EFFECT OF FERTILIZATION ON WEED FLORA IN MAIZE

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ABSTRACT

Plant nutrition is one of the most important intensification factor of crop production. However the nutrients utilization may be modified by a number of productivity factors, including weed presence. Thus, the knowledge of occurring weed species, their abundance, nutrient and water uptake significantly important to establish an appropriate basis for the evaluation of their risk or negative effects on crops. That is why investigations were carried out in a long-term fertilization experiment on the influence of different nutrient supplies (Ø, PK, NK, NPK) on weed flora in maize field at Nagyhörcsök in Hungary.

The weed surveys recorded similar diversity on the experimental area: the species of *A. artemisifolia*, *S. halepense* and *D. stramonium* were dominant, but *C. album* and *C. hybridum* were also common. These species and *H. annuus* were the most abundant weeds.

Based on the totalized and average data of all treatments, density followed the same tendency during the experimental years. It was the highest in the PK treated and untreated plots, and significantly exceeded the values of NK fertilized areas. Presumably the better N availability promoted the development of nitrophilic weeds, while the mortality of other small species increased.

Winter wheat and maize forecrops had no visible influence on the diversity and the intensity of weediness. On the contrary, there were consistent differences in the density of certain weed species in accordance to the applied nutrients. *A. artemisiifolia* was present in the largest number in the untreated control and PK fertilized plots. The density of *S. halepense* and *H. annuus* was also significantly higher in the control areas. The number of their individuals was smaller in those pilot sites where N containing fertilizers were used. Contrary to them, the density of *D. stramonium*, *C. album* and *C. hybridum* was the highest in the NPK treatments.

keywords: weed flora, diversity, density, fertilization, maize

INTRODUCTION

Plant nutrition is one of the most important intensification factor of crop production. The quantity of nutrients that could be taken up from the soil has a decisive effect on the development and the yield of crops. The water supply, which greatly influences nutrient availability, is the most important yield-limiting factor in the agriculture (Árendás et al. 2010).

The utilisation of nutrients may be modified by a number of productivity factors, including the ratio of crops and weeds (Lehoczky et al. 2007). The ability of dominant weeds to accumulate micronutrients varies and depends on the species and the sort of elements (Glowacka 2012). Hejcman et al. (2012) concluded that high N, P and K application rates changed the species composition in sown cut grasslands very quickly and definitely. For example, high N application rates could support the spread of weedy species.

According to Kalsoom et al. (2012) the combined use of NPK was more effective in promoting plant height, fresh and dry biomass and root weight than using them separately. Their findings revealed that macronutrient (fertilizer) application in maize not only favoured the crop growth, but also promoted the growth of perennial weeds. The knowledge of occurring weed species and their abundance, nutrient and water uptake is very important to set an appropriate basis for the evaluation their risk or negative effects on crops (Lehoczky et al. 2012, 2013, 2014).

Among the cultivated plant species, maize has a strategic importance in food supply and is grown on fairly great areas. Its cultivation with wide inter-row spacing and its relatively slow growth at the early stages, however, makes this crop quite sensitive to weed competition, especially during drought years (Glowacka 2012; Yang et al. 2013) and drying spells. Proving the effects of interspecific competitions, Ryan et al. (2010) illustrated that the poor efficacy of weed management in organic systems was the main reason why organic maize did not out-yield conventional ones under standard management conditions. Moreover, they supposed the increased soil resource availability and the faster crop growth rate had probably contributed to the enhanced crop competitiveness and tolerance.

All in all, studies on weed flora and its correlation with nutrient supply are useful and contribute to the clarification of interactions and inter-specific competitions among weeds and cultivated plant species. That is why examinations were carried out in a long-term field experiment on the influence of different nutrient supplies under different weed flora in maize field.

MATERIAL AND METHODS

Present study based on a long-term fertilization field experiment (launched in 2003) with maize (*Zea mays* L. cv. PR4983) on a calcareous loamy chernozem soil (*Calcaric Phaesosem*, according to FAO) at Nagyhörcsök (Fejér County, Hungary) experimental site of the Centre for Agricultural Research, Institute for Soil Science and Agricultural Chemistry for studying the influence of different nutrient supplies on weed flora in maize.

In order to estimate the soil nutrient status of the experimental area, samples were taken in August 2003. Soil analysis results were as follows: pH_{KCl}: 7.1; organic matter: 2.96%; total salt content: 0.02%; $CaCO_3$: 3.9%; y_1: 0; AL-P_2O_5: 90 mg kg^{-1}; AL-K_2O: 167 mg kg^{-1}; KCl soluble Mg: 130 mg kg^{-1}; KCl-Mo: 0.1 mg kg^{-1}; EDTA soluble Fe: 22 mg kg^{-1}; EDTA-Mn: 131 mg kg^{-1}; EDTA-Cu: 2.2 mg kg^{-1}; B: 0.2 mg kg^{-1}.

Fertilization was carried out as treatments [control (Ø), PK, NK, NP, NPK] with different active ingredients, the applied doses being: 150 kg N, 100 kg P_2O_5 and 100 kg K_2O per hectare. P and K fertilizers were spread before autumn ploughing, N was applied in spring, but there were no treatments on control areas (Figure 1).

Figure 1: The experimental area at Nagyhörcsök in 2013

Weed survey on the 4.9x15.00 m (73.5 m^2) size random block experimental plots was done in in six replications. The forecrops were winter wheat in 2011 and maize in 2012. Weed samplings were conducted randomly on 19 June 2012 and on 20 June 2013 in the 8-10 leaf growth stage of maize, in its BBCH 18-19 stages. Based on the sampling, flora composition and the weed density were determined.

The dominance order of weeds was established with the Berger-Parker index (Magurran 1988). Experimental data were statistically analysed with analysis of variance (ANOVA) by MStat software.

TABLE 1: The average frequency and the order of dominance of weed species on the experimental plots in the first weed survey on 19 June 2012

No.	Weed species	Code	Life form	Photosynthesis type	Freq.	Berger-Parker index
1	Ambrosia artemisiifolia L.	AMBAR	T_4	C_3	12	0.360
2	Sorghum halepense (L.) Pers.	SORHA	G_1	C_4	11	0.250
3	Datura stramonium L.	DATST	T_4	C_3	12	0.130
4	Helianthus annuus L.	HELAN	T_4	C_3	12	0.060
5	Solanum nigrum L.	SOLNI	T_4	C_3	10	0.050
6	Chenopodium album L.	CHEAL	T_4	C_3	5	0.040
7	Chenopodium hybridum L.	CHEHY	T_4	C_3	7	0.030
8	Echinochloa crus-galli (L.) P.B.	ECHCG	T_4	C_4	8	0.020
9	Amaranthus blitoides S. Watson	AMABL	T_4	C_4	1	0.020
10	Fallopia convolvulus (L.) Á. Löve	FALCO	T_4	C_3	9	0.010
11	Stachys annua L.	STAAN	T_4	C_3	9	0.010
12	Hibiscus trionum L.	HIBTR	T_4	C_3	4	0.010
13	Heliotropium europaeum L.	HELEU	T_4	C_3	5	0.010
14	Sisymbrium sophia L.	SISSO	T_{2-3}	C_3	2	0.000
15	Portulaca oleracea L.	POROL	T_4	C_3	1	0.000
16	Xanthium strumarium L.	XANST	T_4	C_3	1	0.000
17	Ajuga chamaepitys (L.) Schreb.	AJUCH	T_4	C_3	1	0.000

TABLE 2: Density of weeds (number of weeds per m²) in the experimental plots supplied with different nutrients in the first (19 June 2012) weed survey

Weed density (piece · m⁻²)				
Ø	PK	NK	NPK	$LSD_{5\%}$
131.3	122.0	97.7	81.7	14.0

RESULTS AND DISCUSSION

In the first weed survey carried out on 19 June 2012 altogether 17 species occurred on the herbicide-free sample areas of the experiment, out of which 53% were recorded in all treatment and three of the most frequent species (namely *Ambrosia artemisiifolia* L, *Datura stramonium* L. and *Helianthus annuus* L.) were present on all plots. The occurrence of *Sorghum halepense* (L.) Pers. and *Solanum nigrum* L. was common as well. Based on the totalized and averaged density, the order of dominance was as follows: *A. artemisifolia* (36%), *S. halepense* (25%), *D. stramonium* (13%), *H. annuus* (6%), *S. nigrum* (5%), *Chenopodium album* L. (4%) and *Chenopodium. hybridum* L. (3%). In addition to these, the further ten species recorded in the plots appeared only at a 0.´-2 % rate (Table 1).

Compering the different fertilization treatments with each other, in June 2012 the average weed density was the highest in the untreated areas, which significantly exceeded the values of NK and NPK treatments in the control and the PK treated plots (Table 2).

In the case of *H. annuus*, *Stachys. annua* L. and *Hibiscus trionum* L., statistically justifiable deviations were established in weed density among the fertilization treatments. In addition to this, remarkable differences were observed in the number of individuals of *A. artemissifolia*, *C. album*, *D. stramonium*, *S. nigrum* and *S. halepense,* depending on the sort of applied nutrients.

The average number of *H. annuus* was the largest in the control plots. As compared to the control and PK fertilized areas, it was present in a significantly smaller amount in the NK and NPK treated plots. The density of *S. annua* was also higher in the untreated control and PK treated areas. Similarly, *H. trionum* reached the largest number of individuals in the control, while it showed significant deviation by occurring in minimum amount in NPK treated plots. The density of *A. artemissifolia* and *S. halepense* was the highest in the untreated plots, as well. In contradiction with this, *D. stramonium, C. album, C. hybridum* and *Amaranthus blitoides* were present with the highest number in the NPK treatments (Figure 2).

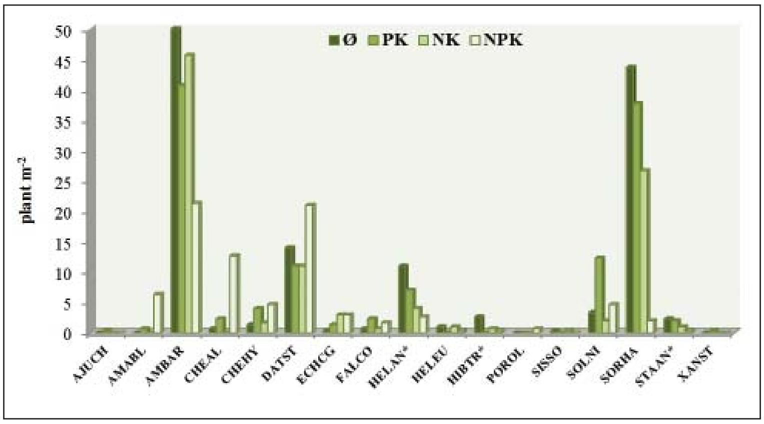

Figure 2: Density of weed species (number of weeds per m²) in the experimental plots supplied with different nutrient treatment (control, PK, NK, NPK) in the first weed survey on 19 June 2012
***Significant differences in weed density among the treatment: LSD5% was 4.61 for HELAN, 2.93 for HIBTR and 1.69 for STAAN**

Figure 3: Distribution of weed dominance at Nagyhörcsök on 19 June 2012

To evaluate the character of the weed flora, the number of the Raunkier's life forms and the C_3-C_4 species was determined in every treatment in 2012 and in 2013, too. The most dominant life form was T_4 but the G_1 and T_{2-3} species are also occurred. The numbers of C4 species were similar in all treatments however the C_3 species were the prevailing types (Figure 3).

Following year, on the 20 June, 2013 altogether 19 weed species were distinguished on the experimental area.

TABLE 3: Average frequency and the order of dominance of weed species on the experimental plots in the second weed survey carried out on 20 June 2013

No.	Weed species	Code	Life form	Photosynthesis type	Freq.	Berger-Parker index
1	Ambrosia artemisiifolia L.	AMBAR	T_4	C_3	23	0.565
2	Sorghum halepense (L.) Pers.	SORHA	G_1	C_4	23	0.144
3	Chenopodium album L.	CHEAL	T_4	C_3	17	0.133
4	Datura stramonium L.	DATST	T_4	C_3	24	0.087
5	Chenopodium hybridum L.	CHEHY	T_4	C_3	11	0.023
6	Echinochloa crus-galli (L.) P.B.	ECHCG	T_4	C_4	10	0.021
7	Fallopia convolvulus (L.) Á. Löve..	FALCO	T_4	C_3	16	0.014
8	Solanum nigrum L.	SOLNI	T_4	C_3	14	0.011
9	Helianthus annuus L.	HELAN	T_4	C_3	14	0.009
10	Hibiscus trionum L.	HIBTR	T_4	C_3	9	0.007
11	Convolvulus arvensis L.	CONAR	G_3	C_3	7	0.005
12	Lepidium draba L.	LEPDR	G_3	C_3	4	0.002
13	Amaranthus blitoides S. Watson	AMABL	T_4	C_4	4	0.002
14	Anagallis arvensis L.	ANAAR	T_4	C_3	1	0.002
15	Heliotropium europaeum L.	HELEU	T_4	C_3	4	0.001
16	Stachys annua L.	STAAN	T_4	C_3	4	0.001
17	Sisymbrium sophia L.	SISSO	T_{2-3}	C_3	3	0.001
18	Polygonum persicaria L.	POLPE	T_4	C_3	1	0.000
19	Ajuga chamaepitys (L.) Schreb.	AJUCH	T_4	C_3	1	0.000

Table 4: Density of weeds (number of weeds per m²) in the experimental plots supplied with different nutrients in the second (20.06.2013.) weed survey

Weed density (piece · m^{-2})				
Ø	PK	NK	NPK	$LSD_{5\%}$
142.2	156.7	93.7	129.5	44.6

Despite the fact that 39% of them were present in all treatments, *D. stramonium* was the only one that could be recorded on every plot of all replications. The specimens of *A. artemissifolia, S. halepense, C. album* and *Fallopia convolvulus* (L.) Á. Löve were also common.

Compared to the total number of individuals, four species were dominant with the following order: *A. artemissifolia* (54%), *C. album* (16%), *S. halepense* (10%) and *D. stramonium* (9%). In addition to these, the further 14 species recorded in the plots accounted for 11% of total density (Table 3).

Following the previous year's tendency, the highest density was observed in the PK treated and untreated plots, where the number of individuals significantly exceeded the values recorded for NK areas (Table 4).

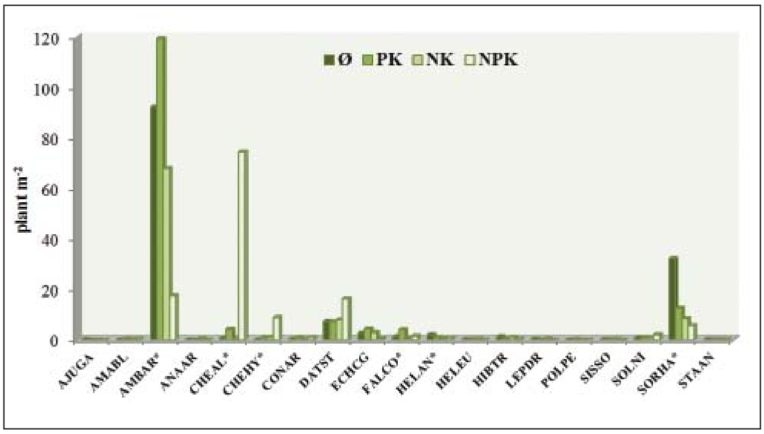

Figure 4: Density of weed species (number of weeds per m²) in the experimental plots supplied with different nutrients in the second weed survey on 20 June 2013
***Significant differences in weed density among the treatments: $LSD_{5\%}$ for AMBAR: 35.2, CHEAL: 37.3, CHEHY: 5.7, FALCO: 2.4, HELAN: 1.5, SORHA: 15.1**

Regarding density, *A. artemisiifolia* was the most abundant and common weed in the experiment. In 2013 it was still present in the largest number in the control and the PK fertilised plots. Compared to the PK supplied areas, its density was significantly lower in the NK and NPK treatments, while in comparison to control areas it was significantly lower in the NPK treated plots (Figure 4).

Similarly to the previous year, the average number of *C. album* was remarkably larger in the NPK fertilised plots than in the controls and all of the other treatments. *C. hybridum* also appeared with significantly higher density in the NPK treated plots. Likewise, the number of *D. stramonium* was the largest and significantly higher in the NPK treatments. Following the former records, *S. halepense* had significantly higher density in the control areas. The volunteer *H. annuus* occurred in a small number, out of which the highest density was found in the controls, with significant deviation from this only in the NK treatments. The occurrence of the low-density *F. convolvulus* was the highest in the PK fertilised plots, but it showed significant difference only from the NK supplied areas' data (Figure 2).

The dominant life form was T_4 similary to the first survey. G_1, G_3 and T_{2-3} species also occurred, but less mass. The numbers of C_4 species were similar in all treatments, likewise one year before.

CONCLUSIONS

In present study the weed surveys were carried out in a long-term fertilization experiment under maize at Nagyhörcsök. Similar weed diversity was recorded in 2012 and 2013 whrere the *A. artemisifolia*, *S. halepense* and *D. stramonium* were dominant, but *C. album* and *C. hybridum* were also common. These species and *H. annuus* were the most abundant weeds according to our surveys.

Based on the totalized and average data of all treatments, weed density followed the same tendency in the experimental years. The PK treated and the untreated (control) plots had the highest diversity, and significantly exceeded the values obtained for NK fertilized areas.

There were consistent differences in the density of certain weed species in accordance with the applied nutrients. *A. artemisiifolia* was present in the largest number in the control and the PK fertilized plots, while its density was significantly lower in the NPK treatments. *S. halepense* also occurred in significantly larger number in the control areas. The volunteer *H. annuus* had the highest density in the controls; the number of its individuals was the smallest in plots where N containing fertilizers were used. In contradiction with this, the density of D. stramonium, C. album and C. hybridum was the highest in the NPK treatments, which exceeded the values of the control and the other treated plots.

The most dominant life form was T_4 and the most occurred weed species was C_3 type during the experiment.

ACKNOWLEDGEMENTS

The present study was financially supported by the Hungarian Scientific Research Fund (OTKA Project No. K105789).

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