EKOLOŠKI UZGOJ PIRA (Triticum spelta L.) I EKONOMSKI REZULTATI

Rapčan, Irena; Galić Subašić, Daria; Ranogajec, Ljubica; Hajduk, Stjepan

Source / Izvornik: **Agronomski glasnik : Glasilo Hrvatskog agronomskog društva, 2021, 82, 135 - 146**

Journal article, Published version
Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

https://doi.org/10.33128/ag.82.3.4

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:151:924223

AGRONOMSKI GLASNIK 3/2020.
ISSN 0002-1954

Review article
Pregledni članak

ORGANIC FARMING OF SPELT (*Triticum spelta* L.) AND ECONOMIC RESULTS

EKOLOŠKI UZGOJ PIRA (*Triticum spelta* L.) I EKONOMSKI REZULTATI

Irena Rapčan, Daria Galić Subašić, Ljubica Ranogajec, S. Hajduk

ABSTRACT

Spelt is an excellent choice for organic farming due to better enduring worse agroecological conditions than wheat. This research on the the family farm "Klica" in Ernestinovo in the season 2014/2015 is an extension of the research of this culture (the cultivar "Frankenkorn") of the previous season in the agroecological conditions of eastern Slavonia on the same family farm. The average grain yield was 3.71 t ha^{-1}, which is 1.08 t ha^{-1} more than the previous season. Realized revenues of HRK 10,419.92 ha^{-1} are also higher than in the previous season.

Keywords: spelt, organic farming, economic results, grain yield

SAŽETAK

Pir je izvrstan izbor za ekološki uzgoj, jer bolje podnosi lošije agroekološke uvjete od pšenice. Ovo istraživanje na površinama obiteljskog gospodarstva „Klica“ iz Ernestinova u sezoni 2014./2015. nastavak je istraživanja ove kulture (kultivar „Frankenkorn“) prethodne sezone u agroekološkim uvjetima u dijelu istočne Slavonije na površinama istog obiteljskog gospodarstva. Prosječni prinos zrna iznosio je 3,71 t/ha, što je za 1,08 t/ha više nego prethodne sezone. Ostvareni prihodi u iznosu od 10.419,92 kn/ha također su veći nego prethodne sezone.

Ključne riječi: pir, organski uzgoj, ekonomski rezultati, prinos zrna

INTRODUCTION

The increasing interest on ancient wheat cultivars is based on their characteristic nature, particularly appropriate for low-input and organic managements, and on the "perceived" higher nutritional value of their flour, with respect to modern wheats, as to conclude Dinu et al. (2018). Spelt (*Triticum spelta* L.) is one of the oldest types of cereals (Andruszczak et al., 2011). The spelt grain is one of the rare plant products, which contains, besides proteins (in some cultivars it is over 20 %), almost all essential amino acids that humans require. Additionally, it is rich in carbohydrates, fibers, unsaturated fats, minerals matters (Ca, K, Fe, P, Mg, Mn, K, Cu, Se, Na), vitamins A, C, and B complex, which are found in spelt in a higher concentration than in modern wheat. It is used mainly in the diets of humans and livestock due to these attributes (Büren et al., 2001). Spelt grows in the farming areas of modern wheat and even endures worse agro-ecological conditions better, which makes it an excellent choice for organic farming. The average grain yield amounts in the eastern part of Croatia are 3 t ha^{-1}. However, utilizing quality agro-technics and crop rotation, even greater yield can be achieved. Troccoli and Codianni (2005) reported an average spelt grain yield of 3.09 t ha^{-1} in southern Italy, Lacko--Bratošava et al. (2010) cited 5.84 t ha^{-1} in Slovakia, Andruszczak et al. (2011) between 4.07 and 4.45 t ha^{-1} in Poland, and Jablonskyte-Rašče (2013) between 3.44 and 5.26 t ha^{-1} in Lithuania. Furthermore, the Republic of Croatia has previously had high spelt grain yields as well. Kovačević (2010) reported that the cultivar "Nirvana" achieved an unshelled grain yield of 6.92 t ha^{-1}, while Pospišil et al. (2011) in research with two cultivars found the average unshelled grain yields of 6.49 and 6.92 t ha^{-1}. The medium late spelt cultivar "BC Vigor", created in the Bc Institut d.d. Zagreb, as quoted by Mlinar and Ikić (2012), in two years of experiments on four locations, gives an average grain yield of 5.002 t ha^{-1}. Farkaš (2012) gained 5.631 t ha^{-1} of unshelled grain with two spelt cultivars during a one-year experiment. Dolijanović et al. (2012) reported a grain yield of 7.34 t ha^{-1} in the organic spelt farming with the organic fertilizer implemented before the sowing and topdressing with a microbiological fertilizer. Topdressing with nitrogen positively influences the unshelled spelt grain yield, so two spelt cultivars achieved a yield of 4.99 and 4.62 t ha^{-1} in the first year, and 6.85 and 6.16 t ha^{-1} in the second year of research (Pospišil et al., 2016). It should be mentioned that spelt endures adverse growth conditions such as moist and cold soil (Campbell et al., 1997). Thus, Rüegger et al. (1990) found that spelt even in those conditions shows a high degree of germination, high ability of shoot formation, and large grain, which allow for higher grain

yield in spelt. Moudry and Dvoracek (1999) conclude that generally, it is possible to recommend spelt for production with lower investments due to its better usage of nutrients and higher content of mineral substances. Thus, growers can extend crop rotation and contribute to the sustainable development and use of genetic plant resources (Konvalina et al., 2010).

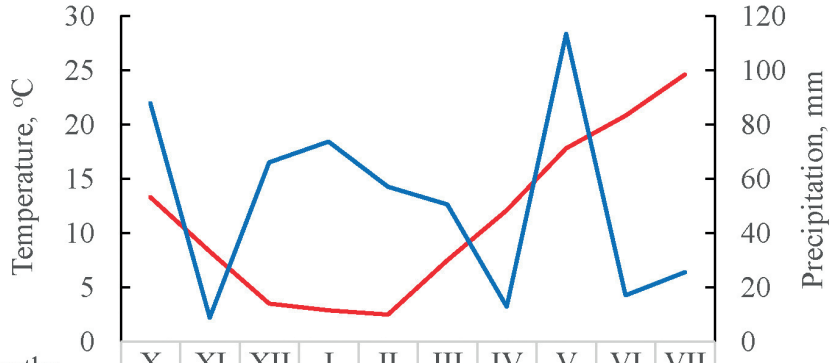
This paper aimed to describe the organic farming of this culture ("Frankenkorn" cultivar) in agro-ecological conditions of a small part of Eastern Slavonija and establish economic indicators for two consecutive growing seasons.

MATERIALS AND METHODS

The family farm "Klica" was registered in 2002 in Ernestinovo, Croatia (45^0 27' N, 18^0 39' E, 84 m altitude). Application for the transition into ecological agriculture was filled in 2010 in the "Prva ekološka stanica" (HR-EKO-02), and three years later their first contracted production was commenced with the German company "Natur Gold Farms", headquartered in Hungary. In sowing season 2014/2015 on 27.99 ha the seed of "Frankenkorn" cultivar of genuine spelt of the German partner production was used. The seed satisfies necessary organic standards and it is certified as organic with the "Institute for ecological agriculture of the Republic of Hungary". Seed purity was 98 % and germination 95 %. This cultivar 1000 grain mass was 40.5 g and the hectolitre mass of shelled grain was 79.5 kg. In the previous season, the same cultivar was grown on this farm (40 ha). During the spelt vegetation, the climate indicators were tracked (average monthly air temperature and monthly rainfall, Graph 1), which in the combination with long-term means (between the years of 1981 and 2010, Graph 2) of the same indicators (Državni hidrometeološki zavod Hrvatske, 2015), were used in the interpretation of climate conditions. The average monthly air temperature in the months during vegetation was 11.33 ^{o}C, which is by 1.58 ^{o}C higher than the average monthly air temperature for that vegetation period in perennial average. The move in temperature was similar for the most part to the perennial pattern, apart from January which was a bit warmer than average. The total rainfall for the months of vegetation was 512.6 mm, which is 38.8 mm less than the sum of the long-term means of the total monthly rainfall for that period. The area was characterized by a period of increased humidity from November to March and a period of more severe drought in June and July. However, in the growing season, three periods of increased humidity (October, December-March, and

May) and three periods of drought (November, April, and June-July) were distinguished. The soil on the area of Ernestinovo is characterized to be semigley, with a good structure, good water and air capacity, well supplied with nutrients and with 3-5 % of mild hummus (Vukadinović, 2012).

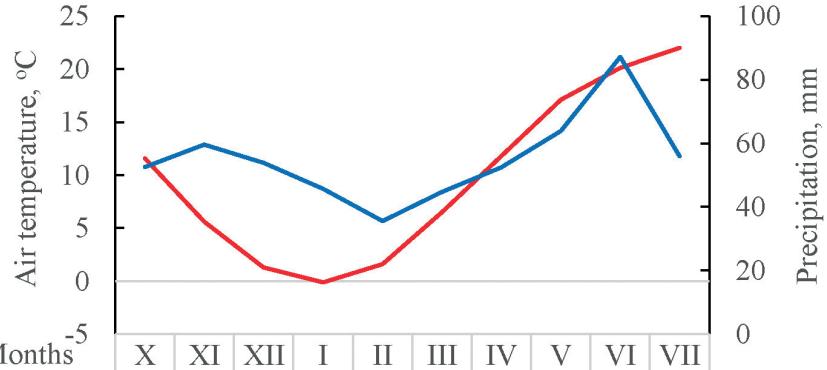
The parameters that indicate the efficiency and profitability of production were made according to Karić (2002). The cost structure was made based on analytical calculation and percentage of share of individual costs in the structure of total costs. Estimates of efficiency and profitability are given based on the calculation of the efficiency coefficient and the rate of profitability, respectively. The price of an hour of work was obtained by multiplying the amount of work and the price of labor (data and prices obtained by researching the same in the area of eastern Croatia).



Months	X	XI	XII	I	II	III	IV	V	VI	VII
Temperature	13,3	8,3	3,5	2,9	2,5	7,5	12,1	17,8	20,8	24,6
Precipitation	87,9	8,8	66	73,7	57,1	50,5	12,9	113	17,1	25,6

Graph 1 Walter climate diagram for the months of spelt vegetation (October 2014 - July 2015) for Ernestinovo (meteorological station Osijek)

Grafikon 1. Klimagram prema Walter-u za mjesece vegetacije pira (listopad 2014. - srpanj 2015.) za Ernestinovo (meteorološka postaja Osijek)



Months	X	XI	XII	I	II	III	IV	V	VI	VII
Temperature	11,6	5,6	1,3	-0,1	1,6	6,5	11,8	17,1	20,1	22
Precipitation	52,5	59,6	53,9	45,7	35,6	44,7	52,4	63,9	87,1	56

Graph 2 Walter climate diagram of a long-term means for a vegetation period of spelt (October – July) for Ernestinovo (meteorological station Osijek)

Grafikon 2. Klimagram prema Walteru višegodišnjih prosjeka za vegetacijsko razdoblje pira za Ernestinovo (meteorološka postaja Osijek)

RESULTS AND DISCUSSION

Spelt was cultivated on 27.99 ha, from which 19.99 ha had a pre-crop of field pea and 8 ha had a pre-crop of soybean. Crop of field pea remained unharvested, so a pass with 1.6 m flail mower Messis and two passes with the disc harrow Olt Drava 34 were implemented. After the harvest of soybean, two passes with disc harrow Olt Drava 34 and one pass with 6 m seedbed cultivator Rau were implemented. Sowing was implemented between the 27th and 29th October 2014, and a pneumatic seed drill Olt Eta 24 in the sowing rate of 200 kg ha^{-1} of grain was used. Fertilization and topdressing were not carried out, and the crop care consisted of a pass with skimming cultivator (Grubber) Rau 12 in early February with the task of destruction of sprouted weeds. Harvest was implemented between 13th and 19th of July of 2015 using a grain harvester Đuro Đaković M1620. The total harvested amount of grain was 104 tonnes. At approximately 5 ha there was no crop due to the waterlogging. The average grain yield was 3.71 t ha^{-1}. In the previous season, an average yield of 2.63 t ha^{-1} was obtained on 40 ha of land (Rapčan et al., 2016). Ugrenović

(2013) quotes spelt grain yield of 3.46 t ha^{-1} in the sowing in early October, but also the lowered yield by 4 % and 19.7 % in late October and in the middle of November sowing respectively. Thus, the yield of spelt grain in the previous season was probably most by influenced by delayed sowing (Rapčan et al., 2016). However, a review of research by a multitude of authors has shown that spelt is a culture that could give far higher yields.

Based on the data collected on material costs and realized revenues in the spelt production on the family farm, economic indicators for the previous (2013/2014) and this (2014/2015) growing season were calculated, which are presented in Tables 1 and 2, and comparison is presented here. According to Ranogajec et al. (2014), one of the goals of agricultural management is to operate economically, ie. to cover the costs from the total revenue realized. Therefore, it is necessary to monitor the technical and technological conditions and economic results of individual crops represented in the sowing structure. In the previous breeding season, 50 t of poorer quality grains were paid HRK 114,600.00, and 55 t of better quality grains were HRK 252,120.00. With incentives, total revenues amounted to HRK 582,430.95 (Rapčan et al., 2016). Thus, a profit of HRK 338,144.69 (HRK 8,453.62 ha^{-1}) was achieved, with a very high efficiency coefficient of 2.38 and a profitability level of 138 %. The most significant item in the cost structure is machine operation (25.67 %), which is calculated from the average work cost of all the machines used. This is followed by seeds (18.76 %), land rental cost (14.49 %), and fertilizer (10.34 %), as can be seen from Table 1. In the second year analyzed, according to the data in Table 2, excellent economic results were achieved in the spelt production, with profit amounting to HRK 291,653.59 (HRK 10,419.92 ha^{-1}).

Table 1 Analytical calculation of spelt production in season 2013 / 2014

Tablica 1. Analitička kalkulacija proizvodnje pira u sezoni 2013. / 2014.

Elements (Elementi)	Unit (Jedinica)	Amount (Količina)	Price, HRK Cijena, kn)	Value, kn (Vrijednost, HRK)
INCOME (PRIHODI)				
Grain	t	50	2,292.69	114,634.50
(Seed)	t	55	4,585.39	252,196.45
Incentives (Poticaji)	ha	40	5,390.00	215,600.00
TOTAL INCOME (UKUPNI PRIHODI)				582,430.95

COSTS (TROŠKOVI)				
Seed (Sjeme)	kg	8,000	5.73	45,840.00
Fertilizer (Gnojivo)	kg	6,000	4.21	25,260.00
Fuel (Gorivo)	l	1,990	6.31	12,556.90
Land rent (Najam zemljišta)	ha	40	885.00	35,400.00
Organic inspection (Ekološki nadzor)	ha	40	335.78	13,431.41
Organic certification (Ekološko potvrđivanje)	ha	40	83.95	3,357.95
People labour (Rad ljudi)	h	600	25.00	15,000.00
Machine work (Rad strojeva)	ha	40	1,567.50	62,700.00
Grain storage (Skladištenje zrna)	t	105	60.00	6,300.00
Crop insurance (Osiguranje usjeva)	ha	40	150.00	6,000.00
General expences (Opći troškovi)	ha	40	350.00	14,000.00
Interest (Kamate)	ha	40	111.00	4,440.00
TOTAL EXPENCES (UKUPNI TROŠKOVI)				244,286.26
PROFIT (DOBIT)				338,144.69

(Source: Rapčan et al., 2016)

The efficiency coefficient was 2.65 with a profitability level of 165 %. Seed costs with a share of 42.68 % ise the most significant cost item, followed by machines (15.79 %), land rent (13.98 %), and production control (5.37 %). A comparison of the economic indicators of the spelt production in two consecutive seasons on this family farm shows that both the efficiency and the profitability of production were higher in the second season (2.38 and 138 % as compared to 2.65 and 165 %, respectively).

Table 2 Analytical calculation of spelt production in season 2014 / 2015

Tablica 2. Analitička kalkulacija proizvodnje pira u sezoni 2014. / 2015.

Elements (Elementi)	Unit (Jedinica)	Amount (Količina)	Price, HRK Cijena, kn)	Value, kn (Vrijednost, HRK)
INCOME (PRIHODI)				
Grain (Sjeme)	t	104	3,057.80	318,006.00
Incentive (Poticaji)	ha	27.99	5,390.00	150,866.10
TOTAL INCOME (UKUPNI PRIHODI)				468,872.10
COSTS (TROŠKOVI)				
Seed (Sjeme)	kg	13,200	5.73	75,636.00
Fuel (Gorivo)	l	1,470	6.10	8,967.00
Land rent (Najam zemljišta)	ha	27.99	885.00	24,771.15
Production control (Nadzor proizvodnje)	ha	27.99	340.00	9,516.60
Organic inspection (Ekološko potvrđivanje)	ha	27.99	83.95	2,349.76
People labour (Rad ljudi)	h	320	25.00	8,000.00
Machine work (Rad strojeva)	ha	27.99	1,000.00	27,990.00
Grain storage (Skladištenje zrna)	t	104	60.00	6,240.00
Crop insurance (Osiguranje usjeva)	ha	27.99	150.00	4,200.00
General expenses (Opći troškovi)	ha	27.99	230.00	6,440.00
Interest (Kamate)	ha	27.99	111.00	3,108.00
TOTAL EXPENCES (UKUPNI TROŠKOVI)				177,218.51
PROFIT (DOBIT)				291,653.59

CONCLUSION

The spelt (*Triticum spelta* L.) cultivar "Frankenkorn" was grown on the 27.99 ha of the "Klica" family farm in Ernestinovo. According to climatic indicators, the growing season was slightly warmer and significantly wetter than the long-term average for this area. The agro-technical measures of cultivation were carried out following the principles of organic plant cultivation. Grain yield of 104 tonnes (3.71 t ha^{-1}) was achieved. Economic indicators for this and the previous season indicate the profitability of organic growing of spelt under these agro--ecological conditions. To promote the cultivation of this valuable grain, further study of numerous cultivars under different agro-ecological conditions should be carried.

REFERENCES

1. Andruszczak, S., Kwiecinska-Poppe, E., Kraska, P., Palys, E. (2011): Yield of winter cultivars of spelt wheat (*Triticum aestivum* ssp. *spelta* L.) cultivated under diversified conditions of mineral fertilization and chemical protection. Acta Scientiarum polonorum, 10 (4), 5-14.
2. Büren, M., Stadler, M., Luthy, J. (2001): Detection of wheat adulteration of spelt flour and products by PCR. European Food research and Technology, 212, 234-239.
3. Dinu, M., Whittaker, A., Pagliai, G., Benedettelli, S., Sofi, F. (2018): Ancient wheat species and human health: Biochemical and clinical implications. Journal of Nutritional Biochemistry, 52, 1-9.
4. Campbell, K.G. (1997): Spelt: agronomy, genetics and breeding. Plant Breeding Reviews, 15, 187-213.
5. Dolijanović, Ž., Oljača, S., Kovačević, D., Jug, I., Stipešević, B., Poštić, D. (2012): Utjecaj agrotehničkih mjera na prinos zrna pira (*Triticum aestivum* spp. *spelta*) u organskom sustavu uzgoja. Zbornik radova 47. hrvatskog i 7. međunarodnog simpozija agronoma, Opatija, Hrvatska, 51-55.
6. Srednje mjesečne temperature zraka i ukupna mjesečna oborina. Državni hidrometeorološki zavod Hrvatske. Dostupno na: www.dhmz.ht.net.hr
7. Farkaš, D. (2012): Utjecaj sorte i intenziteta agrotehnike na prinos i komponente prinosa pira (*Triticum spelta* L.). Diplomski rad, Agronomski fakultet, Sveučilište u Zagrebu.
8. Jablonskyte-Rašče, D., Maikšteniene, S., Mankevičiene, A. (2013): Evaluation of productivity and quality of common wheat (*Triticum aestivum* L.) and spelt (*Triticum spelta* L.) in relation to nutrition conditions. Zemdirbyste-Agriculture, 100 (1), 45-56.

9. Karić, M. (2002): Kalkulacije u poljoprivredi, Poljoprivredni fakultet u Osijeku, Osijek.
10. Konvalina, P., Capouchova, I., Stehno, Z., Moudry, J. (2010): Agronomic characteristics of the spring forms of the wheat landraces (einkorn, emmer, spelt, intermediate bread wheat) grown in organic farming. Journal of Agrobiology, 27 (1), 9--17.
11. Kovačević, M. (2010): Utjecaj gustoće sklopa na prinos i komponente prinosa pira (*Triticum spelta* L.). Završni rad, Agronomski fakultet, Sveučilište u Zagrebu.
12. Mlinar, R., Ikić, I. (2012): Bc Vigor – novi kultivar ozimog pravog pira. Sjemenarstvo 29 (1-2), 15-23.
13. Moudry, J., Dvoracek, V. (1999): Chemical composition of grain of different spelt (*Triticum spelta* L.) varieties. Rostlinna Vyroba, 45 (12), 533-538.
14. Pospišil, A., Pospišil, M., Svečnjak, Z., Matotan, S. (2011): Influence of crop management upon the agronomic traits of spelt (*Triticum spelta* L.). Plant, Soil and Environment 57 (9), 435-440.
15. Pospišil, A., Pospišil, M., Brčić, M. (2016): Influence of seeding rate and nitrogen topdressing upon the agronomic traits of spelt (Triticum spelta L.). Romanian Agricultural Research, 33, 235-240.
16. Ranogajec, Lj., Kanisek, J., Deže, J. (2014): Ekonomski rezultati proizvodnje soje u Hrvatskoj, Zbornik radova 49. hrvatskog i 9. međunarodnog simpozija agronoma, Dubrovnik, Hrvatska, 171-176.
17. Rapčan, I., Jurišić, M., Pugelnik, I., Hajduk, S. (2016): Ekološka proizvodnja pira (*Triticum spelta* L.) na obiteljskom gospodarstvu. Proceedings & Abstracts of the 9th international scientific/professional conference Agriculture in Nature and Environment Protection, Vukovar, Hrvatska, 158-161.
18. Rüegger, A., Winzeler, H., Nösberger, J. (1990): Dry matter production of spelt (*Triticum spelta* L.) and wheat (*Triticum aestivum* L.) under different environmental conditions in the field. Journal of Agronomy and Crop Science, 164 (3), 145-152.
19. Troccoli, A., Codianni, P. (2005): Appropriate seeding rate for einkorn, emmer, and spelt grown under rainfed condition in southern Italy. European Journal of Agronomy, 22 (3), 293-300.
20. Ugrenović, V. (2013): Uticaj vremena setve i gustine useva na ontogenezu, prinos i kvalitet zrna krupnika (*Triticum spelta* L.). Doktorska disertacija. Poljoprivredni fakultet, Univerzitet u Beogradu.
21. Vukadinović, V. (2012): Pedološka karta Osječko-baranjske županije. Available at www.pedologija.com.hr [Accessed 5 September 2015].

Adrese autora - Autor's addresses:
Irena Rapčan, e-mail: irapcan@fazos.hr
Daria Galić Subašić,
Ljubica Ranogajec,
Stjepan Hajduk
Faculty of agrobiotechnical sciences Osijek,
Vladimira Preloga 1, 31000 Osijek, Hrvatska

Primljeno – Received:
17.03.2020.