EFFECTS OF NUTRIENT SUPPLY ON THE WEED FLORA COMPOSITION IN EARLY GROWTH STAGE OF MAIZE

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Abstract: For an appropriate quality and quantity of crop yield, the evaluation of competition between weeds and maize (*Zea mays* L.) is necessary in early phases. The subject of our investigations was to determine the behaviour of weeds depending on different fertilizations. The location of the pilot field is Nagyhörcsök, a long-term fertilization experiment, which was set up in 2003. The survey was carried out in two consecutive years, at 2-4 leaf stage (BBCH 13) of maize. At the time of sampling, weeds were collected by species from 1 square meter herbicide-free plots. The composition of weed flora was described by the presence of weed species, the density, frequency and the order of dominance. The investigated nutrient treatments were as follows: control (without fertilization) Ø, NPK. The obtained data demonstrated a strong correlation between nutrient supply and the presence of weed species. *Ambrosia artemisiifolia* L. and *Datura stramonium* L. proved to be the most dominant species in both experimental years, since they appeared in every plots of every treatments. *Ambrosia artemisiifolia* L. was present with the largest density in all nutrient treatments except NPK. Namely in those plots with good nutrient supply, *Chenopodium album* L. had the highest density values. Weeds have a highly dynamic growing characteristic during the early periods, thus one week difference between the sowing times has notable impacts within the two experimental years.

Keywords: maize, nutrient supply, weed flora, density, dominance

Introduction

As the most important amplification factor in agriculture, the importance of fertilization is admitted. This pattern affects not only the yield and quality of the cultivated plant but the number and cover of weed species too (Černý et al., 2010). For an effective weed control, we need to know the correlations of soil and environmental factors and the interactions between weeds and cultivated plants. In the inspection of interspecific competition, the relevant question is how the populations share from the essential sources like water, light or nutrients (Lehoczky, 2004; 2014a). The study of interplant competition goes back up to 1900 (Kropff&Lotz, 1992). As a consequence of utilization of the same sources, weeds reduce yield quality and quantity measurably, which may occure as financial damage (Froud-Williams, 2002). Maize (*Zea mays* L.) is particularly sensitive to this hazard, the yield loss may reach 30% in case of strong weed growing (Lehoczky et al., 2014a). The diversity and cover of weed species is in close connection with the type and level of fertilization. Water supply also determines the composition of weed flora, as it influences nutrient availability (Lehoczky et al., 2007; 2014b). The contestability of these species depends not only on the consumable forms of nutrients and the applied system, but on the habit and development stage of weeds (Glowacka, 2012). The resource competition between maize and weeds has high importance, that is why examinations were carried out in a long-term field experiment. The objective of this study was to determine the influence of different nutrient supplies on the weed flora.

Materials and methods

Our investigations were carried out in Nagyhörcsök, Hungary. This long-term fertilization experiment was set up in maize (PR 4983) on loamy chernozem soil with lime deposits (FAO Calcaric Phaeozem). The weed flora was studied on control (Ø) and

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fertilized (NPK) plots (N: 150kg·ha^{-1}, P_2O_5: 100kg·ha^{-1}, K_2O: 100kg·ha^{-1}), with 3 replications in 2013 and with 6 in 2014 for a more accurate comparison. The size of the random block experimental plots was 73.5 m^2. The parameters of the soil nutrient status are indicated in *Table 1*.

Table 1. Soil parameters of the experimental area, 2003.

OM %	Total salt %	pH_{KCl}	y_1	$CaCO_3$ %	AL-P_2O_5 mg·kg^{-1}	AL-K_2O mg·kg^{-1}
2.95	0.02	7.1	0	3.9	90	167

The sampling time was the 4th of June in 2013 and the 3rd of June in 2014, both in an early growth stage (BBCH 13) of maize. On each of the examined plots, a small area was kept herbicide free. All of the weed plants were collected from these weedy areas (1m^2). To describe the composition of weed flora, the density and frequency were measured. The order of dominance was determined by the Berger-Parker index (Magurran, 1988). The temperature and precipitation values of the interval between sowing and sampling time do not differ significantly from the 45 years mean. The experimental data were analysed with analysis of variance by MStat software.

Results and discussion

At the time of the weed survey in 2013, altogether 12 weed species were present on the herbicide free sample areas. However 7 species occurred in the control (Ø) and 11 in the fertilized (NPK) plots, this difference was not significant. Comparing the treatments with each other, the total weed density was 168.7 plant·m^{-2} on the NPK treated plots, which significantly exceeded the same value of the control areas (*Table 2*).

Table 2. Frequency, density and dominance index of weed species on the experimental plots in 2013

Weed species	Freq.	Density (plant · m^{-2})			Dominance index		
		Ø	NPK	Average	Ø	NPK	Average
Ambrosia artemisiifolia L. *	6	62.0	23.3	42.7	0.612	0.138	0.375
Datura stramonium L. *	6	4.7	13.3	9.0	0.046	0.079	0.063
Sorghum halepense (L.) Pers. *	4	31.3	8.0	19.7	0.309	0.047	0.178
Chenopodium album L.	3	-	86.7	43.3	-	0.514	0.257
Chenopodium hybridum L.	3	-	5.3	2.7	-	0.032	0.016
Fallopia convolvulus (L.) Á. Löve	3	0.7	3.3	2.0	0.007	0.020	0.013
Helianthus annuus L.	3	1.3	0.7	1.0	0.013	0.004	0.009
Solanum nigrum L.	3	0.7	1.3	1.0	0.007	0.008	0.007
Amaranthus blitoides S. Watson	2	-	24.0	12.0	-	0.142	0.071
Echinochloa crus-galli (L.) P. B.	1	-	2.0	1.0	-	0.012	0.006
Stachys annua L.	1	0.7	-	0.3	0.007	-	0.003
Heliotropium europaeum L.	1	-	0.7	0.3	-	0.004	0.002
Total ($LSD_{5\%}$= 62.3)		101.3	168.7	135.0			

*Significant differences in weed density among the treatments ($LSD_{5\%}$AMBAR: 14.3; $LSD_{5\%}$DATST: 5.4; $LSD_{5\%}$SORHA: 15.7)

From the 12 species found, *Ambrosia artemisiifolia* L. and *Datura stramonium* L. were present on every plots. Remarkable differences were observed in the number of the individuals of the species depending on the applied nutrients. Statistically justifiable deviations were established in density among the treatments in the case of *A. artemisiifolia*, *D. stramonium* and *Sorghum halepense* (L.) Pers. Based on the order of dominance, *A. artemisiifolia* (61%) and *S. halepense* (30%) was in sight in the control treatment. Both species was down in the order of NPK treatment, since *Chenopodium album* L. (51%) and *Amaranthus blitoides* S. Watson (14%) took over the two first place. The dominance index of *D. stramonium* was more than 1.5 times higher in the case of good nutrient supply. The differences in the order of dominance present the results of the interspecific competition.

Nearly one year later 16 weed species occurred on the studied plots, 15 in the control and 14 in the NPK treatment. The total weed density was 120.4 plant·m^{-2} in the control and 109.1 plant·m^{-2} in the plots with good nutrient supply, which difference is not significant (*Table 3*). The only species that was present in every plots is *A. artemisiifolia*. The number of the individuals of this weed species was mathematically proved more in the plots with no added nutrients, as the density tenfold decreased in the NPK treatment compared to the control. The number of individuals of *D. stramonium* was 3.5 more in the plots with favourable conditions, which difference was mathematically provable. The order of dominance was similar to the previous year. The same two species – *A. artemisiifolia* (65%) and *S. halepense* (19%) - were the most dominant in the control plots. The expansion of *C. album* (49%) and *D. stramonium* (24%) was much higher in the fertilized treatment, compared to the control.

Table 3. Frequency, density and dominance index of weed species on the experimental plots in 2014

Weed species	Freq.	Density (plant · m^{-2})			Dominance index		
		Ø	NPK	Average	Ø	NPK	Average
Ambrosia artemisiifolia L. *	12	78.7	7.3	43.0	0.653	0.067	0.360
Datura stramonium L. *	11	7.6	26.9	17.2	0.063	0.246	0.155
Fallopia convolvulus (L.) Á. Löve	9	1.3	2.4	1.9	0.011	0.022	0.017
Chenopodium album L.	7	0.4	54.2	27.3	0.004	0.497	0.250
Chenopodium hybridum L.	9	1.3	6.9	4.1	0.011	0.063	0.037
Setaria pumila (Poir.) Roem. & Scult.	3	0.9	0.7	0.8	0.007	0.006	0.007
Solanum nigrum L.	5	1.1	0.9	1.0	0.009	0.008	0.009
Helianthus annuus L.	6	1.6	0.4	1.0	0.013	0.004	0.008
Heliotropium europaeum L.	6	1.1	0.7	0.9	0.009	0.006	0.008
Convolvulus arvensis L.	5	1.1	0.7	0.9	0.009	0.006	0.008
Sorghum halepense (L.) Pers.	7	23.6	1.1	12.3	0.196	0.010	0.103
Amaranthus chlorostachys Willd.	4	0.4	4.9	2.7	0.004	0.045	0.024
Amaranthus blitoides S. Watson	2	-	1.8	0.9	-	0.016	0.008
Stachys annua L.	3	0.9	0.2	0.6	0.007	0.002	0.005
Hibiscus trionum L.	1	0.2	-	0.1	0.002	-	0.001
Ajuga chamaepithys (L.) Schreb.	1	0.2	-	0.1	0.002	-	0.009
Total ($LSD_{5\%}$= 82.6)		120.4	109.1	114.8			

*Significant differences in weed density among the treatments ($LSD_{5\%}$AMBAR: 34.8; $LSD_{5\%}$DATST: 15.5)

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Conclusions

According to the results of the weed surveys, we can assess the following statements: i) Many similarities were determined between the experimental years. Especially in the order of dominance which proves the different nutritional needs of the weed species (The most dominant weed species of the control treatment were *Ambrosia artemisiifoila* and *Sorghum halepense* and of the NPK treatment were *Chenopodium album* and *Datura stramonium*).

ii) Considering the density of weed species in the different treatments, the interspecific competition is outlined clearly.

iii) There were differences as well. In the second experimental year, more species occurred on the studied plots compared to the first studied year. This proves the strong expansion ability of weed species.

iv) The sowing time was one week later in the year of 2014. Weeds have a highly dynamic growing characteristic during the early periods, thus one week difference between the sowing times has notable impacts. This can explain that the weight of biomass was much less in the second year compared to 2013.

v) Furthermore, in the year of 2013 there was 66.5 mm precipitation between the sawing and sampling time, and the average temperature was 17.7 ^{o}C. The same values were 57 mm and 15.5 ^{o}C in 2014, which also can be an explanation for the smaller amounts of weed biomass in 2014.

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