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The effect of sewage sludge composts and potato pulp on uptaking of macroelements by the grain and straw of the spring triticale

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Taking into consideration the acid pH soil, high content of potassium in relation to nitrogen and phosphorus and the insignificant quantity of heavy metals in the potato pulp and the slight alkaline pH soil as well, high amount of nitrogen and phosphorus in relation to potassium in the municipal sewage sludge, the experiment was carried out in order to define the effect of composts from these waste on uptaking macroelements by the grain and the straw of the Wanad variety spring triticale.
The vegetative – pot experiment was carried out on the brown incomplete soil of the slight acid pH (pH_{KCl} 6,1), of the granulometric composition of slight loam (V complex), an average content of available forms of phosphorus and potassium and a high content of magnesium.
The obtained results show that the grain and the straw of spring trticale took distinctly more macroelements under the influence the fertilization of the composts with the municipal sewage sludge (30%) and the potato pulp (30%) in comparison with the composts with the 60% participation of the potato pulp. The supplementary mineral fertilization which was used against in comparison to composts, increased uptaking the macroelements by the tested plant. The double dose of composts and mineral fertilizers visibly increased nitrogen, phosphorus, potassium, cooper, magnesium and sulphur absorbance by the grain and the straw of spring trticale in comparison with the series with a single dose of composts and a supplementary mineral fertilization.

Keywords: municipal sewage sludge, potato pulp, composts, uptaking macroelements by spring triticale

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INTRODUCTION

Until recently many wastes from agricultural – food industry were used as the components to the fodder production. Decreasing the amount of the cattle and the sheep caused the drop of farmers' interests in those wastes. Because of that, there has been a problem of the utilization or their secondary utilization.

The potato pulp, the waste from the process of potatoes processing into the starchy-flour has an acid pH, contains macroelements needed for plants' growth and development. There is much more potassium compared to nitrogen and phosphorus in this waste. The content of heavy metals is not high (Krzywy E., Krzywy J., 2003, 2005).

Recently more attention has been paid to the possibility of utilizing the sludge that is produced during purifying the municipal sewage, for the purpose of fertilization. Sewage sludge composts according to Baran (2005), Czekała (1999), Krzywy et al. (2000 et 2002), Mazur (1996), Siuta and Wasiak (2001) and Wołoszyk (2003) are characterized by the pH from the lightly acid to the alkaline soil pH, they contain organic mass and a large amount of some nutrients for the plants. As a general rule they include much more nitrogen and phosphorus in relation to potassium. The sewage sludge composts can include excessive amount of heavy metals and pathogenic microorganisms. Therefore, the sewage sludge composts, before being introduced into the soil, must be submitted to the processes of stabilization and hygiene in order to decrease the heavy metals concentration as well the pathogenic microorganisms. One of the most frequently applied ways of the utilization and hygiene of the sewage sludge composts is composting.

Taking into account the acid reaction, a high content of potassium in relation to nitrogen and phosphorus as well as a low amount of heavy metals in the potato pulp and the pH from the lightly acid to the alkaline soil pH, a high quantity of nitrogen and phosphorus in relation to potassium in the municipal sewage sludge, experiments were carried out to define the influence of the composts from those wastes on uptaking the macroelements by the grain and straw spring triticale, were carried out in the years 2003 – 2004.

METHODS OF STUDIES

Realizing the aim of the experiment in 2003 year, composts were made with an addition of the municipal sewage sludge and potato pulp. The rye straw or the sawdust from the conifers were used as the structural-formative components. The composts were subjected to a one-month period of decomposition. The composition of the composts in converting to the dry mass was presented in the Table 2.

In 2004 the vegetative – pot experiment was established. Brown incomplete soil of the mechanic composition of slight loam (the slight soil, V complex) was used in this experiment. The chemical characterization of the soil used in the experiment was presented in Table 1.

The data provided in the table show that the soil, which had been used in the experiment, was characterized by lightly acid pH, an average content of available forms of phosphorus and potassium and also the high content of magnesium. The C: N ratio in the soil was 10,4: 1.

Table 1. The chemical characterization of the soil used in the experiment

pH_{KCl}	Corg. (g·kg^{-1} s.m.)	Total forms (g·kg^{-1} s.m.)						Available forms (g·kg^{-1} s.m.)		
		N	P	K	Ca	Mg	S	P	K	Mg
6,1	8,44	0,81	1,23	5,12	2,16	0,24	0,15	64,2	114,5	54,2

Table 2. The influence of the potato pulp composts and the municipal sewage sludge as well as mineral fertilizers on the absorption of nitrogen, phosphorus, potassium by the grain and straw of spring triticale. Data in g·pot

Type of compost	Composts without an addition of mineral fertilizers			Composts with an addition of mineral fertilizers			Double dose of composts and mineral fertilizers		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
NITROGEN									
compost I*	0,264	0,060	0,324	0,360	0,091	0,451	0,496	0,111	0,607
compost II*	0,264	0,057	0,321	0,328	0,077	0,405	0,514	0,120	0,634
compost III*	0,159	0,053	0,212	0,186	0,068	0,254	0,384	0,108	0,492
compost IV*	0,168	0,047	0,215	0,206	0,064	0,270	0,373	0,125	0,498
Mean	**0,213**	**0,054**	**0,267**	**0,270**	**0,075**	**0,345**	**0,441**	**0,116**	**0,557**
Control	0,124	0,041							
PHOSPHORUM									
compost I*	0,025	0,015	0,040	0,038	0,021	0,060	0,061	0,025	0,086
compost II*	0,032	0,014	0,046	0,038	0,018	0,056	0,060	0,027	0,087
compost III*	0,009	0,011	0,020	0,012	0,015	0,027	0,038	0,024	0,062
compost IV*	0,011	0,010	0,021	0,013	0,015	0,028	0,032	0,026	0,058
Mean	**0,019**	**0,012**	**0,031**	**0,025**	**0,017**	**0,042**	**0,047**	**0,025**	**0,073**
Control	0,008	0,010							
POTASSIUM									
compost I*	0,082	0,130	0,212	0,131	0,197	0,328	0,181	0,236	0,417
compost II*	0,080	0,132	0,212	0,112	0,187	0,299	0,186	0,237	0,423
compost III*	0,057	0,139	0,196	0,066	0,171	0,237	0,157	0,239	0,396
compost IV*	0,060	0,134	0,194	0,068	0,172	0,240	0,147	0,260	0,407
Mean	**0,069**	**0,134**	**0,203**	**0,094**	**0,182**	**0,276**	**0,168**	**0,243**	**0,411**
Control	0,042	0,115							

*Explanation of the composition of the composts in converting to dry mass:
Compost I – (potato pulp 30%, municipal sewage sludge 30% and rye straw 40%)
Compost II – (potato pulp 30%, municipal sewage sludge 30% and sawdust from the conifers 40%)
Compost III – (potato pulp 60%, and rye straw 40%)
Compost IV – (potato pulp 60%, and sawdust from the conifers 40%)

For the purpose of decontamination the soil was sifted through the sieve with the mesh diameter of 5 mm. Then the soil was inserted into the pots in the quantity of 9 kilos per each pot.

Two factors were taken into consideration in the pattern of the experiment. Four types of composts were the first factor and the doses of composts without and with supplementary mineral fertilization were considered the second factor.

In the first series of the experiment the doses of composts (without supplementary mineral fertilization) were established on the level of the content 0,6 g N · pot. It corresponded to 200 kg N · ha^{-1}. The N: P: K relation was accepted for the purpose of establishing supplementary mineral fertilization compared to the composts in the second series of the experiment. This relation N: P: K was to be introduced into the soil with the fertilizers (1,0: 0,30: 0,86). The content of 0,6 g N · pot was a base of the fertilization on the objects with the composts with the potato pulp (30%) and the municipal sewage sludge (30%). Due to a small content of potassium in these composts supplementary fertilization of water solution of salt potassium (50%) was introduced. The content of total potassium was assumed for the purpose of establishing the total dose on the object with composts with the 60% participation of the potato pulp because of a small content of nitrogen and phosphorus in relation to potassium. The dose of potassium in the form of composts was established on the 0,51 g K level · pot, that is 166 g K · ha^{-1}. The shortage of nitrogen and phosphorus was completed with the water solution of urea (46%) and triple superphosphate (20% P). In the third series of the experiment, the doses of composts and supplementary mineral fertilization were doubled in relation to the second one.

The doses of the composts were put on the surface of the soil according to pattern of the experiment and the methodical assumption. The composts were mixed with the soil to the depth of 7 – 8 cm. Next according to the pattern of the experiment water solutions of mineral fertilizers were put into the soil and mixed to the 2 – 4 cm depth.

20 grains of the spring triticale Wanad variety were sown on each of the so prepared soils. The pots were situated under the foil canopy in order to keep constant humidity of the soil on the 60% level of the full water humidity. The soil in the pots was being sprinkled with redistilled water. The selection of plants was carried out after their growing leaving 10 plants in each pot. Each object of the experiment had four repetitions. The plants were cut and dried after that they had reached maturity. Next the size of the yield of the grain and the straw was marked and the samples were taken for the chemical analyses. The content of nitrogen, phosphorus, potassium, calcium, magnesium and sulphur was marked in the grain and the straw of the spring triticale using the method of Ostrowska et al. (1991). Taking into consideration the size of the yield of the grain and straw and also the content of nitrogen, phosphorus, potassium, calcium, magnesium and sulphur in them, the absorption of macroelements by the plant was estimated

Table 3. The influence of the potato pulp composts and the municipal sewage sludge and mineral fertilizers on the absorption of magnesium, calcium, sulphur by the grain and straw of the spring triticale. Data in g·pot

Type of compost	Composts without an addition of mineral fertilizers			Composts with an addition of mineral fertilizers			Double dose of composts and mineral fertilizers		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
MAGNESIUM									
compost I*	0,025	0,014	0,039	0,043	0,022	0,065	0,058	0,029	0,087
compost II*	0,023	0,013	0,036	0,038	0,020	0,058	0,061	0,028	0,089
compost III*	0,016	0,014	0,030	0,024	0,018	0,042	0,050	0,028	0,078
compost IV*	0,018	0,014	0,032	0,026	0,020	0,046	0,047	0,031	0,078
mean	**0,021**	**0,013**	**0,034**	**0,033**	**0,020**	**0,053**	**0,054**	**0,029**	**0,083**
control	0,015	0,012							
CALCIUM									
compost I*	0,009	0,030	0,039	0,011	0,044	0,055	0,016	0,052	0,068
compost II*	0,007	0,032	0,039	0,011	0,042	0,053	0,016	0,056	0,072
compost III*	0,005	0,028	0,033	0,005	0,035	0,050	0,010	0,049	0,059
compost IV*	0,005	0,025	0,030	0,006	0,033	0,039	0,010	0,050	0,060
mean	**0,006**	**0,029**	**0,035**	**0,008**	**0,038**	**0,046**	**0,013**	**0,052**	**0,065**
control	0,004	0,022							
SULPHURE									
compost I*	0,025	0,036	0,061	0,034	0,053	0,087	0,046	0,059	0,105
compost II*	0,025	0,035	0,060	0,030	0,045	0,075	0,049	0,061	0,110
compost III*	0,018	0,035	0,053	0,020	0,044	0,064	0,040	0,061	0,101
compost IV*	0,019	0,035	0,054	0,021	0,044	0,065	0,038	0,067	0,105
mean	**0,022**	**0,035**	**0,057**	**0,026**	**0,046**	**0,072**	**0,043**	**0,062**	**0,105**
control	0,014	0,030							

* Explanations of the composition of the composts in converting to dry mass were presented in Table 2

RESULTS AND DISCUSION

The data regarding absorption of nutrients by the plants can be helpful to estimate the their food and fertilizing requirements. Moreover, the received experiment results show to which extent the plants take the nutrients from the soil and to which extent from the fertilizers.

The obtained experiment results that concern uptaking the macroelements (N, P, K, Ca, Mg i S) by the grain and the straw of spring triticale were presented in Tables 2 and 3.

Analyzing the obtained results it can be said that uptaking nitrogen, phosphorus, calcium, magnesium and sulphur by the tested plant, which had been fertilized by the composts without and with addition mineral fertilizers, was visibly greater compared to the control variant.

The quantity of the uptaking of the individual macroelements by the grain and the straw of spring triticale depended on the obtained yield's mass to a larger extent than on the content of nitrogen, phosphorus, potassium, calcium, magnesium and sulphur in the plant.

The grain of spring triticale took visibly more nitrogen and magnesium in comparison with the straw. However the straw took more phosphorus, potassium, calcium and sulphur. The grain of spring triticale from the variants with the composts with municipal sewage sludge (30%) and potato pulp (30%) accepted more phosphorus than the straw. There are no visible differences in the phosphorus uptake between the grain and straw of the tested plant in the variants with the composts with 60% participation of potato pulp (Tables 2 and 3).

Generally, the grain and straw of spring triticale took more macroelements from variants with the composts with municipal sewage sludge (30%) and potato pulp (30%) in comparison with the composts which included 60% of potato pulp. This situation is connected with a high content of nutrients in the composts with the participation of municipal sewage sludge. Those composts visibly increased the yields of the grain and straw of spring triticale and they insignificantly contributed to an increase of the tested macroelements.

Additional use of mineral fertilizers as a supplement of the doses of nitrogen, phosphorus and potassium, which were put into the soil with the composts, visibly caused an increase of nitrogen, phosphorus, calcium, magnesium and sulphur absorption by spring triticale. The results show that the nutrients which were put into the soil with the composts did not meet the total demand of the plants.

The double dose of composts and mineral fertilizers caused an additional increase of uptaking the nutrients by the grain and the straw of spring triticale in comparison with the series in which the single dose of composts with supplementary mineral fertilization was used.

The structural-formative composts (rye straw or sawdust from the conifers), which were put into the composts mass, did not have much influence on the diversity uptaking macroelements by spring triticale.

Summing up, it can be said that the tested composts influenced the increase of uptaking macroelements by the tested plant. In the variants with the composts with participation of the municipal sewage sludge more effects with uptaking macroelements were obtained. The results confirm the researches which pointed out to the possibility of using the municipal sewage sludge (Baran 2002, Czekała 1999, Krzywy et al. 2000 and 2002, Siuta and Wasiak 2001, Wołoszyk 2003) as well as potato pulp (Krzywy and Krzywy 2003, 2005) for the fertilizing purpose through the composting process.

CONCLUSION

1. Composts with the participation of the municipal sewage sludge and the potato pulp caused visibly an increase in the uptake of nitrogen, phosphorus, potassium, calcium, magnesium and sulphur by the grain and the straw of spring triticale in comparison with the control variant.

2. Composts with the participation of the municipal sewage sludge (30%) and the potato pulp (30%) visibly

caused a bigger uptake of macroelements by the tested plant in comparison with the composts with 60% participation of the potato pulp.

3. Supplementary mineral fertilization, which was put into the soil with the composts, caused an increase of the uptak of macroelements by the grain and the straw of spring triticale.

4. The double doses of composts and mineral fertilizers caused an increase of the uptake of nitrogen, phosphorus, potassium, calcium, magnesium and sulphur by the tested plant in comparison with the series with a single dose of composts and supplementary mineral fertilization.

5. Structural-formative supplements, which were put into the compost mass, did not cause any difference in the uptake of macroelements by the tested plant.

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