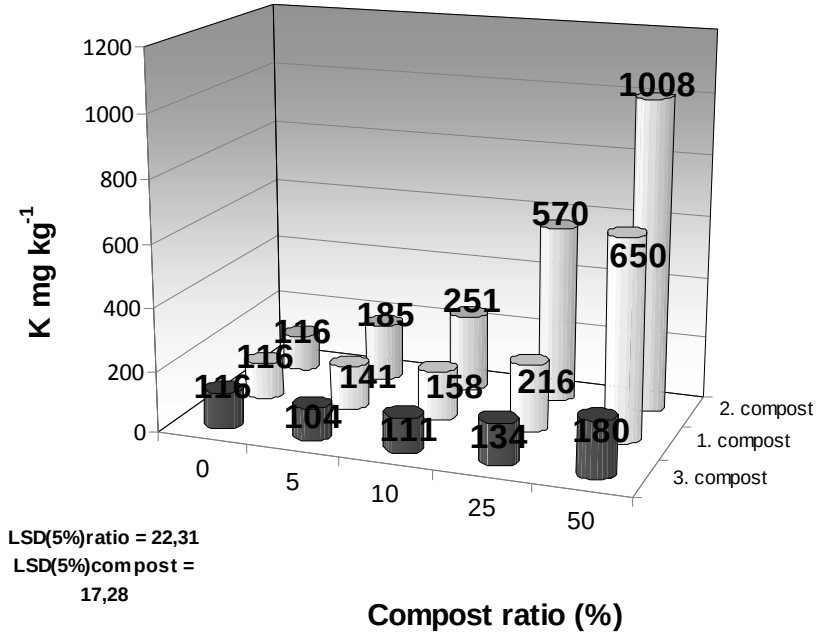

Figure 2: The AL extractable K content of soil

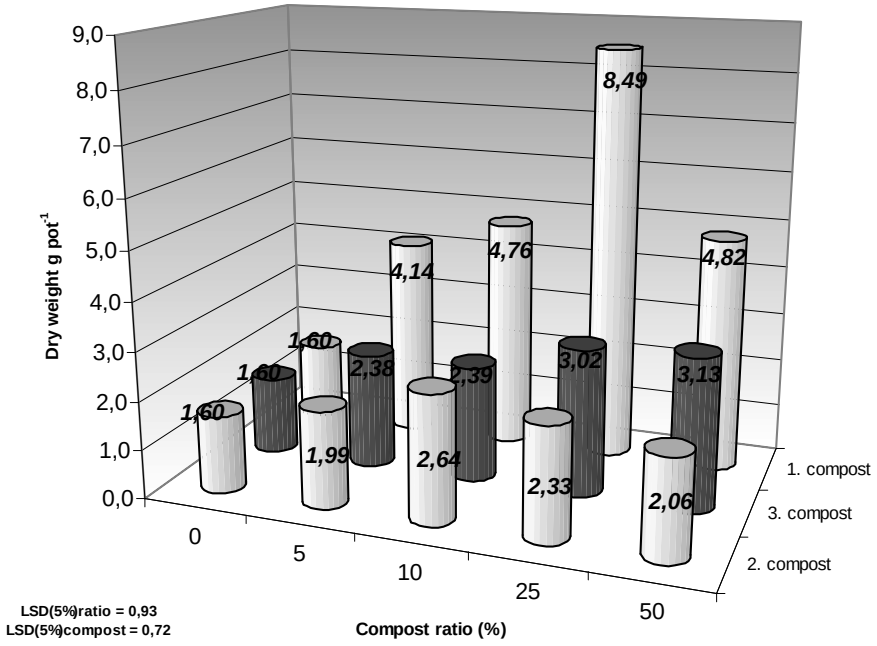

Figure 3: The AL extractable P content of soil

The 2nd compost had the highest AL-K and AL-P contents. We can explain the low yields in the case of this compost with the high nutrient contents. This effect is probably related to cation antagonism. The 1st compost had a lower nutrient concentration than that of 2nd, but the high yields proved that the nutrient contents and proportions are optimal in the case of 1st compost. The lowest yield was observable in pots treated with the 3rd compost. This is probably related to the low nutrient content of this compost, but the explanation of this effect needs further analyses.

The K- and P- content of the soil determined in 0.01 M $CaCl_2$ are presented in Figure 4 and 5. The increasing compost:soil ratio modified significantly ($P \leq 0.001$) the $CaCl_2$ extractable nutrient contents.

As it is presented in Figure 2 by the rising compost ratio the K contents increased consistently. The $CaCl_2$-K content of the 2nd compost was higher than that of other composts. The lowest nutrient content was found in the 3rd compost. These are in accordance with the results of AL method.

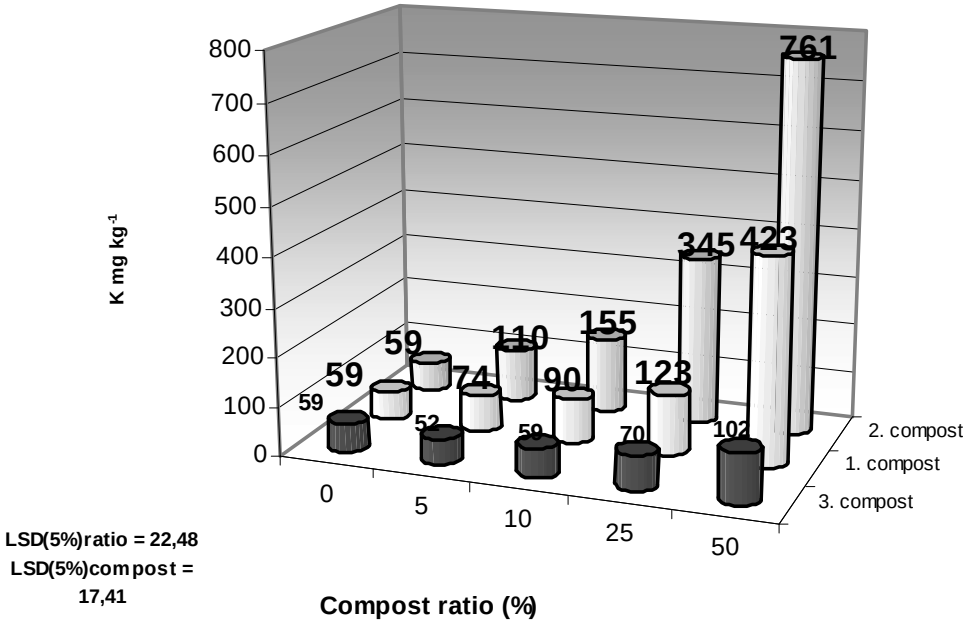

Figure 4: The 0.01 M dm^{-3} $CaCl_2$ extractable K content of soil

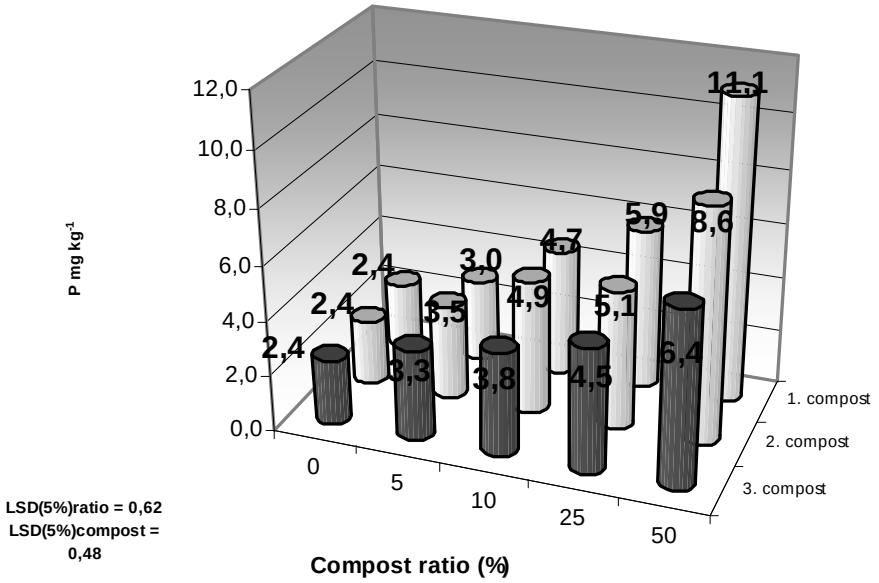

Figure 5: The 0.01 M dm^{-3} $CaCl_2$ extractable P content of soil

All studied compost increased significantly the amount of $CaCl_2$-P (Figure 5). The highest easily available P concentration (11 mg kg^{-1}) was found in pots treated with 50 % rate of 1st compost. Despite of the high P-reserves, the availability of P in 2nd compost is less than that of 1st, according to the $CaCl_2$-P data. A moderate effect was observable in the 3rd compost.

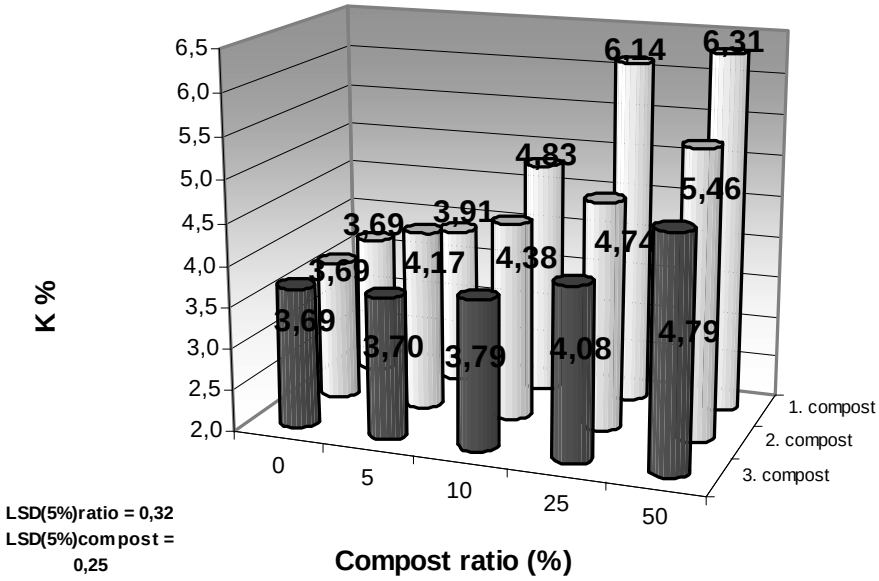

Figure 6: The H_2SO_4 extractable K content of plant

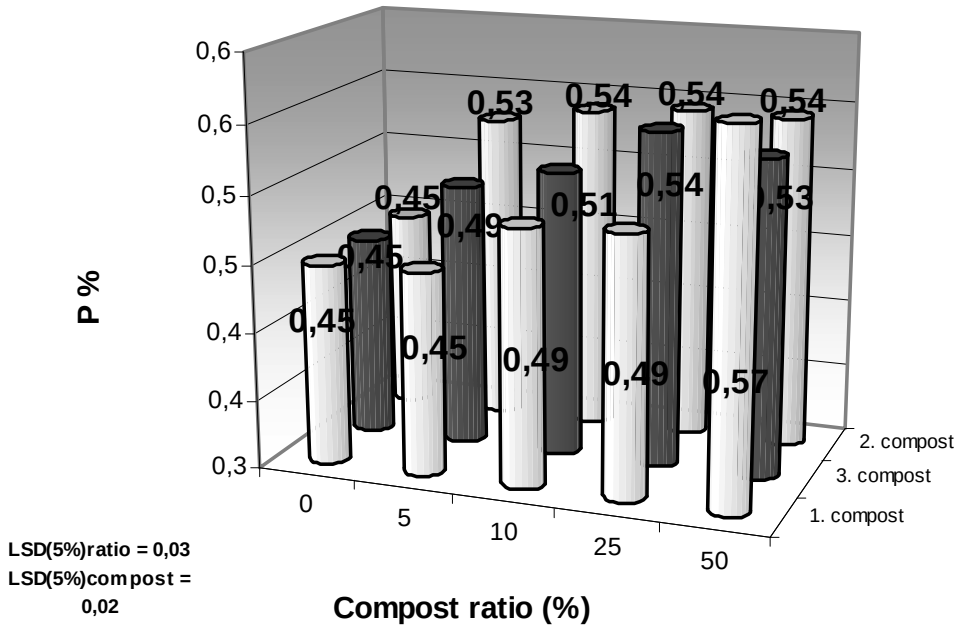

Figure 7: The H_2SO_4 extractable P content of plant

The K content of plant samples are represented in Figure 6. The K content of plant is relatively high compared to other nutrients. The high potassium accumulation of ryegrass as an effect of compost treatments is remarkable. The K content of plant increased nearly twofold as an effect of 1st compost. Even though the K contents of soils treated with 2nd compost were the highest, the 2nd compost had smaller effect on K content of plants.

The P content of plant samples are represented in Figure 7. There was a significant ($P \leq 0.001$) increase in plant P content as an effect of compost doses. The highest P content was observed in the case of 1st compost, but the 2nd compost seemed to be the best P-supplier.

Conclusions

It can be concluded that the effect of composts on dry matter and nutrient contents of plant and nutrient contents of soil are different, so the recommended dose of composts differ as well. The highest positive yield increasing effect was observable in the case of 1st compost, in 25 % rate. Our results should be confirmed by field experiments.

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Sažetak

Učinak povećavajuće količine komposta na promjenu sadržaja P i K u tlu i prinosu engleskog ljulja *(Lolium perenne L.)*

Pokus s tri različite vrste komposta postavljen je u stakleniku Institute of Agricultural Chemistry and Soil Science. Cilj je bio proučiti učinke komposta primijenjenog u različitim dozama na proizvodnju suhe tvari biljke i sadržaj hraniva u biljci i u tlu. Na osnovu rezultata uroda, 1. kompost je imao najbolji učinak. Najviši sadržaj hraniva utvrđen je kod 2. komposta, no taj je imao skroman utjecaj na urod. Niski urodi mogu se objasniti visokim sadržajem hraniva. Ovaj učinak je vjerojatno povezan s antagonizmom a ne optimalnim omjerima hraniva. Optimalna aplikacija i doza tri komposta se razlikuje.

Ključne riječi: omjer komposta, sadržaj hraniva

Section III

sustainability of rural development
održivost ruralnog razvoja

chairmen / moderatori

1. Jadranka DEŽE
2. Ljubica RANOGAJEC
3. Željko DOLIJANOVIĆ

Stručni rad / Expert paper

Vinogradi vinogorja Kutjevo u funkciji obnovljivih izvora energije

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Sažetak

Budući da problematika zagađenja i konstantno povećavanje emisije stakleničkih plinova u atmosferu sve više traži korištenje obnovljivih izvora energije, a istodobno fosilna goriva postaju sve skuplja, sve više raste i interes kako bi se biomasa iz vinograda, koristila kao biogorivo. U radu je prikazana mogućnost korištenja biomase iz vinograda, dobivene rezidbom vinove loze sorte Graševina u vinogorju Kutjevo. Ovim načinom možemo dobiti oko 2052,48 tona biomase iz vinograda te na taj način povećati udio obnovljivih izvora energije.

Ključne riječi: vinograd, vinogorje Kutjevo, obnovljivi izvori energije, biomasa

Uvod

Vinogorje Kutjevo, jedno od najpoznatijih i najkvalitetnijih kontinentalnih vinogorja u Republici Hrvatskoj, u funkciji proizvodnje grožđa i njegove prerade u vina visoke kvalitete datira iz 1232. Godine [8].Vodeća sorta u vinogorju je Graševina, koja je i najviše zastupljena po broju trseva. Danas kada stupanj zagađenja cijelokupnog planeta postaje veliki problem, a istodobno preuzete obveze za povećanjem korištenja obnovljivih izvora energije od strane Vlade Repulike Hrvatske prema EU, vinogradima i vinogradarstvu daju još jednu dodatnu funkciju. Biomasa je najstariji izvor energije koji je čovjek koristio i predstavlja skupni pojam za brojne, najrazličitije proizvode biljnog i životinjskog svijeta. Biomasa se može podijeliti na energetske biljke i ostatke ili otpad. Energetske biljke mogu biti brzorastuće drveće, višegodišnje trave ili alge, dok ostaci uključuju poljoprivredni, šumski i industrijski otpad koji se koristi za proizvodnju toplinske i električne energije te prerađuje u bioplin i tekuća bio goriva [9]. Biomasa je obnovljivi izvor energije koji uključuje ogrjevno drvo, grane i drvni otpad iz šumarstva, te piljevinu, koru i drvni ostatak iz drvne industrije kao i slamu, kukuruzovinu, stabljike suncokreta, ostatke pri rezidbi vinove loze i maslina, koštice višanja i kore od jabuka iz poljoprivrede, životinjski izmet i ostaci iz stočarstva, komunalni i industrijski otpad [5]. Tijekom rezidbe, loza iz vinograda se do sada ili iznosila iz vinograda i spaljivala ili su vlasnici vinograda tu istu lozu malčirali i ostavljali u vinogradima kao zelenu gnojidbu. Prilikom spaljivanja loze u atmosferu ispuštamo određenu količinu štetnih plinova (tzv. staklenički plinovi), čime sigurno ne pridonosimo manjem zaga-

đenju planete, dok kod malčiranja postoji opasnost od potencijalnog širenja bolesti po vinogradu. Nova alternativa na koju bi trebalo obratiti pažnju je mogućnost sakupljanja orezane loze – biomase iz vinograda i korištenja iste kao biogorivo. Prema iskustvima sličnog projekta provedenog u Italiji u vinariji Lungarotti u Torgianu, a u suradnji sa Istraživačkim centrom za biomasu na Sveučilištu u Perugi [1], te znajući za pokretanje kogeneracijskog postrojenja (postrojenja za dobivanje energije iz sekundarne sirovine) u požeškoj tvrtci Spin Valis d.o.o., odlučili smo se za ovo istraživanje na području vinogorja Kutjevo na sorti Graševina.

Materijali i metode

Sorta Graševina je po broju trsova najbrojnija sorta u vinogorju Kutjevo, te je kao takva i sinonim za Kutjevo. Iz tog razloga smo i izabrali upravo ovu sortu kao zanimljivu za istraživanje na ovom polju. Pokus je postavljen na način da je kroz dvije godine obavljena rezidba vinove loze sorte Graševina, na položaju Vetovo u vinogorju Kutjevo. Uzgojni oblik je dvostruki Gyot, što je i najuobičajeniji uzgojni oblik u vinogorju Kutjevo [7]. U tradicionalnom postupku vinogradarske proizvodnje, orezana loza se najčešće izvlači traktorima iz redova te se kasnije na formiranim hrpama spaljuje. Sam cilj pokusa je bio izmjeriti koja je prosječna količina ove orezane mase po trsu i kolika je prosječna vlaga koju sadrži orezana rozgva, kako bi dobili količinu biomase po hektaru pogodnu za korištenje kao biogorivo. U svakoj godini pokusa učinjena su četiri ponavljanja po 20 trseva. Orezana loza sa svakog trsa je vagana i na taj način smo dobili prosječnu težinu orezane mase po trsu. Nakon vaganja uzoraka, sa svakog trsa je uzet prosječni uzorak loze od oko 6 grama (sa grana svih debljina) i to na način da je vinogradarskim škarama rezana na kolutiće debljine od 2-3 mm. Tako dobiveni prosječni uzorci vagani su preciznom elektronskom vagom u laboratorijskom posudicama. Sušenjem na temperaturi od 105 °C tijekom 3 sata u sušioniku, dobili smo razliku u masama uzoraka prije i poslije sušenja, što predstavlja otparenu vodu. Obradom ovako dobivenih podataka dobili smo prosječnu vlagu svakog uzorka. Biomasa, da bi bila pogodna kao gorivo, mora imati određeni stupanj vlage. Prosječna vlaga je uz masu vrlo važan podatak, zbog toga što na taj način određujemo i potrebu za sušenjem orezane mase kako bi bila pogodna za loženje ili iskorištena za proizvodnju bioplina. Kako u neposrednoj blizini vinogorja Kutjevo već postoji započet projekt izgradnje kogeneracijskog postrojenja za dobivanje toplinske i električne energije spaljivanjem drvnog otpada iz proizvodnje namještaja u požeškoj tvrtci Spin Valis d.o.o., a istodobno vlastita količina biomase iz proizvodnje nije dostatna za iskorištavanje punog kapaciteta, razlika potrebne biomase može se nadomjestiti iz šumskog otpada ili dodavanjem dijela biomase iz vinograda [4]. Iskustva u ovakvom načinu korištenja biomase iz vinograda postoje u Italiji, gdje je vinarija Lungarotti (250 hektara vinograda) u potpunosti iskoristila istraživanja vršena na biomasi iz vinograda [1]. Na taj način u prvoj fazi projekta koji je sufinanciran od Talijanskog ministarstva poljoprivrede uspjeli su postići da, samo od biomase iz vlastitih vinograda, proizvode dovoljno toplinske energije potrebne za grijanje i hlađenje postrojenja za proizvodnju vina, a isto tako i ureda. S obzirom na mogućnost prikupljanja orezane mase strojevima za baliranje i njihovo sušenje na otvorenom, prema podacima koji su dobiveni istraživanjem u Italiji, vlaga se ovako može spustiti ispod 10% u ljetnim mjesecima, a čak i uskladištena tijekom slijedeće zime ne raste više od 12%, što je pogodno za korištenje kao gorivo [1].

Rezultati i rasprava

Prema službenim podacima Hrvatskog centra za poljoprivredu i selo, *Zavoda za vinogradarstvo, vinarstvo i voćarstvo dobivenih 2010. godine, u vinogorju Kutjevo ima posađeno 930,82 hektara pod sortom graševina, odnosno oko 4 milijuna trsova, što možemo vidjeti u tablici 1*

[3]. *Postotak u tablici 1 smo izrazili za ukupan broj trsova sorte graševina iz razloga što su sva mjerenja bazirana po trsu, a ne po površini (različiti razmaci sadnje i manji dio vinograda je zasađen na drugom uzgojnom obliku).*

Pokus je započet u zimi 2009. godine u sklopu redovnih radova rezidbe vinove loze na položaju Vetovo vinogorja Kutjevo, kao prva godina pokusa, a nastavljen je prilikom rezidbe 2010. godine. Rezidba je obavljena na uobičajen način, vinogradarskim škarama.

Prikupljanjem uzoraka i vaganjem dobili smo prosječnu težinu orezane mase sa jednog trsa Graševine od 518,72 g ili o,52 kg i prosječni iznos vlage od 47,51%. U prvoj godini pokusa dobiveni su nešto veći prosječni iznosi vlage (ponavljanja GR1-GR4 tablica 3) iz razloga što je prilikom provođenja pokusa počela faza suzenja ili plača vinove loze, uslijed povećanja temperature zraka na 8-10̊C, temperature tla u zoni korijena na 7-9̊C i aktivnih tlakova u korijenu trsa [6].

Tablica 1. Službeni podaci o broju trsova graševine u vinogorju Kutjevo

Sorta	Površina u ha	Ukupni broj trsova	% po broju trsova
GRAŠEVINA	930,8228	3947082	66,59
Ostale sorte	430,1731	1979916	33,41
Ukupno	1360,9959	5926998	100

Tablica 2. Rezltati mjerenja mase i vlage za pojedina ponavljanja

Ponavljanja	masa u g	% Vlage
GR1	532,6	48,59572
GR2	600,7	48,632439
GR3	521,5	51,800214
GR4	453,0	52,664474
GR5	398,2	45,606017
GR6	416,5	43,849654
GR7	593,05	45,025937
GR8	634,2	43,91345
Prosječna vrijednost	518,72	47,51

U drugoj godini, iako smo pristupili pokusu u približno isto vrijeme, uslijed produženja zime i nižih temperatura, loza je još uvijek bila u fazi mirovanja i zbog toga u rezultatima imamo manje prosječne iznose vlage (ponavljanja GR5-GR8, tablica 3).

Kad ovim dobivenim podacima pridodamo službene podatke iz tablice 2, tada možemo zaključiti da u vinogorju Kutjevo imamo potencijalno 2052,48 tone biomase dobivene rezidbom vinograda sorte Graševina, prosječne vlage 47,51 %.

Tablica 3. Ukupna količina biomase od sorte graševina u vinogorju Kutjevo

Sorta	Broj trsova	Prosječna masa u kg/trs	Ukupno biomase u t
GRAŠEVINA	3947082	0,52	2052,48

Zaključak

S obzirom na dobivene rezultate postavljenog dvogodišnjeg pokusa na sorti graševina kao vodećoj kontinentalnoj sorti, moglo bi se zaključiti da u vinogorju Kutjevo uz dokazani vrhunski potencijal za proizvodnju grožđa i vina imamo i još jednu alternativu za iskorištenje biomase iz vinograda kao goriva. Kako je Vlada Republike Hrvatske, početkom procesa pristupanja Europskoj Uniji, prihvatila i obveze povećanja udjela obnovljivih izvora energije u ukupnoj potrošnji energije, vinogradarstvo sigurno, uz ostale izvore biomase, može doprinijeti ostvarivanju ovoga cilja. Treba napomenuti da daljnjim istraživanjem, na drugim sortama, ali i uzimanjem u obzir vinogorja koja su u krugu od svega 50-tak kilometara, dolazimo do ozbiljnih količina biomase. Uključivanjem tih drugih vinogorja u ovakav projekt morala bi se izraditi i studija ekonomske isplativosti prijevoza biomase, što bi odredilo i najveću udaljenost mjesta za skladištenje ili postrojenja za proizvodnju toplinske/električne energije u odnosu na položaj potencijalnih vinogorja koja bi se mogla uključiti. Povezivanjem projekata kao što je projekt tvrtke Spin Valis d.o.o. sa vinogradarstvom, uz šumsku biomasu, ali i mogućnošću iskorištavanja biomase iz vinograda na način primjera iz Italije, pojedine vinarije mogle bi postati potpuno energetski neovisne, koristeći otpad iz vinograda, a u isto vrijeme doprinijeti ekologiji smanjenjem emisije stakleničkih plinova. Pojedine općine i gradovi, u kojima je vinogradarstvo jedna od vodećih grana privrede, mogle bi pokrenuti i vlastite projekte preinake kotlovnica škola, vrtića, pojedinih stambenih četvrti i sl. za korištenje biomase iz vinograda kao goriva, pogotovo što su ovi projekti vrlo atraktivni u smislu ostvarivanja novčanih poticaja iz fondova EU [2]. Troškovi sušenja su minimalni jer se loza suši na otvorenom, te usitnjena direktno loži u kotlovnice. U konačnici, dograđivanjem sustava kotlovnica na način da se otpadni plinovi koriste za proizvodnju električne energije, a ne samo toplinske, možemo znatno smanjiti troškove, a višak energije prodavati i drugim korisnicima, odnosno vraćati natrag u energetski sustav RH .

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Abstract

Vineyard vineyards Kutjevo as a function of renewable energy

Since the problems of pollution and the constant increase of greenhouse gases in the atmosphere is increasingly seeking to use renewable energy sources, is growing and interest to the vineyard biomass, used as bio fuel. The paper describes the use of biomass from the vineyard, pruning obtained Welsh Riesling grape varieties in vineyards Kutjevo. This way we can get about 2052.48 tonnes of biomass from the vineyard and thus increase the share of renewable energy sources.

Key words: vineyard, vineyard Kutjevo, renewable energy, biomass

Pregledni rad / Review paper

Seoskim turizmom prema održivom razvoju

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Sažetak

Pretpostavka adekvatnog organiziranja seoskog turizma jest, između ostaloga, i pridržavanje osnovnih načela održivog razvoja na svim razinama, kako vertikalnih, tako i horizontalnih subjekata uključenih u stvaranje turističkog prozvoda seoskog turizma. U radu se, ponajprije, utvrđuje razlog nužnosti uvođenja načela održivog razvoja kao učinkovite podloge razvitka seoskog turizma u Republici Hrvatskoj. U tu svrhu se ponajprije koriste poznata teoretska saznanja iz područja suvremenih trendova u turizmu koja služe kao temeljni instrument koordiniranja razvoja seoskog turizma kao održivog oblika turizma. Nakon toga se analizira seoski turizam organiziran od strane obiteljskih poljoprivrednih gospodarstava, te se na temelju toga utvrđuje i u konačnici postavljaju temelji za razvoj seoskog turizma na višoj i kvalitetnijoj razini.

Ključne riječi: seoski turizam, održivi razvoj, održivi turizam, obiteljska poljoprivredna gospodarstva

Uvod

Koncept masovnog turizma je u većini država tijekom 20. stoljeća intenzivirao svoj razvoj. Međutim, najnoviji trendovi u turizmu zapostavljaju tradicionalni maritimni turizam, a orijentiraju se na selektivne oblike turizma koji svakom turistu daju dodanu vrijednost temeljenu na različitim resursima. »Bijeg« od masovnog turizma rezultira orijentacijom turističkih subjekata na individualni pristup svakom pojedinom turistu, napuštajući, sada već zastarjelu paradigmu grupnih dolazaka. Problemi zagađenja okoliša, jednoličnosti turističke ponude, narušavanja prirodnog okoliša, stresnog načina života, neadekvatnog korištenja slobodnog vremena i financijskih sredstava, otuđenosti od prirode, doveli su do nove turističke orijentacije ljudi, odnosno potencijalnih turista, za povratak prirodnim i tradicionalnim vrijednostima.

Povratak prirodi je svakako kompatibilan osnovnom značenju pojma održivog razvoja: razvoj koji zadovoljava potrebe sadašnjih bez ugrožavanja budućih generacija. Prema definiciji *World Commission on Environment and Development* (www.un.org): »Održivi razvoj je razvoj koji zadovoljava sadašnje potrebe, a da se pri tome ne umanjuje mogućnost budućih generacija da zadovolje svoje potrebe." Svakako je najveći izazov koji moraju prihvatiti sadašnje generacije održavanje kvalitete životnih uvjeta za buduće generacije.

Održivi razvoj turizma, odnosno održivi turizam, je pojam zasnovan na širem konceptu, odnosno na održivom razvoju, a utemeljen je na sljedećim načelima (Mcintyre, 1993): ekonomskoj održivosti (učinkovitom upravljanju resursima), ekološkoj održivosti (očuvanju bioloških resursa) i socio-kulturnoj održivosti (očuvanju kulturnih vrijednosti i identiteta lokalne zajednice). Za ova se načela može reći kako su opće prihvaćena, ali njihova provedba, posebno u području turizma, je najblaže rečeno, problematična.

Turističke aktivnosti stvaraju dodatne pritiske na prirodne resurse na kojima se temelje sadašnji i budući interesi prirodnog okoliša, turista, lokalne zajednice i turističkih organizacija (George et al., 2009). Sve navedene opasnosti se ne mogu odraziti na seoski turizam, pravilno postavljen i organiziran na obiteljskim poljoprivrednim gospodarstvima, koja nemaju toliku potrebu stvarati novu vrijednost, već kreirati dodanu vrijednost, kako bi se na najbolji mogući način iskoristili postojeći kapaciteti gospodarstva.

Materijal i metode

Analizom postojećeg turističkog stanja i turističkih karakteristika, vrlo brzo će se uočiti nužnost poštivanja načela održivog razvoja. Teorijski nalazi rezultat su saznanja provjerenih intervjuiranjem vlasnika obiteljskih poljoprivrednih gospodarstava koja se bave turizmom u Osječkobaranjskoj županiji (Kristić, 2007) kao i recentne literature iz područja turizma. Korištena je deduktivno-induktivna metoda i metoda analize i sinteze. Neophodno je obaviti kvantitativna terenska istraživanja kojima bi se potvrdio osnovni istraživački cilj ovog rada, odnosno međuovisnost održivog razvoja i seoskog turizma organiziranog na obiteljskim poljoprivrednim gospodarstvima. Takva istraživanja bi trebala uslijediti nakon što se prihvati teorijska podloga ustanovljena u ovom radu, a time bi ovaj rad predstavljao inicijalni korak za realizaciju tog cilja.

Rezultati i rasprava

Održivi razvoj, a osobito održivi razvoj turizma, pojam je koji je, nažalost, još jako daleko od opće prihvaćenog i implementiranog u praksi. Potpuno održivi razvoj zasigurno prije predstavlja utopiju nego realnost. Najveći razlog tomu je činjenica, kako načelno svaki razvoj uglavnom dovodi do negativnog utjecaja na okoliš. Teško je za povjerovati da će se ekonomski orijentirani subjekti svjesno suzdržavati od razvoja i odricati potencijalnog većeg prihoda. Postoje i mišljenja da bi dugoročni učinci turizma mogli ugroziti prirodne resurse koji se moraju zaštititi. Svakodnevni posjeti, makar i ograničenog broja turista, određenim područjima zasigurno djeluju na promjene u životinjskom i biljnom svijetu, a postoji i opasnost od zanemarivanja temeljnih ekoloških načela ponajprije zbog ostvarivanja dobiti pod svaku cijenu. Time bi se kratkoročno ostvarile ekonomske koristi, ali dugoročno gledano, upropastile mogućnosti za dugoročno bavljenje turizmom, *image* turističke destinacije, ali i cijele lokalne zajednice.

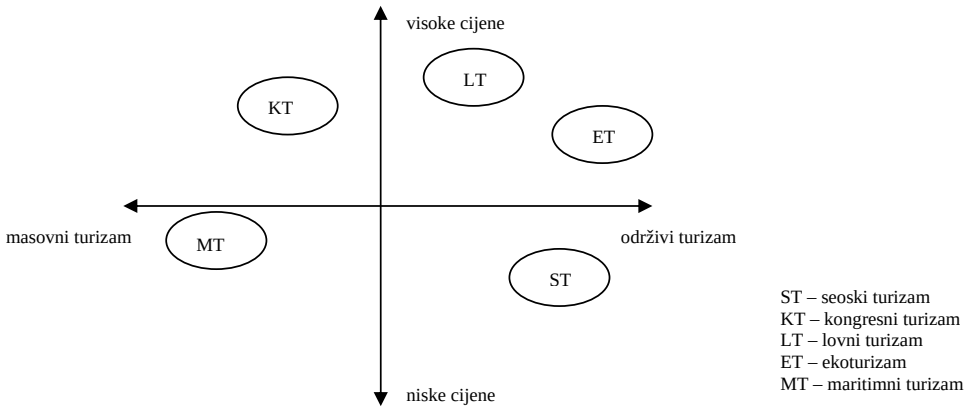
Ukoliko se turizmom ne upravlja na pravilan način, svakako će doći do takvih neželjenih posljedica. Bitno je uravnoteženje s prirodom u svakom smislu i pravilno gospodarenje prirodnim resursima kako ne bi došlo do njihovog iscrpljivanja ili nestajanja. Upravo je seoski turizam taj koji u potpunosti uvažava ruralnu turističku destinaciju. Time se ostvaruje mogućnost za ostvarivanje »*win-win*« situacije – sinergijskim djelovanjem ekonomskog razvoja, društvene odgovornosti i zaštite okoliša te optimalnim zadovoljenjem potreba kako turista tako i obiteljskih poljoprivrednih gospodarstava.

Prema definiciji Hrvatske gospodarske komore (HGK, 2002) seoski turizam je turizam na obiteljskom poljoprivrednom gospodarstvu i predstavlja dopunsku djelatnost vlasnika gospodarstva i njegove obitelji. Nova ponuda znači dopunsku zaradu od turizma na vlastitom obiteljskom

gospodarstvu. Ona također podrazumijeva aktivno uključivanje cijele obitelji i razlog je više da se vlastito gospodarstvo ne napušta. Svako dobro organizirano obiteljsko poljoprivredno gospodarstvo može razvijati posebne oblike seoske turističke ponude, među kojima su najčešće:

- smještaj gostiju na vlastitome gospodarstvu,
- ponuda vlastitih proizvoda,
- ponuda jela iz vlastite kuhinje,
- ponuda pića iz vlastitog podruma,
- degustiranje i kušanje vlastito proizvedenog vina i rakije,
- organizacija izleta u okolicu,
- pružanje usluga prema najavi za najviše 50 osoba ili grupu,
- kampiranje na posjedu i sl.

Seoski turizam je usmjeren na zadovoljenje potreba jedne tržišne niše koja je u najvećem dijelu usmjerena prema prirodi i jednostavnom načinu života. Zadovoljenje potreba turista i ostvarivanje dobiti nisu najvažniji ciljevi. On predstavlja, u jednu ruku, negaciju masovnog turizma, ali i za razliku od ostalih selektivnih oblika poštuje načela održivog razvoja, što je posebno uočljivo na grafikonu 1.



Grafikon 1. Pozicioniranje seoskog turizma u odnosu na ostale selektivne oblike turizma

Seoski turizam, uz ekoturizam, kao jedan od najvažnijih eksponenata održivog turizma, može se pozicionirati kao oblik turizma koji izričito poštuje načela održivog razvoja za razliku od maritimnog koju tu komponentu zapravo uopće ne sadržava. Način kako potrošači percipiraju turistički proizvod na određenom tržištu značajno utječe na stvaranje konkurentske prednosti nad istim ili srodnim turističkim proizvodima (Hudson, 2008). Nesporno je kako je seoski turizam, uz strategiju niskih cijena, u potpunosti iskoristio prednosti održivog razvoja te se na taj način kvalitetno i odgovorno diferencirao od konkurencije.

Kako u kreiranju turističkog proizvoda seoskog turizma najvažniju ulogu imaju obiteljska poljoprivredna gospodarstva, lako je zaključiti kako je upravo lokalna zajednica ta koja bi na najbolji mogući način trebala spriječiti da turizam postane autodestruktivni proces koji uništava osnovne resurse na kojima je temeljen. Nadzor nad turističkim razvojem, ali i dobit koja se od njega ostvaruje, treba ostati u rukama lokalne zajednice jer je upravo održivi razvoj taj koji

promovira decentralizaciju i jače uključivanje lokalnog stanovništva u sve faze odlučivanja o očuvanju ruralnih područja.

Drugim riječima, planiranje održivog turizma trebalo bi prepoznavati prava i potrebe rezidenata (domaćina), uvažavati njihove resurse (fizičko okruženje), životni stil i kulturu kao i pravo da isti utječu na sudbinu lokalnih resursa (Bakić, 2005).

Ovdje je potrebno istaknuti kako prema OECD-u postoji 17 potencijalnih koristi kojima seoski turizam doprinosi ruralnom razvoju, a to su:

1. Zadržavanje zaposlenja
2. Stvaranje zaposlenja
3. Stvaranje različitog zaposlenja (*job diversity*) – što doprinosi obogaćenju ruralnog društva
4. Pluriaktivnost – što označava ostvarivanje prihoda poljoprivrednicima tzv. *part-time* zapošljavanjem, odnosno, ostvarivanje prihoda od ostalih nepoljoprivrednih djelatnosti
5. Zadržavanje usluga u ruralnim prostorima – trgovina i sl.
6. Potpora poljoprivredi
7. Pomoć šumarstvu – diverzifikacijom izvora prihoda u takvim zajednicama
8. Očuvanje krajolika – zbog sve većeg zanimanja turista za posjetu takvim prostorima
9. Očuvanje malih naselja
10. Razvoj ruralne kulture i tradicionalnih obrta
11. Kulturni doprinos ruralnim zajednicama – stvaranjem kulturnih sadržaja za goste i stanovnike ruralnih prostora
12. Zaštita prirode, posebice krajobraza
13. Očuvanje starih građevina
14. Poboljšanja u okruženju – kao što su npr. popravak cesta, bolja regulacija prometa, organizacija odvoza smeća
15. Pomoć malim ribarskim mjestima – organiziranjem sportskih susreta i sl.
16. Poduzetništvo žena
17. Inovativnost i inventivnost

Najvažnije koristi se svakako očituju u pokretanju poljoprivrednih i poduzetničkih aktivnosti pomoću kojih se stvaraju uvjeti za zapošljavanje u seoskoj sredini, zaustavljanju iseljavanja stanovništva, ostvarivanju dodatnog prihoda, ali i razvoju ekološke poljoprivrede te očuvanju izvornih biljnih i životinjskih vrsta (Ružić, 2009). Veliku opasnost predstavlja deklarativna potpora održivom razvoju, a samim time i održivom turizmu. Važnost održivog razvoja za seoski turizam je krucijalna, jer nekontroliranim razvojem i upravljanjem može doći do uništavanja prijeko potrebne resursne osnovice na kojoj počivaju temelji turizma. Kako bi se to spriječilo neophodna je suradnja javnog i privatnog sektora, nevladinih organizacija, političkog sektora, financijskih institucija, obrazovnih institucija, medija i lokalnog stanovništva.

Zaključci

Seoski turizam je taj koji bi trebao postati jedan od reprezenata načela održivog razvoja. Neophodan je interdisciplinarni pristup jer turističke aktivnosti same po sebi nemaju toliko smisla ukoliko u njih nisu uključene gospodarske i izvangospodarske djelatnosti. Jedan od načina kako to postići je i poticanje suradnje obiteljskih poljoprivrednih gospodarstava s ostalim zainteresi-

ranim subjektima, u obliku klastera, zadruga i udruga. Pravilno postavljena i primijenjena turistička politika koju bi sinergijski provodili svi turistički subjekti neophodna je kako bi se ostvarila jača koordinacija aktivnosti svih sudionika u turizmu, usmjerenih na realizaciju postavljenih ciljeva. Velikim naporima svih nositelja turističke ponude, koji izravno ili neizravno sudjeluju u turizmu, pojačat će se međuovisnost seoskog turizma i održivog razvoja, a seoski turizam će svakako postati i ostati vodeći predstavnik održivog turizma odnosno održivog razvoja, kako koncepcija održivog razvoja ne bi postala neodrživa.

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Abstract

Rural Tourism as a Way towards Sustainable Development

There are several preconditions for organizing rural tourism in an adequate manner. One of those is adherence to basic principles of sustainable development at all levels, both vertical and horizontal operators involved in creating rural tourism product. First the paper discusses why it is essential to introduce the principle of sustainability as an efficient basis for the development of rural tourism in the Republic of Croatia. For this purpose, theoretical considerations in the area of contemporary trends in tourism are presented as an instrument for coordinating the development of rural tourism as a sustainable form of tourism. This is followed by the analysis of rural tourism organized by family farms, which will ultimately serve as a foundation for developing rural tourism at a higher quality level.

Keywords: rural tourism, sustainable development, sustainable tourism, family farms

Izvorni znanstveni rad / Original scientific paper

Primjena modela točke pokrića u ekološkoj i konvencionalnoj proizvodnji žitarica

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Sažetak

Točka pokrića predstavlja opseg proizvodnje pri kojoj su izjednačeni troškovi i prihodi, a dobit jednaka nuli. Primjenom modela točke pokrića moguće je utvrditi količinu proizvoda koja je minimalna što je neophodno za odabir strategije izlaska iz nepovoljnog razdoblja nastanka gubitaka u poslovanju. Proizvodnja žitarica je najzastupljenija u strukturi oraničnih površina (65%). Tendencije povećanja udjela ekološke proizvodnje su osobito izražene upravo u ovoj grani. Stoga je cilj rada bio modelom pokrića troškova, utvrditi ekonomske pokazatelje ekološke i konvencionalne proizvodnje žitarica. U strukturi financijskog rezultata, kod ekološke proizvodnje, vrijednost točke pokrića troškova kod kukuruza iznosi 44%, kod pšenice 43%, a kod ječma 17%. Pri konvencionalnoj tehnologiji te su vrijednosti znatno veće, kod kukuruza 66%, ječma 45%, dok je kod pšenice za pokriće ukupnih troškova nedostatan iznos financijskog rezultata.

Ključne riječi: točka pokrića, žitarice, troškovi, prihodi

Uvod

Za uspješno donošenje odluka pri upravljanju gospodarstvom važno je raspolagati kvalitetnim informacijama. **Značajan preduvjet odlučivanju je razumijevanje ponašanja troškova, odnosno načina njihova djelovanja pri različitim uvjetima proizvodnje. Primjenom modela točke pokrića** moguće je točno utvrditi opseg proizvodnje koji je dostatan za pokriće troškova na različitim razinama proizvodnje.

Točka pokrića troškova je ključna veličina za izračunavanje granične točke (break point), koja dijeli zonu dobiti od zone gubitka, odnosno pri kojoj se prihodi i troškovi izjednačavaju. Pri manjem opsegu proizvodnje, posebno na manjim površinama, ukupni troškovi mogu biti veći od prihoda. Stoga je upravo model utvrđivanja minimalne količina proizvoda, kod koje dolazi do izjednačavanja ukupnih prihoda i troškova pogodan alat za analizu odnosa troškova, prihoda i dobiti (Deže i sur, 2010.). Rezultati modela pružaju informacije korisne za donošenja kratkoročnih odluka o strukturi i opsegu proizvodnje, primijenjenoj tehnologiji, načinu korištenja resursa i sl.

Proizvodnja žitarica predstavlja značajan potencijal u poljoprivrednoj proizvodnji sjeveroistočnog dijela Republike Hrvatske. Najzastupljenije žitarice u strukturi sjetve su kukuruz, pšenica i ječam.

Pri konvencionalnoj proizvodnja pšenice i kukuruza postignuta je samodostatnost, dok je ekološka proizvodnja, unatoč povoljnim pretpostavkama, nedovoljno zastupljena. Kako je upravo konvencionalna poljoprivredna proizvodnja povezana sa primjenom mineralnih gnojiva i pesticida, naglasak je na održivim tehnologijama, a osobito ekološkoj proizvodnji. Sustavno praćenje **ekološke poljoprivredne proizvodnje** u Hrvatskoj je započelo 2002. godine ustrojem **upisnika proizvođača** u **Ministarstvu poljoprivrede**. Krajem 2009. evidentirano je 817 gospodarstava, poduzeća i zadruga koje se bave ovom vrstom proizvodnje. Ekološka proizvodnja na početku se odvijala na 54 hektara, a sada je zastupljena na 14.193 hektara (1,64%).

Tablica 1. Zastupljenost žitarica u strukturi ukupnih oraničnih površina (2005-2009.)

Kultura	Površina (ha)	Udjel (%)
Kukuruz	302.938	35,35
Pšenica	166.752	19,46
Ječam	58.724	6,85
Ostale kulture	328.591	38,34
Ukupno oranice i vrtovi (ha)	857.005	100,00

Izvor: Statistički ljetopis 2010. str. 257. i 258.

Cilj rada je analizu točke pokrića i utvrditi odnose između troškova, prihoda i financijskog rezultata pri različitim tehnologijama proizvodnje kukuruza, pšenice i ječma, te utvrditi minimalnu razinu proizvodnje pri kojoj je moguće završiti sa razdobljem stvaranjem gubitaka i započeti sa radobljem ostvarivanja dobitka.

Materijal i metode

Kalkulacije na temelju varijabilnih troškova su pogodne za donošenje brojnih odluka, a posebice odluka o promjeni opsega i strukture proizvodnje. Osim toga, pogodne su za otkrivanje pogrešaka u upravljanju proizvodnjom, te za potrebe planiranja proizvodnje u poljoprivredi. Kalkulacije koje se temelje na varijabilnim troškovima, direct costing kalkulacije, jesu postupci izračunavanja cijene koštanja koja u sebi sadrži samo promjenjive ili varijabilne troškove (Karić, 2002.). One prikazuju troškove i prihode odvojeno za svaki proizvod i za svaku parcelu. Na taj se način dolazi do više informacija za ocjenu uspješnosti i praćenja proizvodnje, te za donošenje kvalitetnijih odluka.

U postupku izrade kalkulacija na temelju varijabilnih troškova utvrđuje se bruto financijski rezultat koji se naziva doprinos za pokriće (Dzp). Izračunava se oduzimanjem varijabilnih troškova od tržišne vrijednosti svake linije proizvodnje (Ranogajec i sur. 2006.).

Kalkulacije su rađene na osnovi prihoda i troškova ostvarenih po hektaru površine, za razdoblje od godinu dana. Struktura modela kalkulacija je prilagođena izračunu prihoda i pokrića varijabilnih troškova, izračunu dohotka i troška proizvodnje po jedinici proizvoda na razini prosječnog prinosa u 2009. godini na obiteljskim gospodarstvima.

Analiza je temeljena na pretpostavkama primjene preporučene agrotehnike, u optimalnim uvjetima proizvodnje i na tlima prosječne plodnosti i kvalitete.

Vrijednost potrebnih inputa izražena je u prosječnim tržišnim cijenama u 2009. godini. Podaci i cijene prikupljeni su iz rzaličitih izvora informacija kao što su: Tržišni informacijski sustav u poljoprivredi (TISUP), Državni zavod za statistiku, cjenici mineralnih gnojiva i sredstava za zaštitu bilja.

U strukturu ukupnih prihoda uključeni su i poticaji proizvodnji po jedinici površine, pod pretpostavkom ispunjavanja minimalno poticanih količina proizvodnje i ostvarivanje poticaja, propisanih zakonom o državnoj potpori.

Rezultati i rasprava

Ukupan prihod pri kojem proizvodnja dostiže točku pokrića troškova moguće je izračunom utvrditi na osnovu sastavljenih direct costing kalkulacija, prema kojima tržišna vrijednost gotovih proizvoda (UP= tc * x) obuhvaća iznos učinjenih ukupnih troškova proizvodnje (vt¸+ FT) i ostvarene dobiti (D).(Ivanković, 2007.)

vt = VT / količina proizvoda
vt – prosječni proporcionalni varijabilni troškovi

Tablica 2. Izračun prosječnih varijabilnih troškova

Kukuruz		Pšenica		Ječam	
K	E	K	E	K	E
vt = VT / količina proizvoda					
0,57 kn/kg	0,46 kn/kg	0,74 kn/kg	0,64 kn/kg	0,68 kn/kg	0,45 kn/kg

K-konvencionalna proizvodnja; E-ekološka proizvodnja

Pretpostavljajući nepromijenjene vrijednosti prosječnog varijabilnog troška i prodajne cijene, moguće je izračunati količine proizvoda dostatne za pokriće fiksnih troškova proizvodnje kako slijedi.

UP = vt + FT + d
tc * x = (vt * x) + FT
x = FT / (tc – vt)

Up = ukupni prihod,
tc = tržišna cijena,
vt = prosječni proporcionalno varijabilni troškovi,
FT = ukupni fiksni troškovi
x = opseg proizvodnje

Tablica 3. Izračun opsega proizvodnje u točci pokrića

Elementi	Kukuruz		Pšenica		Ječam	
	K	E	K	E	K	E
x = FT / (tc – vt)						
FT (kn)	2.221	2.530	2.423	2.543	2.318	2.078
tc (kn/kg)	1,18	2,00	1,31	1,70	1,15	1,70
vt (kn/kg)	0,57	0,46	0,74	0,64	0,68	0,45
x (kg)	1.881	1.265	1.849	1.495	2.015	1.222

K-konvencionalna proizvodnja; E-ekološka proizvodnja

Opseg proizvodnje dostatan za pokriće fiksnih troškova pri ekološkoj tehnologiji je manji u odnosu na konvencionalnu i to kod kukuruza za 617 kg, pšenice 354 kg i ječma 793 kg.

y = FT / [1-(vt * x / tc * x)]
y = tržišna vrijednost u kojoj se dostiže točka pokrića troškova

Tržišna vrijednost proizvoda u kojoj se dostiže točka pokrića je veća pri ekološkoj proizvodnji kukuruza i pšenice dok je kod ječma obrnuto. Razlike nisu značajne obzirom na činjenicu kako su cijene ekoloških proizvoda veće i do 30%. U strukturi dobiti, kod ekološke proizvodnje, vrijednost točke pokrića kod kukuruza iznosi 44%, kod pšenice 43%, a kod ječma 17%. Pri konvencionalnoj tehnologiji te su vrijednosti znatno veće, kod kukuruza 66%, ječma 45%, dok je kod pšenice doprinos za pokriće ukupnih troškova veći od financijskog rezultata..

Tablica 4. Izračun tržišne vrijednosti proizvoda u točci pokrića

Elementi	Kukuruz		Pšenica		Ječam	
	K	E	K	E	K	E
FT (kn)	2.221,00	2.530,00	2.423,00	2.543,00	2.318,00	2.078,00
tc (kn/kg)	1,18	2,00	1,31	1,70	1,15	1,70
vt (kn/kg)	0,57	0,46	0,74	0,64	0,68	0,45
x (kg)	1.881,63	1.264,54	1.848,88	1.495,24	2.014,97	1.221,90
y = FT / [1-(vt * x / tc * x)]						
y (kn)	2.220,52	2.529,77	2.422,44	2.542,62	2.317,41	2.077,74

K-konvencionalna proizvodnja; E-ekološka proizvodnja

Tablica 5. Apsolutna mjerila uspješnosti proizvodnje žitarica po hektaru

Apsolutna mjerila uspješnosti	Kukuruz		Pšenica		Ječam	
	K	E	K	E	K	E
Ukupni prihodi	12.162,00	18.000,00	9.642,00	11.230,00	7.655,00	9.800,00
Ukupni troškovi	7.001,77	6.021,00	6.289,70	5.451,50	5.519,25	3.885,50
Financijski rezultat	5.160,23	11.979,00	3.352,30	5.778,50	2.135,75	5.914,50

K-konvencionalna proizvodnja; E-ekološka proizvodnja

Doprinos za pokriće predstavlja bruto financijski rezultat proizvodnje. Izračunava se tako što se od ukupnog prihoda oduzmu varijabilni troškovi za svaku liniju proizvodnje.

Dzp = UP – VT

Dzp = doprinos za pokriće
UP = ukupni prihodi
VT = varijabilni troškovi

Tablica 6. Izračun doprinosa za pokriće

Elementi	Kukuruz		Pšenica		Ječam	
	K	E	K	K	E	K
Ukupni prihodi	12.162,00	18.000,00	9.642,00	11.230,00	7.655,00	9.800,00
Varijabilni troškovi	4.781,20	3.491,00	3.866,70	2.908,50	3.201,25	1.807,50
Doprinos za pokriće	7.380,80	14.509,00	5.775,30	8.321,50	4.453,75	7.992,50

K-konvencionalna proizvodnja; E-ekološka proizvodnja

Iz ostvarene vrijednosti prihoda potrebno je podmiriti i ostale troškove proizvodnje te nakon oduzimanja ovih troškova nastaje neto financijski rezultat. Stalni troškovi se ne mijenjaju sa povećanjem opsega proizvodnje. Zato se ne obavlja njihov raspored po proizvodima, linijama proizvodnje, granama ili parcelama, a osim toga najveći dio stalnih troškova su opći troškovi koji su zajednički za cijelo poljoprivredno gospodarstvo. Doprinosi za pokriće troškova su znatno veći pri ekološkoj, nego pri konvencionalnoj proizvodnji. U radu je primijenjen model točke pokrića proizvodnje žitarica po 1 ha površine, kroz dva agrotehnička sustava, potrebno je naglasiti kako isti nije moguće linearno implementirati u veće proizvodne cjeline. Razlog je promijenjena struktura ukupnih troškova i ponašanje fiksnih troškova pri promjeni kapaciteta proizvodnje. Stoga je potrebno primijeniti složenije metode odvajanje fiksnih i varijabilnih troškova.

Zaključci

Korisnost modela točke pokrića proizlazi iz mogućnosti kontrole troškova s jedne te prihoda i opsega proizvodnje s druge strane te uspostave odnosa između njih. Analizi prethodi kalkulativni postupak koji obuhvaća varijabilne i fiksne troškova.

Prosječni varijabilni troškovi ekoloških proizvoda sve tri analizirane kulture su niži od konvencionalnih u prosjeku za 22%.

Opseg proizvodnje dostatan za pokriće fiksnih troškova pri ekološkoj tehnologiji je manji u odnosu na konvencionalnu i to kod kukuruza za 617 kg, pšenice 354 kg i ječma 793 kg.

Financijski fezultat kao i doprinos za pokriće ukupnih troškova su veći kod ekološke u odnosu na konvencionalnu proizvodnju. U strukturi dobiti, kod ekološke proizvodnje, vrijednost točke pokrića kod kukuruza iznosi 44%, kod pšenice 43%, a kod ječma 17%. Pri konvencionalnoj tehnologiji te su vrijednosti znatno veće, kod kukuruza 66%, ječma 45%, dok je kod pšenice doprinos za pokriće ukupnih troškova veći od financijskog rezultata.

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Abstract

Application of Break-even point in Ecological and Conventional Crop Production

Break-even point represents a volume of production in which both costs and incomes are alienated and there are zero returns. If the model of break-even point is applied, it is possible to determine the minimal quantity of products reqiured for the selection of the strategy that may help prevail over an unfavourable period that led to the loss in business. Crop production is the most represented in the structure of cultivated land (65%). Especially in this branch, there has been a tendency to increase the share of ecological production. Therefore, the aim of this paper is to establish economic indicators of ecological and conventional crop production by using the break-even point model. When it comes to the structure of financial result in ecological production, the value of coverage of costs in maize amounts 44%, in wheat 43%, in barley 17%. On the other hand, if the conventional technologies are applied, these values are higher: in maize 66%, barley 45%, and in oder to cover total costs in wheat there are no sufficient means.

Key words: Break-even point, crops, costs, income

Pregledni rad / Review paper

Održive melioracije u Republici Hrvatskoj

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Sažetak

Poljoprivredna proizvodnja slovi kao najveći potrošač vode i glavni uzročnik raspršenih izvora onečišćenja vode i tla. Kao posljedica degradacije kvalitete prirodnih resursa javlja se misao održivog razvoja i dobre poljoprivredne prakse u okviru koje održive melioracije prepoznaju problematiku intenzivne poljoprivredne proizvodnje kao i nestručnog iskorištavanja prirodnih bogatstava te nude moguća rješenja, ciljeve i programe održivog razvoja navodnjavanja i odvodnje poljoprivrednih zemljišta.

Ključne riječi: poljoprivredne melioracije, održiva odvodnja, održivo navodnjavanje

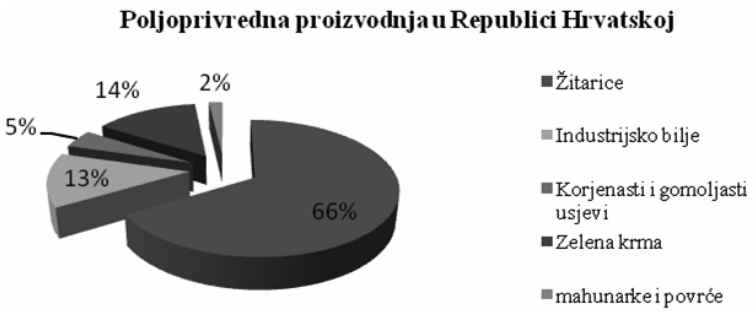
Uvod

Biljna proizvodnja na području Republike Hrvatske orijentirana je na proizvodnju kultura za koje nije dominanto navodnjavanje, ponajprije žitarica. U uvjetima klimatskih promjena, visokih temperatura i manjka oborina javlja se veća potreba biljaka za vodom, a time i potrošnja vode, a čiste pitke vode je sve manje. Uslijed sve učestalijih razdoblja zasušenja i zatopljenja navodnjavanje je našlo primjenu i kao osnovna i kao dopunska mjera kojom se osiguravaju visoki i stabilni urodi. Pored sušnih razdoblja učestala je pojava obilnih i dugotrajnih kiša čime se javlja potreba za odvodnjom suvišne vode sa proizvodnih površina. Održivim melioracijama teži se poljoprivrednoj proizvodnji u kojoj se proizvođači koriste meliorativnim uređenjem proizvodnih površina te proizvode dobra po razumnoj cijeni, a pri tome vode računa da navodnjavanjem ili odvodnjom suvišnih voda ne narušavaju kvalitetu tla, vode i drugih prirodnih bogatstava. Održive melioracije čine sve one mjere i aktivnosti na uređenju vodozračnog režima tla koje će biti praćene povećanjem ili stabiliziranjem biološke različitosti i sprječavanjem nepovoljnog djelovanja na resurse koji su uključeni u biljnu proizvodnju (Univerzitet u Novom Sadu, 2007.). Voda je nezamjenjiv a obnovljiv prirodni resurs, bitan za život ljudi uopće, za proizvodnju hrane, za gospodarski razvoj i za okoliš (Gereš, 1995.). »Održivi razvoj obuhvaća upravljanje prirodnim resursima i orijentaciju ka tehnološkim procesima na takav način da se mogu zadovoljiti potrebe čovjeka i očuvati resursi na dulji vremensko razdoblje. Takav održivi razvoj (poljoprivrede, šumarstva i ribarstva) čuva tlo, vodu, biljke i životinjski genetski potenci-

jal, nije degradirajući je po okoliš, tehnološki prikladan, ekonomski isplativ i sociološki prihvatljiv.« (FAO, 1996.). Ovim znanstvenim radom daje se kratki prikaz postojećeg stanja upravljanja vodnim resursima u Republici Hrvatskoj u melioracijske svrhe s naglaskom na održive melioracije u okviru »dobre poljoprivredne prakse«.

Melioracije u Republici Hrvatskoj

U Republici Hrvatskoj 5 977 ha površina je vrlo visoko pogodno za navodnjavanje, 478 049 ha visoko, 979 178 ha umjereno, 363 268 ha nisko i na 54 546 ha je vrlo niska pogodnost tla za navodnjavanje (NAPNAV, 2007.). Ipak, vrlo malo je poljoprivrednika koji su u svoju proizvodnju uključili agrotehničku mjeru navodnjavanja, prema službenim podacima tek 0.86% površina (9 264 ha) (NAPNAV, 2007.). Navodnjavanje je u kontinentalnom dijelu najviše zastupljeno u povrćarskoj i voćarskoj proizvodnji, a kako je vidljivo iz Slike 1. tek je 0.2% površina uključeno u povrćarsku proizvodnju. U Republici Hrvatskoj biljna proizvodnja je većim dijelom orijentirana ka proizvodnji žitarica (Slika 1.). Na proizvodnim površinama najvećim dijelom je zastupljen kukuruz – 296 195 ha (Državni zavod za statistiku, 2010.). U sušnim razdobljima koja se u Hrvatskoj javljaju svakih 3 do 5 godina NAPNAV, za uzgoj kukuruza prosječno nedostaje 100 mm do 600 mm vode koju bi se trebalo nadoknaditi navodnjavanjem (Hrvatske vode, 2008.).



Slika 1: Poljoprivredna proizvodnja u Republici Hrvatskoj (Izvor: Državni zavod za statistiku, 2010.)

Na području slivova Drave i Dunava najčešće se iskorištavaju površinske vode iz vodotoka, no u Međimurju i Podravini za navodnjavanje se upotrebljava i podzemna voda, iako je na tom području izgrađeno nekoliko višenamjenskih akumulacija koje za sada ne služe za tu svrhu (Hrvatske vode, 2008.). Provedbom Nacionalnog projekta navodnjavanja i gospodarenja poljoprivrednim zemljištem i vodama (NAPNAV), navodnjavane površine u Hrvatskoj u razdoblju od 2005. – 2007. godine povećane su za više od 50%, tako da se zaključno sa 2007. godinom navodnjava oko 15 000 ha poljoprivrednih površina (Hrvatske vode, 2008.).

Tablica 1. Izgrađenost sustava melioracijske odvodnje u Republici Hrvatskoj

Sliv	Vel. mel. područja	Izgrađenost sustava odvodnje					Duljine kanala		Crpne stanice		Odvodni tuneli	
		Površinska odvodnja			Kombinirana		I	II	Broj	m^3/sec	Broj	Dulji-na (km)
		*	**	***	*	**	reda	reda				
	ha						km					
Sava	955	348	107,1	499,8	71,2	7,3	1,7	1,5	39	168	0	0
Drava i Dunav	626	362	204,7	59,5	48,2	19,8	1,4	1,5	21	55	0	0
Primorsko-istarski	43	1,7	3,0	38,2	1,7	0	71	37	4	9	2	6
Dalmatinski	49	12,4	9,7	26,8	314	0	141	265	10	59	7	11
Hrvatska	**1 674**	**724,7**	**324,6**	**624,4**	**121,5**	**27,2**	**3,28**	**3,31**	**74**	**291**	**9**	**17**
*=potpuno izgrađena, **=djelomično izgrađena, ***=neizgrađena,												

(Izvor: Hrvatske vode, 2008.)

Hrvatska ima dugu tradiciju projektiranja, izgradnje i iskorištavanja hidromelioracijskih sustava. U početku izgradnje melioracijskih sustava (70-tih godina) izgrađeno je mnogo hidromelioraciojskih objekata, a njihova izgrađenost je na bivšim kombinatima bila financijski potpomognuta od strane države. Promjenama strukture vlasnika (kombinati, privatni posjednici), domovinskim ratom i nemogućnošću održavanja (minski sumnjiva područja i devastacija postojećih objekata) hidrotehničkih objekata, te bez financijskog praćenja izgradnje od strane države današnja dinamika izgrađenosti pa i održavanja nije na zadovoljavajućoj razini. Problem koji je pridonio takvom stanju su i neriješeni imovinski pravni odnosi i uzimanje zemlje u zakup. U svijetlu rješavanja problematike imovinsko pravnih odnosa u Hrvatskoj je u tijeku izrada zakona koji se usklađuju sa zakonima europske unije u kojima bi se definirala prava i obveze svih korisnika hidrotehničkih objekata. Meliorirane poljoprivredne površine najčešće se nalaze na područjima potencijalno ugroženim od poplava. Sustavi površinske odvodnje u 2008. godini u potpunosti su izgrađeni na 724 749 ha, a djelomično na 324 662 ha. Sustavi kombinirane odvodnje u potpunosti su izgrađeni na 121 484 ha, a djelomično na 27 169 ha. Duljina kanala I. reda iznosila je 3 282 km, a duljina kanala II. reda iznosila je 3 313 km (Hrvatske vode, 2008.).

Održivo navodnjavanje

Agrotehnička mjera navodnjavanja značajno povećava urod, ali isto tako može imati nepoželjne posljedice u smislu trošenja velike količine čiste pitke vode, vodene erozije, onečišćenja vodotoka, zaslanjenja i dr. Ideja o održivom navodnjavanju javlja se kao odgovor na negativne posljedice koje je prouzročilo nestručna primjena navodnjavanja. Nestručno provođenje agrotehničke mjere navodnjavanja može dovesti do niza problema kao što su: prekomjerno i neracionalno trošenje čiste pitke vode, dolazi do narušavanja staništa životinjskog i biljnog svijeta. »Održivo navodnjavanje podrazumijeva vrlo aktivno poznavanje svakog segmenta poljoprivredne proizvodnje (do razine profesionalnosti) kao i njegovo provođenje u cilju stvaranja sveobuhvatne zaštite okoliša i dobivanje konkurentnog proizvoda.« (Josipović et al., 2009.). Primjenjujući principe integralnog upravljanja vodama i održivog razvoja dolazi se do glavnih

izazova u navodnjavanju a to su: unapređenje zaštite i očuvanja vode tehnološkim intervencijama i poboljšanje upravljanja sustava za navodnjavanje (Gereš, 1994.) Održivo navodnjavanje teži razviti sustave kojima se s ograničenim vodnim resursima učinkovito povećava proizvodnja hrane dok se istovremeno smanjuje negativan utjecaj navodnjavanja na vodne resurse i tlo. Takvim sustavom osigurava se razumno iskorištavanje površinskih i podzemnih voda čime se čuvaju akvatični sustavi i osigurava se dovoljna količina vode za navodnjavanje kao i urbane i industrijske potrebe. Sofisticirano upravljanje vodnim resursima vodi do optimalnog i održivog iskorištavanja vode (Gereš, 1994.). Navodnjavanje uvijek treba izvoditi tako da se ne prouzroči erozija, s manje vode, kroz više obroka prema potrebama usjeva. »Vodu valja dodavati sitnim kapima i prekinuti dodavanje kada se voda nakupi.« (Ministarstvo poljoprivrede, ribarstva i ruralnog razvoja, 2009.). Ekološki indikator održivog navodnjavanja uglavnom se odnosi na očuvanje kvalitete vode i tla. Isto tako, održivim navodnjavanjem teži se postizanju visokih uroda sa što manjom količinom utrošene vode (»more crop per a drop«). Prema tome, održivo navodnjavanje teži novim tehnologijama u obradi tla, stvaranju novih genotipova manje osjetljive na sušu i gdje je god to moguće teži objediniti sustav sa melioracijskom odvodnjom. Održivim navodnjavanjem potiče se uporaba sustava koji štede vodu i energiju: sustavi navodnjavanja kapanjem i mikrorasprskivači. Prema Đurovki i dr. (2006.) iskorištenost vode u sustavu »kap po kap« je čak do 95%. Kako je koncept »dobre poljoprivredne prakse« orijentiran ka obnovljivim izvorima energije, sustav održivog navodnjavanja izvor energije može biti u bioplinskim postrojenjima (energija kao nusproizvod), energiji vjetra kao i solarnoj energiji. U Republici Hrvatskoj ciljeve i zadaće politike upravljanja vodama donosi Hrvatski Sabor (Zakon o vodama (»Narodne novine«, br. 107/95 i 105/05.), Strategija upravljanja vodama (»Narodne novine«, br. 91/08.)). U okviru Zakona o vodama nalaze se odredbe na kojima se temelji načelo održivog razvoja u pogledu zaštita voda u smislu njene kvalitete i količine. Izrada Zakona o korištenju voda se usklađuje sa zakonima Europske unije. Mjerama za zaštitu voda teži se smanjenju raspršenih izvora onečišćenja vode i tla koja potječu od poljoprivredne proizvodnje. Politika upravljanja vodnim dobrima provodi se na nacionalnoj, regionalnoj i lokalnoj razini (Hrvatske vode, 2008.). U održivom navodnjavanju svi korisnici sustava trebaju znati svoja prava i obveze što treba biti određeno zakonskim regulativama.

Održiva odvodnja

Održiva odvodnja podrazumijeva značajniju uporabu novih tehnologija u izgradnji otvorenih kanala koje nepovoljne učinke svode na minimum. Prema Scheumannu i Freisemu (2002.) razlozi za primjenu odvodnje u održivoj poljoprivredi su da štiti osnovne resurse biljne proizvodnje, povećava i poboljšava kvalitetu uroda, štiti ljudske živote i imovinu i od poplava i visokih razina podzemnih voda, poboljšava zdravstvene uvjete življenja, štiti kvalitetu vode. Melioracijski kanali mogu imati dvojaku ulogu u poljoprivrednoj proizvodnji, odvođenje suvišne vode i kao izvor vode za navodnjavanje. Ako je u kanalu smanjen protok vode, odnosno ako u većem dijelu godine voda u kanalu stoji, kanali tada poprimaju ekološke osobine bara odnosno jezera. U takvim uvjetima razvijaju se akvatične biljne vrste, odnosno korovi koji ometaju normalno funkcioniranje tih objekata. Jedna od pogodnih mjera održavanja kanala kojom se omogućuje kontrolirani razvoj biljne vegetacije i fitoplanktona u kanalima je uvođenje riblje populacije. U okviru održive odvodnje predlaže se zatravljivanje stranica pokosa kanala i zaštitnog pojasa sa zadatkom očuvanja hidrauličnog profila kanala, sprijačavanje erozije i povećavanje zelene površine. U primjeni održive odvodnje za filtar materijal prikladna je primjena prirodnih materijala (kokosovo vlakno). Kao biološki način poboljšanja vodo-zračnog režima tla mogu se primijeniti nasadi brzorastućih vrsta listopadnog drveća (Heuperman et al., 2002.) koje prirodnim

procesima transpiracije koristi velike količine vode i na taj način poboljšava vodo zračni režim tla. Potrebno je naglasiti kako je ovaj vid drenaže odnosno poboljšanja vodo zračnog režima tla primjenjiv na površinama koje nisu uključene u biljnu proizvodnju jer pogoduje razvoju korova i bolesti, smanjuje proizvodnu površinu, mijenja se površina parcele i njen pravilan oblik (Belić et al., 2008.). U Republici Hrvatskoj melioracijska odvodnja i njeno unapređenje zajednička je zadaća sektora poljoprivrede i vodnog gospodarstva. Zajedničkim programima se potiče obnova postojećih sustava kao i izgradnja novih sustava koji će zadovoljiti potrebe i financijske mogućnosti poljoprivrednih proizvođača, a u što manjoj mjeri narušavati postojeću biocenozu i prirodni krajolik.

Zaključak

Voda je u Republici Hrvatskoj prepoznata kao nacionalno blago te su u skladu s tim doneseni brojni zakoni o zaštiti i upravljanju vodnim resursima. U okviru održivih melioracija vodno bogatstvo je prepoznato kao razvojni resurs s kojim treba racionalno i održivo gospodariti. Osnova održivosti melioracija leži u interdisciplinarnom i integriranom pristupu ekonomskih, ekoloških i sociooloških čimbenika. Ciljeve održivog razvoja melioracija i integralnog upravljanja vodama utvrđuju sami korisnici unutar svojih područja (županija), a obuhvaćaju zaštitu površinskih i podzemnih voda kao dijela ekosustava u cilju održavanja biološke raznolikosti.

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Abstract

Sustainable melioration practice in Republic of Croatia

Food production is closely connected to amount of available clean water. Agricultural production is the largest consumer of fresh clean water and main cause of soil and water degradation. Idea of sustainable agricultural production and sustainable melioration practice comes as result of degradation of natural treasures, water and soils. Sustainable melioration as a part of good agricultural practice has recognized the consequences of intensive agricultural practise and inadequate exploitation of natural treasures and so has give the solution and guidelines to achieve high and stabile yields in harmony with ecological systems.

Key words: agricultural melioration, sustainable irrigation, sustainable drainage

Stručni rad / Expert paper

Primjena načela dobre poljoprivredne prakse u zaštiti voda na mliječnim farmama Osječko-baranjske županije

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Sažetak

Nitratna direktiva Europske unije je dokument koji se između ostaloga odnosi i na zaštitu voda od onečišćenja nitratima iz poljoprivrednih izvora. Ova direktiva bi se najviše mogla odnositi na farme koje bi sada trebale imati vlastite sustave za odlaganje gnoja. Istraživanja su provedene na mliječnim farmama Osječko-baranjske županije s ciljem utvrđivanja kako se provode načela dobre poljoprivredne prakse u zaštiti voda. Rezultati su pokazali da 19 farmi ispunjava preporuke Pravilnika po pitanju dopuštenog opterećenja UG/ha, dok tri farme ne. Obzirom na uvjete za skladištenje stajskog gnoja tijekom šest mjeseci, samo devet farmi ispunjavaju preporuke Pravilnika, a čak 13 farmi ne ispunjavaju tražene uvjete. Hrvatskim farmerima bit će potrebna stručna i financijska pomoć pri rješavanju ovoga problema, jer postoji mogućnost da ovakve farme u budućnosti ostanu bez novčanih potpora pri ulasku Hrvatske u Europsku uniju.

Ključne riječi: dobra poljoprivredna praksa, zaštita voda, nitratna direktiva, mliječne farme.

Uvod

Kako bi se smanjilo onečišćenje okoliša uslijed sve veće ekspanzije poljoprivredne proizvodnje, Europski parlament je 1991. godine usvojio propis pod nazivom Nitratna direktiva (Council Directive 91/676/EEC). Ovaj dokument se između ostaloga odnosi i na zaštitu voda od onečišćenja nitratima iz poljoprivrednih izvora, a intenzivna poljoprivredna proizvodnja se sve više usmjerava u pravcu zaštite okoliša, očuvanju prirodnih resursa, dobrobiti životinja i sl. Prema navodima (Vincek i Ernoić, 2009.) na kakvoću podzemnih voda najviše negativno utječe slijedeće: neriješena odvodnja naselja: fekalne vode iz domaćinstava, otpadne vode iz industrijsko-zanatskih pogona (servisne i mehaničarske radione, autopraone, razna obiteljska proizvodnja manjeg obima, pilane i finalna drvna proizvodnja, manje farme u sklopu naselja, klaonice i sl.), neriješena odvodnja otpadnih voda s životinjskih farmi, neriješeno zbrinjavanje krutog otpada s životinjskih farmi, posebice peradarskih (stelja i kruti dio fekalija), prekomjerno tretiranje poljoprivrednih površina mineralnim gnojivima i sredstvima za zaštitu bilja, - nelegalno odlaganje otpada koji sadrži komponente opasnog karaktera (istrošene baterije, stari lijekovi, ambalaža od boja, ulja, lakova i otapala, mineralnih gnojiva, sredstava za zaštitu bilja i dr.).

Navedena direktiva u praksi bi se ponajviše odnosila na farme, koje bi sada trebale imati vlastite sustave za odlaganje gnoja. Svaka članica Europske unije sama treba odrediti područja koja su izložena mogućem zagađenju voda nitratima iz poljoprivrede, te osmisliti način kako spriječiti takva onečišćenja. Shodno tome Ministarstvo poljoprivrede Republike Hrvatske donijelo je Pravilnik o dobroj poljoprivrednoj praksi u korištenju gnojiva (N.N.56/08), koji stupa na snagu danom stupanja Hrvatske u Europsku uniju.

Cilj ovog rada je bio utvrditi koliko je mliječnih farmi na području Osječko-baranjske županije u skladu s načelima Dobre poljoprivredne prakse u zaštiti voda, a koje su izgrađene sredstvima Operativnog programa razvoja govedarske proizvodnje Republike Hrvatske od 2003. do 2008. godine.

Materijal i metode

Istraživanje su provedena na području Osječko-baranjske županije i to na farmama koja se bave proizvodnjom mlijeka. Sve farme obuhvaćene istraživanjem su koristile novčana sredstva iz Operativnog programa razvoja govedarske proizvodnje Republike Hrvatske od 2003. do 2008. godine preko Hrvatske banke za obnovu i razvoj (HBOR). Ovim radom su ukupno obuhvaćene 22 farme. Prikupljani su podatci o broju goveda na farmi po kategorijama starosti, proizvodnji mlijeka, obradivim površinama, raspoloživim kapacitetima laguna i platoa za gnojovku i stajnjak. Istraživanja su provedena u siječnju 2011. godine i to u skladu s Pravilnikom o dobroj poljoprivrednoj praksi u korištenju gnojiva (N. N. 56/08). U tablici 1. prikazana su osnovna obilježja istraživanih farmi.

Rezultati istraživanja i rasprava

Proizvodnja mlijeka na području Osječko-baranjske županije postala je jedna od najznačajnijih poljoprivrednih grana kojom se bavi oko 1.500 proizvođača. Sve je veći broj uvjetnih grla (UG) po hektaru, što dovodi i do povećanja opterećenosti zemljišta dušikom. Rezultati u tablici 2. pokazuju kako se opterećenje UG/ha kreće od 0,5 do 5,4, a godišnje opterećenje zemljišta dušikom je u rasponu od 33,1 do 380,3 kg N/ha. Prema tome, preporuku Pravilnika o dobroj poljoprivrednoj praksi u korištenju gnojiva (N.N. 56/08) ispunilo je 19 obuhvaćenih poljoprivrednih gospodarstava, dok tri gospodarstva nisu. Razlog neispunjenju je u nedostatku obradivih površina s kojima raspolažu ova gospodarstva. Mjerodavne ustanove i tijela svakako bi mogla pomoći u rješavanju ovog problema na način da se farmama koje nemaju dovoljne površine zemlje omogući zakup ili kupovina državne zemlje.

Tablica 1. Osnovna obilježja istraživanih farmi na području Osječko-baranjske županije za 2010. godinu.

Gospo-darstvo	Način držanja	Pasminski sastav goveda na farmi	Broj muznih krava na farmi	Godišnja proizvodnja mlijeka na farmi (kg)
1.	Slobodan (ležišni boksovi)	simentalac	73	496.629
2.	Slobodan (ležišni boksovi)	simentalac	25	105.278
3.	Slobodan (ležišni boksovi)	holštajn	42	308.218
4.	Slobodan (kosa ploča)	holštajn	30	194.239
5.	Slobodan (kosa ploča)	holštajn	33	325.817
6.	Slobodan (ležišni boksovi)	holštajn	80	454.691
7.	Slobodan (kosa ploča)	holštajn	28	107.404
8.	Slobodan (ležišni boksovi)	mješoviti	35	160.458
9.	Slobodan (ležišni boksovi)	holštajn	347	2.909.717
10.	Slobodan (ležišni boksovi)	holštajn	25	242.818
11.	Slobodan (ležišni boksovi)	holštajn	80	689.620
12.	Slobodan (ležišni boksovi)	mješoviti	39	255.892
13.	Slobodan (ležišni boksovi)	holštajn	117	818.378
14.	Slobodan (ležišni boksovi)	simentalac	35	253.763
15.	Slobodan (ležišni boksovi)	holštajn	60	208.000
16.	Slobodan (kosa ploča)	holštajn	40	219.769
17.	Slobodan (ležišni boksovi)	holštajn	38	326.625
18.	Slobodan (ležišni boksovi)	holštajn	65	446.126
19.	Slobodan (kosa ploča)	holštajn	35	342.714
20.	Slobodan (ležišni boksovi)	simentalac	48	278.136
21.	Slobodan (kosa ploča)	holštajn	36	200.996
22.	Slobodan (kosa ploča)	holštajn	56	299.850

Količina gnojiva, koja se može upotrijebiti po hektaru poljoprivredne površine može ovisiti o više čimbenika kao što su: trenutno stanje zemljišta, klimatski uvjeti, načinu korištenja zemljišta i plodoreda. Na tragu takvih razmišljanja i djelovanja je i »Nitratna direktiva« Vijeća Europske Unije (91/676/ECC), prema kojoj je potrebno osigurati prostor za skladištenje gnoja za najmanje 6 mjeseci, zbog zabrane njegovog odlaganja na poljoprivrednim površinama u razdoblju bez intenzivnije vegetacije. U tablici 3. su prikazani rezultati o raspoloživom kapacitetu laguna i platoa i potreban kapacitet laguna i platoa na farmi za 6 mjeseci u skladu s preporukom Pravilnika o dobroj poljoprivrednoj praksi u korištenju gnojiva(N.N 56/08). Iz navedenih rezultata možemo vidjeti da od 14 farmi koje koriste lagune 9 farmi ne ispunjava uvjete, a 5 ispunjava. Od 7 farmi koje koriste platoe za stajnjak 3 farme ne ispunjavaju uvjete, a 4 farme ispunjavaju. Sveukupno promatrano vidljivo je da od 22 farme samo njih 9 ispunjava uvjete za skladištenje stajskog gnoja tijekom 6 mjeseci, dok 13 farmi ne ispunjava.

Tablica 2. Rezultati o broju uvjetnih grla (UG), raspoloživome zemljištu, opterećenosti zemljišta uvjetnim grlom i količinom dušika po hektaru (ha) godišnje u skladu s preporukom Pravilnika o dobroj poljoprivrednoj praksi u korištenju gnojiva (N. N. 56/08).

Gospo-darstvo	Ukupni broj UG na farmi	Raspoloživo zemljišta (ha)	Opterećenje zemljišta (UG/ha)	Opterećenje zemljišta (kg N/ha/godini)	Preporuka Pravilnika (N.N. 56/08)
1.	144,6	125	1,2	81,0	ispunjena
2.	46,2	55	0,8	58,7	ispunjena
3.	75,6	47	1,6	112,6	ispunjena
4.	48,7	91	0,5	86,0	ispunjena
5.	63,4	64	1,0	69,3	ispunjena
6.	141,3	26	5,4	380,3	neispunjena
7.	32,6	34	1,0	67,0	ispunjena
8.	60,6	70	0,9	60,6	ispunjena
9.	535	130	4,1	288,1	neispunjena
10.	50,1	96	0,5	36,5	ispunjena
11.	121	168	0,7	50,4	ispunjena
12.	48,5	22	2,2	154,3	ispunjena
13.	176,8	244	0,7	50,7	ispunjena
14.	50,85	48,2	1,1	73,8	ispunjena
15.	86,3	35,5	2,4	170,2	ispunjena
16.	56,7	120	0,5	33,1	ispunjena
17.	51,9	67	0,8	54,2	ispunjena
18.	128,4	50	2,6	179,8	ispunjena
19.	54,1	31	1,7	122,2	ispunjena
20.	93,5	30	3,1	218,1	neispunjena
21.	60,8	79	0,8	53,8	ispunjena
22.	94,4	90	1,0	73,4	ispunjena

Razlog neispunjenju ovih uvjeta je u tome zato što je nažalost većina farmi sagrađena prije donošenja Pravilnika o dobroj poljoprivrednoj praksi u korištenju gnojiva (N.N 56/08). Mjerodavna tijela u Republici Hrvatskoj trebala su prije reagirati i upoznati proizvođače s trendovima u Europskoj uniji, a koja se dotiču problematike zaštite okoliša.

Tablica 3. Rezultati o raspoloživome kapacitetu lagune i platao, potrebama kapaciteta lagune i platoa na farmi za šest mjeseci u u skladu s preporukom Pravilnika o dobroj poljoprivrednoj praksi u korištenju gnojiva (N. N. 56/08).

Gospodarstvo	Raspoloživi kapacitet lagune (m^3)	Potreban kapacitet lagune za 6 mjeseci (m^3)	Preporuka Pravilnika (N.N. 56/08) za lagunu	Raspoloživi kapacitet platoa (m^2)	Potreban kapacitet platoa za 6 mjeseci (m^2)	Preporuka Pravilnika (N.N. 56/08) za plato
1.	650	1446,0	neispunjena	0	0	0
2.	430	461,5	neispunjena	0	0	0
3.	480	756,0	neispunjena	0	0	0
4.	0	0	0	431	194,6	ispunjena
5.	0	0	0	150	253,4	neispunjena
6.	1050	1412,5	neispunjena	0	0	0
7.	0	0	0	160	130,2	ispunjena
8.	990	606,0	ispunjena	0	0	0
9.	5200	5350,0	neispunjena	0	0	0
10.	720	500,5	ispunjena	0	0	0
11.	0	0	0	700	484	ispunjena
12.	520	485	ispunjena	0	0	0
13.	650	1767,5	neispunjena	0	0	0
14.	735	508,5	ispunjena	0	0	0
15.	729	863	neispunjena	0	0	0
16.	0	0	0	296	226,8	ispunjena
17.	600	519	ispunjena	0	0	0
18.	750	1284	neispunjena	0	0	0
19.	0	0	0	135	216,4	neispunjena
20.	174	934,5	neispunjena	0	0	0
21.	0	0	0	0	0	0
22.	0	0	0	187	377,4	neispunjena

Stanje glede nitratne direktive nije puno bolje niti u drugim županijama Republike Hrvatske. Tako Vincek i Ernoić, 2009. navode da na području Varaždinske županije još uvijek veliki broj obiteljskih gospodarstava nema na adekvatan način riješen problem zbrinjavanja stajskog gnoja. U prosjeku 78% farmi u Hrvatskoj, nema adekvatne smještajne prostore za stajski gnoj. Osim što se zagađuje okoliš uslijed konstantnog cijeđenja, mnogi poljoprivrednici nisu ni svjesni ekonomskog gubitka uslijed toga. Naime, zbog neadekvatnog skladištenja stajskog gnoja, godišnje se po jednom UG, izgubi oko 35 EUR-a u gubicima dušika, kalija, fosfora. Osječko-baranjska županija u želji da pomogne svojim proizvođačima ušla je 2007. godine u pilot projekt pod nazivom Projekt kontrole onečišćenja s poljoprivrednih površina (APCP) financiran od strane Svjetske banke.

Zaključak

Na temelju provedenih istraživanja došli smo do sljedećih zaključaka:

– većina istraživanih gospodarstava raspolaže dovoljnim površinom zemljišta za zbrinjavanje stajnjaka s gospodarstva (19 od 22 farme),

– stanje je mnogo lošije obzirom na potrebni kapacitet za skladištenje stajskog gnoja tijekom šest mjeseci. Samo 9 od 22 gospodarstva ispunjava preporuke Pravilnika.

Najveći je problem što bi gospodarstva koja ne ispunjavaju preporuke Pravilnika mogla izgubiti pravo na potpore od strane Europske unije, a Hrvatska bi u konačnici mogla imati manju proizvodnju mlijeka i mesa. Stoga je potrebno učiniti dodatni napor kako bi se pomoglo poljoprivrednim proizvođačima koje se bave farmskom proizvodnjom u smanjenju troškova za izgradnju sustava odlagališta gnoja i što kvalitetnije ih pripremiti za Europsku uniju.

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Abstract

Applying the Principles of Good Agricultural Practices to Protect Water on Dairy Farms in Osječko-Baranjska County

Nitrates Directive of the European Union is a document which, among other things, refers to the protection of waters against pollution by nitrates from agricultural sources. This directive would be most able to relate to the farm which should now have their own systems for the disposal of manure. Investigations were conducted on dairy farms in Osječko-Baranjska county, with the aim of determining how to implement the principles of good agricultural practices to protect water. The results showed that 19 farms meet the recommendations of the Ordinance regarding allowable load conditional throat (CT) CT/ha, while the three farms do not. Given the conditions for the storage of manure during the six months, only nine farms meet the recommendations of the Ordinance, and as many as 13 farms do not meet the requirements. Croatian farmers will need technical and financial assistance in solving this problem, because there is a possibility that these farms remain in the future without any financial support to Croatian accession to the European Union.

Keywords: Good Agricultural Practices, Protection of Water, Nitrates, Dairy Farm

Stručni rad / Expert paper

Struktura poljoprivredne proizvodnje Brodsko - posavske županije

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Sažetak

Područje Županije Brodsko-posavske tradicionalno je poznato po značajnoj proizvodnji svih važnijih ratarskih i industrijskih kultura, premda su agroekološke prilike povoljne i za uzgoj voća, vinove loze i povrća. Izrađene studije »Bonitetno vrednovanje, zaštita i gospodarenje tlima Brodsko-posavske županije" i »Razvitak poljoprivrede na području Brodsko-posavske županije" su okosnica i vodilja suvremenog razvitka poljoprivrede Županije.

Najveći udio u obradivim površinama čine oranice i vrtovi (72%), dok u zasijanim površinama prednjače tradicionalne kulture, kukuruz i pšenica. Ipak, njihov je udio u laganom padu, a trend je povećanje površina pod pivarskim ječmom i uljanom repicom. Voćarstvo je zastupljeno sa 2.5%, a vinogradarstvo sa 1.2% u poljoprivrednim površinama Županije. Provođenjem Programa sufinanciranja voćnih sadnica i loznih cijepova, Županija Brodsko-posavska je u 2004. potaknula podizanje višegodišnjih nasada. Stočarstvo je također tradicionalna proizvodnja na području Županije, posebice govedarstvo, uzgoj muznih krava i svinjogojstvo. Tržište je prouzročilo blago opadanje udjela navedene stočarske proizvodnje, ali i rast broja peradi, ovaca i konja.

Ključne riječi: biljna proizvodnja, žitarice, govedarstvo,svinjogojstvo, gospodarstvo

Uvod

Brodsko – posavska županija je vrlo značajna i tradicionalno poznata poljoprivredna regija u Republici Hrvatskoj.

Prema popisu iz 2001. godine, 8.801 stanovnik aktivno se bavi poljoprivredom, odnosno 20.704 domaćinstva se bave poljoprivredom, od čega 15.310 obiteljskih gospodarstava ima manje od 3 ha (73.95%), 314 gospodarstava više od 20 ha (1.52%), a svega 27 poslovnih subjekata (od registriranih 109) ima površinu veću od 100 ha (24.6%).

Brodsko - posavska županija obuhvaća prostor od ukupno 2.027 km^2. Smještena je u južnom dijelu Slavonske nizine, na prostoru između planine Psunj, Požeškog i Diljskog gorja sa sjevera i rijeke Save s juga. Podrucje Županije poznato je po značajnoj proizvodnji svih važnijih ratarskih i industrijskih kultura, premda su agroekološke prilike povoljne i za uzgoj voća, vinove loze i povrća.

Prema Bogunović i sur. (2002.), izuzme li se ponešto povećan sadržaj olova, napose u tlima doline Save, tla su vrlo čista, pogodna za uzgoj povrća i drugih kultura za posebne namjene, što omogućuje proizvode visoke kakvoće.

Na podrucju Županije poljoprivredne površine iznose oko 120 000 ha (SLJH, 1999.), od čega je 75% u odjelu hidromorfnih tala, a 25% automorfnih tala.

Uvažavajući navedene činjenice, povoljne agroekološke prilike i tradiciju ovog kraja, temelj gospodarskog oporavka i razvitka treba biti suvremena i moderna poljoprivreda, koja će se bazirati na znanstvenim osnovama, ocjeni proizvodnih potencijala tala za uzgoj pojedinih biljnih vrsta, okrupnjavanju usitnjenih posjeda, te mogućim preporukama za njihov popravak.

Materijal i metode

U svrhu razvoja poljoprivrede na području Županije načinjena je studija pod naslovom: »Bonitetno vrednovanje, zaštita i gospodarenje tlima Brodsko-posavske županije" (Bogunović i sur., 2002.). Da bi analize stanja i preporuke za suvremenu poljoprivrednu proizvodnju bile upotpunjene, načinjena je i studija »Razvitak poljoprivrede na području Brodsko - posavske županije" (Bašić i sur., 2002.). Cilj studije je bio potaknuti optimalno korištenje prirodnih resursa Županije Brodsko-posavske kroz tri sustava proizvodnje: intenzivne poljoprivrede na preostalim dijelovima kombinata, održive na privatnim posjedima kojih ima više od 80%, te ekološke poljoprivrede kao perspektivne i vrlo dohodovne proizvodnje.

Analizom rezultata prikazanih u ovoj studiji te dostupnih rezultata iz Državnog zavoda za statistiku i Ureda za poljoprivredu Brodsko - posavske županije u razdoblju nakon 1999. godine, cilj je bio ukazati na trenutno stanje poljoprivredne proizvodnje Županije, te u kojoj mjeri studija ostvaruje svoj cilj.

Prema podacima Ureda za katastarsko - geodetske poslove, koji su korišteni u izradi prostornog plana Županije za 2000. godinu, prikazana je struktura zemljišta po kategorijama (tablica 1).

Tablica 1. Struktura zemljišta po kategorijama

Područje	**Obradive polj.površine**				Ukupno obradive površine	**Ostale polj. Pov.**		Ukupno poljopr. površine	Ukupno površine BPŽ
	Oranice	Voćnjaci	Vinogradi	Livade		Pašnjaci	Ribnjaci		
	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)
S.Brod	49.766	1.924	969	7.553	60.211	5.249	1.820	67.279	108.532
N.Gradiška	37.410	1.086	445	6.396	45.338	7.811	-	53.149	96.856
Ukupno BPŽ	87.176	3.009	1.415	13.949	105.549	13.060	1.820	120.429	205.388
Udjel u pov. Žup.	51.8%	1.4%	0.7%	6.7%	50.7%	6.3%	0.9%	57.8%	100%
Udjel u polj. pov.	72%	2.5%	1.2%	11.6%	87.6%	10.8%	1.5%	100%	

Izvor: prerađeno prema dokumentaciji Prostornog plana BPŽ

U Brodsko - posavskoj županiji je 120.429 ha poljoprivrednih površina od kojih su 105.549 ha obradive površine što predstavlja 87.6 % ukupnih poljoprivrednih površina.

U strukturi korištenih obradivih površina najveći udjel je oranica i vrtova sa 87.176 ha (72 %), što je posljedica prirodnih i agroekoloških uvjeta.

Za sadašnje stanje poljoprivrede u Županiji, odnosno usmjeravanje razvitka važna je činjenica kako privatni sektor posjeduje više od 80% svih poljoprivrednih površina. To će se zasigurno odraziti i na kvalitetu i kvantitetu poljoprivredne proizvodnje u cijeloj Županiji.

Rezultati i rasprava

Kada govorimo o biljnoj proizvodnji područja Brodsko-posavske županije, s pravom možemo govoriti o tradicionalnoj proizvodnji tog tipa na ovim prostorima. Zasijane površine u Županiji stalno kolebaju, što je posljednjih nekoliko godina najviše uvjetovano iskorištavanjem sustava poticaja, pa proizvođaći gotovo isključivo siju prema odobrenim mjerama i kvotama.

U strukturi zasijanih površina, pored kolebanja koja prate biljnu proizvodnju, bilježi se i pad u ukupno zasijanim površinama, tako da u odnosu na spomenuto razdoblje površine su smanjene za oko 11.000 ha. Najveći pad bilježi se u 2005.godini, jednim dijelom i zbog Programa poticanja višegodišnjih nasada koji je Županija pokrenula 2004.godine.

U 2006. godini, žitarice čine 70%, industrijsko bilje 17%, povrće 2% , te krmno bilje sa 11%. Iako je evidentan pad u ukupnim površinama pod žitaricama, zasijane površine na obiteljskim gospodarstvima su u blagom porastu, (tablica 2).

Tablica 2. Zasijane površine u Županiji 1991-2007.godine

	Godina	Ukupno	Žitarice	Ind.bilje	Povrće	Krmno bilje	Rasadnici cvijeće	Ugar
Županija OPG	1991	72.008 45.611	52.918 33.933	8.086 830	5.041 4.984	5.963 5.864	-	14.935 7.453
	1999	63.874 55.914	41.468 36.239	8.093 5.388	6.847 6.842	7.466 7.455	145 114	22.658 9.864
	2001	71.093 62.453	48.908 42.713	9.410 5.377	7.186 6.983	7.396 7.370	138 98	16.412 8.483
	2004	68.784 61.820	46.411 41.824	7.626 5.417	6.810 6.696	7.937 7.883	- 104	20.588 7.326
	2005	56.084 46.661	37.524 31.744	11.140 7.875	1.018 968	6.369 6.069	33 5	-
	2006	57.001 51.224	39.565 36.212	10.173 8.085	1.171 1.134	6.073 5.795	19 19	-

Izvor: Preračunato prema dokumentaciji DZSH

Najveću zastupljenost bilježe kukuruz i pšenica, (tablica 3). U posljednje se vrijeme, zbog preradbenih kapaciteta industrije slada u Novoj Gradišci, kao dohodovna i tehnološki vrlo primjenjiva, povećava proizvodnja pivarskog ječma, čak za 14.5%. Povećava se i dohodovnija proizvodnja industrijske kulture, uljane repice i to za 53.4% u odnosu na 1999.(tablica 3). Visina i struktura proizvodnje žita i industrijskog bilja ovisi o sustavu poticaja i udjelu Županije u odobrenim i poticanim površinama.

Tablica 3. Požnjevene površine i proizvodnja glavnih usjeva u Županiji

Godina	Pšenica			Ječam			Kukuruz		
	Požnj. pov. (ha)	Prinos (t/ha)	Proizvod. (t)	Požnj. pov. (ha)	Prinos (t/ha)	Proizv. (t)	Požnj. pov. (ha)	Prinos (t/ha)	Proizv. (t)
1997	14.266	4.2	59.369	5.118	3.4	17.625	26.361	6.4	167.831
1999	12.224	4.1	50.182	5.735	2.6	15.093	20.975	5.6	117.925
2001	15.692	4.1	64.104	6.257	3.0	18.802	24.615	5.7	142.063
2006	11.908	4.0	48.362	6.237	3.0	19.528	17.619	6.7	118.537
2007	10.422	4.8	48.367	6.565	4.1	26.692	16.667	4.6	76.834

Godina	Šećerna repa			Uljana repica			Suncokret		
	Požnj. pov. (ha)	Prinos (t/ha)	Proizvod. (t)	Požnj. pov. (ha)	Prinos (t/ha)	Proizv. (t)	Požnj. pov. (ha)	Prinos (t/ha)	Proizv. (t)
1997	2.046	40.8	83.461	287	2.9	842	1.324	2.2	2.913
1999	1.852	41.1	76.128	972	2.2	2.151	2.219	1.8	4.102
2001	1.615	44.6	71.949	1.146	2.7	3.092	1.622	1.8	2.855
2006	1.965	42.0	82.578	862	2.4	2.120	1.773	2.2	3.825
2007	1.241	43.6	54.090	1.491	3.0	4.464	895	2.6	2.310

Izvor: Preračunato prema dokumentaciji DZSH

U proizvodnji voća najveću zastupljenost imaju šljiva i jabuka. Proizvodnja šljiva je ustrojena u obiteljskim gospodarstvima i bilježi blagi pad, a rezultati proizvodnje ukazuju da je nužno pristupiti uvođenju u proizvodnju novih produktivnijih sorti, racionalnijih i suvremenijih tehnologija (tablica 4). Proizvodnja jabuke je u značajnom porastu za 54%.Evidentirana je i proizvodnja kruške, marelice i trešnje, ali je proizvodnja zanemariva i uglavnom na obiteljskim gospodarstvima. Vinogradarstvo bilježi najveći pad.

Tablica 4. Proizvodnja važnijih vrsta voća i vinove loze u 1997., 2000. i 2006. godini

Vrsta		1997.		2000.		2006.	
		Ukupno	OPG	Ukupno	OPG	Ukupno	OPG
Šljiva	Broj stabala	464.203	464.203	469.025	469.203	429.958	429.958
	Prinos/ stablu(kg)	-	-	8.2	8.2	11.80	11.80
	Proizvodnja (t)	4.624	4.624	3.835	3.835	5.075	5.075
Jabuka	Broj stabala	194.592	194.592	208.386	126.806	321.408	191.382
	Prinos/ stablu(kg)	-	-	19.5	18.3	24.76	25.0
	Proizvodnja (t)	3.031	3.031	4.058	2.317	7.958	4.785
V. loza	Broj trsova(tisuća)	4.626	4.327	4.444	4.145	1.323	1.150
	Prinos /trsu(kg)	-	-	1.10	1.10	1.3	1.2
	Proizvodnja (t)	7.462	6.993	4.909	4.546	1.716	1.380

Izvor: Preračunato prema dokumentaciji DZSH

Brodsko-posavska županija je 2004. godine pokrenula Projekt sufinanciranja nabave voćnih sadnica i loznih cijepova u cilju povećanja podizanja novih dugogodišnjih nasada vinograda i voćnjaka. Prema podacima Izvješća o stanju u poljoprivredi na području Brodsko-posavske županije (2009.), u vremenu od 2004.-2009. godine na području Brodsko-posavske županije podignuto je novih 586,43 ha višegodišnjih nasada.

Proizvodnja povrća uglavnom je organizirana na obiteljskim gospodarstvima, najviše u blizini gradova, te se glavnina proizvoda plasira na tržnicu. Proizvodnja povrća za preradu ne postoji, pa prerađivački kapaciteti Hladnjaće u Brodu i Sušionice povrća u Vrpolju, nisu iskorišteni.

Iz navedenih podataka, do 2001. godine vidljiv je porast površina povrća, što je pozitivno jer se radi o dohodovnijim kulturama kojima se na manjim, usitnjenim posjedima, može ostvariti bolji dobitak. Međutim, statistički podaci nakon 2004. godine su poražavajući, ne samo u Županiji nego i na nivou cijele Hrvatske, gdje se bilježi jaki pad.

Tablica 5. Proizvodnja, površina i prinosi povrća 1997.,2001. i 2005.

Godina		Krumpir			Rajčica			Grah		
		Rodna pov. (ha)	Prinos (t/ha)	Proizvod. (t)	Rodna pov. (ha)	Prinos (t/ha)	Proizv. (t)	Rodna. pov. (ha)	Prinos (t/ha)	Proizv. (t)
Hrvatska	1997	-	-	618.032	5.141	9.4	48.085	-	-	9.973
	2001	65.641	10.2	670.233	6.801	10.9	73.882	6.470	1.3	16.542
	2005	18.903	14.4	273.409	1.192	24.3	28.930	1.774	1.8	6.041
Županija	1997	-	-	25.661	447	9.3	4.145	-	-	1.167
	2001	2.038	10.9	22.287	512	11.0	5.634	552	1.5	1.129
	2005	632	15.2	9.616	49	24.7	1.212	96	3.0	422

Izvor: Preračunato prema dokumentaciji DZSH

Tablica 6. Stanje stočnog fonda Brodsko-posavske županije

Struktura	1997.	2003.	2006.	2007.	2008.
Ukupno broj goveda	19.025	16.921	20.844	18.978	16.416
- krave i steone junice	12.066	10.687	12.178	11.771	9.412
- muzne krave	9.987	7.872	9.531	9.407	7.004
- namuzeno mlijeko (u 000l)	26.625	29.360	34.642	34.557	16.770
Ukupno broj svinja	90.314	114.079	124.415	117.378	104.300
- krmače i suprasne nazimice	15.408	14.467	11.400	9.575	9.758
Ukupno broj ovaca	4.250	13.903	11.382	11.637	14.444
Ukupno broj koza	-		2.931	3.768	3.036
Ukupno broj konja	897	441	452	711	841
Ukupno perad	355.336	568.847	543.510	592.928	609.868
- kokoši i nesilice	214.000	406.804	351.263	369.190	293.600
- proizvodnja jaja (000 kom.)	33.290	52.268	54.252	46.707	40.570

Izvor: Preračunato prema dokumentaciji DZSH

Brodsko - posavska županija tradicionalno je stočarski kraj, pa do 2006.godine bilježimo porast u gotovo svim granama stočarstva. U 2007. i 2008. godini taj trend se nastavlja u broju peradi, pa bilježimo porast od 66.358 komada ili 12%, broju konja za čak 389 ili 86%, te broju ovaca za 3.062 ili 27%. Evidentirani pad u govedarstvu (27%) i svinjogojstvu (14%), odraz je stanja tržišta tim proizvodima (tablica 6).

Zaključak

Brodsko – posavska županija je tradicionalno poljoprivredni kraj, uglavnom pogodan za sve oblike biljne proizvodnje uz određene agromelioracijske korekcije. Poljoprivredna proizvodnja se odvija većim dijelom na usitnjenim obiteljskim gospodarstvima. Važno je istaknuti da je samo 4% educiranog poljoprivrednog stanovništva, dok preostali dio čine poljoprivrednici sa praktičnim iskustvom. Iako su izrađene studije trebale biti vodilje i oslonac za suvremenu poljoprivrednu proizvodnju Županije, pokrenuti projekti, poticaji i naknade od strane Županije, nisu u potpunosti polučili očekivane rezultate. Kolebanja u poljoprivrednoj proizvodnji, smanjenje zasijanih površina, broja grla goveda i svinja, rezultat su pretjeranog uvoza poljoprivrednih proizvoda, kalkuliranja oko poticajnih mjera i naknada, ekonomske krize i drugih razloga. Iz svih tih razloga postoji opravdanje za postojanje Poljoprivredno savjetodavne službe i Hrvatske poljoprivredne agencije koje će kontinuirano raditi na terenu, educirati i podizati nivo poljoprivredne proizvodnje koja zasigurno ima osnovu da bude vodeća grana gospodarskog razvitka Županije i regije.

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Abstract

Structure of agricultural production in Brod- posavina county

Brodsko – posavska County area is traditionally known for it's significant production of all important agricultural and industrial products, even though agro-ecological conditions are favorable for growing fruits, grapevine and vegetables. Studies undertaken » Ground classification, protection and management in Brod-posavina county" and » Agricultural development of Brod-posavina county" are base and guide of modern agricultural development in county. The largest part of arable land are planes and gardens (72%), while among sown area lead traditional cultures, corn and wheat. However, their apart is slowly decreasing, while trend is in increasing surface under the brewer barley and oilseed rape. In the agricultural areas of the county fruit production is present by 2.5% and viticulture by 1.2%. By implementation of co-financing fruit seedlings and vine grafts program in 2004, county has encouraged lifting up perennial plantation. Cattle breeding is also traditional for the county area production, especially cattle, breeding dairy cows and pig husbandry. Market caused slow decrease share in listed livestock production, but also increasing number of poultry, ships and horses.

Key words: cattle, cereals, crop production, pig husbandry, economy

Izvorni znanstveni rad / Original scientific paper

Održivost upotrebe postrnih zaštitnih usjeva u ekološkoj proizvodnji kukuruza kokičara

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Sažetak

Upotreba postrnih usjeva u ekološkoj/organskoj poljoprivredi je priznata metoda za održavanje ugorenosti tla, zaštite tla protiv vremenskih neprilika, konzervacije hraniva u tlu te čak i borbe protiv korova. Konzervacija dušika od prethodnog leguminoznog usjeva je čak važnija funkcija, posebice u ekološkoj poljoprivredi gdje je upotreba mineralnih dušičnih gnojiva izrijekom zabranjena, te postrni usjevi mogu poslužiti za čuvanje dušika od ispiranja iz tla za sljedeći usjev u plodoredu s visokim zahtjevima za dušikom. Nažalost, izbor postrnih usjeva nije dostatno istražen, posebice za agroekološke uvjete u Hrvatskoj. Stoga je postavljen pokus u Valpovu, Republika Hrvatska, na eutričnom smeđem tlu, tijekom 2007/2008. godine, s ciljem da se istraže učinci različitih postrnih usjeva i njihovih kombinacija na komponente prinosa i prinos kukuruza (*Zea mais L. everta*) u ekološkoj (organskoj) poljoprivredi, a u plodoredu iza predusjeva soje (*Glycine max L.*). Pokus je postavljen kao potpuno slučajan blok raspored u četiri repeticije, sa dvanaest tretmana postrnih usjeva: N – kontrola, bez postrnih usjeva; W – ozima pšenica (*Triticum aestivum*); R – ozima raž (*Secale cereale*); F – facelija (*Phacelia tanacetifolia*); P – stočni grašak (*Pisum arvense*); V – ozima grahorica (*Vicia vilosa*); te tretmani mješavina postrnih usjeva WP, WV, RP, RV, FP i FV. U ovom pokusu najboljim su se pokazali tretmani P, FV i RP, koji su, u odnosu na kontrolni tretman bez postrno-pokrovnih usjeva, imali i viši prinos kukuruza kokičara i višu relativnu dobit.

Ključne riječi: ekološki kukuruz kokičar, postrni usjevi, žitarice, leguminoze, facelija

Uvod

Uporaba postrnih zaštitnih usjeva znan je način poljoprivredne proizvodnje za poboljšanje kvalitete i održavanje plodnosti tla (De Bruin i sur., 2005; Stipešević i sur., 2005), zaštite tla od degradacije okolišnim čimbenicima, čuvanja hranjivih tvari i akumulacije i konzervacije vode u tlu (Karlen i Doran, 1991). Uz pomoć postrnih zaštitnih usjeva poboljšava se biomasa mikro-

organizama u tlu (Motta i sur., 2007.), pa se čak i vrši borba protiv korova (Alsaadawi , 2001; Williams i sur., 1998;. Reddy, 2001; Reddy i Koger, 2004). Dobijanje dušika iz leguminoznih zaštitnih usjeva je njihova napose važna funkcija (Kessavalou i Walters, 1997), posebice u ekološkoj poljoprivredi gdje je upotreba mineralnih N-gnojiva strogo zabranjena. Također, postrni zaštitni usjevi mogu se koristiti u plodoredu kao usjevi za dodatnu akumulaciju hraniva prije usjeva s visokim zahtjevom za dušik (Kessavalou i Walters, 1999; Pietsch i sur., 2002.). Pravilni izbor postrnih zaštitnih usjeva, međutim, nedovoljno je istražen, posebice u hrvatskim agroklimatološkim uvjetima, što čak više vrijedi za organsku poljoprivredu, koja je definirana kao kompleksan sustav (Brumfield i sur., 2000) gdje se mogu postići bolji urodi nakon više godina u ekološkom upravljanju bilinogojstvom (Lockeretz i sur., 1981). Nekoliko istraživanja (Liebhardt i sur., 1989; MacRae i sur., 1990) je pokazalo da se u prijelaznom periodu iz konvencionalne u ekološku (organsku) poljoprivredu ostvaruju niži urodi, nakon kojih se mogu očekivati visine prinosa ravne onima u konvencionalnom bilinogojstvu. Stoga, glavni cilj ovog istraživanja bio je utvrditi najprikladniju kombinaciju postrnih zaštitnih usjeva za za prevladavanje problema vezanih uz prijelazno razdoblje, te ekonomsku održivost upotrebe postrnih zaštitnih usjeva u ekološkom (organskom) uzgoju kukuruza kokičara.

Materijal i metode

Pokus s zaštitnim usjevima postavljen je blizu Valpova, na smeđem eutričnom kambisolu, tijekom 2007. godine. Glavni cilj ovog pokusa bio je istražiti učinke primjene različitih pokrovnih usjeva i njihovih smjesa na prinos ekološki uzgajanog kukuruza kokičara (*Zea mays L. everta Stuart.*) u 2008. godini, te istražiti održivost uporabe istih. Pokus je postavljen kao kompletno randomizirani blok dizajn u četiri repeticije, s veličinom osnovne pokusne parcelice od 5 x 30 m^2. Ukupno je korišteno dvanaest tretmana postrno-pokrovnih usjeva: N – kontrola, bez pokrovnih usjeva; W – ozima pšenica (*Triticum aestivum L.*) kao pokrovni usjev, gdje je korišten kultivar »Žitarka«, kreacija Poljoprivrednog instituta Osijek, s ciljanom gustoćom sklopa od 700 biljaka po m^2 sjetvenoj normi od 300 kg ha^{-1}; R – ozima raž (*Secale cereale L.*) kao pokrovni usjev, kultivar »Eho Kurz«, nabavljen od sjemenskog proizvođača RWA, s ciljanom gustoćom sklopa od 400 biljaka po m^2 i sjetvenom normom od 150 kg ha^{-1}; P– stočni grašak (*Pisum arvense L.*) kao pokrovni usjev, kultivar »Osječki zeleni" Poljoprivrednog instituta Osijek, s ciljanim sklopom od 100 biljaka po m^2 i normom sjetve od 125 kg ha^{-1}; V - ozima grahorica (*Vicia vilosa L.*) kao pokrovni usjev, kultivar »Poppelsdorf«, nabavljen od proizvođača Semenarna Zagreb, s ciljanom gustoćom sklopa od 250 biljaka po m^2 i sjetvenom normom od 120 kg ha^{-1}; F – facelija (*Phacelia tanacetifolia L.*), kultivar »Balo«, nabavljen od sjemenskog proizvođača Semenarna Zagreb, s ciljanom gustoćom sklopa od 500 biljaka po m^2 i sjetvenom normom od 10 kg ha^{-1}; WP – smjesa ozime pšenice (W) i stočnog graška (P), sijanih u omjeru 50%:50% od prije navedenih normi sjetve za svaki usjev posebno; RP – smjesa ozime raži (R) i stočnog graška (P), također sijanih u omjeru 50%:50% u odnosu na originalne sjetvene norme svakog od usjeva posebno; WV – smjesa ozime pšenice (W) i ozime grahorice (HV), sijanih u omjeru 50%:50% od prije navedenih normi sjetve za svaki usjev posebno; RV – smjesa ozime raži (R) i ozime grahorice (V), također sijanih u omjeru 50%:50% u odnosu na originalne sjetvene norme svakog od usjeva posebno; FP – smjesa facelije (F) i stočnog graška (P), sijanih u omjeru 50%:50% od prije navedenih normi sjetve za svaki usjev posebno; FV – smjesa facelije (F) i ozime grahorice (V), također sijanih u omjeru 50%:50% u odnosu na originalne sjetvene norme svakog od usjeva posebno. Svi zaštitni usjevi bili su usijavani »omaške«, tj. rasipanjem po pokusnoj površini u netom požnjevene ostatke soje zatanjurane u tlo jednim prolazom teške tanjurače tipa »Tara«, krajem listopada. Prinos kukuruza kokičara utvrđen je nakon ručne berbe, runjenja i

utvrđivanja vlage zrna putem automatskog vlagomjera (Dickey John GAC 2100), te preračunat na 14% vlage zrna. Statistička obrada rezultata provedena je putem analize varijance (ANOVA) osnovnog dizajna pokusa. Za statističku obradu korišten je statistički paket SAS (V 8.02, SAS Institute, Cary, NC, USA, 1999.), a za usporedbu srednjih vrijednosti izračunate su najmanje signifikantne razlike za statističku značajnost P = 0.05 ($LSD_{0,05}$), te u skladu s Fisher-ovom zaštitom značajnosti signifikantnih razlika.

Rezultati istraživanja s raspravom

Prosječni prinos za kontrolnu repeticiju »nula« bio je 1576 kg ha^{-1} (tablica 1), usporedno s tim kukuruz je imao najveći prinos kad je za postrno – pokrovni usjev imao smjesu facelije i ozime grahorice (FV, 2201 kg ha^{-1}) ili samo stočni grašak (P, 2164 kg ha^{-1}). Relativno zadovoljavajući rezultati prinosa su ostvareni i kod slijedećih postrno – pokrovnih usjeva: ozime grahorice (V, 1979 kg ha^{-1}), smjese ozime raži i stočnog graška (RP, 1816 kg ha^{-1}) te smjese ozime pšenice i ozime grahorice (WV, 1807 kg ha^{-1}). Najlošije prinos kukuruz je ostvario kada je za postrno – pokrovni usjevi imao smjesu ozime raži i ozime grahorice (RV) 1013 kg ha^{-1}) ili samo ozime raži (R, 1450 kg ha^{-1})

Tablica 1. Ekonomski prikaz troškova sjemenske robe i relativne dobiti

Trt	Prinos kukuruza (kg ha^{-1})	Ostvarivi prihod (kn ha^{-1})	Troškovi sjemenske robe (kn ha^{-1})	Relativna dobit (kn ha^{-1})
N	1576 c[†]	7094 c	-1172 f	5922 e
W	1763 d	7935 d	-1172 -915 cd	5848 e
R	1450 b	6523 b	-1172 -549 e	4802 cd
F	1799 de	8095 de	-1172 -1042 c	5880 e
P	2164 g	9739 g	-1172 -1098 c	7468 g
V	1979 f	8904 f	-1172 -3542 a	4188 b
WP	1650 c	7423 c	-1172 -457 -549 cd	5244 d
WV	1807 de	8131 de	-1172 -457 -1771 b	4730 c
RP	1816 e	8171 e	-1172 -549 -274 de	6175 ef
RV	1013 a	4561 a	-1172 -274 -1771 b	1342 a
FP	1572 c	7074 c	-1172 -521 -549 c	4831 cd
FV	2201 g	9905 g	-1172 -1771 -521 b	6441 f
$LSD_{0,05}$	99	495	497	501

[†]vrijednosti u koloni označene istim slovom se statistički ne razlikuju na razini signifikantnosti P<0,05

Najjednostaviji izračun održivosti postrno – pokrovnih usjeva u ekološkoj proizvodnji kukuruza kokičara jest usporedba relativne dobiti tretmana, koja je razlika ostvarivog prihoda pri prodaji uroda kukuruza kokičara i cijene koštanja ulaganja u sjemensku robu (glavni usjev i postrni zaštitni usjevi). U kontrolnom (N) tretmanu, bez postrno-zaštitnog usjeva, tako je za jedini trošak uzeta cijena sjemena kukuruza kokičara (1172 kn ha^{-1}), dok su svi drugi tretmani imali usto i trošak upotrebljenih postrno-zaštitnih usjeva. Kako se cijena kukuruza kokičara kreće oko 4,5

kn kg^{-1}, ostvarivi prihod jest umnožak prinosa kukuruza i ove cijene. Relativna dobit, kao razlika između troškova sjemena i ostvarivog prihoda, pokazuje da je kontrolni tretman ostvario 5922 kn ha^{-1}. Najboljim postrno – pokrovnim usjevom, kako po urodu tako i po ostvarenoj relativnoj dobiti, pokazali su se tretmani sa stočnim graškom (P) i smjesom facelije i grahorice (FV). Kod ova dva tretmana ostvaren je prinos kukuruza jednak ili viši od kontrole, kao i relativna dobit od 6441 kn ha^{-1} za tretman FV, te čak 7468 kn ha^{-1} za tretman P. Zanimljivo je istaći i tretman smjese raži i graška (RP) koji je, unatoč nešto nižem prinosu, jedini još imao višu relativnu dobit od kontrolnog tretmana N.

Najslabiji tretman postrno – pokrovnih usjeva bila je smjesa raži i ozime grahorice (RV). Ovaj tretman je ostvario daleko najmanji prinos od 1013,47 kg/ha, što daje, uz tržišnu cijenu kukuruza kokičara od 4,5 kn/kg, ostvarivi prihod od svega 4560,62 kn. Relativna dobit ostvarena urodom kukuruza kokičara ovim tretmanom dala je vrlo niskih 1342,42 kn ha^{-1}, što je bilo za čak 4580 kn ha^{-1} niže od kontrolnog usjeva.

Zaključak

Sjetva postrnih-pokrovnih usjeva je znana metoda unaprijeđivanja poljoprivredne proizvodnje usjeva kroz podizanje kvalitete tla i održavanja ugorenosti tala, zaštite tla od oštećenja vremenskim nepogodama, podizanja razine hraniva u tlu, te akumulacije i konzervacije vlage tla, poboljšanja mase i aktivnosti mikroorganizama tla, te čak i suzbijanja korova.

Ovim pokusom dokazano je da sjetva postrno – pokrovnih usjeva također utječe i na visinu prinosa u ekološkoj proizvodnji kukuruza kokičara, ali da također utječe i na visinu troškova i da visina prinosa na kraju ne mora biti presudna kod ekonomske isplativosti.

Ključ održivosti i ekonomske isplativosti postrno – pokrovnih usjeva je u pravilnom odbariru postrnog usjeva. Pravilnim odabirom postrno – pokrovnih usjeva može se znatno povećati visina prinosa kukuruza. U ovom pokusu najboljim su se postrno-pokrovnim usjevima pokazali tretman stočnog graška, te smjese facelija + ozima grahorica i raž + stočni grašak, koji su, u odnosu na kontrolni tretman bez postrno-pokrovnih usjeva, imali i viši prinos kukuruza kokičara i višu relativnu dobit.

Napomena

Ovaj rad je nastao na temelju diplomskog rada studenta Marka Grgoševića, apsolventa Poljoprivrednog fakulteta u Osijeku. Korišteni podatci dio su istraživanja zProjekta »Postrni usjevi u ekološkom ratarenju«, financiranog od strane Ministarstva znanosti, obrazovanja i sporta Republike Hrvatske, te rezultat bilaterala Republike Hrvatske i Republike Mađarske, te Republike Hrvatske i Republike Srbije.

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Abstract

Sustainability of cover crop use in pop-corn maize organic farming

The cover crop use in organic agriculture is a known method of maintaining the soil tilth, soil protection against environmental deterioration, soil nutrients conservation and even the weed control. The nitrogen conservation from previous leguminose crop is even more important, especially in the organic agriculture where use of N-fertilizers is the strictly forbiden, and cover crops can be used as a catch crops for nutrients in rotation prior to the crops with the high N requirement. The choice of the proper cover crop has, however, been insufficiently investigated, especially for agri-environmental conditions of the Panonian agricultural area in Croatia. The cover crop experiment was established in Valpovo, Croatia, in the eutric brown soil type, during the years 2007/2008. The aim of the experiment was to investigate the effects of different cover crops and their combinations on maize (Zea mais L.) yield and yield components in organic agriculture after soybean (Glycine max L.) in crop rotation. The experimental design was set up as a CRBD in four repetitions, with soybean as a previous crop in crop rotation. The twelve cover crop treatments were: N – Control, without cover crop; W – winter wheat (*Triticum aestivum*); R – rye (*Secale cereale*); P – fodder pea (*Pisum arvense*); V - hairy vetch (*Vicia vilosa*); F - phacelia (*Phacelia tanacetifolia*); and cover crop mixtures WP, WV, RP, RV, FP and FV. In this trial the best treatments of cover crops proved to be treatments P, PV and RP, which, compared to control treatment without cover crop, recorded a higher yield of popcorn maize and a higher relative income.

Key words: organic pop-corn maize, cover crops, cereals, legumes, phacelia

Pregledni rad / Review paper

Prikaz osnovne etologije konja u prirodnim i kontroliranim uvjetima

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Sažetak

S obzirom da je prošlo 5.000 godina od pripitomljavanja konja on još uvijek nije izgubio potrebe za kretanjem koje je stekao kao životinja plijena otvorenih stepa. Cilj rada bio je prikazati manifestiranje prirodne etologije (ponašanja) konja u kontroliranim uvjetima uzgoja. Konji za preživljavanje u prvom redu trebaju hranu i vodu, ali zahtijevaju i socijalni kontakt, kretanje, svjetlo i svježi zrak. Smještaj treba konju osigurati udobnost i opušteno ponašanje koji pored fizičkog osigurava i psihičko zdravlje.

Ključne riječi: etologija, konj, aktivnost, kontrolirani uvjeti.

Uvod

Svako živo biće u tijeku evolucije savršeno se prilagodilo na svoje prirodno stanište, ne samo u pogledu morfologije i fiziologije nego i u etologiji. Prilagodba je imala za rezultat da određeni okolišni uvjeti moraju biti zadovoljeni prije nego što konj može razviti svoje urođene obrasce ponašanja. Konj ima prirodnu potrebu za kretanjem, prostorom, prirodnom svjetlošću, zrakom i slično. Divlji konj prima slušne, njušne i vidne podražaje iz svog staništa i sam sudjeluje u njemu. U svakom trenutku imaju kontakt o onome što se dešava ispred, iza i/ili pokraj njega. Nesmetano se može češkati po drveću i valjati po pijesku, blatu ili slično (Bachmann, 1998.). Cilj rada bio je prikazati »urođene obrasce« etologije (ponašanja) konja u suvremenim kontroliranim uvjetima uzgoja.

Pokazatelji potrebe za krdom

Život u staji pruža konju osjećaj sigurnosti, kontakt s drugim konjima što je potreba svakog grla. Igra, a posebice međusobna njega (međusobno češkanje zubima) predstavljaju društvenu funkciju i jačaju koheziju krda gdje je suživot reguliran strogom hijerarhijom. Uključivanje novog konja u krdo dovodi do novog poretka u hijerarhiji (Hoffmann, 2008.). Odnos između pripadnika krda mora se neprestano održavati i produbljivati kroz međusobne socijalne kontakte, primjerice kroz njegu kože kao što je međusobno grickanje područja grebena i leđa te mirnog stajanja jednog konja pored drugog i sl. (Bachmann, 1998.). Socijalni kontakt sa pripad-

nicima iste vrste pridonosi razvoju ravnoteže psihičkog stanja konja i njegovu motivaciju u radu (Henning, 2004.). Držanje jednog konja bez društvenog partnera nije u skladu s potrebnim uvjetima uzgoja, stoga je uzgoj u krdu prikladan za njihov nesmetan psiho-sociološki razvoj. Nedostatak društva može se generirati kroz probleme u radu i poremećajem u ponašanju. Minimalno što se mora osigurati za individualni uzgoj konja je mirisni, vizualni i slušni kontakt s drugim životinjama. Kontakti među konjima su vrlo često minimalni, usprkos tome što se drže u istoj staji. Boksovi su vrlo često zatvoreni željeznim šipkama, tako da ne postoji mogućnost kontakta susjednih konja. Stoga vrlo često konji nemaju mogućnost postavke »rang liste« krda, kao ni uspostave komunikacija sa susjednim konjem. Ovakav način uzgoja ne pruža mogućnost učenja od starijih, svojih vršnjaka i mlađih konja, te ujedno ne stječe pravilno ponašanje konja. Takav konj neće znati primjereno reagirati na signale i upozorenja pripadnika iste vrste te primjerice nepostojanje odgovora ili krivi signal drugom konju može dovesti do opasnih ugriza i/ili udaraca (Bachmann, 1998.).

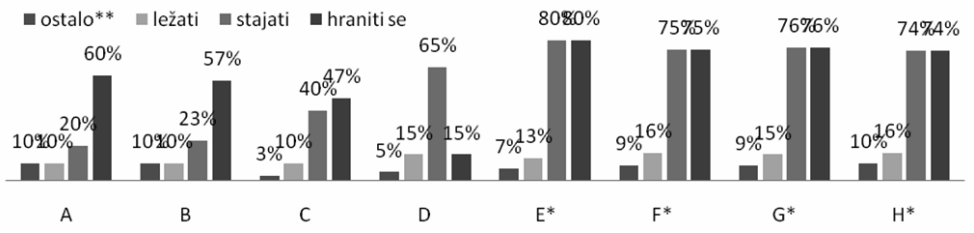
Etološki pokazatelji ugode i odmora konja

Karakteristike ugode konja mogu se promatrati kroz aktivnosti koje pojedina životinja može obaviti sama, primjerice čišćenje kože i dlake zubima, valjanje i/ili trljanje. Druga područja aktivnosti se iskazuju unutar krda, primjerice međusobno čišćenje dlake, tjeranje insekata. Bez obzira na način držanja konja dnevno valjanje je jedna od najosnovnijih radnji kojom iskazuju svoje zadovoljstvo i njeguju dlaku, preferirajući pješčanu, suhu i prašnjavu podlogu. Frekvencija valjanja ne ovisi o njezi konja i godišnjem dobu. Dobro njegovan konj držan u staji iskazuje tu ugodnu radnju toliko često kao i konj držan na otvorenom (Schäfer, 1991.). Za dobrobit konja nezamjenjiva je njega od strane čovjeka kada čovjek postaje dio krda, a time daje mogućnost konju za uspostavu novog sociološkog kontakta. Za konje koji slobodno žive u prirodi vrijedi fraza da najviše vremena provode odmarajući. U odraslih konja to je otprilike od pet do devet sati dnevno (Hoffmann, 2008.). Domesticirani konj 19 ¼ sata je budan i živahan, dva sata je trom i umoran, dva sata je u laganom i ¾ sata u dubokom snu. Konji miruju i spavaju neprestano u razmacima po minutu ili najduže jedan do dva sata. Konji odmaraju u stajanju i ležanju, pri čemu razlikujemo tri intenziteta: najlakši nivo odmora je drijemanje, konj stoji sa potpuno opuštenom glavom. Konji u stajanju mogu drijemati ili zaspati na minutu, pri čemu težinu tijela često oslanjaju na tri noge. Naizmjenično jednu od zadnjih nogu oslanja samo na prednji nokatni dio kopita te pri tome opušta bedrene mišiće i odmara zadnje noge. Drijemanje je glavni oblik regeneracije odmora odraslih Equida. Sljedeći nivo intenziteta odmora je spavanje. Pri tome se konji postavljaju u pravilnu poziciju ležanja, na prekriženim nogama leži prsima i stražnjem dijelu trupa. Položaj glave ovisi o mirovanju ili spavanju, pri čemu može biti držana muskulaturom vrata ili poduprta njuškom na noge ili pod. Kod spavanja san je puno jači nego kod drijemanja, ali odrasle životinje mogu se poprilično lako probuditi i dići iz ove pozicije. U dubokom snu životinja leži bočno, istegnutih nogu i glave položene obrazom na tlo. U tako potpuno opuštenom položaju provede 10% ciklusa dan-noć. U dubokom snu se više ne percipiraju senzualni utjecaji okoline, buđenje je postupno i u fazama. Obično dubok san nikada ne traje dulje od jednog do dva sata noću i između ponoći i izlaska sunca (Geiser, 2001.). Glavni čimbenici koji utječu na osobine ležanja su doba dana, namjena i način držanja konja. Studija o etologiji u ovisnosti o sistemu držanja pokazuje da konji leže: u boksu (53,9 min.), standardnom držanju (44,6 min.), u padoku (27,3 min.), u lauf staji (21,7 min.) i na livadi (3,0 min.) (Hoffmann, 2008.).

Važnost i udio pojedinih aktivnosti kod konja

U svijetu konja gotovo svaka aktivnost povezana je s kretanjem. Nekoliko minuta nakon ždrijebljenja zdravo ždrijebe je na nogama te traži vime majke. U divljini konji pasu do 16 sati dnevno, lagano se kreću prema naprijed i u bijegu postižu kratkoročnu brzinu galopa od 65 km/h (Geiser, 2001.). Kretnje su potrebne za: pravilan razvoj mišićno skeletnog sustava, samo čišćenje dišnih puteva, tijek metabolizma, cirkulaciju, psihološki razvoj, izbjegavanje preduhitrenih aktivnosti i razvoj tipičnih kretnji. Drugi oblik kretanja konja predstavlja igra koja se može promatrati kod mladih i starijih konja. Radi se o bez-ciljnoj kretnji koja je u stvari refleks te siguran znak dobrobiti životinje. Velika važnost kretnji u koraku, kasu i/ili galopu je kod društvenih sukoba unutar krda, igri, predvođenja i naravno bijega (Bachmann, 1998.).

Konji u prirodi se hrane oko 16 sata dnevno. Pri svakom zagrizu pokrenu se jedan do dva koraka unaprijed, tako mijenjaju položaj u prosjeku svakih 12 sekundi. Između odlaze na pojilište i piju poveće količine svježe vode (Rieder i sur., 2006.). Ispašom od 12 do 16 sati konj zadovoljava oko 60% dnevnih aktivnosti i pored stajanja predstavlja dominantnu aktivnost u etologiji konja. Istodobno se hranidbom ostvaruje najveći postotak kretnji, a ostalo su 3 do 16% kretnje koje se izvode u druge svrhe. Krdo prezewalski konja u jednom danu u prosjeku 46% (11 h) hrani se, 34% (8,2 h) stoji, 7,4% (1,8 h) je u pokretu i 5,3% (1,3 h) leži (Boyd i sur., 1988.). Iz grafikona 1. može se jasno vidjeti činjenica da se razlikuju u etologiji konja koji se uzgajaju u francuskoj pokrajini camargue u prirodnim uvjetima od onih u samostalnim boksovima u staji. Velika odstupanja vidljiva su u kretanju i hranidbi konja. Dnevno kretanje modernog konja svodi se u prosjeku jedan sat pod sedlom u zatvorenoj prašnjavoj jahaoni.



*zajednički prikaz stajanja i hranidbe; **skakanje, opiranje, udaranje, češkanje, uriniranje i slično.

Grafikon 1. Etologija konja ovisno o sistemu držanja. (A) Camargue konja unutar jedne godine; (B) Osam konja, smještenih u ispustu s hranidbom po volji sijenom i slamom; (C) Tri konja, smještenih u samostalne boksove, s hranidbom po volji sijenom i slamom, te s mogućnošću međusobnih kontakata njuhom, vidom i dodirom; (D) Konji u staji sa samostalnim boksovima bez mogućnosti međusobnih kontakata i obročnom hranidbom; (E*) Konja u samostalnom boksu i ispustu bez dodatnih mogućnosti kretanja; (F*) Konja u grupnom sistemu bez mogućnosti dodatnih kretnji; (G*) Konji s dodatnim kretnjama u šetalici; (H*) Konji s dodatnim kretnjama na pašnjaku (Duncan, 1980., Kiley-Worthington, 1990., Hoffmann, 2008., Rose-Meierhöfer i sur., 2010.).

Dnevna ruta kretanja konja

Pod prirodnim uvjetima konj na ispaši kreće se laganim korakom i pri tome prođe oko 8 km (Marten, 1996.). Ovisno o stanju vegetacije konji koji se drže u divljini udaljavaju se od pojilišta 20 do 30 km. U dobrim uvjetima ispaše radijus kretanja je manji, ali konj onda postaje izbirljiviji, znatiželjniji i kreće se više (Bender, 1999., Rose-Meierhöfer i sur., 2010.). Putanje

i rute kretanja divljih konja ovise prvenstveno o ekološkim uvjetima terena. Prema Geiseru (2001.) divlji konji u stepama Sjeverne Amerike dnevno prijeđu do 16 km (od pašnjaka od pojilišta), dok Henning (2004.) piše da divlji konj dnevno prođe do 20 km. Istraživanja na new forest ponijima, camargue i mustang konjima došlo se do dnevne rute kretanja od 6 do 11 km. Napomenuli su također da bi pod istim uvjetima pasmine konja koje vole kretanje (arapski i engleski punokrvnjak) prošle dužu rutu kretanja. Schäfer (1991.) potvrđuje rutu kretanja od 6 km kod camargue konja, a od 7 do 10 km kod poludivljeg new forest ponija. Praćenjem divljih fjordskih konja na oko 25 hektara prirodnog skandinavskog pašnjaka utvrđeno je vremensko razdoblje hranidbe od 11 do 16 sati uz rutu od 4 do 7 km (Bender, 1999.). Frentzen (1994.) istraživao je dvije grupe haflingera. Jedna grupa bila je držana na pašnjaku te je unutar 24 sata prešla 8,4 km. Druga grupa bila je neprestano hranjena u razdoblju od 24 sata i prešla je 4,8 km. Konji svoje kretnje rasporede kroz čitav dan. Konje u konjičkim klubovima: privatni konji dnevno su u pokretu 41 minutu i prolaze 4,9 km, konji za školu jahanja dnevno prođu od 9,9 km u 84 minute (Rodewald, 1989.). Konji držani na ovakav način prođu veću udaljenost, ali u relativno kratkom vremenskom razdoblju. Konji se puno brže kreću, sistem pruža kretanje, ali ne u skladu s njegovim fiziološkim potrebama.

Motoričke aktivnosti u ovisnosti od radnji u sistemu držanja

Rehm (1981.) istraživao je efekte različitih sistema držanja na motoričke aktivnosti konja. Promatrao je pet konja u tri sistema držanja (na vezu, samostalni boks i grupni boks). Konji na vezu i u samostalnom boksu dnevno su boravili dva sata u padoku, a konji iz grupnog boksa sedam sati u padoku bez mogućnosti ulaska u staju. Konji su na svoje motoričke aktivnosti bili promatrani prva dva sata od dolaska u padoku. Rezultat promatranja bio je pojačano kretanje u padoku onih konja koji su u staji bili ograničeni kretanjem. U kratkom vremenskom razdoblju od premještanja u novi sistem držanja uočena je promjena kod svakog pojedinog konja u motoričkim aktivnostima. Klingler (1988.) je promatrala 30 konja podijeljenih u tri skupine i smještenih u tri sistema držanja (na vezu, samostalni boks i grupni boks). Konji su bili promatrani u njihovim kretnjama i putanjama kretanja na pašnjaku. Prilikom odlaska na pašnjak najaktivniji su bili konji iz samostalnih boksova koji su se prvenstveno kretali u kasu i galopu. Konji iz grupnog boksa prošli su najmanju putanju kretanja, na pašnjaku su bili najmirniji, najtemeljitiji i najviše su iskazivali izvorno ponašanje divljih konja. Frentzen (1994.) promatrao je haflingere u njihovim motoričkim aktivnostima i čimbenike koji utječu na isto, u sistemu držanja velike grupe s ispustom. Promatrao je hranidbene rituale i duljinu puta između jedenja i pijenja, motoričke aktivnosti i etologiju u kretanjima. Istraživanje je pokazalo da frekvencija hranjenja uvelike utječe na motoričke aktivnosti. Kod pojačane frekvencije hranidbe (s 4 na 6 hranjenja po danu) i kratkog puta između funkcionalnih područja (hraništa, pojilišta) došlo je do porasta motoričkih kretnji za 42%. Pod uvjetima iste frekvencije hranidbe, ali dužeg puta između funkcionalnih područja porast motoričkih kretnji bio je za 29%. Dok udaljenost funkcionalnih područja nije imalo statističko značajne razlike na motoričke kretnje. Šetalica bi trebala služiti kao alternativa za motoričke kretnje konja. Osobito je praktična na velikim ergelama, konjičkim klubovima, hipodromima i slično. Služi za istovremeno održavanje kondicije i mišićno-koštanog sustava više konja, predstavlja korisno pomagalo kod zagrijavanja i hlađenja. Također u liječenju i terapiji jer se motoričke kretnje mogu kontrolirati brzinom i vremenom. U šetalici se treba izbjegavati monotonost u ritmu kretanja, smjeru trajanja i brzini. Konji u šetalici najčešće se kreću hodom većinom u kombinaciji s kasom. Na velikim hipodromima nije rijetkost kretanja konja u šetalici pri 20 km/h (Pirkelmann, 2002.).

Zaključak

Konji za preživljavanje u prvom redu trebaju hranu i vodu, ali zahtijevaju i socijalni kontakt, kretanje, svjetlo i svježi zrak. Smještaj treba konju osigurati udobno i opušteno ponašanje koji pored fizičkog osiguravaju i psihičko zdravlje. Kretnje su posebice bitne za konja, osiguravaju prokrvljenost organa i mišićno-koštanog sustava, razvoj i elastičnost mišićja, tetiva i ligamenata, samočišćenje respiratornog sustava i osiguravaju njegovo zdravlje. Veliki poticaj za kretanje predstavlja hrana što se vidi kod konja držanih na ispaši koji se dnevno kreću 12-16 sati, a divlji konji dnevno prijeđu i do 20 km. Ograničeno kretanje u staji dovodi do povećanja aktivnosti u padoku ili na pašnjaku. Frekvencija hranjenja, udaljenosti i sistem smještaja povećavaju mišićno-koštanog aktivnost.

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Abstract

Review of Basic Equine Ethology in Natural and Controlled Conditions

Despite the fact that 5000 years had passed since horse domestication horses still have not lost the need for movement which they gained as animal preys of open steppes. The aim of this work is to show manifestation of natural equine ethology (behavior) in controlled conditions of breeding. First of all, horses need food and water for survival but they also need social contact, movement, light and fresh air. Accommodation should enable comfortable and relaxed behavior of horses, which will ensure them with physical as well as mental health.

Keywords: Ethology, Horse, Activity, Controlled Conditions

Section IV

harmony of crop and environment
suživot usjeva i okoliša

chairmen / moderatori

1. Gabriella KANIŽAI ŠARIĆ
2. Đuro BANAJ
3. Dobrivoj POŠTIĆ

Pregledni rad /Review paper

Nematode kao bioindikatori zdravlja tla

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Sažetak

Nematode su organizmi koji žive u filmu vode oko čestica tla, te svaka promjena koja se odvija u tlima izravno utječe na promjene u strukturi zajednice nematoda preko njihove kutikule. Za razliku od druge faune imaju niz karakteristika koje ih čine dobrim bioindikatorima i mogu poslužiti kao izvrsni pokazatelji stanja ekosustava i zdravlja tla. Cilj ovoga rada je dati pregled najvažnije literature koja ukazuje na mogućnosti korištenja nematoda kao bioindikatora zdravlja tla.

Zajednica nematoda mijenja se pod utjecajem obrade, gnojidbe, poboljšivača tla, toksičnih elemenata i drugih antropogenih utjecaja, a svrha korištenja nematoda kao bioindikatora je povećanje znanja o funkcioniranju i osjetljivosti ekosustava tla kako bi ga što duže očuvali ekološki čistim, a u svrhu biološke produktivnosti i očuvanja okoliša.

Ključne riječi: nematode, tlo, zdravlje tla, bioindikatori

Uvod

Tlo je prirodno tijelo nastalo iz rastresite stijene ili na trošini čvrste stijene pod utjecajem pedogenetskih čimbenika i kao rezultat pedogenetskih procesa (Škorić, 1990.). Ono predstavlja kritički važnu komponentu zemljine biosfere, čija svrha nije samo proizvodnja hrane nego i održavanje lokalne, regionalne i globalne kvalitete okoliša (Glanz, 1995.). Najvažnije prijetnje tlima su zagađenja, erozije, smanjenje organske tvari i bioraznolikosti, zbijanje tla, povećanje slanosti kao i poplave i odroni zemlje.

Osnovno načelo u korištenju termina ''zdravlja tla'' je da je tlo ne samo supstrat za rast, već živi, dinamičan i održivi ekosustav. Tlo kao supstrat za život mnogobrojnim organizmima osigurava neophodne funkcije ekosustava kao što su povećenje produktivnosti biljaka, reguliranje odnosa tlo-voda-biljka i mineralizacija hranjiva, razgradnja organske tvari i dr.

Potraga ekologa za organizmima koji će kvalitetno reflektirati zdravlje tla, a istovremeno biti prilično jednostavni za proučavanje, dovela je do nematoda koje su u hranidbenom lancu jed-

nu stepenicu iznad mikrofaune tla, te su zastupljene u svim tlima na zemlji s velikom brojnošću i raznolikošću vrsta. Nematode obavljaju vrlo važnu ulogu u funkciji tla kao sekundarni potrošači (Mulder *et al.* 2005.). Zajednica nematoda je korištena u procjenama kvalitete vode već u 70.-tim godinama prošlog stoljeća (Zullini, 1976.). Povećanjem svijesti za potrebama održivosti ekosustava tla i njegove ranjivosti, koja se intenzivirala tijekom 80.-tih godina prošlog stoljeća, nematode poprimaju sve veću važnost u procjenama kvalitete okoliša (Zullini i Peretti, 1986.). Daljnjim istraživanjima u 90.-tim godinama 20.-tog stoljeća dolazi do izražaja važnost strukture zajednice nematoda kao korisnog pokazatelja stanja ekosustava tla (Bongers, 1990., Ettema, 1998.). Također, ne treba zanemariti činjenicu kako se nematode koriste i u procjenama kvalitete pitke vode i procjenama onečišćenja rječnih i morskih tokova (Höss *et al*., 2004.).

Cobb je još davne 1915. godine rekao: ''Kada bi svu materiju svemira izbrisali, naš svijet svejedno bi bio prepoznatljiv, i ako bi ponovno mogli istraživati takav svijet, npr. kao duhovi, pronašli bi njegove planine, brda, rijeke, jezera i oceane već prema tankom sloju nematoda na njima''.

Cilj ovoga rada je prikazati mogućnosti korištenja nematoda kao bioindikatora zdravlja tla u različitim agroekoustavima.

Materijali i metode

U radu je prikazan pregled najvažnijih literaturnih referenci vezanih uz mogućnosti korištenja nematoda kao bioindikatora.

Uloga nematoda u procjeni zdravlja tla

Nematode su najbrojni višestanični organizmi na Zemlji (više od 3 milijuna jedinki i preko 200 vrsta na m^2 u pojedinim uzorcima) (Yeates, 2003.), a sastav rodova i vrsta u pojedinim tlima reflektira teksturu tla, klimu i zemljopisni položaj, organsku tvar, ali i prirodna i antropogena uznamirenja (Yeates, 1984., Neher 2001.) iz čega je vidljiva njihova golema uloga u procjeni zdravlja tla. Procjenjuje se da četiri od pet višestaničnih organizama na Zemlji pripada nematodama (Platt, 1994.), a danas je poznato oko 26 600 vrsta (Hugot *et al*., 2001.). Neki autori procjenjuju kako bi na svijetu moglo postojati između 40 000 i 10 000 000 vrsta nematoda (Yeates i Boag, 2006.).

Većina nematoda je mikroskopske veličine, u prosjeku manje od jednog milimetra u dužinu, ali postoje životinjski paraziti koji su prilično veliki i lako vidljivi golim okom. Voda u tlu omogućava život nematoda te su one uvijek okružene filmom vode, koja im omogućava kretanje (Bongers i Ferris 1999.).

Za razliku od druge faune koju nalazimo u tlu, nematode su posebno pogodni bioindikatori radi slijedećih osobina (Freckman, 1988.):

- posjeduju veliku raznolikost vrsta;
- pojavljuju se u velikom broju u svim staništima;
- lako se uzorkuju i identificiraju;
- mogu se uzorkovati u svim sezonama;
- veliki broj vrsta može podnijeti anaerobne uvjete;
- mogu se zamrznuti ili dehidrirati (radi proučavanja);
- prisutne su svugdje i tamo gdje je makrofauna rijetka;
- opna im je u stalnom kontaktu s otopinama u kapilarnoj vodi tla;

– moguće ih je rangirati po različitim kriterijima: trofička grupa, vrijeme reprodukcije, dominantna vrsta i dr;
– mnoge vrste se lako »uzgajaju« u laboratorijima u svrhu istraživanja.

Pregled korištenja nematoda kao bioindikatora

Nematode, kao sveprisutni organizmi u tlu, odražavaju promjene u njegovoj ekološkoj funkciji i strukturi, pouzdanije i učinkovitije od ostale faune i flore tla, zasluženo dobivaju sve veću pažnju u ekološkim istraživanjima u posljednjih 20-tak godina (Ficus i Neher, 2002.). Procjenjuje se kako u poljskim uvjetima, u konvencionalnim i integriranim poljoprivrednim sustavima, nematode pridonose mineralizaciji dušika od 8 do 19% (Beare, 1997.).

Nematode se koriste kao indikatori kvalitete tla pri uzgoju različitih usjeva (Villenave *et al*., 2001.), u različitim tipovima ekosustava (Neher *et al*., 2005), pri mehaničkom uznemirenju (Brmež *et al.,* 2006.), različitoj obradi tla (Okada i Harada, 2007.), unošenju različitih mineralnih ili organskih gnojiva (Gruzdeva *et al*., 2007.), upotrebi pesticida (Liang *et al*., 2001.), herbicida (Yeates *et al*., 1999.), i fungicida (Villenave *et al.,* 2004.). Upotrebljavaju se i kao pokazatelji promjena u tlu pri fumigaciji tla (Okada *et al.,* 2004.), unosu organskih malčeva (Forge *et al*., 2003.), pri procjeni kvalitete tla u konvencionalnom i ekološkom poljoprivrednom uzgoju (Ferris *et al*., 1996.) ali i utjecaju čovjekove aktivnosti u urbanim sredinama (Cheng i Grewal, 2009.). Nematode se sve češće koriste u proučavanju onečišćenja ekosustava tla teškim metalima (Korthals, 1997., Sanchez-Moreno *et al*., 2006.) kao i u procjeni kvalitete različitih tipova tla i staništa (Sanchez-Moreno *et al*., 2008.).

Nematode kao bioindikatori proučavane su na Poljoprivrednom fakultetu u Osijeku kroz tri projekta »Nematode kao bioindikatori stanja agroekosustava«, »Nematode kao bioindikatori promjena u agroekosustavima" i »Nematode kao bioindikatori ekološkog stanja tla«.

Zaključak

Nematode su prisutne u svim tlima i svi procesi koji se odvijaju u tlu, izravno utječu na zajednice nematoda, a one među prvima reagiraju na promjene.

Svrha korištenja nematoda kao bioindikatora je povećanje znanja o funkcioniranju i osjetljivosti ekosustava tla kako bi ga što duže očuvali ekološki čistim, a u svrhu biološke produktivnosti i očuvanja okoliša.

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Abstract

Nematodes as bioindicators of soil health

Soil nematodes exist in water films on particle surfaces in soil and every change in soil properties may be reflected in changing of nematode communities through their permeable cuticle. They are ubiquitous organisms and possess several characteristics that make them better ecological indicators than any other organisms. The aim of this paper is to present the most important literature review concerning possibilities of using nematodes as bioindicators of soil health.

The diversity of nematode populations in the soil ecosystem provides information on the 'ecological health' of the soils and when linked with other soil chemical and physical parameters provide an indication of the soil conditions.

Nematode communities in soil environment can be affected by management practices, habitat, application of soil conditioners, fertilizers (mineral and organic), toxic elements and therefore may serve as good indicator of sustainability of land use.

Key words: nematodes, soil, soil health, bioindicators

Izvorni znanstveni rad / Original scientific paper

Ocjena pokazatelja kvaliteta sjemena hibrida rajčice (*Lycopersicon esculentum* Mill.)

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Sažetak

Cilj ispitivanja bio je ocjena pokazatelja kvalitete sjemena devet hibrida rajčice. Prosječna čistoća ispitivanih hibrida bila je 99,7%, a energija klijanja 84%. Najmanju energiju klijanja postigao je hibrid S.I. 867 F1 60 %, a najveću hibridi Monroe F1 i Harem F1 91 %. Ukupna klijavost hibrida u prosjeku bila je 92%. Najveću ukupnu klijavost 96% postigao je hibrida Monroe F1. Hibridi sa najvećom energijom klijanja postigli su najveću ukupnu klijavost. Prosječna vlažnost sjemena hibrida bila je 11,2%. Zdravstveno stanje svih ispitivanih hibrida bilo je ispravno, što zadovoljava zakonom propisane vrijednosti.

Ključne riječi: kvaliteta, klijavost, sjeme, rajčica, hibridi

Uvod

Rajčica je jedna od najčešćih i veoma značajnih povrtlarskih biljaka, u Srbiji se gaji na oko 20.000 ha sa veoma niskim prinosom od 8,4 t/ha (Republički zavod za statistiku, 2010), što je za 23 t manje u odnosu na europski prosjek 31,4 t/ha. Razlozi ovako niskih prinosa nisu u genetskom potencijalu sorti i hibrida već u neadekvatnoj tehnologiji gajenja prije svega navodnjavanja, gnojidbe i zaštite. Sjeme obilježava početak svake biljne proizvodnje i zato je osiguravanje njegove kvalitete imperativ suvremenog sjemenarstva i preduvjet za visoke prinose svih biljnih vrsta. Kvaliteta sjemena se može definirati kao skup osobina koji osiguravaju uspješan razvoj nove biljke u okviru agroekoloških uvieta sredine. Kvaliteta sjemena ovisi od sorte, odnosno određen je genetikom, a također ga u visokoj mjeri definiraju uvjeti uzgoja i fiziološki procesi. Kao što je dobro poznato klijavost i vigor sjemena rajčice definirani su genetikom, uvjetima uzgoja, zrelošću plodova (Takač i sur., 1994; Rosales, 2002;) i metodom ekstrakcije (Demir and Samit, 2001).

Sjeme visoke kvalitete je jedan od osnovnih preduvjeta za sigurne, visoke i kvalitetne prinose rajčice. Klijavost sjemena predstavlja jedan od najvažnijih pokazatelja kvalitete sjemena, odnosno životne sposobnosti od koje ovisi i njena upotrebna vrijednost (Poštić i sur., 2010a). Ukoliko su uvjeti tla skoro idealni klijavost sjemena dobivena u laboratorijskim uslovima dobar je pokazatelj životne sposobnosti sjemena kojim se može predvidjeti poljsko nicanje (Durrant and Gummerson, 1990). Klijavost predstavlja sposobnost sjemena da u povoljnim uvjetima omogući normalan rast i razvoj klice iz koje će se razviti buduća biljka. Međutim, osim visoke

ukupne klijavosti važno je da sjeme ima i visoku energiju klijanja koja predstavlja važan pokazatelj životne sposobnosti sjemena. U proizvodnji svake gajene biljke veoma je važno brzo i ujednačeno nicanje koje upravo ovisi od energije klijanja sjemena (Poštić i sur., 2010b). Brže klijanje sjemena u polju, uvjetovat će bolje i ujednačenije nicanje biljaka, bujniji razvoj, veću otpornost na uvjete okoliša, bolesti i štetočine, jer razvijenije biljke posjeduju veću otpornost (Poštić i sur., 2011).

Cilj rada je prikazati pokazatelje kvalitete sjemena devet hibrida rajčice ocjenjivanih u laboratoriji za ispitivanje kvaliteta semena i sadnog materijala Instituta za zaštitu bilja i životnu sredinu, Beograd, u razdoblju od 2000 do 2005 godine.

Materijal i metode rada

Kao materijal u istraživanjima poslužili su uzorci sjemena rajčice prikupljeni iz Slovenije, Italije, Nizozemske i Izraela u razdoblju od 2000 do 2005 godine. Ispitivanja su obuhvatila devet hibrida rajčice (Cronos F1, Harem F1, S.I. 867 F1, Monroe F1, Ofira F1, Nemo-Tami F1, Tamaris F1, Syta F1 i Jenna F1). Ocjena kvalitete sjemena obavljena je u laboratoriji za ispitivanje kvaliteta semena i sadnog materijala poljoprivrednog bilja Instituta za zaštitu bilja i životnu sredinu u Beogradu. Praćeni su slijedeći pokazatelji kvalitete: postotak čistoće sjemena, energija klijanja, ukupna klijavost, broj nenormalnih klijanaca, neklijavo sjeme i vlažnost sjemena. Ispitivanje klijavosti 70 uzoraka sjemena izvršeno je standardnom laboratorijskom metodom između filter papira navlaženog 0,2% vodenom otopinom KNO3 na 4x100 sjemena. Sjeme je inkubirano 14 dana na temperaturi 20-30^{o}C i relativnoj vlažnosti zraka od 95%. Petog dana inkubacije ocijenjena je energija klijanja (EK), a 14-og dana ukupna klijavost (UK), odnosno broj tipičnih klijanaca (ISTA Rules, 2009). Energija klijanja predstavlja broj normalnih klijanaca u odnosu na broj sjemena stavljenih na klijanje utvrđen poslije proteka vremena predviđenog za prvo ocjenjivanje. Klijavost sjemena predstavlja broj normalnih klijanaca u odnosu na ukupan broj sjemena stavljenih na klijanje utvrđen posle proteka vremena predviđenog za završno ocjenjivanje. Nenormalni klijanci su oni za koje se ocjeni da nemaju sposobnost da se razviju u normalnu biljku u povoljnim poljskim uvjetima, jer je jedna ili više osnovnih struktura nepovratno oštećeno (oštećeni, deformirani, truli). Neklijavo sjeme je sjeme koje ne klija do proteka vremena predviđenog za trajanje ispitivanja (tvrdo, svježe, mrtvo sjeme itd.) (Sl. list SFRJ br. 47/87).

Tablica 1. Dozvoljena zastupljenost štetnih organizama (%) u sjemenu rajčice
Table 1. Allowed pests presence (%) in the seeds of tomato

Štetni organizmi *Pests*	Dozvoljeni (%) u sjemenu u prometu *Allowed (%) in seeds in trade*
Alternaria solani	5
Rhizoctonia solani	5
Septoria lycopersici	5
Clavibacter michiganensis ssp.	0
Pseudomonas syringae pv. tomato	1
Fusarium spp.	5
Botrytis cinerea	1
Virusi TabaccoMV., Tomato MV.	0

Pravilnikom o kvalitetu sjemena (Sl. list SFRJ br. 47/87) definirani su parametari kvalitete sjemena rajčice neophodni za rad: veličina partije 10.000 kg sjemena jedne sorte, prosječni uzorak 15g, najmanja propisana čistoća 97%, najveća dozvoljena vlažnost 12%, minimalna dozvoljena klijavost 75%. Prema Pravilniku o zdravstvenom pregledu usjeva i objekata za proizvodnju sjemena, rasada i sadnog materijala i zdravstvenom pregledu sjemena, rasada i sadnog materijala (Sl. glasnik RS br.119/2007) izvršeno je ispitivanje zdravstvenog stanja sjemena (tablica 1).

Dobiveni rezultati su obrađeni statistički, korištenjem osnovnih pokazatelja deskriptivne statistike (SD i CV) kojima je utvrđeno apsulutno i relativno odstupanje ispitivanih obilježja od srednjaka.

Rezultati i rasprava

Prosječna čistoća sjemena hibrida rajčice u ispitivanom periodu bila je 99,7 % (tablica 2) što predstavlja odličan rezultat. Najnižu vrijednost čistoće sjemena zabilježili su hibridi S.I. 867 F1 i Jenna F1 99,5%. Čistoća sjemena predstavlja značajan pokazatelj kvaliteta i čini udio čistog sjemena u uzorku (Poštić i sur., 2010a).

Energija klijanja (EK) hibrida u prosjeku bila je 84%, dok je ukupna klijavost (UK) 92% (tablica 2). Najmanju EK postigao je hibrid S.I. 867 F1 60%, a najveću Monroe F1 i Harem F1 od 91%. Energija klijanja je važna biološka osobina sjemena od koje ovisi brzina i ravnomjernost klijanja i nicanja (Poštić i sur., 2010b).

Tablica 2. Kvaliteta sjemena hibrida rajčice u periodu od 2000-2005 godine.
Table 2. *Average seed quality of tomato hybrids during 2000-2005*

Hibrid/*Hybrid*	ČS*(%)	EK (%)	NK (%)	NS (%)	UK (%)	VS (%)
Cronos F1	99,7	87	1	4	94	11,2
Harem F1	99,7	91	2	4	94	11,4
S.I. 867 F1	99,5	60	2	14	84	11,4
Monroe F1	99,7	91	1	3	96	11,2
Ofira F1	99,7	86	2	5	93	11,2
Nemo-Tami F1	99,7	89	1	4	95	11,2
Tamaris F1	99,7	85	2	5	93	11,2
Syta F1	99,7	82	3	8	89	11,0
Jenna F1	99,5	89	2	4	94	11,3
Prosek/Average	99,7	84,4	1,78	5,67	92	11,2
SD	0,09	9,62	0,67	3,43	3,71	0,12
CV	0,09	11,39	37,50	60,49	4,02	1,09
Poljoprivredna (upotrebna) vrednost sjemena hibrida je 92,08 (%) *Agricultural (usabillity) value of the seed*						

***ČS** - Postotak čistoće sjemena (*Pure seeds*), EK- energija klijanja (*Germination energy*), NK- nenormalni klijanci (*Abnormal seedlings*), NS- Neklijavo sjeme (*Hard, fresh and dead seeds*), UK- ukupna klijavost (*Germinability*), VS- vlažnost sjemena (*Seed moisture*).

Prosječan postotak nenormalnih klijanaca (NK) 1,78% hibrida rajčice (tablica 2) bio je manji u odnosu na postotak učešća NK 3,30% kod sorti rajčice (Poštić i sur., 2011). Također su Poštić i sur., (2011) u svojim istraživanjima utvrdili da je prosječan postotak neklijavog sjemena (NS) bio znatno veći kod sorti rajčice 9,14%, u odnosu na postotak NS hibrida 5,67% (tablica 2). Hibrid S.I. 867 F1 imao je najveće učešće 14% NS, a najmanje 3% NS Monroe F1.

Najmanju UK od 84% ostvario je hibrid S.I. 867 F1, dok je hibrid Monroe F1 postigao najveću UK od 96% (tablica 2). Klijavost predstavlja postotak sposobnog sjemena proizvesti tipičan ponik, odnosno da nikne u polju pod optimalnim uvjetima okoline (Poštić i sur., 2010b). Najveći postotak rasada povrća proizvodi se u zaštićenom prostoru bez dopunskog zagrijavanja tako da od veličine ovog pokazatelja kvalitete sjemena izravno ovisi i postotak niklih biljaka (Poštić i sur., 2011). Za predviđanje poljskog nicanja klijavost sjemena predstavlja veoma pouzdan pokazatelj. Durrant and Gummerson (1990) su dobili visok stupanj korelacije (r=0,75-0,97) ove dvije vrijednosti, ali samo u idealnim uvjetima polja.

Dobijen stupanj varijabilnosti energije klijanja i ukupne klijavosti ispitivanih hibrida rajčice je manji u odnosu na varijabilnost sjemena sorti rajčice ispitivanih u istom razdoblju (Poštić i sur., 2011). Prosječna vlažnost sjemena bila je 11,2%. Vlažnost sjemena hibrida rajčice kretala se u intervalu 11,0-11,4%. Sadržaj vlage u sjemenu definira životnu sposobnost sjemena i uvjetuje duljinu njegovog čuvanja. Zdravstveno stanje bilo je na zadovoljavajućoj razini, time su zadovoljene norme predviđene Pravilnikom o zdravstvenom pregledu usjeva i objekata za proizvodnju sjemena, rasada i sadnog materijala i zdravstvenom pregledu sjemena, rasada i sadnog materijala (Sl. glasnik RS br.119/2007).

Zaključak

Na temelju iznijetih rezultata ispitivanja kvalitete sjemena devet hibrida rajčice može se zaključiti sljedeće:

Čistoća sjemena je u prosjeku za sve ispitivane hibride bila je iznad zakonskog minimuma od 97%. Razlike u čistoći sjemena između pojedinih hibrida bile su male (0,1-0,2%). Vlaga sjemena hibrida varirala je u intervalu 11,0-11,4%.

Hibridi sa većom energijom klijanja sjemena utjecat će na brže i ravnomjernije nicanje što će naročito doći do izražaja u proizvodnji rasada rajčice u zaštićenom prostoru bez dopunskog zagrijavanja.

Postotak učešća nenormalnih klijanaca i neklijavog sjemena kod hibrida rajčice raste sa smanjenjem energije klijanja i ukupne klijavosti sjemena. Po pravilu hibridi sa najvećom energijom klijanja imaju najveću ukupnu klijavost i obrnuto.

Niže vrijednosti ukupne klijavosti hibrida odrazit će se na upotrebnu vrijednost sjemena tako da će količina sjemena za sjetvu biti veća po jedinici površine. Ocijenjeni pokazatelji kvalitete sjemena hibrida rajčice bili su iznad zakonom propisanih normi i ispunjavaju uvjete stavljanja sjemena u promet. Visoka kvaliteta sjemena hibrida rajčice dobra je početna osnova da se uz ostale uvjete proizvodnje (agrotehnika, gnojidba, navodnjavanje i zaštita) mogu ostvariti visoki prinosi dobre kvalitete.

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Abstract

Evaluation of quality parameters of tomato (*Lycopersicon esculentum* Mill.) hybrids seeds

The aim of this study was to evaluate the seeds quality parameters of nine tomato hybrids. The average purity of tested hybrids was 99.7% and 84% for germination energy. The lowest germination energy achieved by the hybrid S.I. F1 867 60%, and highest 91% for hybrids Monroe F1 and Harem F1. The average total germinability of hybrids was 92%, and highest total germinability 96% achieved by Monroe F1 hybrids. The hybrids with the highest germination energy achieved the highest total germination Average moisture content of the seeds was 11.2%. Health status of all investigated hybrids was correct and all observed parameters of the seeds quality were within the legally prescribed limits.

Key words: Quality, germination, seeds, tomato, hybrids

Izvorni znanstveni rad / Original scientific paper

Utjecaj antioksidanasa i masnih kiselina na rast *Fusarium graminearuma* i sintezu B trihotecena u stočnoj hrani

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Sažetak

Uskladišteni materijal (stočnu hranu) neophodno je zaštititi od kontaminacije gljivama i mikotoksinima kako bi se izbjegla njihova štetna djelovanja na zdravlje životinja, te konzumacijom proizvoda animalnog podrijetla, i zdravlje ljudi. Strategija nadzora, između ostaloga, obuhvaća korištenje kemijskih i prirodnih konzervanasa u skladištima i silosima. U ovom istraživanju ispitan je utjecaj smjesa sintetskih (butilirani hidroksianisol, propil paraben), prirodnih antioksidanasa (timol) i masnih kiselina (oktanska i dekanska) na rast *Fusarium graminearuma* i sintezu B trihotecena u krmnim smjesama. Stimulirana sinteza deoksinivalenola zabilježena je u svim ispitanim smjesama tvari koja najvjerojatnije nastaje kao odgovor gljive na stresne abiotske uvjete.

Ključne riječi: *Fusarium graminearum*, B trihoteceni, stočna hrana, antioksidansi, masne kiseline

Uvod

Fusarium graminearum Schw. je dominantna vrsta izolirana sa svih dijelova pšenice (Ćosić i sur., 2004). Ovaj fitopatogen je uzročnik truleži korijena, paleži klijanaca, paleži klasova pšenice i ječma (Ćosić, 1997; Wang i sur., 2006; Osborne i sur., 2007). Kontaminacija ovim fitopatogenom može nastati na polju, ali i tijekom skladištenja. Osim nastale ekonomske štete, bitne su i zdravstvene posljedice koje izazivaju B trihoteceni (uglavnom dekosinivalenol, nivalenol, 3-acetil deoksinivalenol i 15-acetil deoksinivalenol), mikotoksini koje sintetizira *F. graminearum*. Simptomi trovanja ljudi i životinja uključuju gubitak težine, odbijanje hrane, povraćanje, krvavu dijareju i teške hemoragijske dermatitise (Eriksen, 2003). Prevencija kontaminacije uskladištenih žitarica i stočne hrane s *F. graminearumom* i drugim gljivama i njihovim pripadajućim otrovnim metabolitima obuhvaća korištenje fizikalnih, kemijskih i bioloških agenasa. U cilju smanjivanja kemijskih konzervanasa stočnoj hrani se uz sintetske antioksidanse mogu dodavati eterična ulja ili pojedini njihovi sastojci te masne kiseline antifungalnih i antimikotoksikogenih osobina. Sintetski antioksidansi kao što su butilirani hidroksianisol i propil paraben su u širokoj upotrebi kao antioksidansi stočne hrane u cilju zaštite nezasićenih lipida i drugih tvari od kvarenja oksidativnom degradacijom (Giridhar i sur., 2001). Osim antioksidativnih oso-

bina intenzivno se proučava i fungitoksičan učinak fenolnih antioksidanasa i to već spomenutih butiliranog hidroksianisola, propil parabena i drugih (Ahmand i sur., 1981; Lin i sur., 1983; Nesci i sur., 2003). Antifungalnu aktivnost pokazuju i eterična ulja i pojedini njihovi sastojci koji sadrže fenolnu komponentu, npr. oksigenirani monoterpeni (timol, karvakrol, citral) te fenolni benzenski derivati (eugenol) (Ruberto i sur., 2000). Masne kiseline srednjeg lanca također posjeduju antifungalne osobine (Riháková i sur., 2002; Walters i sur., 2003; Altieri i sur., 2009), a utvrđeno je i mogu dovesti do razgradnje pojednih mikotoksina (Hajjaj i sur., 2000).

U ovom radu je istražen utjecaj fenolnih sintetskih (butilirani hidroksianisol i propil paraben) i prirodnih antioksidanasa (timol) te masnih kiselina (oktanska i dekanska) na fungalni rast *F. gramimearuma* i biosintezu B trihotecena u gotovim krmnim smjesama.

Materijal i metode

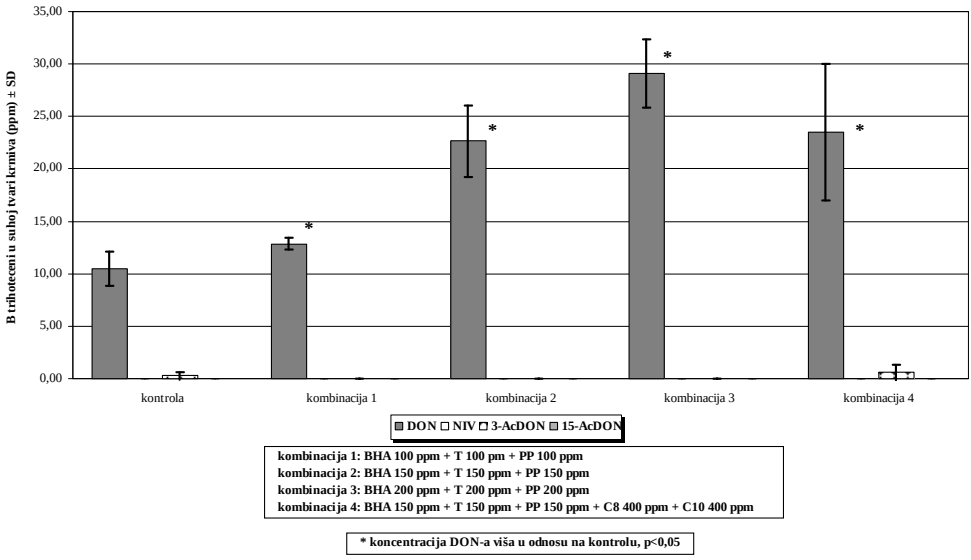
U istraživanjima je korišten izolat *Fusarium graminearuma* Schwabe 110250 (Centraalbureau voor Schimmelcultures, Nizozemska) s dobrom sposobnošću biosinteze B trihotecena. Stočna hrana korištena kao supstrat obuhvatila je smjesu za tov pilića u porastu (PPT-2) i krmnu smjesu za krmače dojilje i nerastove (SK-D-N) koja je sterilizirana gama zrakama od 12 kGy. Ispitani antifungalni agensi: timol (T), propil paraben (PP), butilirani hidroksanisol (BHA), oktanska (C8) i dekanska kiselina (C10) su odvagani u sterilnim uvjetima i otopljeni u deioniziranoj vodi, 95% alkoholu i 10% Tweenu 80 (9:2:2) nakon čega su umiješani u stočnu hranu. Prema krivulji adsorpcije vlage za svako krmivo provedena je hidratizacija krmnih smjesa sterilnom deioniziranom vodom do željenog aktiviteta vode (aw 0,98). Aktivitet vode u smjesi je provjeren aw- metrom (HygroPalm AW1, Rotronic). Koncentracije antifungalnih tvari za krmnu smjesu PPT-2 iznosile su po 100, 150, 200 ppm svakog od antioksidanasa (BHA, T i PP) ili po 150 ppm ovih tvari uz dodatak 400 ppm C8 i 400 ppm C10. Za krmnu smjesu SK-D-N ispitana smjesa je sadržavala po 200 ppm BHA, T, i PP uz po 400 ppm C8 i C10. Kontrolne probe su sadržavale krmne smjese i vodu. Nakon 48 sati uravnoteženja vlage, stočna hrana je razvagana u petri ploče te inokulirana micelijskom diskom promjera 7 mm čiste kulture *F. graminearuma* poraslom na krumpir-dekstroznom agaru (BioLife). Petri ploče su inkubirane pri 25ºC±0,2°C u okruženju iste relativne vlažnosti kao i krma. Sve probe su sadržavale tri ponavljanja. Svakodnevno je praćen porast izmjeravanjem dva promjera kolonije pod pravim kutom dok kolonija nije dosegla rub petrijeve zdjelice. Fungalni porast je korišten za računanje stope rasta (mm/po danu) uz primjenu linearne regresije. Uzorci su nakon inkubacije sušeni na 50ºC 48 h a zatim su usitnjeni do veličine čestica od 0,8 mm. Uzorci su čuvani na -20°C do konačne analize mikotoksina. Postupak pripreme uzoraka za analizu mikotoksina uključivao je ekstrakciju, prečišćavanje ekstrakcijom na čvrstoj fazi (MultiSep 227 Trich+ kolone, Romer Labs) kolonama ili imunoafinitetnim kolonama (Vicam). Koncentracija B trihotecena određena je na HPLC uređaju (Varian HPLC sustav ProStar 330 PDA detektor i ProStar 230 ternarna pumpa). Normalnost raspodjele numeričkih varijabli testirana je Kolmogorov-Smirnov testom. Skupovi podataka testirani su Studentovim t-testom. Za statističku analizu podataka korišteni su programski sustavi Excel 2003 (Microsoft) i Statistica 7.0 (StatSoft).

Rezultati i rasprava

Nijedna ispitana kombinacija antifungalnih tvari nije učinkovito inhibirala sintezu B trihotecena (Slika 1) na krmivu PPT-2. Ove antifungalne tvari nisu bile dovoljno inhibitorne ni u redukciji radijalnog rasta *F. graminearuma* koji se kretao od 4,2 do 5,0 mm po danu što je u prosjeku 39-46% kontrolnog rasta. Ispitane smjese očigledno vrlo stresno utječu na *F. graminearum* te je utvrđena stimulacija sinteze DON-a uz statistički značajnu razliku između ispitanih kombinacija

i kontrole (p<0,05). Povećanjem sveukupne koncentracije antioksidanasa (300, 450 i 600 ppm), povećava se i koncentracija DON-a za 23%, 116% i 179% u usporedbi s kontrolom. Značajnu ulogu vjerojatno ima oksidativni stres koji izazivaju velike doze primijenjenih antioksidansa, a koji rezultira stimuliranom biosintezom DON-a. Slične rezultati utvrdili su Ponts i sur. (2007) koji su zabilježili sedam puta veću akumulaciju B trihotecena u uvjetima oksidativnog stresa u usporedbi s kontrolom. Autori su pretpostavili kako je biosinteza deoksinivalenola i njegovih acetiliranih formi nastaje kao adaptacijski odgovor *F. graminearuma* na oksidativni stres.

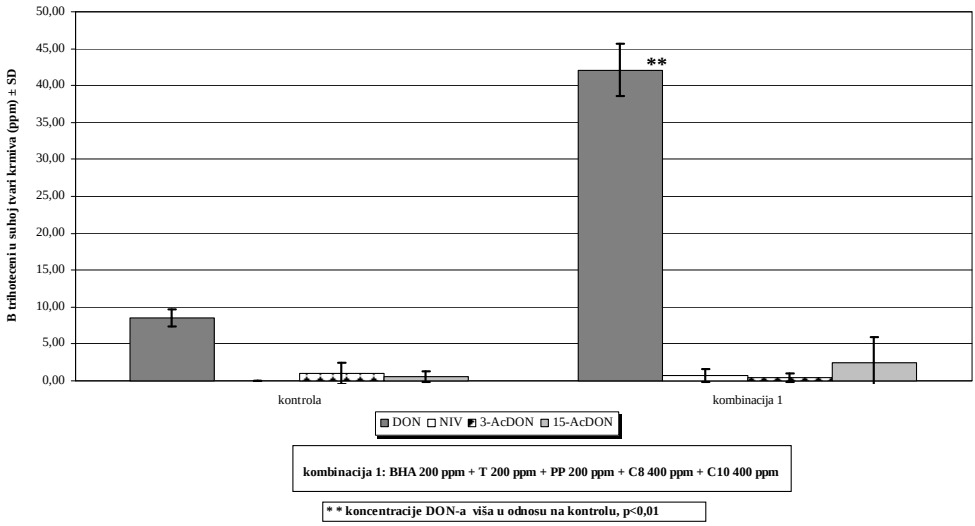
Slika 1: Koncentracije B trihotecena u suhoj tvari krmiva PPT-2 uz odabrane kombinacije tvari pri aw 0,98



Na krmnoj smjesi SK-D-N ispitana kombinacija antioksidanasa s masnim kiselinama (Slika 2) stimulira sintezu DON-a, pri čemu su utvrđene statistički značajne razlike između ispitane kombinacija i kontrole (p<0,01).

Ispitani antifungalni agensi nisu bili učinkoviti niti u smanjenju radijalnog rasta koji je iznosio 5 mm dnevno što iznosi 56% kontrolnog porasta. Drugi autori (Magan i sur., 2002; Ramirez i sur., 2004) su također uočili pojavu stimulirane sinteze deoksinivalenola pri primjeni subletalnih doza fungicida na zrnu pšenice. Audenaert i sur. (2010) su u kombiniranom *in vivo/in vitro* pokusu također utvrdili kako subletalne doze fungicida nakon 48 h primjene povećavaju proizvodnju DON-a. Stimulacije sinteze DON-a nastaje kao rezultat interakcije fungalnog genoma i okolišnih faktora sugeriraju istraživači.

Sastav krmnih smjesa ne utječe značajno na koncentraciju B trihotecena. Krmna smjesa PPT-2 po svom sastavu (51% kukuruza, 40% soje) je masnija (21% bjelančevina, 6% masti) za razliku od krmiva SK-D-N koji po sastavu sadrži 46% kukuruza, 15% ječma i 15% soje (15% bjelančevina, 3% masti) koje je manje masno. Koncentracija B trihotecena je na krmnoj smjesi PPT-2 manja pri istim primijenjenim ispitivanim tvarima nego na krmivu SK-D-N što bi se moglo objasniti boljom dispergiranosti lipofilnih sastojaka antifungalnih smjesa (BHA i T) u masnijem krmivu.



Slika 2: Koncentracije B trihotecena u suhoj tvari krmiva SK-D-N uz odabrane kombinacije tvari pri aw 0,98

Zaključci

Smjese prirodnih i sintetskih antioksidanasa s masnim kiselinama pri većoj vlažnosti supstrata (aw 0,98) nemaju inhibitoran učinak na rast *F. graminearuma*. Ove smjese tvari stimuliraju biosintezu B trihotecena i to uglavnom deoksinivalenola na obje ispitane krmne smjese. Daljnja istraživanja trebala bi razjasniti uvjete pod kojima dolazi do stimulirane sinteze mikotoksina što može pomoći u formulaciji učinkovitijih antifungalnih i antimikotoksikogenih dodataka.

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Abstract

Influence of antioxidants and fatty acids on the growth of *Fusarium graminearum* and *B trichothecenes* synthesis in livestock feed

Stored material (livestock feed) necessarily has to be protected from fungal and mycotoxins contamination in order to avoid its harmful effect on animal health, and consequently by animal origin product consummation on people's health. Control strategy, among others, includes utilization of chemical and natural preservatives in storages and silos. In this research, influence of mixture of synthetic (butylated hydroxyanisol, propyl paraben) and natural (thymol) antioxidants with fatty acids (octanoic and decanoic) on growth of *Fusarium graminearum* and B trichothecenes synthesis was investigated in fodder mixtures. Stimulated synthesis of deoxynivalenol was recorded in all investigated mixtures and is probably fungal response to stressing abiotic conditions.

Key words: *Fusarium graminearum*, B trichothecenes, livestock feed, antioxidants, fatty acids

Stručni rad / Expert paper

Provedba GLOBALGAP standarda u Republici Hrvatskoj

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Sažetak

U cilju poboljšanja kontrole hrane u Republici Hrvatskoj pojedine tvrtke provode GLOBALGAP standard radi izvoza poljoprivrednih proizvoda u EU gdje je na snazi taj pravilnik. Stoga, niti jedan od poljoprivrednih proizvoda ne može ići na tržište EU bez toga dokumenta. Jedna od točaka ovog pravilnika je ispravna i testirana poljoprivredna tehnika, u ovom slučaju tehnički sustavi u zaštiti bilja. Zavod za mehanizaciju Poljoprivrednog fakulteta u Osijeku posjeduje svu potrebnu opremu za provedbu ovog standarda te daje uslugu testiranja i baždarenja svih tehničkih sustava u zaštiti bilja.

Ključne riječi: raspršivač, prskalica, GLOBALGAP standard, testiranje

Uvod

U cilju poboljšanja kontrole hrane u Europskoj Uniji od 2000. godine u potpunosti je izmijenjen »stari« zakon o hrani novim strožim zakonskim propisom (Generalni zakon o hrani), koji je stvoren kako bi pružio informaciju potrošaču na koji način je proizveden određeni poljoprivredni proizvod kojeg kupuje. U današnje vrijeme potrošač želi znati ne samo odakle je proizvod kojeg kupuje, već i njegovu zdravstvenu ispravnost koja se u potpunosti može iščitati na svakom proizvodu pod ovom normom. Od komercijalnih standarda u Europskoj uniji, prvo mjesto zauzima EUREPGAP (European Retail Product and Good Agricultural Practice) kasnije u 2007 godini, kada je uspostava EUREPGAP standarda proširena po cijelom svijetu, mijenja se naziv u GLOBALGAP. Treba istaknuti da je ovo jedan od najraširenijih svjetskih standarda koji se odnosi na primarnu proizvodnju svježeg voća i povrća. Norma je definirana s ciljem stvaranja opće prihvaćene norme dobre poljoprivredne prakse (DPP/GAP), dokumentirane na način da je prikladna za provedbu procesa certifikacije prema međunarodno prihvaćenim procedurama. Norma se odnosi na sve aktivnosti na farmi, a to je primjena: dobre poljoprivredne prakse (DPP/GAP), programa integrirane kontrole pesticida (IPC), sustava upravljanja kvalitetom (QMS) i HACCP načela. Cilj primjene GLOBALGAP-a je jačanje povjerenja kupaca u kvalitetu i zdravstvenu ispravnost poljoprivrednih proizvoda, smanjenje negativnog utjecaja konvencionalne poljoprivredne proizvodnje na okoliš te stalna briga o zdravlju i sigurnosti zaposlenika u poljoprivrednoj proizvodnji kao i životinja u uzgoju. Danas se certifikacija proi-

zvoda/proizvodnje prema normi GLOBALGAP-a pojavljuje kao jedna od bitnih preporuka trgovačkih lanaca usmjerena prema dobavljačima poljoprivrednih proizvoda. Točka 8.4. i »annex CB.3« Globalgap standarda odnosi se na tehničke sustave u zaštiti bilja. Ova točka definira obavezu poljoprivrednih proizvođača koji primjenjuju standard da jednom godišnje obave pregled poljoprivrednih strojeva, kao i njihovu kalibraciju. Pregled radne ispravnosti tehničkih sustava u zaštiti bilja mora biti obavljena u skladu s europskim standardom EN 13790. Osim standarda koji trebaju ispuniti prskalice i raspršivači, standard EN 13790 propisuje metode i opremu sa kojom se pregled mora obaviti.

Materijal i metode

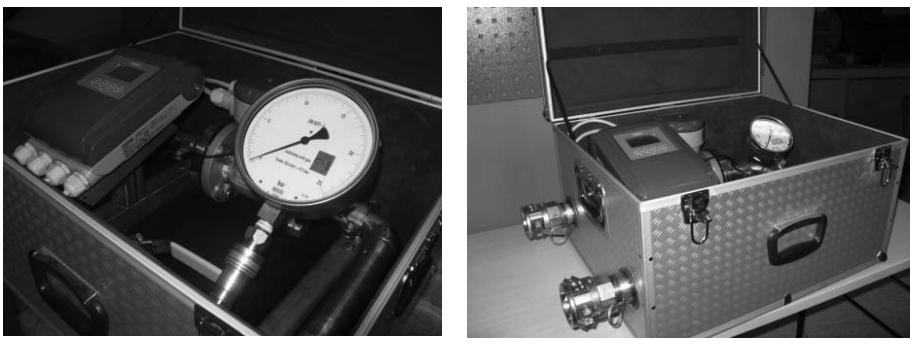
Za provedbu testiranja u ovom radu korištena je oprema Zavoda za mehanizaciju, Poljoprivrednog fakulteta u Osijeku. Zavod posjeduje svu potrebnu opremu za provedbu testiranja tehničkih sustava u zaštiti bilja po normi »EN 13790« koja je osnova za posjedovanje GLOBALGAP standarda. Mjerenje kapaciteta crpke obavljeno je pomoću elektromagnetskog mjerača protoka tvrtke *Krohne* (Slika 1.) dok je ispravnost manometra utvrđivana pomoću komparatora tlaka *Volos* (Slika 2.). Mjerenje protoka mlaznica na raspršivaču provedeno je s uređajem domaće izrade (Slika 3.) te s elektronskim mjeračem protoka tvrtke *AAMS* (Slika 3.). Zavod za mehanizaciju također posjede uređaj *Spray Scanner* tvrtke AAMS (Slika 4.) koji je primjenjen za utvrđivanje površinske raspodijele tekućine kod ratarskih prskalica. U zimskim mjesecima u novo otvorenom »Edukativno-servisnom centru« zavoda moguća je kompjuterska provjera mlaznica na stolnom elektronskom uređaju za mjerenje protoka (Slika 5.), te provjera površinske raspodjele tekućine kod svih tipova mlaznica – na testno ispitnom stolu (Slika 6.).

Pregled raspršivača

U tvrtki »Impulscommerce" d.o.o., 20. srpnja 2010. godine obučeni tim laboratorija za testiranje tehničkih sustava u poljoprivredi Zavoda za mehanizaciju Poljoprivrednog fakulteta u Osijeku obavio je provjeru ispravnosti raspršivača, za potrebe dobivanja certifikata Globalgap standarda. Provjera ispravnosti rada raspršivača obavljeno je s čistom vodom.

Kontrola kapaciteta crpke

Prema normi »EN 13790« dozvoljeni pad kapaciteta crpke može najviše iznositi do 10 % od nazivnog kapaciteta. Kod svih ispitivanih raspršivača, ugrađene crpke polučile su vrijednosti smanjenja kapaciteta unutar dozvoljenih 10%. Skupni prikaz testiranih crpki raspršivača prikazan je u tablici 1.



Slika 1. Elektromagnetni mjerač kapaciteta crpke tvrtke *Krohne*

Tablica 1. Rezultati dobivenih mjerenja kapaciteta crpki

Redni broj	Raspršivač	Tip crpke	Unutar 10% dopuštenog odstupanja
1.	Munckhof 1500 TIP 105/09 - 10503103	WM - 70	Da
2.	Munckhof 1500 TIP 105/09 - 10502045	WM - 70	Da
3.	Munckhof 1500 TIP 105/08 - 10502047	WM - 70	Da
4.	Agromehanika AGP 1500 E I	BM 105/20	Da
5.	Master – PIAVE	IDS-2000	Da

Kontrola ispravnosti manometra

Komparator tlaka *Volos* prema standardu EN 837-1 posjeduje kontrolni manometar koji posjeduje valjani certifikat, s klasom točnosti 0.6 s mjernim područjem do 25 bar. Na uređaj »Volos« postavlja se kontrolni manometar i manometar koji se treba provjeriti. Rezultati ispitivanih manometara prikazani su u tablici 2.

Slika 2. Komparator tlaka *Volos*

Po novim normama u EU manometri koji se ugrađuju na tehničke sustave u zaštiti bilja moraju imati minimalni promjer od 100 mm te točnost manometra koji se ispituje mora biti ± 0,2 bar kada se radi o ispitnom području od 0 do 2 bar. Ako se radi o većem ispitnom području odstupanje može iznositi do ± 10 %.

Tablica 2. Rezultati ispitivanja manometara

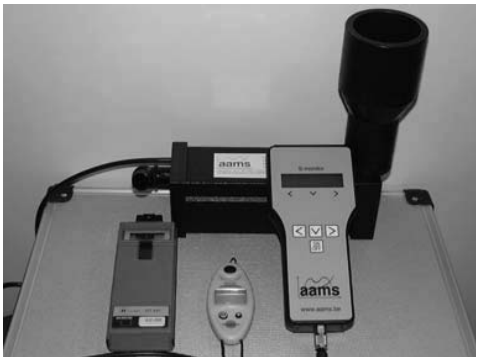
Područje ispitivanog radnog tlaka – kontrolni manometar								
Raspršivač*	5 bar		9 bar		15 bar		20 bar	
	Izmjera (bar)	Odstupanje (%)	Izmjera (bar)	Odstupanje (%)	Izmjera (bar)	Odstupanje (%)	Izmjera (bar)	Odstupanje (%)
Munckhof 1	5,60	+ 10,71	10,60	+ 17,77	15,90	+ 5,66	21,00	+ 4,76
Munckhof 2	6,10	+ 18,03	10,60	+ 17,77	16,50	+ 9,09	21,80	+ 8,25
Munckhof 3	5,10	+ 2,00	10,00	+ 10,00	16,10	+ 6,83	21,80	+ 8,25
Agromeha-nika	5,40	+ 8,00	10,00	+ 10,00	17,20	+ 12,79	23,50	+ 14,89
Piave	5,10	+ 2,00	9,80	+ 8,16	16,80	+ 10,71	23,00	+ 13,04

*Munckhof 1 (1500 – ser. 10503103); Munckhof 2 (1500 – ser. 10502045); Munckhof 3 (1500 – ser. 10502047); Agromehanika (AGP 1500 E I); Piave Master

Iz dobivenih rezultata može se utvrditi da manometri raspršivača Munckhof (ser. 10503103 i 10502045) ne rade ispravno u ispitnom području od 5 i 9 bar, dok manometri raspršivača Agromehanika i Piave ne rade ispravno u ispitnom području od 15 i 20 bar.

Kontrola ispravnosti mlaznica

Mlaznice predstavljaju najveći problem pravilnog rada tehničkog sustava u zaštiti bilja. Vrlo je često da se izlazni otvor mlaznice brzo potroši pa se poveća protok s obzirom na tablično označenu vrijednost. Vrlo često imamo pojavu da se mlaznice začepe uslijed lošeg pročišćavanja tekućine. Europski standard nalaže da treba zamijeniti svaku mlaznicu koja ima protok manji ili veći od 10% s obzirom na tablične vrijednosti pri odgovarajućem radnom tlaku. U tablici 3. prikazane su samo ispitivane žute mlaznice pri radnom tlaku od 9 bar. Mjerenje protoka mlaznica obavljeno je s uređajem domaće izrade koji na sebi ima menzuru za svaku ispitivanu mlaznicu, slika 3. Prema ISO standardu 10625 žute mlaznice (ISO 02) pri radnom tlaku od 9 bar trebaju ostvariti protok od 1,38 l/min. Prema normi »EN 13790« mlaznice koje imaju veći protok od 10% u odnosu na tablične vrijednosti, moraju se zamijeniti. Prema tome, mlaznice označene žutom bojom koje ostvare protok veći od 1,51 l/min moraju se zamijeniti s novima. Mjerenje je također moguće obaviti s elektronskim uređajem tvrtke *AAMS*, slika 3. U ovome ispitivanju svim mlaznicama se potrošio izlazni otvor te ostvaruju značajno veći protok od dozvoljenog.

Slika 3. Uređaji za mjerenje protoka mlaznica

Tablica 3. Rezultati dobivenih mjerenja protoka mlaznica

Protok mlaznica tvrtke Lehler TR 80 – 02 pri radnom tlaku od 9 bar										
	Lijeva strana raspršivača					Desna strana raspršivača				
	Redni broj mlaznice					Redni broj mlaznice				
	1.	2.	3.	4.	5.	1.	2.	3.	4.	5.
	Izmjereni protok (l/min)					Izmjereni protok (l/min)				
Munckhof 1500 TIP 105/09 – 10503103	**1,68**	**1,70**	**2,00**	**1,68**	**1,63**	**1,80**	**1,74**	**1,72**	**1,70**	**1,69**
Munckhof 1500 TIP 105/09 – 10503103	**2,00**	**2,10**	**1,60**	**1,64**	**1,60**	**1,50**	**1,50**	**1,58**	**1,46**	**1,59**
Agromehanika AGP 1500	**1,52**	**1,66**	**1,64**	**1,68**	**1,70**	**1,60**	**1,65**	**1,50**	**1,66**	**1,52**

Pregled ratarske prskalice

Kontrola ispravnosti rada ratarske prskalice ne razlikuje se mnogo od pregleda raspršivača. Pregledavaju se svi važniji sustavi te je jako važno da se obavi ispitivanje površinske raspodijele tekućine, što nalaže norma »EN 13790«. Zavod u svome edukativno servisnom centru posjeduje uređaj *Spray Scanner tvrtke AAMS* za takvo mjerenje.

Ispitivanja u edukativno – servisnom centru Zavoda za mehanizaciju

U laboratoriju Zavoda za mehanizaciju na Poljoprivrednom fakultetu u Osijeku postoji mogućnost ispitivanja protoke mlaznica na stolno – elektronskom uređaju. Prije testiranja mlaznice se podvrgnu pranju, čišćenju te numeriranju, da bi se nakon toga postavile (10 kom.) u pomični nosač. Provjera se obavlja sa čistom vodom. Ispitni stol ima elektronsku jedinicu za mjerenje protoka *AAMS* koja mjeri trenutni protok mlaznice te rezultat sprema u vlastitu memoriju. Rezultati se naknadno obrađuju u posebnom softveru – *spray monitor.* Ujedno u Zavodu postoji i mogućnost provjere površinske raspodjele tekućine kod svih tipova mlaznica na testno – ispitnom stolu.

Zaključak

Pristupanjem Hrvatske EU svi tehnički sustavi u zaštiti bilja morat će biti testirani i evidentirani, radi toga Zavod za mehanizaciju krenuo je u niz projekata kroz obuku rukovatelja i provjere ispravnosti tehničkih sustava u zaštiti bilja. Veliki broj provjera obavljen je za potrebe dobivanja GLOBALGAP standarda. Dosadašnja ispitivanja tehničkih sustava u zaštiti bilja nisu pokazala dobre rezultate na području Slavonije i Baranje, kako radi starosti raspršivača ili prskalica tako i radi nedovoljne obučenosti rukovatelja.

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Abstract

The implementation of GLOBALGAP standard in Republic of Croatia

Towards to improvement of food control in Republic of Croatia some companies implement GLOBALGAP standard for the purpose of exporting agricultural products in EU where is that regulation on in force. So, no one of the agricultural products can't go on market without this document. One point of this regulation is proper implementation of agricultural techniques, in this case technical systems in crop protection. Department for agricultural machinery in Agricultural faculy in Osijek owns all neccessary equipment for implementation of this standard and gives service of testing and calibration all techical systems in crop protection.

Keywords: atomizer, sprayer, GLOBALGAP standard, testing

Sažetak / Abstract

Gospodarenje otpadnim jestivim uljima s aspekta zaštite okoliša

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Sažetak

Otpadno jestivo ulje nastaje u ugostiteljskoj i turističkoj djelatnosti, industriji, obrtu, zdravstvenoj djelatnosti i drugim djelatnostima u kojima se priprema više od 20 obroka dnevno i predstavlja neopasni otpad. Prema podacima Fonda za zaštitu okoliša i energetsku učinkovitost 2009. godine sakupljeno je 2 383 413,35 L (2 145,07 t) otpadnog jestivog ulja. Od te količine oporabljeno je 1 674 717,00 L (1 507,25 t). Gospodarenje otpadnim uljima regulirano je Pravilnikom o gospodarenju otpadnim uljima (NN 124/06, 121/08, 31/09, 156/09). Zbog svojih svojstava može se koristiti u energetske svrhe kao obnovljivi izvor energije, odnosno u proizvodnji bioplina i biodizela. Loše gospodarenje otpadnim jestivim uljima predstavlja opasnost za okoliš, a time i za zdravlje ljudi.

Ključne riječi: otpadna jestiva ulja, otpad, obnovljivi izvori energije, zaštita okoliša

Abstract

Waste cooking oils management in the aspect of environmental protection

Waste cooking oil is produced in the catering and tourist industry, industry, trade, health services and other activities in which is more than 20 meals prepared a day, and it is a non-hazardous waste. According to data from the Environmental protection and energy efficiency Fund in 2009 was collected 2 383 413.35 l (2 145.07 t) of waste cooking oils. Recovered was 1 674 717.00 l (1 507.25 t). Used oils are regulated by the Ordinance on Used Oils (NN 124/06, 121/08, 31/09, 156/09). Because of its properties, it can be used for energy production as a renewable energy source, in the production of biogas and biodiesel. Poor management of waste cooking oils pose a risk to the environment, and for human health.

Keywords: waste cooking oil, waste, renewable energy, environmental protection

Izvorni znanstveni rad / Original scientific paper

Biološka zaštita krastavaca od cvjetnog štitastog moljca (*Trialeurodes vaporariorum* Westwood)

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Sažetak

Uzgoj krastavaca u zaštićenim prostorima pogoduje boljem rastu i razvoju biljaka, ali i pojavi i razmnožavanju različitih štetnika, posebice cvjetnog štitastog moljca (*T. vaporariorum*). Redovito kemijsko suzbijanje dovodi do brojnih negativnih posljedica za ljudsko zdravlje i okoliš za razliku od primjene bioloških sredstava. U radu je ispitivana mogućnost zamjene kemijskih sredstava biološkim. Pokus se sastojao od tretiranja imaga cvjetnog štitastog moljca, u nasadu krastavca tijekom ljetnog i jesenskog vegetacijskog perioda, kemijskim pripravkom Bokser 200 SL, te biološkim pripravcima Bio-Algen S-90, Biomit plussz®, Agri mix i Agri 50 u dvije različite doze. Uspoređeno je djelovanje bioloških pripravaka u odnosu na kemijsko sredstvo. Svi biološki pripravci, osim pripravka Agri 50 u nižoj dozi tijekom ljetnog uzgoja, djelovali su podjednako dobro na smanjenje populacije cvjetnog štitastog moljca. S obzirom da biološki pripravci nemaju negativan utjecaj na zdravlje čovjeka i okoliš, treba im dati prednost nad primjenom kemijskih sredstava u stakleničkom uzgoju.

Ključne riječi: biološka zaštita, cvjetni štitasti moljac, krastavci, zaštićeni prostori.

Uvod

Krastavac je poslije rajčice i paprike, najznačajnija povrtlarska kultura čija je proizvodnja u svijetu oko 26,5 mil. t/ha. Proizvodnja u Europi iznosi 17,3 t/ha na 237 tis. ha, dok je u Hrvatskoj prosječni prinos 6,3 t/ha na 3000 ha (Lešić et al., 2002.). Uzgoj povrća u zaštićenim prostorima češći je nego na otvorenom, zbog mogućnosti berbe tijekom cijele godine i puno većoj proizvodnji po jedinici površine, međutim uzgoj u zaštićenim prostorima zahtijeva i intenzivniju zaštitu od štetočinja.

Na krastavcima se u zaštićenom prostoru mogu pojaviti brojne bolesti (pepelnica, plamenjača, antraknoze, krastavost ploda) i štetnici (cvjetni štitasti moljac, duhanski štitasti moljac, kalifornijski trips, lisni mineri) (Kišpatić i Maceljski, 1981., Maceljski et al., 2004.). Cvjetni štitasti moljac sišući biljne sokove uzrokuje zaostajanje biljke u rastu, te smanjenje prinosa. Lučenjem

medne rose uzrokuje naseljavanje gljiva čađavica, čime se smanjuje asimilacijska površina listova, dok se plodovima zbog nagrđenog izgleda umanjuje komercijalna vrijednost. Ovaj štetnik ima od 10 – 12 generacija godišnje i visok potencijal razmnožavanja (Kišpatić i Maceljski, 1981.).

Iako je prednost kemijskih sredstava ta što mogu suzbiti gotovo sve štetnike, uzročnike bolesti i korove, te su rentabilni i njima se postižu brzi rezultati, kemijsko suzbijanje štetnih organizama u povrću nije dugoročno i perspektivno rješenje. Redovita i višekratna primjena kemijskih sredstava ima brojne posljedice kao što su ostatci sredstva (rezidue) u plodovima, pojava rezistentnosti, perzistentnost pesticida, onečišćenje atmosfere, tla i vode, opasnost za zdravlje osoba koje vrše tretiranja (Znaor, 1996., Maceljski et al., 2004.). Osim toga, iako je u Hrvatskoj u 2005. g. dozvolu za promet imao 771 pripravak sredstava za zaštitu bilja, vrlo mali broj sredstava za suzbijanje cvjetnog štitastog moljca ima dozvolu za korištenje u povrću (Maceljski, 1999., 2005.). S druge strane, biološko suzbijanje štetnih organizama nema opasnosti za zdravlje čovjeka niti za okoliš i temelji se na uporabi prirodnih neprijatelja štetnika: uzročnika bolesti štetnika (bioinsekticidi), grabežljivaca i parazita. Prema Parađiković (2009.) cvjetni štitasti moljac uspješno se lovi žutim i plavim ljepljivim pločama u zaštićenom prostoru.

Cilj rada je utvrditi mogućnost zamjene kemijskih sredstava za zaštitu bilja biološkim, odnosno utvrditi djelotvornost i učinkovitost bioloških pripravaka na populaciju imaga cvjetnog štitastog moljca (*T. vaporariorum*) u odnosu na kemijske (kontrola) u stakleničkom uzgoju tijekom ljetnog i jesenskog vegetacijskog perioda.

Materijal i metode

Istraživanje je provedeno tijekom 2005. godine u eksperimentalnom stakleniku Instituta za jadranske kulture i melioraciju krša u Splitu na krastavcima (*cv*. *Dinero*). Krastavci su uzgojeni u hidroponima na kamenoj vuni, a pokus je postavljen na dva nasada odnosno tijekom dva vegetacijska perioda (ljetnom i jesenskom). Masovna infestacija nasada krastavaca bila je osigurana umjetnim putem odnosno unošenjem zaraženih biljaka gerbera u pokusni prostor.

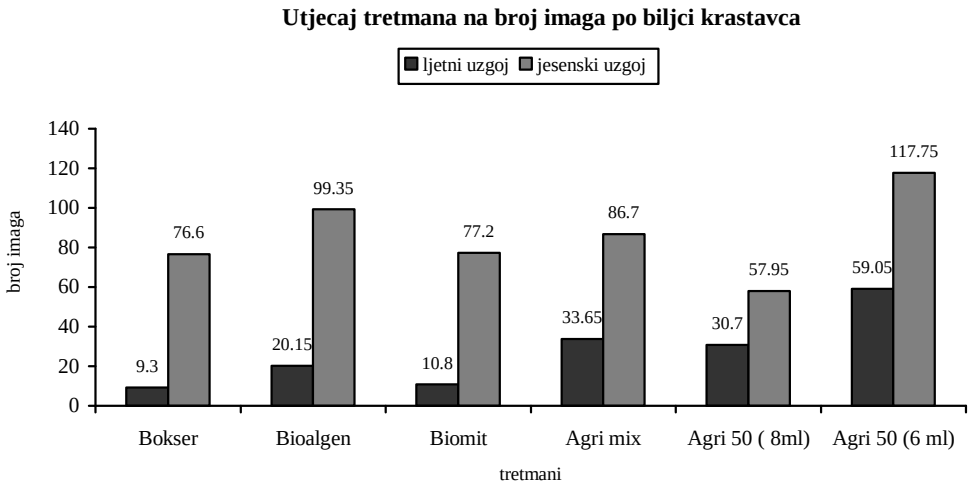
Pokus je postavljen po metodi slučajnog blok rasporeda u četiri ponavljanja. Pokusna parcela sastojala se od šest redova, a svaki red od 4 bloka kamene vune na kojima su posađene po 3 biljke (4 bloka x 3 biljke = 12 biljaka / redu). Ponavljanje se sastojalo od brojanja imaga i pupa na naličju listova krastavca i tretiranja zaštitnim sredstvom svakih sedam dana uzastopce, pa je u obje vegetacijske sezone obavljeno pet brojanja i četiri tretiranja. Prelijetanje cvjetnog štitastog moljca iz jednog reda u drugi spriječeno je odjeljivanjem redova zaštitnim zavjesama.

Za suzbijanje imaga cvjetnog štitastog moljca korišteno je šest različitih zaštitnih pripravaka, od toga jedan kemijski i pet bioloških. Od kemijskih pripravaka korišten je insekticidni pripravak Bokser 200 SL (sistemični insekticid) u dozi od 2 ml/ 2 l vode, a od bioloških pripravaka korišteni su sljedeći pripravci: Bio-Algen S-90 u dozi od 40 ml/ 2 l vode, Biomit plussz® (folijarno gnojivo i preventivno zaštitno sredstvo) u dozi od 40 ml/ 2 l vode, (Agri mix u dozi od 3 ml/ 2 l vode), Agri 50 (alternativni fizikalni insekticid) u dozi od 8 ml/ 2 l vode, te Agri 50 u dozi od 6 ml/ 2 l vode.

Rezultati i rasprava

Rezultati istraživanja pokazali su razlike među tretmanima u infestaciji krastavaca imagom cvjetnog štitastog moljca tijekom ljetnog i jesenskog vegetacijskog perioda (Grafikon 1.).

U ljetnom uzgoju, broj imaga cvjetnog štitastog moljca po biljci krastavca bio je najmanji na tretmanu 1 – Bokser i iznosio je 9,3, dok je najveći utvrđen na tretmanu 6 – Agri 50 (6 ml) i iznosio je 59,05. Najbolju učinkovitost u odnosu na kemijsko suzbijanje pokazao je tretman 3 – Biomit plussz® na kojemu je utvrđeno 10,8 imaga, a najslabiju tretman 6 – Agri 50 (6 ml).



Grafikon 1. Utjecaj tretmana na broj imaga po biljci krastavca u ljetnom i jesenskom uzgoju

U jesenskom uzgoju, broj imaga cvjetnog štitastog moljca po biljci krastavca bio je najmanji na tretmanu 5 – Agri 50 (8 ml) i iznosio je 57,95, dok je najveći utvrđen na tretmanu 6 – Agri 50 (6 ml) i iznosio je 117,75. Najbolju učinkovitost u odnosu na kemijsko suzbijanje pokazao je tretman 5 – Agri 50 (8 ml), a najslabiju tretman 6 – Agri 50 (6 ml).

Osim za tretman 6 – Agri 50 (6 ml) u ljetnom uzgoju, ni za jedan drugi biološki tretman u oba vegetacijska roka nije utvrđena statistički značajna razlika ($P>0,05$) za broj imaga po biljci u odnosu na kemijski tretman odnosno biološki tretmani su podjednako dobro djelovali na smanjenje populacije imaga kao i kemijski tretman. Također, kemijski je tretman imao najbolje inicijalno insekticidno djelovanje i to samo nakon prve primjene, dok su biološki tretmani pokazali dulje rezidualno djelovanje. Žanić et al. (2008.) navode da fizikalni insekticidi/fungicidi Agri 50 i SB Plant Invigorator uspješno kontroliraju imaga cvjetnog štitastog moljca pri uzgoju u stakleniku. Cvjetni štitasti moljac može se uspješno suzbiti i drugim biološkim mjerama, primjerice uporabom parazitske osice *Encarsia formosa* (Parađiković et al., 2007., Jelovčan i Igrc Barčić, 2005.). Choi et al. (2003.) navode niz esencijalnih ulja koja bi se mogla upotrijebiti kao fumiganti pri suzbijanju cvjetnog štitastog moljca. S obzirom da biološki tretmani nemaju štetne posljedice na zdravlje čovjeka i okoliš, u stakleničkom uzgoju treba im dati prednost nad kemijskim sredstvima.

Zaključak

Proizvodnja krastavca u zatvorenim prostorima moguća je tijekom cijele godine i odvija se u optimalnim uvjetima za rast i plodonošenje, međutim ujedno pogoduje i pojavi i razmnožavanju cvjetnog štitastog moljca. Zbog brojnih problema primjene kemijskih sredstava ispita-

na je mogućnost njihove zamjene biološkim pripravcima. Utvrđeno je da biološki pripravci u određenim dozama jednako dobro suzbijaju imaga cvjetnog štitastog moljca kao i kemijska sredstva te da imaju bolje rezidualno djelovanje.

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Abstract

Biological protection of cucumber against greenhouse whitefly (*Trialeurodes vaporariorum* Westwood)

Growing cucumbers in greenhouse conditions is conducive to better plant growth and development, but also to the appearance and reproduction of various pests, especially the greenhouse whitefly (*T. vaporariorum*). Regular chemical control leads to numerous negative consequences for human health and the environment as opposed to the use of biological control agents. The paper examined the possibility of replacing chemicals with biological control agents. The experiment consisted of treating greenhouse whitefly adults in greenhouse-grown cucumbers during summer and autumn growing periods, with the chemical agent Bokser 200 SL, and biological control agents Bio-Algen S-90, Biomit plussz®, Agri mix and Agri 50 in two different doses. The effects of biological control agents were compared in relation to the chemical agent. All biological preparations, other than the preparation Agri 50 in lower dose during summer growing period, had an equally well effect in reducing greenhouse whitefly population. Given that biological control agents don't have a negative impact on human health and the environment, they should be given an advantage over the use of chemicals in greenhouse production.

Key words: biological protection, greenhouse whitefly, cucumbers, protected area

Prethodno priopćenje / Preliminary communication

Razlike u prinosima hibrida kukuruza u vlažnim uvjetima 2010. godine

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Sažetak

Kukuruz (*Zea mays* L.) je ratarski usjev koji zauzima najveće obradive površine u Republici Hrvatskoj. U razdoblju od 2005. – 2008. godine kukuruz se uzgajao na prosječno 302937 ha što je oko 35 % oranica Hrvatske. Cilj ovog istraživanja je bio utvrditi razlike u prinosu između 10 hibrida kukuruza Poljoprivrednog Instituta Osijek (Drava 404, Os 430, OsSK 444, Os 499, OsSK 515, Os 5717, OsSK 552, OsSK 596, OsSK 602, OsSK617) uzgajanih na umjereno kiselom tlu u Podgoraču 2010. godine.Vegetacijska sezona 2010. godine se može okarakterizirati kao izrazito vlažna jer je u razdoblju od svibnja do listopada palo 606 mm oborina, što je dva puta više u odnosu na višegodišnji prosjek (VGP 1961.- 1990.: 315 mm). Prosječni prinos 10 hibrida kukuruza u poljskom pokusu je iznosio 8,41 t ha^{-1} s variranjima između hibrida od 6,58 t ha^{-1} do 9,86 t ha^{-1}. Najviši prinosi ostvareni su kod hibrida Os 499 (9,86 t ha^{-1}) i OsSK 602 (9,03 t ha^{-1}), a najniži kod hibrida Os 5717 (6,58 t ha^{-1}). Razlika između najvišeg (Os 499) i najnižeg (Os5717) ostvarenog prinosa iznosi 3,28 t ha^{-1} ili 33%.

Ključne riječi: hibridi kukuruza, prinosi, vlažni uvjeti

Uvod

Najzastupljenija ratarska kultura na obradivim površinama u Republici Hrvatskoj je kukuruz (*Zea mays* L.). U razdoblju od 2005. – 2008. godine kukuruz se uzgajao na prosječno 302937 ha što čini oko 35 % oraničnih površina Hrvatske pri čemu je ostvaren prosječni prinos od 6,74 t ha^{-1} (Državni Zavod za statistiku, 2010.). Mnogi autori (Josipović i sur., 2005.; Kovačević i Josipović, 2005.; Kovačević i sur., 1994.; Šoštarić i Josipović, 2006.; Maklenović i sur. 2009.) navode značajan utjecaj vremenskih prilika na prinose kukuruza. U promatranom desetogodišnjem razdoblju od 1996.-2005. prinos zrna kukuruza je varirao u širokom rasponu od 3,86 t ha^{-1} do 6,92 t ha^{-1} uslijed utjecaja vremenskih prilika (Kovačević i sur., 2009a). Glavni čimbenik niskih prinosa kukuruza je nedostatak oborina u kombinaciji s visokim temperaturama zraka (Shaw, 1988.) naročito ako se pojavljuju u fazama metličanja, svilanja i polinacije. Prema

Pucariću (1992.) u istočnoj Hrvatskoj nedostaje oko 70 mm oborina, najviše u srpnju i kolovozu, što je glavni limitirajući činitelj postizanja viših prinosa kukuruza. U normalnim i vlažnim godinama sa stajališta uzgoja kukuruza, vremenske prilike doprinose povećanju prinosa zrna kukuruza (Kovačević i sur., 2009b).

Cilj ovog rada je bio ispitati reakciju 10 hibrida kukuruza različitih vegetacijskih skupina na vlažne uvjete u vegetacijskoj sezoni 2010.

Materijal i metode

Analiza vremenskih prilika temeljena je na mjesečnim količinama oborina i srednjim mjesečnim temperaturama zraka za vegetacijsko razdoblje kukuruza ta na višegodišnjim prosječnim vrijednostima (VGP) za razdoblje 1961.-1990. Podatci su prikupljeni na meteorološkoj postaji Državnog hidrometereološkog zavoda Republike Hrvatske u Osijeku. Poljski pokus je postavljen u proljeće 2010. na proizvodnim površinama Anagalis d.o.o u Podgoraču (40 km zapadno od Osijeka). Uzgajano je deset domaćih hibrida kukuruza Poljoprivrednog Instituta Osijek različitih vegetacijskih grupa FAO 400-600 (H1 - Drava404, H2 - Os430, H3 - OsSK444, H4 - Os499, H5 - OsSK515, H6 - Os5717, H7 - OsSK552, H8 - OsSK596, H9 - OsSK602 i H10 - OsSK617). Provedene analize uzoraka tla su pokazale da je tlo pokusne površine umjereno kiselo (pH u 1M KCl = 5,38) i vrlo visoke opskrbljenosti lakopristupačnim fosforom (P_2O_5 31,1 mg/100 g tla) i kalijem (K_2O 39,8 mg/100 g tla) prema AL-metodi (Egner et al., 1960.). Pokus je postavljen prema slučajnom bloknom rasporedu u četiri ponavljanja. Sjetva je obavljena 05. svibnja 2010. godine na dvije različite gustoće sjetve, ovisno o vegetacijskoj skupini, te je teoretski sklop za hibride H1-H7 iznosio 70863 biljaka ha^{-1}, a za hibride H8-H10 65683 biljaka ha^{-1}. Posijano je po dva reda svakog hibrida na dužinu redova 10 m te je veličina osnovne parcele iznosila 14 m^2. Tijekom vegetacije provedene su sve standardne agrotehničke mjere. Berba je obavljena 15. listopada 2010. Kukuruz je obran ručno tako da su sa svake parcele obrana dva reda svakog hibrida, te je određena masa klipova. Također je prilikom berbe određen broj biljaka za utvrđivanje realizacije sklopa i broj klipova po parceli. Nakon toga odvojen je prosječni uzorak od deset klipova sa svake parcelice za određivanje vlažnosti zrna i udjela oklaska. Prinos zrna kukuruza izračunat je na osnovu mase klipa po parcelici, udjela oklaska i sadržaja vode u zrnu i izražen na bazi realiziranog sklopa u t ha^{-1} s 14% vode. Statistička obrada podataka obavljena je analizom varijance, te je testiranje razlika između prosječnih vrijednosti obavljeno pomoću t-testa uz $LSD_{5\%}$.

Rezultati i rasprava

Prema općoj ocjeni klime (Državni hidrometeorolški zavod, 2011.) godina 2010. na području Hrvatske bila je toplija od prosjeka na 85% površine te ekstremno kišna, vrlo kišna i kišna na 99% površine. Lipanj i kolovoz na području oko Osijeka ocjenjeni su kao ekstremno kišni, a svibanj i rujan kao vrlo kišni, te se cijelo vegetacijsko razdoblje kukuruza može okarakterizirati kao izrazito vlažno.

Table 1. Oborine i prosječne temperature zraka (Osijek) u vegetacijskoj sezoni 2010. i usporedba sa višegodišnjim prosjekom (VGP=1961-1990) (Državni hidrometereološki zavod u Zagrebu)

Godina	Mjesec					Ukupno/ prosjek
	Svibanj	Lipanj	Srpanj	Kolovoz	Rujan	
Oborine (mm)						
2010.	121	234	32	111	108	606
VGP	59	88	65	58	45	315
Prosječne temperature zraka (°C)						
2010.	16,5	20,4	23,2	21,7	15,6	19,5
VGP	16,5	19,5	21,1	20,3	16,6	18,8

U razdoblju od svibnja do listopada palo je ukupno 606 mm oborina, što je čak dva puta više u usporedbi s višegodišnjim prosjekom (VGP 1961-1990: 315 mm, Tablica 1.). Svi mjeseci osim srpnja su bili iznadprosječno kišoviti, a naročito lipanj kada je palo 234 mm oborina, odnosno 146 mm više u odnosu na višegodišnju prosječnu vrijednost (88 mm). U istom promatranom razdoblju prosječna temperatura zraka je bila viša (19,5°C) od tridesetogodišnjeg prosjeka. Najtopliji mjesec je bio srpanj, kada je izmjerena temperatura bila viša za 2,2°C.

Ovakvi vlažni uvjeti odrazili su se i na nešto višu vlažnost zrna u berbi, osobito kod hibrida duže vegetacije, premda je berba obavljena relativno kasno. Vlažnost zrna u berbi se povećavala od ranih prema kasnim hibridima te je varirala od 23,2 % do 29,4%. Vlažnost zrna manju od 25% imala su samo dva hibrida (H1 i H2) dok je kod četiri hibrida koji pripadaju kasnijim FAO skupinama (H7-H10) izmjerena vlažnost zrna iznad 28,0% (Tablica 2).

Tablica 2. Prinosi (t ha^{-1}), vlaga zrna (%), sklop (biljaka ha^{-1}) i realizacija sklopa (%) 10 hibrida kukuruza u vegetacijskoj sezoni 2010.

Hibridi kukuruza		Prinos zrna (t ha^{-1})	Vlaga zrna u berbi (%)	Realizacija sklopa (%)	Sklop (biljaka ha^{-1})
H1	Drava 404	8,92 b#	23,2 d	89,0	63068
H2	Os 430	8,33 c	23,8 d	87,6	62076
H3	OsSK 444	7,98 cd	25,5 cd	78,7	55769
H4	Os 499	9,86 a	27,6 ab	88,5	62714
H5	OsSK 515	7,79 d	26,9 bc	85,7	60730
H6	Os 5717	6,58 e	27,4 bc	77,1	54635
H7	OsSK 552	8,75 bc	28,7 ab	81,6	57842
H8	OsSK 596	8,18 c	29,4 ab	76,6	50313
H9	OsSK 602	9,03 b	29,4 a	78,8	51758
H10	OsSK 617	8,68 bc	28,6 ab	79,8	52415
Prosjek		8,41	27,1	82,3	
LSD 5%		0,56	1,97		

#Razlike između vrijednosti označenih različitim slovima unutar kolone statistički su značajne (P≤0,05)

Prosječni prinos 10 hibrida kukuruza u poljskom pokusu je iznosio 8,41 t ha^{-1} uz značajna variranja između hibrida te razlika između najvišeg i najnižeg ostvarenog prinosa iznosi 3,28 t ha^{-1} ili 33 %. Najviši prinos, statistički opravdano viši od svih ostalih, utvrđen je kod Os 499 (9,86 t ha^{-1}), a slijede ga hibridi OsSK 602 s 9,03 t ha^{-1} i Drava 404 s 8,92 t ha^{-1} (Tablica 2.). Najniži prinos, koji je bio ujedno i signifikantno niži u odnosu na prinos svih ostalih hibrida, imao je hibrid Os 5717 (6,58 t ha^{-1}), što može biti i posljedica nešto manje gustoće usjeva u uvjetima suviška vlage. S druge strane, OsSK 602 ostvario je visoki prinos unatoč slabijoj realizaciji sklopa (Tablica 2.). Premda je 2010. godina zapamćena po velikim poplavama, na pokusnoj površini nije bilo zadržavanja oborinskih voda duže vrijeme, zahvaljujući odvodnim kanalima. Premda se moglo očekivati da će kasniji hibridi FAO skupina 500 i 600 ostvariti više prinose upravo zahvaljujući velikoj količini oborina tijekom osjetljivog razdoblja cvatnje i oplodnje, rezultati su ukazali na značajne razlike između hibrida, odnosno genotipova unutar istih vegetacijskih skupina. Istraživanja nekih autora (Pavičić i sur., 2009.) pokazuju kako postoji razlika u prinosu između hibrida kukuruza različitih vegetacijskih grupa u različitim agroekološkim uvjetima. Temeljeno na ovim preliminarnim istraživanjima hibrid Os 5717 se pokazao osjetljivim na vlažne uvjete, dok je Os 499 pokazao tolerantnost na suvišak vode u vegetaciji.

Zaključak

Osnovno obilježje vremenskih prilika tijekom vegetacijskog razdoblja 2010. godine je ekstremno kišno ljeto i vrlo kišno proljeće uz višu prosječnu temperaturu zraka. Općenito, višak vode nije negativno utjecao na prinose zrna, iako je ostvareni sklop kod nekih hibrida bio niži od 80%. Prosječni prinos 10 hibrida kukuruza u poljskom pokusu je iznosio 8,41 t ha^{-1}, uz značajno variranje te razlika između najvišeg i najnižeg ostvarenog prinosa iznosi 3,28 t ha^{-1} ili 33 %. Najviši prinosi utvrđeni su kod hibrida Os 499 (9,86 t ha^{-1}) i OsSK 602 (9,03 t ha^{-1}), a najniži kod hibrida Os 5717 (6,58 t ha^{-1}). Najkasnije FAO skupine zastupljene u pokusu nisu bile i najprinosnije. Temeljeno na ovim jednogodišnjim istraživanjima hibrid Os 499 se pokazao tolerantnim, a Os5717 osjetljivim na suvišak vode u vegetaciji. Ova istraživanja bi se nastavila u sljedeće dvije godine s ciljem preciznije definicije utjecaja okolišnih čimbenika (tla i vremenskih prilika) na prinose različitih genotipova kukuruza.

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Abstract

Yield differences among maize hybrids under wet conditions of the 2010 growing season

Maize (*Zea mays* L.) is the main field crop which occupies the most arable land in Croatia. In the period from 2005 - 2008 average harvested area of maize was 302937 ha or about 35% of arable land. The aim of this study was to determine the yield differences among 10 maize hybrid created in Agricultural Institute Osijek (Drava 404, Os 430, OsSK 444, Os 499, OsSK 515, Os 5717, OsSK 552, OsSK 596, OsSK 602, OsSK617) which were grown in Podgorac, east Croatia, in the 2010. The growing season of 2010 was very wet. In the period May – September amount of precipitation was 606 mm or almost twofold more in comparison with long-term average (LTA 1961-1990: 315mm). Mean yields of 10 maize hybrids in field trial were 8.41 t ha^{-1} with variations among the hybrids from 6.58 t ha^{-1} to 9.86 t ha^{-1}. The highest yield achieved hybrid Os 499 (9.86 t ha^{-1}) and OsSK 602 (9.03 t ha^{-1}) and lowest yield had hybrid Os 5717 (6.58 t ha^{-1}). Yield differences between the highest and lowest hybrid was 3.28 t ha^{-1} or 33%.

Key words: maize hybrids, yield, wet conditions

IN MEMORIAM

Prof.dr. Davor Šamota

Rano ujutro 11. svibnja 2011. godine naš dragi kolega, prof.dr. Davor Šamota, došao je do kraja svog životnog puta. Prerano nas je napustio izgubivši bitku s teškom bolešću. Optimist, kao i uvijek govorio je kako će mu biti bolje. Nikada se nije žalio. Bio je blag i dobronamjeran čovjek koji nikog nije uvrijedio. Svladavao je životne teškoće s mnogo strpljenja i uvijek s osmijehom na licu. Bio je druželjubiv, zračio vedrinom i spreman pomoći svima. Svoje znanje nesebično je prenosio mladim naraštajima. Studenti su ga voljeli i pamtit će ga kao pristupačnog, neposrednog i dragog profesora. Ono što posebno valja istaknuti je ljudska dobrota koju je Davor imao u sebi.

Prof.dr. Davor Šamota rođen je 7. siječnja 1951. godine u Osijeku. Osnovnu školu i gimnaziju završio je u Osijeku. Diplomirao je na Poljoprivredno-prehrambeno-tehnološkom fakultetu u Osijeku 1976. godine, kada se i zaposlio na istom fakultetu u Zavodu za zaštitu bilja. Magistrirao je 1980. i doktorirao 1990. godine na Poljoprivrednom fakultetu u Osijeku. Specijalizaciju iz nematologije obavio je u Krakovu i Poznanu u Poljskoj, 1980. godine. Na Poljoprivrednom fakultetu u Osijeku izabran je u sva znanstvena i nastavna zvanja, od znanstvenog asistenta do znanstvenog savjetnika i redovitog profesora. Bio je koordinator i suradnik u većem broju modula na diplomskom i poslijediplomskom studiju iz Zaštite bilja i sveučilišnom studiju iz Zaštite okoliša. Obnašao je dužnost predstojnika Zavoda za zaštitu bilja. Bio je voditelj jedanaest stručnih i znanstvenih projekata od kojih su dva međunarodna te jednog znanstvenog programa. Objavio je kao autor ili koautor ukupno 53 znanstvena rada.

Poseban doprinos prof.dr. Šamota dao je svojim brojnim predavanjima održanim u suradnji s Hrvatskim agronomskim društvom, Savjetodavnom službom RH, kemijskim industrijama, kombinatima, zadrugama i drugim institucijama. Od 1997. godine prof. Šamota predstavljao je naš Fakultet u Vijeću za istraživanja u poljoprivredi pri Ministarstvu poljoprivrede, Povjerenstvu za izradu zakona o organsko-biološkoj poljoprivredi te u Povjerenstvu za ekološku proizvodnju pri istom ministarstvu. Bio je predsjednik Odbora za dodjelu potvrdnica u ekološkoj proizvodnji te član dviju pregovaračkih skupina za pristupanje RH u EU. Odigrao je pionirsku ulogu u osnivanju i razvoju ekološke poljoprivrede.

Bio je istaknuti član IFOAM-a – Međunarodnog društva za ekološku poljoprivredu, HED-a – Hrvatskog entomološkog društva, HAD-a – Hrvatskog društva agronoma, HDBZ-a – Hrvatskog društva biljne zaštite; BIOS-a – Hrvatskog društva za unapređivanje zdravlja RH, Vijeća za istraživanja u poljoprivredi, Ministarstvo poljoprivrede i šumarstva, Nacionalnog odbora za koordinaciju UNEP/GEF projekta "Development of National Biosafety Frameworks" za Republiku Hrvatsku (Ministarstvo zaštite okoliša i prostornog uređenja), te nekoliko županijskih odbora i savjeta povezanih uz razvoj ekološke poljoprivrede.

Zbogom dragi Davore, počivao u miru Božjem!

Prof.dr.sc. Mira KNEŽEVIĆ

Prof.dr. Davor Šamota 1997. godine s kolegama je osnovao udrugu Biopa - udrugu za organsko-biološku proizvodnju sa sjedištem u Osijeku s ciljem promicanja, edukacije i uspostave ekološke proizvodnje u Hrvatskoj, čiji je bio dopredsjednik. Tada je udruga imala jednu od odlučujućih uloga u poticanju razvoja ekološke proizvodnje u Hrvatskoj kao nevladina udruga. Zahvaljujući njegovoj inicijativi, kroz projekte i suradnju sa švicarskim partnerom, ali i ostalim zemljama u EU i našem okruženju, educirao je poljoprivredne proizvođače i pružao prva saznanja o ekološkoj proizvodnji. Kroz razne domaće i međunarodne projekte širio je ideju ekološke poljoprivrede i zaštite okoliša, ali i na taj način omogućavao mnogim gospodarstvima samozapošljavanje i nova radna mjesta.

Kao stručnjak na ovom području sudjelovao je u stvaranju prve zakonske regulative o ekološkoj proizvodnji poljoprivrednih i prehrambenih proizvoda, a kasnije i u usklađivanju s europskim normama. Uspostavom sustava kontrole i certifikacije ekološke proizvodnje, bio je predsjednik Odbora za potvrđivanje u BIOINSPEKTU d.o.o. iz Osijeka.

mr.sc. Berislav VRKLJAN

AGROglas

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Veliko istraživanje Hrvatske agencije za hranu (HAH):

Percepcija građana RH o rizicima iz hrane

Hrvatska agencija za hranu provela je, tijekom veljače 2011. godine, u suradnji s agencijom Ipsos Puls, veliko nacionalno istraživanje: *Percepcija građana RH o rizicima iz hrane.*

Time je Hrvatska prva država **izvan** EU u kojoj je provedeno istraživanje jednako onom na području Europske unije, a provodi se svakih pet godina (Eurobarometer „Food-related risks"), te je provedeno tijekom 2005. i 2010. godine, na inicijativu Europske agencije za sigurnost hrane (EFSA-e).

Hrvati su najzabrinutiji ostacima pesticida u hrani te kvalitetom i svježinom hrane i GMO-om: Hrvati navode kako su „jako zabrinuti": ostacima pesticida u hrani (25%), kvalitetom i svježinom hrane, GMO-om u hrani i pićima (oba 20%) te aditivima i ostacima antibiotika ili hormona u hrani (oba 19%). Građani RH najmanje su zabrinuti pretilošću (8%) te neuravnoteženom prehranom (6%).

Povjerenje u izvore informacija o rizicima iz hrane: Hrvati, vezano za rizike iz hrane, najviše vjeruju obitelji i prijateljima (85%), liječnicima i zdravstvenim radnicima (78%) te znanstvenicima (72%). Visoku razinu povjerenja uživaju i organizacije potrošača, udruge za zaštitu okoliša (oba 67%), poljoprivredni proizvođači (58%) te Hrvatska agencija za hranu i EFSA (obje 56%).

Percepcija građana RH: „Hrana proizvedena u Hrvatskoj je sigurnija" Čak oko 70% građana smatra kako je hrana u Hrvatskoj sigurnija od one uvezene. Tek 26% ispitanika smatra kako je hrana danas sigurnija nego prije 10 godina.

Građani RH ignoriraju vijesti o nesigurnoj hrani: Najveći broj građana navodi kako su ignorirali vijest da neka hrana nije sigurna i nisu promijenili svoje prehrambene navike, dok je 32% ispitanika priznalo kako se zabrinulo, ali na kraju nije ništa poduzelo. 28% ispitanih neko je vrijeme izbjegavalo spomenutu hranu, a trajno je promijenilo svoje prehrambene navike tek njih 2% .

Republika Hrvatska će biti obuhvaćena istim istraživanjem, kao članica Europske unije 2015. godine, te će biti zanimljivo vidjeti kakav je pomak i što se promijenilo razvojem novih tehnologija, ali i ulaskom Hrvatske u EU.

Glas Slavonije

najčitanije novine slavonije i baranje

HRVATSKA POLJOPRIVREDNA KOMORA

NOVOSTI IZ IPARD PROGRAMA

Raspisan je novi, 5. natječaj za dodjelu sredstava iz IPARD programa, za mjere 101 i 103.
Iskoristite priliku i unaprijedite svoje poslovanje.

REPUBLIKA HRVATSKA
AGENCIJA ZA PLAĆANJA U POLJOPRIVREDI,
RIBARSTVU I RURALNOM RAZVOJU
10000 Zagreb, Ul. grada Vukovara 269d
Telefon: 60 02 700, Telefax: 60 02 851

MJERA 101

Ulaganja unutar ove mjere su dozvoljena u sljedećim sektorima:

- sektor mljekarstva
- sektor govedarstva
- sektor svinjogojstva
- sektor peradarstva
- sektor jaja
- sektor voća i povrća
- sektor žitarica i uljarica.

Ukoliko ste vlasnik poljoprivrednog gospodarstva upisanog u Upisniku poljoprivrednih gospodarstava i obveznik PDV-a, mogući ste korisnik IPARD sredstava.

Znate li da, ukoliko ulažete u prihvatljive investicije čija je vrijednost između 13.500 EUR-a i 900.000 EUR-a (2.000.000 EUR-a u sektoru jaja), možete ostvariti povrat i do 75% uloženih sredstava.

MJERA 103

Ulaganja unutar ove mjere su dozvoljena u sljedećim sektorima:

- sektor mlijeka i mljekarstva
- sektor prerade mesa
- sektor ribarstva
- sektor prerade voća i povrća
- sektor vinarstva
- sektor maslinovog ulja

Obrti, trgovačka društva i zadruge, obveznici PDV-a u rangu mikro, malih ili srednjih poduzeća, naši su potencijalni korisnici.
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INFORMIRAJTE SE NA VRIJEME O POSTUPKU PRIJAVE I POTREBNOJ DOKUMENTACIJI

Uprava za ruralni razvoj, Upravna direkcija
SAPARD/IPARD programa
e-pošta: ipard@mps.hr
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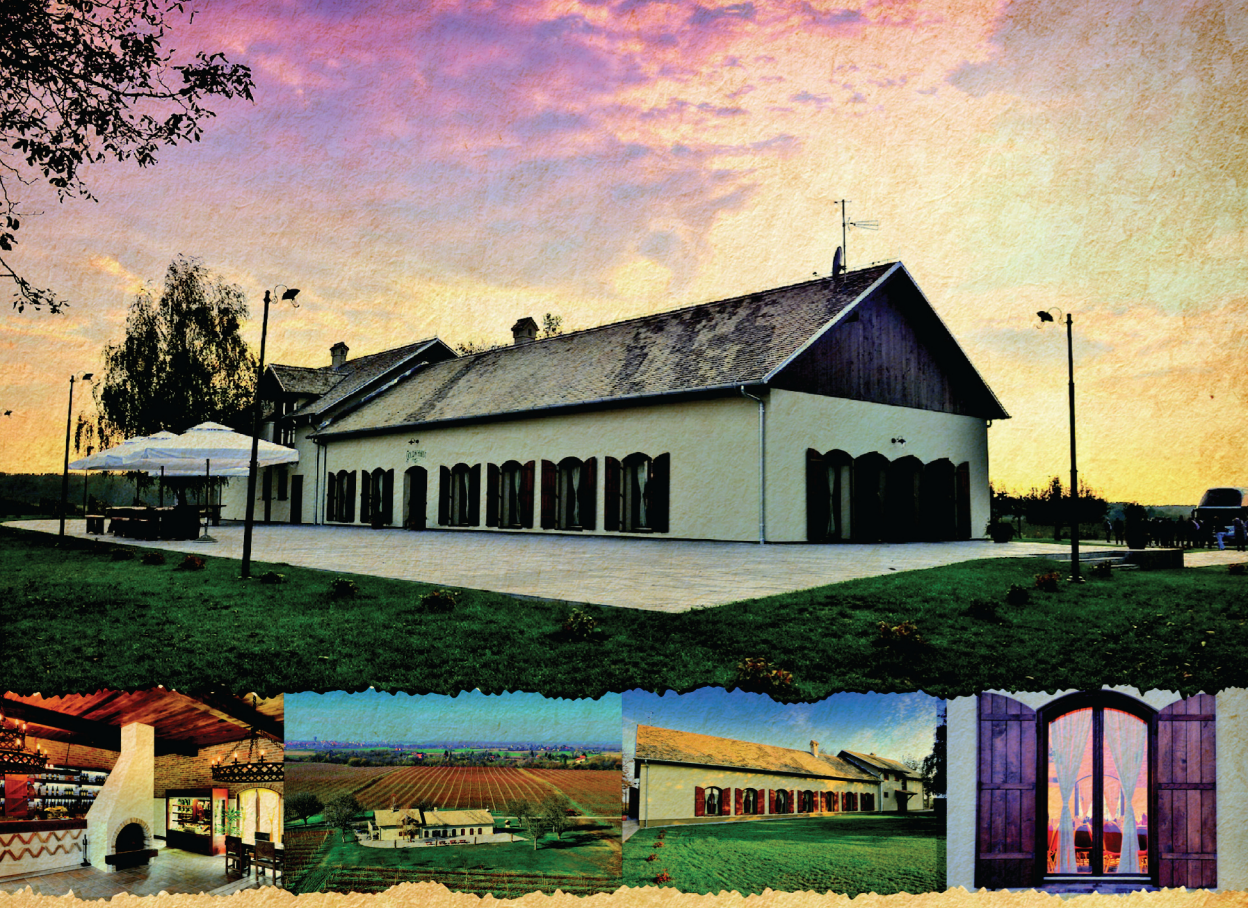
Detaljnije informacije o mjerama možete pronaći u Pravilniku (NN10/2011), Vodiču za korisnike i IPARD planu objavljenima na www.mps.hr i www.apprrr.hr



VINOGRADARSKA KUĆA

GOLDSCHMIDT

Na obroncima Fruške gore, okupana ranojutarnjim suncem, okružena rodnim vinogradima iz kojih će i ove jeseni poteći vino, smjestila se vinogradarska kuća Goldschmidt.

Plodna zemlja, blaga kontinentalna klima, marljiva i radišna ruka vinogradara, kao plod daju prepoznatljiva vina.

Najistočniji dio Hrvatske, gdje se spajaju slavonska ravnica i srijemski brežuljci, Istok i Zapad, mjesto je gdje je jedno od najvažnijih arheoloških lokaliteta u Hrvatskoj, lokalitet Vučedol.

Cvrkut ptica, lagani povjetarac, miris Dunava i pogled na rodni vinograd, savršeno se nadopunjuju s bogatom ponudom slavonskih specijaliteta, posluženih uz vina vinogradarske kuće, Goldschmidt vina.

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