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EFFICASY OF NATURAL POPULATION OF *Trichogramma* WASPS AGAINST EUROPEAN CORN BORER IN FIELD MAIZE

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SUMMARY

The aim of this study was to determine the natural infestation of European corn borer (ECB) eggs by Trichogramma wasps (Hymenoptera: Trichogrammatidae) under field conditions. The experiment was set up in Osijek, Croatia in 2013. The experiment included two levels of irrigations, two nitrogen rates and two maize genotypes. Parameters of ECB feeding activity and maize tolerance (cob mass, tunnel length, number of ECB larvae per plant), as well as number of parasitized ECB eggs by Trihogramma wasps were evaluated. Genotypes were significantly different in terms of tolerance to ECB injury. In treatments with nitrogen fertilization, ECB feeding activity was increased at both nitrogen rates. Agricultural practices did not significantly affect parasitism of ECB eggs by Trichogramma. Correlation between parameters of ECB feeding activity and parasitism by Trichogramma was slight to moderate and not significant. Natural occurrence of Trichogramma wasps were not significantly affected by agricultural practices in maize, and population of these parasitoids was low significantly affect ECB feeding activity.

Key-words: Trichogramma wasps, irrigation, hybrid, nitrogen fertilization

INTRODUCTION

The two most important pests on maize in Croatia are European corn borer and western corn rootworm (Raspudić et al., 2013; Brkić et al., 2012; Ivezić et al., 2009; Ivezić et al., 2011; Šimić et al., 2007). Biological control of European corn borer, *Ostrinia nubilalis* (Hübner) with *Trichogramma* wasps (Hymenoptera: Trichogrammatidae) had a lot of attention in recent years (Kuhar et al. 2002; Wang et al., 1999; Wright et al., 2001, 2002; Hoffmann et al., 2002). Beneficial insects such as *Trichogramma* wasps can be used as part of an integrated management program for European corn borer to reducedamage. *Trichogramma* spp. s*howed* promise as *biocontrol* agents against European corn borer (Gardner at al. 2012). Many authors have hypothesized that greater plant surface area results with lower parasitism rate of the host plant (Ables et al. 1980; Burbutis and Koepke 1981; Wang et al. 1997; Gingras and Boivin 2002). *Trichogramma* wasps show certain level of control against the European corn borer in field maize, sweet corn, potatoes and sweet peppers (Kuhar et al. 2002; Wright et al. 2002; Hoffmann et al. 2006). Since in Croatia there are no reports on natural population of *Trichogramma* in maize, these ones are the first findings.

The aim of this investigation was to determine influence of natural population of *Trichogramma* wasps against European corn borer under different irrigation and fertilization rates in maize field.

MATERIAL AND METHODS

An experiment was set up during 2013 growing season under field conditioned of Agricultural Institute in Osijek. Two maize hybrids have been tested in order to determine the influence of *Trichogramma* wasps on European corn borer damage. Irrigation and nitrogen fertilization treatments were also included in the experiment. The experiment was set up as split-split plot design with three repetitions. The treatment includes three irrigation levels, A1 - control variant, only natural precipitation, A2 - 60% -100% field water capacity (FWC), and A3 - 80%-100% FWC. Three rates of the nitrogen fertilizer (B1 - control variant, B2 - 100 kg N ha^{-1} and B3 - 200 kg N ha^{-1}) were used. Two different genotypes with

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similar vegetation group were tested: C1 = OSSK 596; C3 = OSSK 602. At the end of vegetation, before harvest, dissection parameters where determined from ten maize plant on each variant of the experiment. Tested variable were MC - mass of cob (g), TL - tunnel length (cm), LS - number of larvae in stalk, LES - larvae in ear shank and ESD - ear shank damage. During the vegetation season parasitized eggs with *Trichogramma* wasps were also monitored on ten maize plants of each variant. Only the second generation of ECB eggs was infested with natural population of *Trichogramma* wasps. For the analysis of variance, an ANOVA was carried out with the Tukey test. Statistical Software Package (SAS, 2009) procedure.

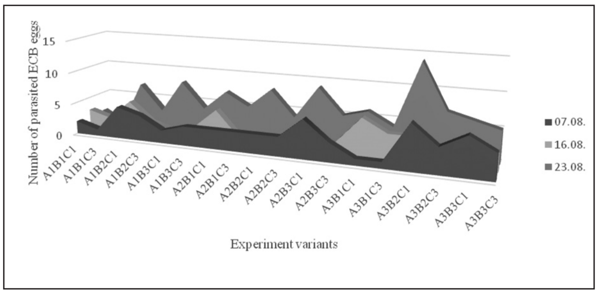

Figure 1. Parasitized ESB eggs by *Trichogramm*a wasps

Slika 1. Parazitirana jajašca kukuruznoga moljca Trichogramma osicama

RESULTS AND DISCUSSION

The most parasitized ECB egg masses were on 23 August (Figure 1). 14 parasitized egg masses by *Trichogramma* were found on hybrid OSSK 596 at higher level of irrigation and lower level of nitrogen fertilization (A3B2C1). Only one parasitized egg mass was found on few variants on 7th August (A3B1C3, A1B1C3 and A3B1C1). Hybrid C1 had higher number of parasitized egg masses than hybrid C3 in all tested variants. We can say that the peak of the *Trichogramma* wasp flight was in the second half of August in this area.

Influence of nitrogen fertilization on tested variables is presented in Table 1. Nitrogen fertilization increased mass of cob in all the tested variants but also increased ECB attack and damage. All the tested variables had greater damage and more larvae number in fertilized variants than the control (Szulc et al., 2008; Yanni et al., 2010). There were no big differences in tested parameters between the two nitrogen fertilization rates. *Trichogramma* wasp infestation was also higher in the variant with higher level of nitrogen but there were no statistically significant differences (Wang et al., 1997).

Table 1. Nitrogen fertilization influence on the tested variables between different hybrids

Tablica 1. Utjecaj dušične gnojidbe po hibridu na ispitivanim varijablama

Genotype - C1 *Genotip – C1*					
	MC	TL	TLN	ESD	T
B1	196.81^{b}	22.27^{b}	2.05^{b}	1.53^{b}	4.00^{a}
B2	314.11^{a}	40.70^{a}	2.51^{a}	2.20^{ab}	6.00^{a}
B3	350.48^{a}	44.85^{a}	3.52^{a}	2.68^{a}	4.66^{a}
Genotype - C3 *Genotip – C3*					
B1	192.80^{b}	16.87^{b}	1.78^{b}	1.98^{a}	2.33^{a}
B2	318.22^{a}	31.01^{a}	2.08^{b}	1.86^{a}	3.44^{a}
B3	356.21^{a}	33.95^{a}	2.53^{a}	2.55^{a}	3.44^{a}

Values with different letter in the same column are statistically different ($P<0.05$)

Plant complexity may have been a factor for pests attraction (Gingras and Boivin, 2002). Hybrid C1 had higher mass of cob than hybrid C3 in all the tested variants except in A2B3 – 343.90; A3B1 – 214.10 and A3B2 – 295.20 (Table 2). By raising nitrogen level mass of cob increased. All B3 variants had high influence on the mass of cob especially interact with irrigation. C1 hybrid was more susceptible to corn borer attack than hybrid C3. In all the tested variants tunnel length was higher at C1 hybrid than C3. Maximum tunnel length was in the variant without irrigation at both levels fertilization at hybrid C1 (A1B2C1-54.17; A1B3C1-51.23) and in the variant with the highest irrigation level and also both levels of nitrogen fertilization (A3B2C1- 40.47; A3B3C1-50.17). Hybrid C3 had the highest value tunnel length in variant A3B3 (39.16). Number of ECB larvae per plant was also higher on hybrid C1 than C3 in all variants except A3B1 – 1.60. Number of ECB larvae was higher in variants with nitrogen fertilization (B2, B3) than in the control (B1). Ear damage was higher at C3 hybrid than C1 and this can be the reason for smaller mass of cob C3 hybrid. Number of parasitized ECB egg masses was higher in C1 than C3 hybrid in all the tested variants.

Table 2. Influence of all the tested variants on European corn borer damage parameters

Tablica 2. Utjecaj ispitivanih varijanti na parametre oštećenja od kukuruznoga moljca

	Mass of cob (g) *Masa klipa (g)*	Tunnel length (cm) *Dužina oštećenja stabljike (cm)*	Larvae *Ličinke*	Ear shank damage *Oštećenje drške klipa*	*Trichogramma* parasitized eggs *Jajašca parazitirana s Trichogramma*
A1B1C1	197.07^{cd}	21.23^{defg}	2.07^{abcd}	1.16^{def}	2.33^{bc}
A1B1C3	181.20^{d}	17.53^{g}	1.67^{bcd}	1.70^{abcdef}	1.00^{c}
A1B2C1	305.13^{ab}	54.17^{a}	2.67^{abcd}	2.93^{abcd}	5.66^{ab}
A1B2C3	296.67^{abc}	31.70^{abcde}	2.00^{abcd}	2.13^{abcde}	3.00^{bc}
A1B3C1	323.33^{a}	51.23^{ab}	3.27^{abc}	3.10^{abc}	3.66^{bc}
A1B3C3	305.80^{ab}	36.80^{abcdef}	2.67^{abcd}	3.43^{a}	3.00^{bc}
A2B1C1	179.27^{d}	28.23^{abcdefg}	2.50^{abcd}	2.00^{abcdef}	5.33^{ab}
A2B1C3	161.60^{d}	16.30^{fg}	2.00^{abcd}	2.06^{abcdef}	3.00^{bc}
A2B2C1	342.00^{a}	27.47^{bcdefg}	2.30^{abc}	1.00^{ef}	4.00^{bc}
A2B2C3	325.27^{a}	25.57^{cdefg}	2.03^{bcd}	0.63^{f}	3.00^{bc}
A2B3C1	343.90^{a}	33.17^{abcd}	3.67^{ab}	1.23^{cdef}	5.66^{ab}
A2B3C3	387.93^{a}	25.90^{bcdefg}	2.50^{abcd}	1.30^{bcdef}	3.33^{bc}
A3B1C1	214.10^{bcd}	17.37^{g}	1.60^{d}	1.45^{bcdef}	4.33^{abc}
A3B1C3	235.60^{bcd}	16.80^{efg}	1.70^{cd}	2.20^{abcde}	3.00^{bc}
A3B2C1	295.20^{ab}	40.47^{abc}	2.57^{abcd}	2.66^{abcde}	8.33^{a}
A3B2C3	332.73^{a}	35.77^{abcde}	2.23^{abcd}	2.83^{abcd}	4.33^{abc}
A3B3C1	384.20	50.17^{abc}	3.63^{a}	3.73^{ab}	4.66^{abc}
A3B3C3	374.90	39.17^{abc}	2.43^{abcd}	2.91^{abcde}	4.00^{bc}

Values with different letter in the same column are statistically different ($P<0.05$)

There was no statistically significant and strong correlation between tested parameters and parasitized ECB eggs by *Trichogramma* wasps (Table 3). There was a moderate relationship in the control variant of irrigation between mass of cob and *Trichogramma* wasps but no statistically significant (0.572). Also, results suggest negative weak correlation between mass of cob and *Trichograma* wasps in both variants of nitrogen fertilization (-0.424 and -0.416) but not statistically significant.

Table 3. Correlation coefficient between dissection parameters and *Trichogramma* wasps infection in different variants

Tablica 3. Korelacijski koeficijent između parametara oštećenja kod disekcije izaraženosti jaja Trihogramma osicama na različitim varijantama

	Irrigation levels *Varijante navodnjavanja*			Nitrogen fertilization *Varijante dušične gnojidbe*			Genotype *Genotip*	
	A1	A2	A3	B1	B2	B3	C1	C3
$r_{mc;t}$[1]	0.572	-0.378	-0.133	-0.424	-0.416	-0.245	0.063	0.284
$r_{tl;t}$[2]	0.278	-0.043	0.009	0.019	0.054	-0.130	-0.183	0.166
$r_{ls;t}$[3]	0.120	0.225	0.247	0.455	0.147	0.021	0.214	0.066
$r_{les;t}$[4]	0.023	-0.018	-0.161	0.043	-0.080	0.054	-0.163	0.206
$r_{tln;t}$[5]	0.132	0.167	0.221	0.428	0.118	0.062	0.193	0.118
$r_{esd;t}$[6]	-0.166	0.337	0.028	-0.477	0.491	0.249	0.202	-0.002

[1]mc-mass of cob, t-*Trichogramma* infected egg masses, [2]tl-tunnel length, [3]ls- number of larvae in maize stalk, [4]les-number of larvae in ear shank, [5]tln-total larvae number per plant, [6]esd-ear shank damage

CONCLUSION

Hybrid C1 was more susceptible than hybrid C3 on European corn borer attack, but this hybrid also had satisfactory yield. In all the tested ECB damage parameters, values were higher in hybrid C1 than hybrid C3. By raising nitrogen fertilization rate ECB damage also increased. *Trihogramma* infected eggs were more in C1 hybrid than C3. Different levels of nitrogen fertilization and irrigation didn't have high influence on occurrence of the *Trichogramma* wasps. These results suggest that efficacy of *Trichogramma* wasps might be constrained by field corn planted at a greater density, and is typically a taller crop with greater leaf area than other crops. *Trichogramma* activity was not enough strong in natural conditions and it is necessary to apply artificial infestation against this pest.

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UČINKOVITOST PRIRODNE POPULACIJE OSICA *Trichogramma* U SUZBIJANJU KUKURUZNOGA MOLJCA U POLJSKIM UVJETIMA

SAŽETAK

Cilj rada bio je utvrditi parazitiranost jajašaca kukuruznoga moljca s osicama roda Trichogramma (Hymenoptera: Trichogrammatidae) u prirodnim uvjetima. Pokus je postavljen u Osijeku, Hrvatska, 2013. godine. U pokus su uključene dvije razine navodnjavanja i gnojidbe i dva hibrida kukuruza. Mjereni su parametri oštećenja te tolerantnost hibrida (masa klipa, dužina oštećenja stabljike kukuruza, broj ličinki kukuruznoga moljca po biljci), kao i broj parazitiranih jajašaca osicom Trichogramma na oštećenost od kukuruznoga moljca. Hibridi su se značajno razlikovali u pogledu tolerantnosti na parazitaciju kukuruznim moljcem. Parazitacija kukuruznim moljcem povećana je u obje razine gnojidbe dušikom. Poljoprivredna praksa nije značajno utjecala na parazitaciju jajašaca osicom Trichogramma. Korelacija između parametara oštećenja od kukuruznoga moljca i parazitiranih jajašaca Trichogrammom bila je slaba do umjerena te nije bila statistički značajna. Parazitacija jajašaca kukuruznoga moljca osicom Trichogramma u prirodnim uvjetima nije značajno utjecala na oštećenja kukuruza od kukuruznoga moljca, jer je populacija bila malobrojna.

Ključne riječi: Trichogramma osice, hibrid, dušična gnojidba, navodnjavanje

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