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INFLUENCE OF DIFFERENT TYPES OF NITROGEN FERTILISERS ON BARLEY'S PHOSPHORUS UPTAKE AND PHOSPHORUS CONTENT IN BARLEY'S TISSUES.

ABSTRACT

A number of pot experiments was conducted to investigate the influence of four types of nitrogen fertilisers: NS 32:5, ammonium nitrate (AN, N 34,5%), NS 26:15 and ammonium sulphate (AS, N 21%) on uptake of phosphorus from soil by spring barley and on phosphorus content in plant tissues. Experiment were conducted on three soil types: sod-podzol well-cultivated soil with high level of P and K (soil I); sod-podzol low-cultivated soil with high level of P and medium level of K (soil II) and sod-podzol low-cultivated soil with low level of P and K (soil III). It was found that application of NS 32:5 increased degree of extraction of phosphorus from soil III and from soil III with additive of ground phosphate rock; application of NS 26:14 increased degree of extraction of phosphorus from soils I and II, application of AS showed similar results. Also, it was found that application of NS 32:5 on soil III increased phosphorus content in plants by 12,3-16,5% in comparison with other tested fertilisers.

Keywords:
Phosphorus uptake, NS 32:5, degree of extraction of phosphorus, NS 26:14.

INTRODUCTION

The efficient use of phosphorus is very important, because phosphate rock is a finite, non-renewable resource, and it must be used efficiently in order to maximize its life span [1]. The two mail factor controlling the availability of soil P to plant roots are the concentration of phosphate ions in the soil solution and the ability of the soil to replenish these ions when plant roots remove them, i.e. the P-buffer capacity of the soil. It's widely known that phosphorus is taken up from the soil solution by plant roots as orthophosphate ions, $H_2PO_4^-$ and HPO_4^{2-} (less) [1]. Several factors can affect the recovery of P reserves accumulated in the soil from pat addition of P-fertilisers: P-concentration in soil solution and P-buffer capacity of the soil and the size of the root system.
Some chemical processes increase concentration of the available-P into the soil.

Biotransformation of ammonium-ion in soils

$$2NH_4^+ + 4O_2 + 2H_2O \longrightarrow 4H_3O^+ + 2NO_3^-$$

Ion-exchange processes:

$$Ca_3(PO_4)_2 + 2H_3O^+ + SO_4^{2-} \underset{k_2}{\overset{k_1}{\rightleftharpoons}} 2CaHPO_4 + CaSO_4 + 2H_2O$$

Slow-acting phosphorus deposit — Partially available for plants

$k_1 > k_2$

$$2CaHPO_4 + 2H_3O^+ + SO_4^{2-} \underset{k_4}{\overset{k_3}{\rightleftharpoons}} Ca(H_2PO_4)_2 + CaSO_4 + 2H_2O$$

Water soluble Sulphate-ion has ability to activate phosphorus — Available for plants

$k_3 > k_4$

Ease to see that presence of nitrogen (in the ammoniacal-form) contributes to accumulation of H_3O^+- ion, which, in turn, increases concentration of the available-P.
The mail goal of this work is investigation of the influence of different form of nitrogen fertilisers on plant's P-uptake and P-content in plants tissues.

MATERIALS AND METHODS

The experiment was conducted in pots in a glass-greenhouse
located at the experimental farm of The Moscow State University, Soil Science Department (16 pots, each contained 5 kg of soil, 4 replications).
Test crop: spring barley *(Hordéum vulgáre L.)*.
Experiment were conducted on three soil types: sod-podzol well-cultivated soil with high level of P and K (soil I); sod-podzol low-cultivated soil with high level of P and medium level of K (soil II) and sod-podzol low-cultivated soil with low level of P and K (soil III).

The following soil characteristics were determined: pH, (in 1M KCl), $C_{org.}$ (Tiurin method), mobile forms of P and K, (Kirsanov method), soil NH_4^+ and NO_3^- - content (potentiometry), total P (Denige method), total K (AES, Leki FP 640).

Soils agrochemical characteristics are shown in Table 1.

Table 1. Soil agrochemical status of soils under experiment (before sowing)

	Organic matter, %	pH	NH_4^+	NO_3^-	P_2O_5	K_2O
			mg/100g soil			
Soil I	3,0-3,5	7,0-,77	0 – 0,1	60 - 65	83 - 95	45-50
Soil II	2,5-3,0	7,0-6,6	0 – 0,1	16 - 17	42-47	9-12
Soil III	1,2-1,5	6,0 –5,7	2 - 3	5,4 – 5,6	9,5-13,5	3,5-5,5

Nitrogen fertilisers were applied in following dose: 0,1g/N per 1 kg of soil (i.e. 300kg N/ha).
Ground phosphate rock (P_2O_5 19,5%) was applied in following dose: 0,5g per 1 kg of soil (i.e. 1.5 t/ha)

DATA COLLECTION AND ANALYSIS

Plant's samples were collected in 40 days after fertilization during tillering growing stage. Phosphorus content in plant tissues was determined (wet combustion Ginsburg method).

Figure 1. Influence of different forms of nitrogen fertilisers on barley P-uptake. Soil III.
1 – NS 32:5; 2 – AS; 3 – NS 26:14; 4 – AN

RESULTS AND DISCUSSION

Content of mobile phosphorus forms in soil

It was found that application on all tested fertiliser on all soil types showed the same effect on mobile phosphorus content in soil. The differences weren't statistically significant (Table 1).

Table 1. Mobile phosphorus content in soil (mg per pot).

Fertiliser	Soil I	Soil II	Soil III	Soil III + rock phosphate
Ammonium nitrate (N34)	4250	2328,5	640	1272,5
NS – 26 - 14	4010	2166,0	680	1305
Ammonium sulphate	4005	2084,5	620	1385
NS – 32 - 5	4665	2232,5	665	1245,5

All tested fertilisers contain ammonium-ion and ion-exchange processes are equiprobable.

Content of phosphorus in plant's tissues

It was found that application of NS 26:14 and AS on soil II increased phosphorus content in plants and application of NS 32:5 on soil III significantly increased (12,3-16,5%) phosphorus content in plants in comparison with other tested fertilisers. On soil III with additional amount of rock phosphate application of NS 32:5 and AS showed similar results (Table 2).

Table 2. Phosphorus content in plant's tissues.

Fertiliser	Soil II		Soil I		Soil III		Soil III + rock phosphate	
	%	g/pot	%	g/pot	%	g/pot	%	g/pot
Ammonium nitrate (N34)	1,15	0,06	1,26	0,07	0,77	0,02	0,57	0,02
NS – 26 - 14	1,45	0,08	1,60*	0,09	0,74	0,02	0,87	0,03
Ammonium sulphate	1,27	0,07	1,74*	0,09	0,99	0,02	0,98	0,03
NS – 32 - 5	1,41	0,07	1,20	0,06	1,22*	0,04	1,23*	0,04

* Values significantly different at the P≤0.05 level

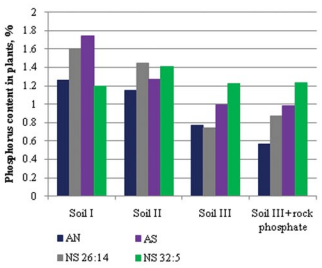

Figure 2. Phosphorus content in plant's tissues.

Soil I conditions were extremely good for plants (this soil contained enough initial nitrate-nitrogen) and plants grew and developed normally. High content of ammoniacal nitrogen in NS 26:14 and AS resulted in the formation of more bioavailable $H_2PO_4^-$ - anion, which was uptaked by plants. This fact explains increased phosphorus content in plants, treated by NS 26:14 and AS on soil I. Soil III conditions were poor and plants grow was inhibited. AN and NS 32:5 contain maximum dose of "starting" nitrate nitrogen (immediately available for plants), but NS 32:5 also contains additional sulphur and plants consumed more nitrogen because of synergetic effect "nitrogen-sulphur" and developed better. Better physiological state contributed to increase of nutrients absorption from the soil. This is a subject of further investigation.

The influence of different fertilisers on degree of phosphorus extraction from soil

It was found that application of NS 32:5 increased degree of extraction of phosphorus from soil III and from soil III with additive of ground phosphate rock; application of NS 26:14 increased degree of extraction of phosphorus from soils I and II, application of AS showed similar results (Table 3).

Fertiliser	Soil I	Soil II	Soil III	Soil III + rock phosphate
Ammonium nitrate (N34)	1,6	2,6	3,1	1,6
NS – 26 - 14	2,2	3,4	2,9	2,3
Ammonium sulphate	2,2	3,4	3,2	2,2
NS – 32 - 5	1,3	3,1	7,1	3,2

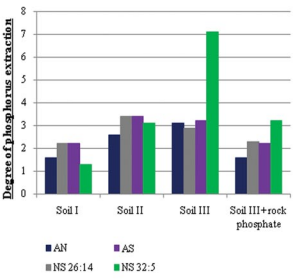

Figure 3. Influence of different form of N-fertiliser on degree of P-extraction from soil.

For a more textured data it's necessary to carry out a longer experiment. It's a topic for further investigations.

CONCLUSIONS

Application of NS 32:5 increased degree of extraction of phosphorus from soil III and from soil III with additive of ground phosphate rock; application of NS 26:14 increased degree of extraction of phosphorus from soils I and II, application of AS showed similar results. Application of NS 32:5 on soil III increased phosphorus content in plants by 12,3-16,5% in comparison with other tested fertilisers.

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