The residual effect of fertilizer application of granulated organic-mineral fertilizers formed from spent mushroom substrate on pH of soil

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Spent Mushroom Substrate (SMS) were used to formed granulated organic-mineral fertilizers. Four granulated organic-mineral fertilizers were formed from Spent Mushroom Compost (SMC) before granulation supplemented by mineral fertilizers (urea, single superphosphate, K salt, ammonium saltpeter, ammonium sulfate). Two granulated organic-mineral fertilizers were based on compost from Spent Mushroom Compost and sewage sludge and one of them was supplemented by ammonium sulfate before granulation. The pH-value of the fertilizers range from 6.17 to 6.94. Fertilizers and composted Spent Mushroom Substrate are using on two doses on account of applied nitrogen content, these doses are 100 and 200 kg N ha^{-1}. 10 fertilizers combinations on four replications are used in experiment. These organic-mineral fertilizers were applied just before planting first test plant – common cabbage. Second test plant – corn and third test plant – oat were grown without fertilization in these same vases-ground. Organic-mineral fertilizers are excellent source of macronutrients (22.0-83.0 g N· kg^{-1}, 6.70-18.50 g P· kg^{-1}, 2.70-27.0 g K· kg^{-1}, 41.1-71.3 g Ca· kg^{-1}, 3.1-4.3 g Mg kg^{-1}, 18.7-101.6 g S· kg^{-1}) and organic matter (182.8-411.3 g Corg · kg^{-1}). After application the residual effect on pH of soil was observed. The soil pH-value on every object with fertilization was changed compare to control object without fertilization. Increased pH-value first year (5.35-5.92), second year (4.71-5.19) and third year (4.28-4.71). After harvest were collected samples of soil, prepared to physical and chemical analyses and estimated pH-value of soil. Statgraphics 4.0. program was using to statistic data processing of the results.

Keywords: Spent Mushroom Substrate, sewage sludge, organic-mineral fertilizers, soil reaction

Introduction

Poland is a European Leader in mushroom production (third place in the world production of mushrooms). In the production of 1 kilogram of mushrooms (*Agaricus bisporus*), 5 kilograms Spent Mushroom Substrate (SMS) are generated [1]. In Poland were about 1 675 000 tonnes in 2015 [2] and 1 625 000 tonnes in 2017 [3] fresh weight of this by-product. Spent Mushroom Substrate contains peat mixed with straw and horse dung or poultry manure, chalk, gypsum and with mineral fertilizer supplement [4, 5]. It is an excellent source of organic matter and macronutrients [6, 7]. The composition of this waste allows using them in the farming [8, 9]. According to [10] this by-product was cataloged like a waste. In Poland is problem with too lower soil organic matter content. It is negative, because organic matter influenced on soil properties (like pH-value) and decided about soil fertility [11].

The Aim of Investigations

The objective of the study has been to determine the effect of granulated organic-mineral fertilizers (OFM) formed from Spent Mushroom Substrate on changes of soil pH in condition of three-years microplot experiment.

Material and Methods

The research was carried out based on the microplot field experiment located at the Experimental Station of the Faculty of Agriculture and Biology – Warsaw University of Life Sciences-SGGW which is located in Skierniewice (Central Poland). Stoneware pots (1.2 m long and 40 cm wide) used in this experiment and experimental conditions were described according to [12]. All fertilizers (Tab. 1) and composted Spent Mushroom Substrate were used in two doses corresponding to 100 and 200 kg N·ha^{-1}. Control Object was without fertilization. Soil samples for analyses were collected after harvest from the surface soil layer of each mi-

Tab. 1. The composition of granulated organic-mineral fertilizers formed from Spent Mushroom Substrate (SMS)

Type of fertilizer	Ingredients of the organic-mineral fertilizers
OFM1	composted Spent Mushroom Substrate, urea, single superphosphate, K salt
OFM2	composted Spent Mushroom Substrate, ammonium saltpeter, single superphosphate, K salt
OFM3	composted Spent Mushroom Substrate, ammonium sulfate, single superphosphate, K salt
OFM4	composted Spent Mushroom Substrate, ammonium saltpeter
OFM5	composted mixture Spent Mushroom Substrate and sewage sludge
OFM6	composted mixture Spent Mushroom Substrate and sewage sludge, ammonium sulfate

croplot (0-30cm deep). The soil samples were dried in the laboratory and were sieved through a sieve with a mesh 2 mm. In the samples, there was assessed soil pH – by potentiometric method after extraction in 1 mol·dm^{-3} KCl (10 g of soil was suspended in 25 ml of KCl and left for 24 hours to equilibrate), using a pH meter (Schott, Mainz, Germany) with a glass electrode. The results were statistically analysed with ANOVA using Statgraphics 4.0. program.

Results

Value of soil pH was significantly dependent of fertilizer's kind and doses applied in experiment . For all the fertilized objects there were statistically significant changes in pH of the soil (Fig. 1, Fig. 2, Fig. 3). Soil fertilized was characterized by a statistically significantly higher value of the pH as compared to the control object. In the first year of experiment the strongest impact on soil pH was observed in condition of fertilizers formed from composted spent mushroom substrate with sewage sludge (OFM5) application (Fig. 1). The residual effect of fertilization on soil pH was observed in second and third year after studied fertilizers application (Fig. 2, Fig. 3). Between granulated organic-mineral fertilizers (OFM1, OFM2, OFM3, OFM4, OFM5, OFM6) were not reported statistically significant differences in their effects on pH of the soil (Tab. 2). With

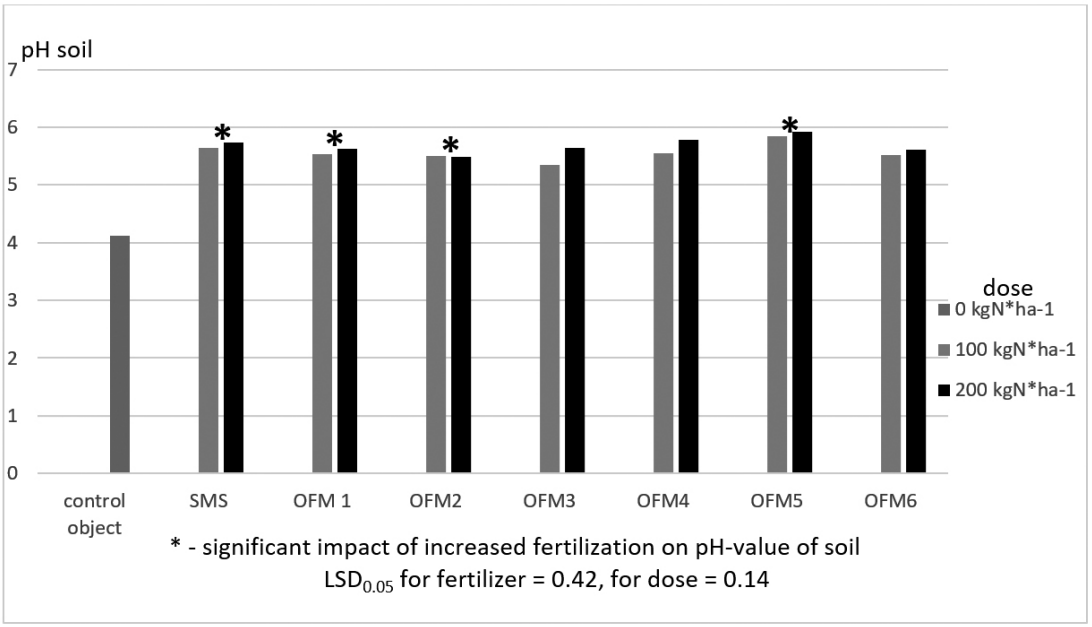

Fig. 1. The Effect of Organic-Mineral Fertilizers on soil pH After Cabbage Harvest

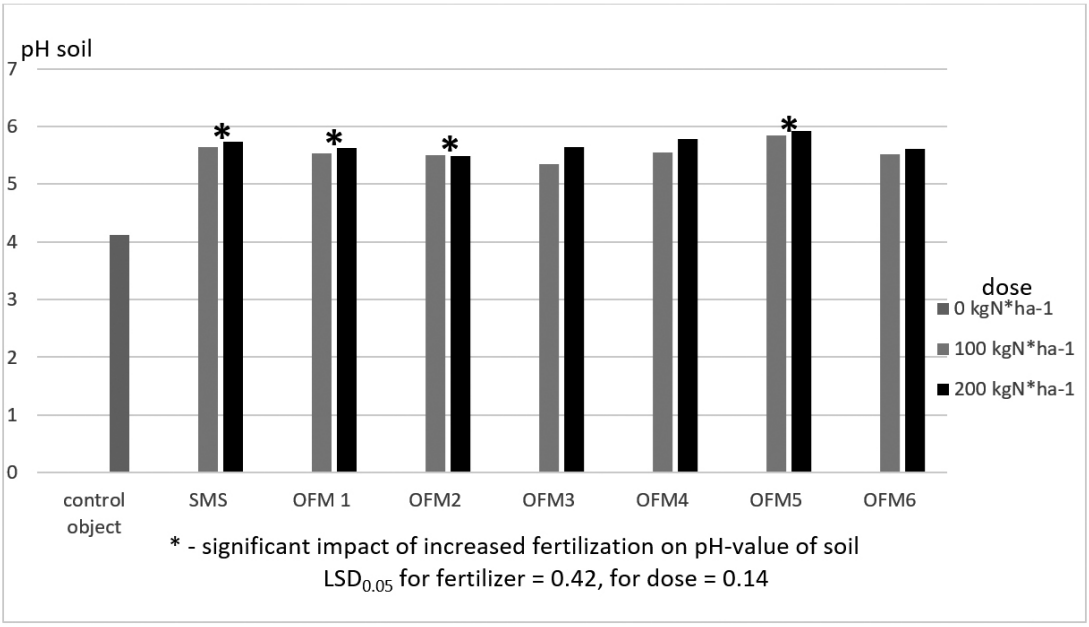

Fig. 2. The Residual Effect of Organic-Mineral Fertilizers on soil pH After Corn Harvest

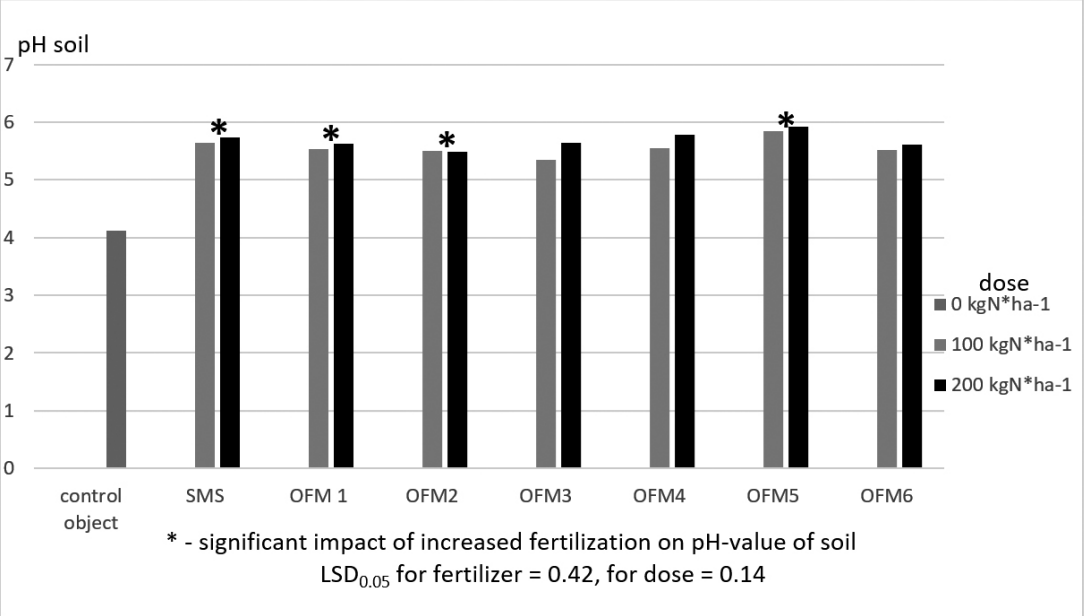

Fig. 3. The Residual Effect of Organic-Mineral Fertilizers on soil pH After Oat Harvest

increasing doses of fertilizers OFM1, OFM2, OFM4, OFM5, OFM6 and with increasing doses of spent mushroom compost the soil pH value increases (Fig. 1, Fig. 2, Fig. 3). The increase of dose caused stronger impact of fertilizers on soil pH-value [13]. In the first year of experiment and in the third year of experiment the level of fertilization was statistically significant for impact on soil pH only in objects with OFM1, OFM2, OFM5 and composted spent mushroom substrate (Fig. 1 and Fig. 3). In the second year of experiment observed statistically significant impact of fertilizer dose on soil pH in condition of OFM1, OFM2, OFM4, OFM5 and composted spent mushroom substrate application (Fig. 2). Independent of applied dose the greatest soil pH obtained in objects fertilized with granulated organic-mineral fertilizer formed from spent mushroom substrate supplemented with sewage sludge (OFM5), with urea, potassium salt and powdery superphosphate (OFM1) and granulated organic-mineral fertilizer formed from spent mushroom substrate supplemented with ammonium nitrate. Similar effect on soil pH was observed after application of SMS. Increase of dose studied fertilizers resulted stronger impact on soil pH value according to [11] and [14,15,16].

Fertilizers formed from spent mushroom substrate supplemented with sewage sludge (OFM5 and OFM 6) proved significant influence on changes of pH of the soil. Wastes like sewage sludge positive influencing on soil pH. With increasing doses of sewage sludge the soil pH increase [17]. Production of fertilizers from sewage sludge and spent mushroom substrate can be good idea to simultaneous manage both organic residues.

Granulated organic mineral fertilizers and SMS changed of soil acidification. In the first year of experiment soil was slightly acid on objects with greater dose of OFM1, OFM3, OFM4, OFM6 and acid on objects with both doses of Spent Mushroom Substrate and OFM5. In the second year of experiment soil on all fertilized object was acid (soil on control object without fertilization was very acid). In the third year of experiment soil from objects with both doses of Spent Mushroom Substrate and with greater dose of OFM2 and OFM5 was acid. Other organic-mineral fertilizers improved soil pH-value compare to object without fertilization, but did not change range of soil acidification.

Conclusions

1. Application of organic-mineral fertilizers formed from Spent Mushroom Substrate caused de-acidification of soil.
2. Value of soil pH was depended on kind and dose of fertilizers applied in the experiment. The greater dose caused stronger de-acidification of the soil.
3. The greatest pH value obtained on object manured by fertilizer formed from spent mushroom substrate composted with sewage sludge and fertilizer formed from spent mushroom substrate with urea, potassium salt and triple superphosphate.
4. The production of fertilizers from composted spent mushroom substrate with sewage sludge can be a good idea to simultaneous manage both organic wastes.

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