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Effects of N imbalances on shoot and root growth of corn and velvetleaf

P Varga, K Sárdi*, I Béres

University of Veszprém, Georgikon Faculty of Agriculture Keszthely, Keszthely, Hungary

ABSTRACT Effects of Nitrogen imbalances were studied on the shoot and root growth of corn (*Zea mays* L.) and velvetleaf (*Abutilon theophrasti* Medic.) under greenhouse conditions. A pot experiment was carried out using plastic pots with 2.2 kg of a brown forest soil *(Eutric cambisol)*. Soil moisture was kept at 70 percent WHC (water holding capacity) of the soil. Beside the unfertilized control, nutrient treatments in the order of NPK were as follows: 111, 222, 022, 044, 422 and 822, respectively. From the results of our experiment, it was evident that significant differences were obtained for both the weed and the crop species in most treatments and parameters studied. Nitrogen imbalances resulted in considerable changes in the shoot:root ratios of plants showing the plant responses to the stress conditions: e.g. the decrease of shoot:root ratio of plants in N deficiencies. Differences were statistically significant in treatments resulting in strong nutrient imbalances or stress conditions for both plant species.

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KEY WORDS

Nitrogen imbalances
Zea mays
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greenhouse experiments

Nutritional imbalances may cause stress conditions for plants in their ion concentrations and thus disorders in their metabolic processes. High rates of N fertilizers may change the competitive ability of weed species. Pessios (1979) reported that even at high rates of N causing yield depression of maize, DM production of weeds was increased in several cases. The close relationship between leaf area and yield levels of maize was observed several decades ago (Hanway 1962). Recently, velvetleaf (*A. theophrasti* Medic.) is considered one of the most dangerous weed species in Hungary.

In our present study, effects of Nitrogen imbalances and stresses were studied on the shoot and root growth of corn (*Zea mays L.),* (Dekalb 471 variety, FAO 410) and velvetleaf (*A. theophrasti*) under greenhouse conditions.

Materials and Methods

Pot experiments were carried out in the years 2000 and 2001 with the same treatments, results were evaluated in the averages of the two experiments. Five plants were grown for 4 weeks in pots with 2.2 kg of a brown forest soil from Keszthely (FAO taxonomy: *Eutric cambisol*) having relatively low levels of plant available nutrients. Soil moisture was kept at 70 percent WHC of the soil. Beside the unfertilized control, increasing N rates were applied. Nutrient treatments in the order of NPK were as follows: $N_1P_1K_1$, $N_2P_2K_2$, $N_0P_2K_2$, $N_0P_4K_4$, $N_4P_2K_2$ and $N_8P_2K_2$, respectively, where N_1 = 120 mg per kg soil, P_1 = 100 mg per kg soil and K_1 = 150 mg per kg soil. Effects of treatments were studied in 4 replicates. At the harvest, plant height, leaf area as well as fresh and DM production of plant shoots and roots were determined and shoot:root ratios of plants were calculated.

*Corresponding author. E-mail: sardi@georgikon.hu

Results and Discussion

From the results of our experiment, it was evident that significant differences were obtained for both the crop and weed plants in most treatments and parameters studied in our experiments.

Responses of plant height of corn were markedly different to those of velvetleaf. Plant height was slightly increased even in the N deficient treatments (Table 1). This could be due to the benefit of other nutrients applied. Increases were significant in both levels of balanced nutrient supply. In the higher level of N excess, (N8P2K2 treatment) seeds of *A. theophrasti* actually could not germinate thus evaluation of treatment effects could not be done for this treatment. Increase in plant height for *A. theophrasti* could only be observed in the N1P1K1 treatment, at the lower level of "balanced nutrient supply".

Leaf area of 4 week old corn plants was highly affected by nitrogen imbalances or stresses (Fig. 1). Nitrogen deficiencies had resulted in considerable decreases in leaf area of plants. On the other hand, balanced nutrient supply had a favourable effect on leaf area in both levels: maximum values were obtained in the N2P2K2 treatment. As the reverse of

Table 1. Plant height, shoot and root fresh weight, shoot:root ratios of 4 weeks old corn.

Treatments	Plant height (cm)	Shoot fresh weight (g/pot)	Root fresh weight (g/pot)	Shoot: root ratio
Control	75.88	87.29	36.52	2.06
022	78.25	98.07	44.10	1.87
044	79.50	100.78	47.84	1.72
111	82.03	119.34	55.26	1.86
222	83.53	131.24	67.77	1.66
422	76,03	91.18	47.24	1.61
822	63.13	65.13	25.99	2.18
$LSD_{5\%}$	3.62	6.27	2.89	0.079

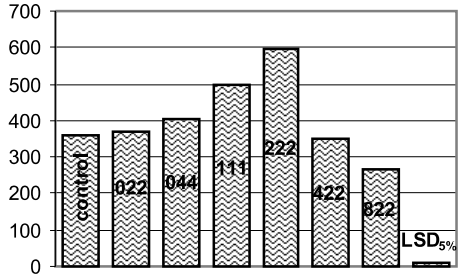

Figure 1. Leaf area (cm² per plant) of 4 weeks old corn plants.

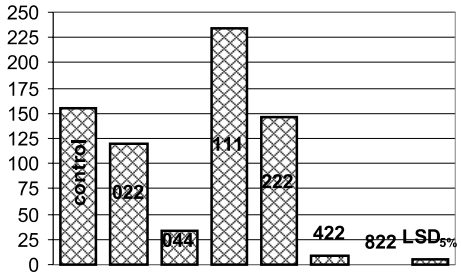

Figure 2. Leaf area (cm² per plant) of 4 weeks old velvetleaf plants.

this, leaf area of corn was reduced with excess nitrogen rates. Changes in leaf area of velvetleaf were highly significant in each treatment (Fig. 2). Nitrogen deficiencies had resulted in dramatic decreases in leaf area of 4 week-old plants.

Nitrogen imbalances resulted in considerable changes in the shoot:root ratios of plants showing the plant responses to the stress conditions: *e.g.* the decrease of shoot:root ratio of plants in N deficiencies. This is in good agreement with our results obtained in previous experiments (Béres et al. 1996; Sárdi and Csitári 1996). Increased shoot:root ratio was observed for corn in the N8P2K2 treatment.

Differences were statistically significant in treatments resulting in strong nutrient imbalances or stress conditions for both plant species.

Nitrogen deficiencies resulted in significant decreases both in shoot and root fresh and DM weight of young plants. Effect of excess nitrogen had also reduced these parameters, decreases were exceeding those of N deficiency. Responses of corn plants were weaker, fresh weight was slightly increasing even in the treatments of nutrient imbalance.

Increases in root fresh and DM weight in the N deficient treatments thus decreases in shoot:root ratios were significant indicating the ability of *A. theophrasti* to improve its chances for enhanced nutrient uptake. These results are in good agreement to literature data as well as to our previous findings.

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