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EFFECT OF THE NITROGEN FERTILIZER FORM AND THE PLANT SPECIES ON SOIL pH CHANGES

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A b s t r a c t. Fertilization of plants with ammonium nitrogen form leads to the soil acidification. Leguminous plants with higher requirements of basic cations, acidify soil quicker than other plants such as, e.g., of the *Gramineae* family. These relationships were confirmed in the pot experiments with broad bean and maize. In the present experiment the effect of fertilization with different nitrogen forms on yield and pH value of soil was investigated. It has been found that the application of ammonium sulphate with a nitrification inhibitor results in a significant increase of the pH value of soil under broad bean. It can be presumed that this effect would be caused by physiologically basic reaction of ammonium sulphate due to the blockade of nitrification and to a more intensive utilization of sulphur ions by broad bean as compared to ammonium ions.

K e y w o r d s: soil pH, nitrogen fertilizers, broad bean, maize

INTRODUCTION

Consequences of the effect of ammonium nitrogen and nitrate nitrogen on soil are known since long. Fertilization of plants with ammonium form leads to an increased soil acidification, whereas application of nitrate form results in smoothing this effect [6,7]. These relationships are caused by physiological reaction of fertilizers determined to a considerable degree by the process of biological change of nitrogen in soil [4].

Most works prove a high efficiency of piridin inhibitors in checking the nitrification process in soil at a simultaneous lack of their effect on yields of plants [2,10].

It is well known that plants belonging to the family of *Papilionaceae* cause as compared to other crops a more intensive acidification of seedbed [5,8]. A part of the authors explains this phenomenon by a considerably higher requirement of these plants for basic cations, particularly for calcium and as a nitrogen source, which constitutes in leguminous plants mostly symbiotically bound air nitrogen [8].

While considering the factors affecting acidification of soil, the thesis has been formulated, according to which the effect of ammonium form of nitrogen containing fertilizers on the soil pH depends on the plant species. This thesis has been verified in the experiment with broad bean and maize.

MATERIALS

The vegetative experiment was established in the Wagner's pots of the capacity of 8 kg filled with soil of light loamy sand with pH KCl= 6.0.

The following basic fertilization was applied (in g/pot): 0.6 P_2O_5 in the form of NaH_2PO_4 H_2O; 1.0 K_2O in the form of KCl; 0.2 MgO in the form of $MgSO_47H_2O$.

The effect of the following fertilizing treatments on the plant matter and soil pH was investigated: 1) no nitrogen, 2) $Ca(NO_3)_2$, 3) $(NH_4)_2SO_4$, 4) $(NH_4)_2SO_4$+ N-Serve. The

N dose in all the treatments with nitrogen for broad bean amounted to 0.8 g/pot and for maize to 1.2 g/pot.

The N-Serve dose amounted in relation to the soil matter to 5 mg kg^{-1} in the experiment with broad bean and to 10 mg kg^{-1} in the experiment with maize.

The soil moisture was maintained in the growth period of plants at the level of 60 % of total capillary water capacity.

The experiment was finished after 42 days of the growth of plants. The mass of above ground parts and roots of plants as well as the soil pH were determined after the harvest of broad bean and maize.

RESULTS

The above-ground mass of broad bean did not undergo any significant differentiation under the effect of fertilization with various nitrogen forms. The highest mass was found in the treatment of no nitrogen fertilization (Table 1). On the other hand, the mass of broad bean roots underwent a significant change under the effect of the nitrogen fertilization. The calcium nitrate application led to a considerable reduction of the mass of roots. Also lower mass of roots was found in the treatments of ammonium sulphate, nevertheless the difference with the treatment of no nitrogen fertilization was not significant (Table 1).

The above-ground mass of maize was the highest in the treatments of ammonium sulphate (Table 2). Significantly lower yields were obtained in the treatment of no nitrogen and in that of calcium nitrate. The mass of maize roots was significantly lower in treatments of calcium nitrate as compared to the remaining treatments (Table 2).

The nitrogen fertilizer form affected significantly the soil reaction. Its changes were different and depended on the plant species. The calcium nitrate application did not cause any significant changes in the soil pH value in the experiment with broad bean, leading, on the other hand, to a slight increase of this value in the experiment with maize. A significant decrease of the soil pH occurred under the effect of ammonium sulphate (Table 3). The respective differences were higher in the experiment with maize. Checking of ammonium sulphate nitrification led to a significant increase of the pH value of soil in the experiment with broad bean. This value increased not only in comparison to

Table 1. Mass of broad bean depending on the nitrogen fertilization form (g of d. m. per pot)

Fertilization	Above-ground parts	Roots	Above-ground parts plus roots
No nitrogen	17.5	5.3	22.8
$Ca(NO_3)_2$	15.5	3.5	19.0
$(NH_4)_2SO_4$	15.4	4.0	19.4
$(NH_4)_2SO_4$+N-Serve	15.1	4.2	19.3
LSD (P=0.05)	3.77	1.65	4.25

Table 2. Mass of maize depending on the nitrogen fertilization form (g of d. m. per pot)

Fertilization	Above-ground parts	Roots	Above-ground parts plus roots
No nitrogen	7.5	3.7	11.2
$Ca(NO_3)_2$	8.0	1.8	9.8
$(NH_4)_2SO_4$	15.2	3.2	18.4
$(NH_4)_2SO_4$+N-Serve	14.4	3.3	17.7
LSD (P=0.05)	2.51	1.32	17.7

Table 3. Soil pH after the harvest of plants depending on the fertilization with different nitrogen forms

Fertilization - factor A	Plant species - factor B			
	broad bean		maize	
	pH H_2O	pH KCl	pH H_2O	pH KCl
No nitrogen	6.1	5.8	6.3	6.0
$Ca(NO_3)_2$	6.1	6.0	6.5	6.4
$(NH_4)_2SO_4$	5.4	5.1	5.2	4.9
$(NH_4)_2SO_4$ + N-Serve	6.7	6.4	6.0	5.7
LSD (P=0.05) A/B	0.31	0.37	0.31	0.37
LSD (P=0.05) B/A	0.23	0.27	0.23	0.27

ammonium sulphate without nitrification inhibitor, but also in comparison to treatments of the calcium nitrate application. Whereas in the experiment with maize, pH of soil in the treatments of ammonium sulphate with N-Serve was lower as compared to the treatments of calcium nitrate (Table 3).

DISCUSSION

Ammonium sulphate with the nitrification inhibitor exerted an acidifying effect on soil, but only in the experiment with maize, whereas in the experiment with broad bean its effect was inverse, i.e. it alkalized the soil. The soil pH changes due to the calcium nitrate and ammonium sulphate application for maize were higher as compared to analogical changes in the broad bean cultivation. This can be explained by a reduced share of fertilizer nitrogen in covering the broad bean requirement for this element. More complex is the interpretation of results proving that checking of the ammonium sulphate nitrification would increase the soil pH in the broad bean cultivation. It seems that this could be caused by more intensive uptake of sulphates as compared to ammonium ions. Analogical differences in the experiment with maize were weaker in spite of very high requirements of maize for sulphur [1,9]. It could be caused, most probably by significantly higher ammonium nitrogen uptake by maize as compared to broad bean.

CONCLUSIONS

1. pH value changes of soil due to application of nitrogen fertilizers are higher in the maize cultivation as compared to this of broad bean.

2. Checking of the ammonium sulphate nitrification leads in the broad bean cultivation to alkalization of the soil. It is presumed that this would be the consequence of more intensive uptake of sulphate ions by the broad bean roots as compared to ammonium ions.

3. The N-Serve application weakens the acidifying effect of ammonium sulphate on soil.

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WPŁYW FORMY AZOTU NAWOZOWEGO I GATUNKU ROŚLINY NA ZMIANĘ pH GLEBY

Nawożenie roślin formą azotu amonowego zwiększa zakwaszenie gleby. Rośliny motylkowate, mające większe zapotrzebowanie na kationy zasadowe, zakwaszają szybciej glebę niż inne np. z rodziny *Gramineae*. Zależności te potwierdzono w doświadczeniu wazonowym z bobem i kukurydzą. W doświadczeniu badano wpływ na plony i pH gleby nawożenia różnymi formami azotu. Stwierdzono, że zastosowanie siarczanu amonowego z inhibitorem nitryfikacji istotnie zwiększa pH gleby pod bobem. Przypuszcza się, że działanie to było spowodowane fizjologicznie zasadową reakcją siarczanu amonowego na skutek blokady nitryfikacji oraz większego wykorzystania przez bób jonów siarczanowych w porównaniu z amonowymi.

S ł o w a k l u c z o w e: pH gleby, nawozy azotowe, bób, kukurydza.