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COMPARISON OF AGROCHEMICAL EFFICIENCY OF NPKS MIXTURE APPLIED AS DUST AND TABLET FORMS

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ABSTRACT

The application of fertilizers in tablet form becomes more popular due to the global climate change, in particular the heavy rains and floods in many countries, including Bulgaria. The present investigation tests the agricultural efficiency of complex NPKS (containing the elements Nitrogen, Phosphorus, Potassium, Sulphur) mixture that utilizes ammonium sulphate from the electron-beam desulphurization unit of "Maritza East 2" Thermal Power Plant. The fertilizer is applied as dust and tablet form in pots with low-productive substrate, where white beans plants are grown. Measurements and comparison of the leaves' number, trunks diameter and height were performed. The roots and green mass were dried, measured and analyzed. The P_2O_5 contents were also determined. All data and analyses performed prove the agrochemical applicability of the complex mixture. The positive results obtained are grounds to recommend utilization of the tablet form for individual fertilization.

Keywords: complex NPKS fertilizer, white beans, agriculture, tablet form, electron-beam technology, coal ashes.

INTRODUCTION

The modern agriculture and the high yields are related to the effective agrochemical activities, among which the fertilization plays a major role. In the last decades more researches are dedicated to the form of fertilizer application – liquid, dust or tablets, in respect to achieve better agricultural and economic efficiency. The use of tablet form is an important tendency, notable on the European fertilizers market, becoming more actual in relation to the global climate change and heavy rains and floods in many countries, including Bulgaria [1]. The present study aims to compare the agrochemical efficiency of NPKS fertilizer applied in dust and tablet form.

EXPERIMENTAL

Materials. The main components of the developed NPKS mixture, determined after optimization [2], are: $(NH_4)_2SO_4$ from the electron-bream technology of "Maritza East – 2" Thermal Power Plant [3]; dry sludge from production of dicalcium phosphate for forage purposes; standard fertilizer K_2SO_4; and sorption component – 30 % mass ashes collected by the dedusting facilities of "Maritza East – 2" Thermal Power Plant and "Brikel" Briquette Factory. This composition allows for achieving the required static straight, volumetric weight and water retention capacity, as well as minimal mass loss at 313 K. The dry components were mixed and watered to reach 12 % moisture and extrusion was per-

formed under pressure of 6 kg cm^{-1} through a nozzle with diameter 5.10^{-2} m using 'Netsch' extruder. After drying at 313 K certain quantity from the material is grinded to particles less than 1.10^{-3} m, while other quantity is cut down to tablets 5.10^{-3} m and diameter 5.10^{-2} m.

Methods

For research purposes the following apparatus was used: CDRV 62 Tacussel Electronique electroconductivity and resistance meter; LP 17 pH-meter; Sartorius 1602 MP analytical scales and Spekol 11 spectrophotometer. Standard methodologies for determination of non-soluble particles in ammonium sulphate and spectrophotometric determination of P_2O_5 in dry mass were done [4]. The concentrations of nutrients in the new complex fertilizer are 4.01 % N, 5.9 % P_2O_{5total} and 4 % K_2O were analyzed in an authorized laboratory.

Experimental scheme

Two series of experiments in 36 pots with 0.5 kg growth substrate (95 % sand and 5 % low-productive soil 9th cathegory) were performed. The plants were supplied with the new complex NPKS mixture: series A in a dust form, series B as tablets. The white beans 'Smilyansky' brand was selected as an experimental culture. The pots were allocated under open air and watered daily with 20 ml of water, but after the 42th day of growth the watering was increased to 40 ml due to temperature raise. The experimental period was 100 days. For each series three pots with different fertilization rates were planted: 50 %, 100 %, 150 %, 200 %, 250 % and 0 % (control) from the optimal fertilization rate (OFR), calculated according to [5].

RESULTS AND DISCUSSION

The measured heights and diameters of the plants, as well as the leaves number after 40 days development are presented in Tables 1 and 2. The data show that in the beginning after 15 days development the plants have very similar parameters. The minor deviations could be explained by individual seed' specificity, but after 40 days growth the biases are caused by differences in fertilization. Sertain plants are taller with smaller leaves, while others have relatively thicker trunk and wider leaves or more leaves.

Because of the very big differences between the plants' parameters for the 40th and the 100th day of development and the small plants number, statistically significant conclusions could not be given because the trial dispersion value is above the acceptable level.

From the data obtained the following conclusions become evident: for series A the best developed plants were supplied with 100 % OFR and 150 % OFR, all plants are characterized by very well developed stems

Table 1. Mean taxonometric data for series A.

Fertilization rate	Mean data 15th day			Mean data 40th day		
	Height, m,	Diameter, m,	Leaves, number	Height, m,	Diameter, m,	Leaves, number
0%	0.066	0.0018	0.0533	0.01183	0.0025	14.67
50%	0.0650	0.0016	0.0467	0.01627	0.0023	14.67
100%	0.0617	0.0016	0.0533	0.02293	0.0025	17.33
150%	0.0650	0.0018	0.0533	0.02003	0.0023	17.33
200%	0.0577	0.0017	0.0533	0.01783	0.0020	15.33
250%	0.0580	0.0016	0.0533	0.01600	0.0017	16.00

Table 2. Mean taxonometric data for series B.

Fertilization rate	Mean data 15th day			Mean data 40th day		
	Height, m,	Diameter, m,	Leaves, number	Height, m,	Diameter, m,	Leaves, number
0%	0.0660	0.0018	0.0533	0.01183	0.0025	14.67
50%	0.0650	0.0016	0.0467	0.01917	0.0023	16.00
100%	0.0617	0.0016	0.0533	0.02280	0.0026	16.00
150%	0.0650	0.0018	0.0533	0.03500	0.0022	17.33
200%	0.0577	0.0016	0.0533	0.01797	0.0018	16.00
250%	0.0580	0.0017	0.0533	0.02350	0.0019	14.00

Table 3. Plants dry masses after 100 days growth.

FR	Stem and leaves, 1.10^{-03} kg			Roots, 1.10^{-03} kg		
	A	B	Difference, %	A	B	Difference, %
0%	3.319			2.374		
50%	1,350	4,528	335,41	0,336	1,001	297,92
100%	4,475	5,998	134,03	4,506	6,335	140,59
150%	4,742	5,527	116,55	3,650	3,122	85,53
200%	4,546	4,700	103,39	1,425	1,643	115,30
250%	3,149	2,284	72,53	1,392	0,411	29,53

Table. 4. Contents of P_2O_5 in plants tissues after 100 days growth.

FR	P_2O_5 % in stem and leaves			P_2O_5 % in roots		
	A	B	Difference, %	A	B	Difference, %
50%	0.39	0.44	112.82	0.15	0.12	80
100%	1.09	0.62	56.88	0.38	0.14	36.84
150%	0.79	1.82	230.48	0.32	0.52	162.5
200%	0.68	0.75	110.24	0.27	0.37	137.04
250%	0.43	0.34	79.07	0.26	0.30	115.38

and green mass. For series B maximum growth was registered for fertilization with 100 % OFR and 150 % OFR too. These plants responded with faster initial growth during the beginning phase due to the higher nutrients quantities available.

The leaves and roots masses were dried and measured (Table 3), but it is important to mention that during the final growth period green mass losses occurred due to invaders, strong winds and drying of lower level leaves. Therefore, it is recommended the future experiments to include more plants and to be in greenhouse conditions.

The data from Table 3 exhibit the strong green mass development for fertilization with 50 % and 100 % OFR, while development associated with the higher norms is weaker. The differences between series A and B, calculated to be 134 % and 140 % respectively, prove the better tablets efficiency. The higher fertilization rates do not beneficiate the plants development significantly, may be because the root system can not utilize more nutrients under the given conditions. This is confirmed by the comparison of availability of P_2O_5 after 100 days of development. Probably for uptake of nutrients in higher rates (250 % OFR), abundance of water is required, because the better sorption capacity retains the irrigation waters and reduces its availability to roots.

It is evident from Table 4 that the best P_2O_5 uptake is obtained for application of 100 % OFR for series A and 150 % OFR for series B, respectively, which is confirmed by taxonometric data. The denser and larger tableted fertilizer obviously does not release nutrients fast in the soil solution. This is a good prerequisite for providing longer period of nutrients availability and preventing their leaching due to rains and consequent mass losses.

CONCLUSIONS

The studies performed have proven the positive agrochemical impact of the complex NPKS mixtures on the beans specie growth under optimal growth rates. The input of tablets proved better uptake of nutrients and general higher efficiency, which is a ground to express recommendations for further wider application. The tablets supply is characterized by certain advantages related to nutrients uptake by roots and potential to reduce surface and groundwater pollution, thus obtaining a positive environmental effect. It is recommended to expand and deepen the experimental topic with other species in higher numbers to obtain statistically significant results.

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