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THE EFFECT OF SUPERPHOSAMMONIUM ON THE MASS OF SPRING BARLEY AND UPTAKE OF NUTRIENT COMPOUNDS DEPENDING ON LIMING ACIDIC SOIL

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A b s t r a c t. The pot experiment investigated how the fertilizing value of superphosammonium (granulated mixture of ammonium sulphate and powdery superphosphate) changes compared with equivalent quantity of substrates. The evaluation of the fertilizer value was tested on acidic soil and soil limed with calcium carbonate according to single hydrolytic acidity. The plant used in the experiment was spring barley Diva cultivar.

Test results show a considerable more advantageous influence of superphosammonium on the barley yield and quantity of nitrogen and phosphorus absorbed, compared with substrates from which it has been produced. This difference has been observed both in objects with and without lime.

Stopping nitrification by N-Serve decreased the difference between the separately applied ammonium sulphate with powdery superphosphate and superphosammonium.

The obtained results suggest, that the reason for better fertilizing action of superphosammonium is probably the decrease in the rate of nitrification of ammonium ions present in this fertilizer.

K e y w o r d s: superphosammonium, acid soil, liming, spring barley

INTRODUCTION

Tarnobrzeg Siarkopol Factory in agreement with the Department of Agricultural Chemistry began in 1992 production of a fertilizer of ammonium sulphate with powdery superphosphate and is generally intended for broad use in plant growth. The main aim for production of the new fertilizer was based on a long known corelation that ammonium ions in majority of cases allow uptake of phosphorus by plants. Granulating of ammonium sulphate mixture with powdery superphosphate creates a concentration of ions which is believed to additionally contribute to better uptake of fertilizing phosphorus by plants. Besides phosphates also fertilized nitrogen present in superphosammonium could modify fertilizing value of a product in comparison to separately used substrates due to its concentration in a granule and close presence of localally high phosphate concentrations.

The aim of the experiment was finding an answer on the following questions: how does the fertilizing superphosammonium value change compared with an equal quantity of substrates: does the anticipated change depend on soil pH and is it caused by similar or different utilization of phosphorus and fertilizing nitrogen?

MATERIALS AND METHODS

Superphosammonium designated for spring fertilizing which contained 13.50 % N and 6.46 % P_2O_5 was used in experiment.

Experiment was conducted in Wagner pots on light loamy sand soil with following chemical-agricultural features: pH_{KCl} 4.0, hydrolytic acidity 1.9 mmol H^+/100 g, available nutrient contents in 100 g of soil: 2.4 mg P_2O_5, 5.4 mg K_2O and 2.2 mg MgO.

The use of acidic soil in the experiment was done on purpose and had following explanation: the disadvantage of ammonium sulphate its strong acidic action. The aim of the experiment was to evaluate the methods which decrease this disadvantage. It was belived that on acidic soil the influence of this ammonium sulphate feature on barley plants, will apper more clearly and it will be easier to evaluate in what degree the acidifying action of the fertilizer will be decreased by limiting the nitrification and granulation with powdery superphosphate.

The experiment has conducted in 5 replications. The following dosages of nutrient compounds were used in g per pot, containing 8 kg of soil: 0.60 g N, 0.29 g P_2O_5 (the phosphate dose was determined by ratio of the examined components in superphosammonium). Basic fertilizing was used in the amount of: 0.9 g K_2O in the form of KCl and 0.2 g MgO in the form of $MgSO_4$ $7H_2O$.

The examined objects (Table 1) were compared on acidic soil and acidic soil limed with $CaCO_3$ according to hydrolytic acidity. Lime and nutrient compounds were mixed with the whole mass of soil placed in the pot. As a testing plant the spring barley Diva cultivar was used.

During the period of vegetation the soil moisture in the pots was maintained at the level of 60 % the soil total capillary water capacity. The harvest occurred in the phase of full maturity of the grain. The measurement of nitrogen and phosphorus contents was made in grain and straw samples, averages from replications. The nitrification inhibitor N-Serve was used in the concentration of 5 mg kg^{-1} in ratio to the soil mass.

RESULTS AND DISCUSSION

Observations carried out during vegetation showed big differences in appearance of plants between particular objects.

On non-limed soil in objects, in which only ammonium sulphate or granular superphosphate were used, the plants were short and wakly brached out.

In objects with phosphate-nitrogen fertilizing the plants were developed, best were superphosammonium and superphosphate, ammonium nitrate, and nitrification inhibitor were used.

Soil liming favoured growth and branching of plants. At the same time the differences in appearance of plants between objects, in which phosphate-nitrogen fertilizing was used were decreasing.

The factors investigated in the experiment caused significant changes in grain and straw mass (Table 1). Statistical analysis shows the significance of interaction of mineral fertilizing and soil liming. Ammonium sulphate used on acidic soil caused a relative decrease of plants mass, and on limed soil their increase.

The application of superphosammonium (object 5) or ammonium sulphate, superphosphate and N-Serve (object 4) caused significantly higher grain yield (Table 1) compared with the objects, in which simultaneously quantities of ammonium sulphate and granular superphosphate were added (object 3). However, no significant differences were observed in grain mass between objects in which ammonium sulphate, superphosphate and N-Serve (object 4) and superphosammonium (object 5) were used.

On the non-limed soil the straw mass appeared to be significantly higher on superphosammonium in comparison with the objects in which superphosphate and ammonium sulphate were applied. However, on limed soil no significant difference between the objects in question was observed.

Nitrogen and phosphorus percentage contents in barley grain and straw have changed slightly depending on nitrogen phosphate fertilization (Table 2). In combination with superphosammonium (object 5) the nitrogen contents was higher compared with the use of ammonium sulphate and superphosphate applied sepparately, but on non-limed soil. On limed soil no such differences were observed.

Similar comparison of phosphorus content also indicates a better superphosammonium action, especially in relation to the concentration of this compound in grain. The amount of nitrogen and phosphorus in the barley grain

Table 1. Superphosammonium effect on the mass of spring barley (g/pot)

Nitrogen-phosphate fertilizing	Grain		Straw		Grain + straw	
	without lime	without lime	without lime	without lime	without lime	without lime
1. Granular superphosphate	2.9	3.4	4.7	4.1	7.6	7.5
2. Ammonium sulphate	1.4	13.2	3.8	16.8	5.2	30.0
3. Granular superphosphate +ammonium sulphate	7.3	19.2	10.1	21.4	17.4	40.6
4. Granular superphosphate + ammonium sulphate + N-Serve	9.9	21.1	9.6	20.4	19.5	41.5
5. Superphosammonium	9.0	22.3	12.9	21.9	21.9	44.2
LSD (P=0.05)	1.53		1.51		2.74	

Table 2. Superphosammonium effect on nitrogen and phosphorus content (% d.m.)

Nitrogen-phosphate fertilizing	N (% d.m.)				P_2O_5 (% d.m.)			
	grain		straw		grain		straw	
	without lime	with lime	without lime	with lime	without lime	with lime	without lime	with lime
1. Granular superphosphate	1.16	1.26	0.54	0.60	0.68	0.72	0.21	0.19
2. Ammonium sulphate	2.40	1.54	1.79	0.97	0.48	0.49	0.10	0.06
3. Granular superphosphate + ammonium sulphate	2.02	1.64	1.03	0.76	0.74	0.78	0.20	0.16
4. Granular superphosphate + ammonium sulphate + N-Serve	2.14	1.54	1.00	0.69	0.78	0.80	0.18	0.16
5. Superphosammonium	2.20	1.58	1.28	0.76	0.79	0.81	0.22	0.15

and straw registered on superphosammonium appeared to be significantly higher in comparison with the object, in which ammonium sulphate and granular superphosphate were applied separately (Table 3). It also turned out that this difference was relatively small on limed objects and very high on acidic non-limed soil. Therefore the positive effect of granulation was significantly increased with the decrease of soil pH, that is with the worsening of conditions for barley growth.

The presented results show that the granulation of ammonium sulphate with powdery superphosphate produce in effect similar action as N-Serve. It also suggests that more advantageous effect of superphosammonium can be induced by a higher degree, through granulation affecting the nitrification process and nitrogen uptake and by a lesser degree through better results of supplying plants with phosphates. The results also prove the thesis that granulation and chemical composition of fertilizers with the participation of nitrogen compounds constituts an important factor of nitrogen changes in the soil [1].

CONCLUSIONS

1. Superphosammonium indicates more beneficial influence on the yield of spring

Table 3. Superphosammonium effect on quantity of nitrogen and phosphorus in barley plants (mg/pot)

Nitrogen-phosphate fertilizing	N		P_2O_5	
	without lime	with lime	without lime	with lime
1. Granular superphosphate	59	67	30	32
2. Ammonium sulphate	102	366	11	75
3. Granular superphosphate +ammonium sulphate	252	477	74	184
4. Granular superphosphate + ammonium sulphate + N-Serve	308	466	95	201
5. Superphosammonium	363	519	100	214

barley compared with substrates from which it was produced. This difference increases as growth conditions caused by soil acidity become worse.

2. More advantageous fertilizing action of superphosammonium is connected with larger uptake by plants of mainly nitrogen and also phosphorus.

3. Application of the N-Serve nitrification inhibitor increases the fertilizing action of ammonium sulphate used for spring barley.

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WPŁYW SUPERFOSAMONU NA MASĘ JĘCZMIENIA JAREGO I POBRANIE SKŁADNIKÓW POKARMOWYCH ZALEŻNIE OD WAPNOWANIA GLEBY KWAŚNEJ

W doświadczeniu wazonowym badano jak zmienia się wartość nawozowa superfosamonu (zgranulowana mieszanka siarczanu amonowego i superfosfatu pylistego) w porównaniu do równoważnej ilości substratów. Ocenę wartości nawozu badano na glebie kwaśnej i zwapnowanej węglanem wapnia wg pojedyńczej kwasowości hydrolitycznej. Jako rośliny testowej użyto jęczmienia jarego odmiany Diva.

Otrzymane wyniki wskazują na istotnie korzystniejsze działanie superfosamonu na plony jęczmienia i ilość pobranego azotu i fosforu w porównaniu do substratów, z których został wyprodukowany. Różnicę tę stwierdzono tak w obiektach bez wapna, jak i z wapnem. Zahamowanie nitryfikacji N-Servem zmniejszyło różnicę między stosowanymi oddzielnie siarczanem amonowym i superfosfatem pylistym a superfosamonem (porównanie obiektów 3 i 4). Otrzymane wyniki sugerują, że powodem lepszego nawozowego działania superfosamonu jest prawdopodobnie obniżenie tempa nitryfikacji jonów amonowych obecnych w tym nawozie.

Słowa kluczowe: superfosamon, gleba kwaśna, wapnowanie, jęczmień jary.