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COMPOSITION, DENSITY AND DOMINANCE OF WEEDS IN MAIZE AT DIFFERENT NUTRIENT SUPPLY LEVELS

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Abstract: As the world's third most important crop, maize has to be researched in many ways. The composition of weed flora, number of species, density and dominance of weed species were studied in a long-term fertilization experiment, which was set up in 2003 in Nagyhörcsök, Hungary. The experimental area has loamy chernozem soil with lime deposits. The examinations were proceeded in two treatments: control and NPK. Weeds were collected in 1 square meter sampling areas in every plot by species. Conclusions were deduced by mathematical statistics in the context of nutrient supply. Experimental results proved a strong correlation between density of weeds and nutrient supply. As a result of the NPK treatment, the total weed density was 65% more compared to the untreated control plots. Eight weeks after sowing of maize, the average weed density was 133 plant·m^{-2}. The dominance index of weed species was different in the control and NPK treatment. In the order of dominance *Ambrosia artemisiifolia* (61%) was on the first place in the control plots and *Chenopodium album* (52%) in the NPK treated plots.) In the control treatment without fertilizers A. artemisiifolia was the most frequented weed species and had a highest density. It had strong competitiveness under these conditions.

Keywords: maize, weeds, competition, density, dominance index, nutrient supply

Introduction

Nowadays weed control is dominated by herbicides, which requires the development of alternative methods. For a sustainable crop production, the interactions between weeds and cultivated plants, and the behaviour of weeds in agro-ecosystems have to be known (Lehoczky & Márton, 2012; Lehoczky et al., 2004). Maize (*Zea mays*) is highly sensitive to weed competition, which may cause even 30% yield loss (Lehoczky et al., 2006). Nevertheless a little amount of investigation paid attention for the competition between maize and weeds (Rajcan & Swanton, 2001).

As a result of the increasing fertilizer usage and changing of crop production technologies, the weed flora and its composition have changed (Lehoczky et al., 2013). The nowadays dominant and spread species have strong adaptive capacity, and bring direct or indirect damage on crop yield. Remarkable differences can be shown in the diversity and cover of weeds depending on the type and level of fertilization (Lehoczky et al., 2008). Weed species react differently to the nutrient supply (Kismányoky & Lehoczky, 2007). Well known fact that nutrients help crop growth, but on the other hand, fertilizers promote weeds even more in certain cases (Chamanabadi et al., 2007). For example, the addition of N can increase the nitrophilous species, such as *Chenopodium album* L., which accumulates nitrogen and potassium (Lehoczky 1989, Chamanabadi et al., 2007), or *Amaranthus retroflexus* L. is able to accumulate several times much phosphorus than crops (Maqbool, 2006). Thus, the depletion of nutrients with the presence of weed species is required to be investigated (Lindquist et al., 2010).

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Materials and methods

Investigations were carried out in a long-term fertilization experiment with maize (DKC 4983), sown on April 23, 2013 in Nagyhörcsök, Hungary. The fore crop was maize. The soil is loamy chernozem with lime deposits (FAO Calcaric Phaeozem). Soil samples were taken in August, 2003 to estimate the soil nutrient status. Results are indicated in *Table 1*.

Table 1 The soil properties on the experimental area

OM	Total salt	pH_{KCl}	y_1	$CaCO_3$	AL-P_2O_5	AL-K_2O
%	%			%	$mg \cdot kg^{-1}$	
2.95	0.02	7.1	0.0	3.9	90	167

Weed survey was executed on control (Ø) and fertilized (NPK) plots (150kg $N \cdot ha^{-1} \cdot yr^{-1}$, 100kg $P_2O_5 \cdot ha^{-1} \cdot yr^{-1}$, 100kg $K_2O \cdot ha^{-1} \cdot yr^{-1}$), with 3 replications. The size of randomly blocked plots was 4.9 x 15m (73.5 m^2). On each of them two 2x2m (4m^2) areas were kept herbicide free. Sampling and counting of weeds was carried out on the non-controlled weedy areas (1m^2) and all of the plants were collected from. The composition of weed flora and the density of weed species were determined on 4th June, 2013, on the eighth week after the sowing of maize. This was the first sampling time in growth stages of 2-4 leaves of maize (BBCH 13).

Between sowing and the first sampling time 66.5 mm precipitation was detected which is not differs significantly from the 45 years mean. Similar statement can be established for the temperature values too.

The index of dominance of weeds was calculated by the Berger-Parker index (Magurran, 1988). Statistical analysis of the experimental data was made by MSTAT software.

Results and discussion

At the time of the investigation, 12 weed species occurred on the studied herbicide free sample areas. 7 species were present on the control (Ø) plots and 11 on the fertilized (NPK) treatments (Table 2). The difference between the number of species of the Ø and NPK plots was not significant. The total weed density was 165.4 $plant \cdot m^{-2}$ on the NPK treated plots, which is mathematically proved more with 65% than on the control plots.

From the 12 weed species of the whole experiment, *Ambrosia artemisiifolia* L. and *Datura stramonium* L. occurred on every plots. From those species which were recorded in both treatments (Ø, NPK), the followings were found with the largest density: *A. artemisiifolia* > *Sorghum halepense* (L.) Pers. > *D. stramonium* (Table 2). The number of individuals of *A. artemisiifolia* and *S. halepense* was significantly higher in the control (Ø) plots compared to the fertilized (NPK) plots. For *A. artemisiifolia* and *S. halepense* this difference was 2.7 and 3.9 times more respectively. From all of the weeds in the control areas, 92% was represented by *A. artemisiifolia* and *S. halepense*, 4.6% by *D. stramonium*, and the remaining 3.4% by the additional four species. The density of *D. stramonium* was nearly three times higher in the case of the plots with good nutrient supply (NPK), which is associated with the remarkable nutrient requirements of this species. *Chenopodium album* and *Amaranthus blitoides* S. Watson also prefer this treatment (NPK), which are nitrophilous species (Lehoczky, 2004). The

individuals of these species were only presented on the fertilized plots. In NPK treatment, 52% of the total weed density was given by *C. album*.

Table 2 Density and frequency of weed species on the experimental plots

Weed species	Code	Freq.	Density (plant · m^{-2})		
			Ø	NPK	Average**
Ambrosia artemisiifolia L.	AMBAR*	6	62.0	23.3	42.7
Datura stramonium L.	DATST	6	4.7	13.3	9.0
Sorghum halepense (L.) Pers.	SORHA*	4	31.3	8.0	19.7
Chenopodium album L.	CHEAL	3	-	86.7	43.3
Fallopia convolvulus (L.) Á. Löve	FALCO	3	0.7	3.3	2.7
Solanum nigrum L.	SOLNI	3	0.7	1.3	2.0
Chenopodium hybridum L.	CHEHY	3	-	5.3	1.0
Helianthus annuus L.	HELAN	3	1.3	0.7	1.0
Amaranthus blitoides S. Watson	AMABL	1	-	20.7	10.3
Echinochloa crus-galli (L.) P. B.	ECHCG	1	-	2.0	1.0
Heliotropium europaeum L.	HELEU	1	-	0.7	0.3
Stachys annua L.	STAAN	1	0.7	-	0.3
		Total:	101.4	165.4	$LSD_{5\%}=28.2$

* $LSD_{5\%}$ AMBAR: 27.3 pc·m^{-2}; SORHA: 13.6 pc·m^{-2}; ** in average of control and NPK treatments

Based on the experimental results, dominance index was calculated for weed species of the different treatments (*Table 3*). According to the order of dominance, *A. artemisiifolia* was on the first place (61%) in the untreated control plots and on the second place (14%) in NPK treatments. *S. halepense* represented the second place of the range regarding the Ø, but in the NPK treatment this species was only the fifth. Nevertheless both species marginalized as a result of the interspecific competition by the highly competitive *C. album*. In the NPK treatment *A. blitoides* was present with a notable rate (13%), which resulted in the third place of the dominance order. The dominance index of *D. stramonium* is 1.5 times higher in the treatment which provides favourable conditions (NPK).

Table 3 Dominance of weed species in the different treatments

Weed species	Ø	NPK	Average*
Ambrosia artemisiifolia L.	0.610	0.140	0.320
Sorghum halepense (L.) Pers.	0.310	0.050	0.150
Datura stramonium L.	0.050	0.080	0.070
Solanum nigrum L.	0.010	0.007	0.007
Helianthus annuus L.	0.010	0.004	0.007
Stachys annua L.	0.010	-	0.002
Fallopia convolvulus (L.) Á. Löve	0.006	0.020	0.020
Chenopodium album L.	-	0.520	0.330
Amaranthus blitoides S. Watson	-	0.130	0.080
Chenopodium hybridum L.	-	0.030	0.020
Echinochloa crus-galli (L.) P. B.	-	0.010	0.007
Heliotropium europaeum L.	-	0.004	0.002

* in average of control and NPK treatments

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Conclusions

Based on the results of investigations on the long-term fertilization experiment, we can assess the following statements: i) On the eighth week after sowing of maize, remarkable weed density was detected on the herbicide free sample areas. It was in average of control and NPK treatments 133 plant·m^{-2}. ii) The total weed density was 101 plant·m^{-2} on the control plots (Ø) and 165 plant·m^{-2} on the plots with good nutrient supply (NPK). iii) The number of the weed species was higher in the fertilized treatment (11) compared to the control (7). iv) The dominance index of weed species was different in the control and NPK treatment. In the order of dominance, *A. artemisiifolia* (61%) was on the first place in the control plots and *C. album* (52%) in the NPK treated plots. This latter species was dominant in the weed flora with higher number of species and density, which proves its notable competitiveness. *A. artemisiifolia* represented the second place of dominance order with 14% in the case of NPK treatment contrary to the 61% in the control. v) In the control treatment without fertilizers *A. artemisiifolia* was the most frequented weed species and had a highest density. It had strong competitiveness under these conditions.

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