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Research Article

THE INFLUENCE OF VERMICOMPOST FROM KITCHEN WASTE ON THE YIELD-ENHANCING CHARACTERISTICS OF PEAS *PISUM SATIVUM* L. VAR. *SACCHARATUM* SER. BAJKA VARIETY

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ABSTRACT

This study determined the possibility of using the vermicompost produced from kitchen waste (by *Eisenia fetida* earthworms) to grow sugar peas. Its influence on the dynamics of sprouting of peas and their growth to 21st day was investigated in a pot experiment. Four combinations were realised (control – standard garden soil; (50W) – its mixture with 50% of vermicompost; (25W) and (10W) – with 25% and 10% of vermicompost addition respectively (n=5)). Vermicompost from kitchen waste turned out to be useful in the cultivation of peas. No significant differences in the impact of all the analysed substrates on the sprouting of this plant were found. A 10% vermicompost addition (10W) was shown to be the most favourable substrate. Its positive influence was shown in the impact on the increase of total average mass (by 33%; $p<0.001$) and height of the plants (by 12%; $p<0.05$) and average mass (by 39%; $p<0.001$) and length (by 12%; $p<0.05$) of stems.

Keywords: kitchen waste, vermicompost, *Pisum sativum.*

INTRODUCTION

The uncontaminated natural environment is highly valued in an era of widespread human-related pressure. One of the most important problems concerning this issue is the utilization of household organic waste, which has become a global problem related not only to the protection of the natural environment and long term fertility of soil, but also to human life and health.

The world recognizes the urgent need to create pro-environmental systems of waste management, which consist of actions preventing waste generation, in reuse of waste, not been prevented from being generated (the significance of recycling, including organic recycling) and in the neutralization of the remaining waste before it is disposed of in well-equipped dumping sites. The above mentioned assumptions cannot be implemented without the active participation of all the citizens in the system – the waste producers, whose involvement, already at the household level in the form of proper actions, has to be a decisive factor in the apprioprate division of waste streams for the purpose of recycling (including organic recycling). Organic waste isolated in this way can be utilized in earthworm ecological boxes [9].

Because Directive no. 31/EC of the European Union (of April 1999) obliges all member countries to reduce the organic content in disposed waste, the aim of the present work is to determine the possibility of using the vermicompost produced from kitchen waste to grow sugar peas of the Bajka variety.

MATERIALS AND METHODS

Origin of vermicompost used in the experiment

The vermicompost used in the experiment was produced from kitchen waste with the participation of *Eisenia fetida* earthworms, with an average population density of 133 ± 74 specimens · dm^{-3}, in 6 plastic bins, each of 3 dm^3, over a period of 16 weeks. The waste for vermicomposting contained the following: bread and pasta leftovers, apple and potato peelings, cellulose; which were introduced into the vermiculture in the same volumes and compositions (in the ratio of 1:1:1:1:1). The characteristics of the vermicompost obtained (Table 1) were specified as follows: pH in the water was specified by means of the potentiometric method, the concentration of salt - by means of the conductometric method, the N-NO_3 content in the extract of 0.03 moles of acetic acid (CH_3COOH) – potentiometrically, selected macro-elements: assimilable P, K, Mg and calcium Ca were determined in the extract of 0.03 moles of acetic acid.

Experimental design

The influence of produced vermicompost on the dynamics of sprouting of peas, their growth and fresh mass was investigated in a pot experiment. The researched plant material was certified (EC level of qualification) pea seeds of Bajka variety of Polan company (Krakowska Hodowla i Nasiennictwo Ogrodnicze Sp. z o.o.), purchased from retail outlets. The subject of the research was a mixture of garden soil (Tab. 1) and vermicompost. In the experiment, 4 treatments were realised (n=5), with the following arrangements:

- 0 – control; standard substrate – garden soil (C),
- 1 – 50% of vermicompost was used in the mixture (50W),
- 2 – 25% of vermicompost was used in the mixture (25W),
- 3 – 10% of vermicompost was used in the mixture (10W).

Plastic pots with a diameter of 20 cm were filled with the substrate prepared according to the adopted combinations, leaving 3 cm of substrate to cover the seeds. Next, onto the above mentioned substrate the peas were sown into pots, 10 seeds in each and covered with a layer of the same substrate mixture. The growing plants were watered equally, if needed, maintaining a constant humidity of the substrates. The volume of the pots was 2.5 dm^3. The experiment was conducted in an open vegetative hall with 5 replicates for each combination and in two series.

Level of germination (sprouting) was recorded 7, 14 and 21 days after sowing and analysed. At the end of the experiment the plants were removed from the substrate and cleaned, rinsed in running water, and then, after blotting on filter paper, the whole plants and their overground and root parts were measured and weighed.

Statistical analysis

Results (presented as mean ± standard deviation) were analysed by means of Analysis of variation (ANOVA), using Tukey's test.

RESULTS

In the conducted experiment no significant differences on the impact of each of the substrates on the sprouting of peas were found ($p>0.05$). However, substrate 10W was the most favourable substrate with the addition of vermicompost (10%). Regarding the control, the average sprouting reached 90%. In the substrates with the addition of 25 and 50% of vermicompost (25W and 50W), the efficiency of pea sprouting was lower (86 and 84% respectively), while these differences were not statistically significant.

In the experiment it was shown that there is a positive influence of the addition of vermicompost from kitchen waste on the average total mass of cultivated plants. That is the addition of

Table 1. The chemical composition of the vermicompost from the kitchen waste and the gardening soil used in the experiment

Characteristic	The researched element / unit						
	pH in H_2O	Concentration of salt NaCl [g·dm^{-3}]	N-NO_3	P assimilable	K assimilable	Ca	Mg assimilable
			mg· dm^{-3}				
Gardening soil	6.2	0.5	1.8	63	186	1027	141
Vermicompost	5.44	5.84	888	191	913	1911	235

10% of vermicompost to the substrate was again most favourable. Plants from this substrate had a higher total mass (2.042 ± 0.342 g), although this value did not differ markedly from the mass of peas cultivated in the substrates with the addition of 25 and 50% of vermicompost (1.948 ± 0.505 g and 1.947 ± 0.397 g, respectively). However, significant differences in the total average mass were determined in comparison to the peas grown in the control substrate (1.548 ± 0.317 g), with the plants cultivated with the addition of 10% of vermicompost ($p<0.001$) (Fig. 1).

Similar significant differences were found in case of the total average length of plants. On the 21st day of cultivation, the pea plants from substrate 10W grew to the length of 77.3 ± 10.4 cm, while the control plants grew to 69.1 ± 11.2 cm ($p<0.05$) (Fig. 2).

Peas cultivated on the substrates with the addition of vermicompost had a larger mass of stems in comparison with the control group (Table 2). Peas which grew on the 10W substrate (10% of vermicompost) had the heaviest mass of stems (1.475 ± 0.268 g), while in the substrate with the addition of 25 and 50% of vermicompost the peas reached 1.336 ± 0.360 g and 1.333 ± 0.282 g, respectively. The lowest value of the analysed characteristic (1.055 ± 0.255 g) was shown in pea plants cultivated in the control substrate – with no addition of vermicompost. The values were significantly different compared with those obtained from substrates with various addition of vermicompost ($p<0.001$) (Table 2).

The impact of the analysed substrates was also similar in terms of the length of the pea stalks. In the 10W substrate the length was equal to 55.8 ± 7.6 cm and was significantly larger in comparison with the plants growing in the control substrate (49.9 ± 9.7 cm) ($p<0.05$) (Tab. 2). In this case, the addition of 10% of vermicompost to the substrate seemed to be the most favourable.

Vermicompost had a stimulating effect on the root mass of the analysed plants. Peas cultivated with 25 and 50% of vermicompost produced 0.612 ± 0.176 g and 0.613 ± 0.2 g, respectively, of root mass, while the control plants had roots

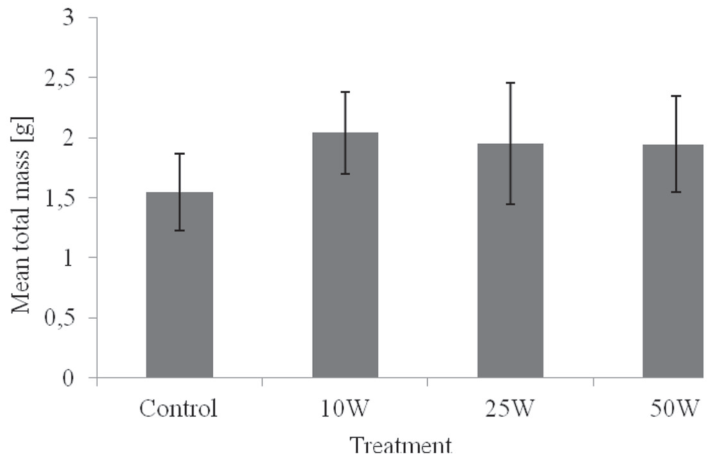

Fig. 1. The mean total mass of plants depending on the type of substrate [g]

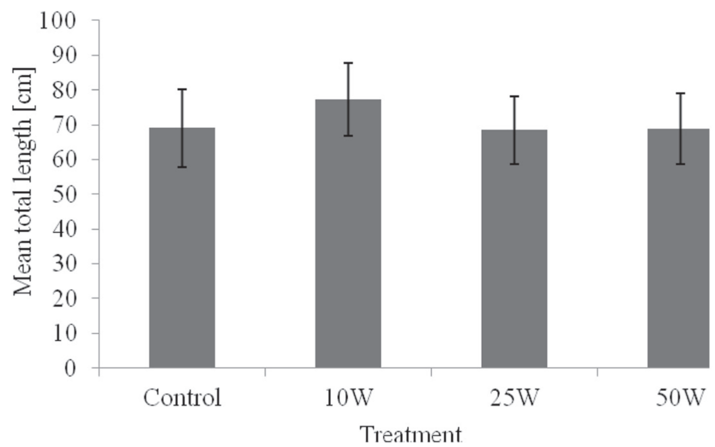

Fig. 2. The mean total length of plants depending on the type of substrate [cm]

Table 2. The average mass [g] and length [cm] of the stalks of the plants depending on the type of substrate

Characteristic \ Treatment	C	10W	25W	50W
Mean stalk mass (g)	1.055 ± 0.255[b]	1.475 ± 0.268[a]	1.336 ± 0.360[a]	1.333 ± 0.282[a]
Mean stalk length (cm)	49.9 ± 9.7[c]	55.8 ± 7.6[d]	51.9 ± 8	51.7 ± 7.6

a, a – no statistical differences; b, a – statistically significant differences (p<0,001)
c, d – statistically significant differences (p<0,05)

with a mass of 0.493 ± 0.110 g (20% difference) ($p<0.05$). Peas from the substrate with 10% of vermicompost had a total average root mass 13% larger compared with the control, but the difference was not significant ($p>0.05$). When analysing the average root length across treatments, the important influence of 10% addition of vermicompost to the soil can be highlighted once more. Peas in the process of growing in this substrate produced roots with the length of 21.5 ± 3.9 cm, while the control plants produced shorter roots (19.2 ± 3.4 cm) ($p<0.05$). Shorter roots were also produced by pea plants when growing in the substrates with 25 and 50% addition of vermicompost (16.5 ± 2.7 cm and 17.3 ± 3.8 cm, respectively).

DISCUSSION

Breeding earthworms has a wider application in the promotion of sustainable management of organic waste and sustainable agriculture because it allows: (1) biodegradation and stabilization of municipal and industrial organic waste, transforming it into vermicompost, rich in nutritional elements for plants; (2) restoration and improvement of the fertility of soil and the increase in the production of food without using chemical methods, which could be harmful to the environment; (3) production of fodders (earthworm biomass with high content of protein and other elements constitutes a valuable food source for numerous species of farm animals.

In the process of vermicomposting, it is possible to utilize organic waste which is produced in the paper industry, alcohol distillation industry, vegetable oil industry, potato, corn and sugar cane processing industry and in the mining industry [7, 2, 10]. The leaders in this field are American breeders, but it must be mentioned that increasingly there are breeders across the world, especially in countries of the Far East [5, 8, 4, 3].

Recently, importance has been attached to the separation of the organic fraction from the waste mass generated in households and processed at the site of production. This pertains mainly to poor countries, where large amounts of organic matter lie in dumping grounds and precipitate the spread of disease. Therefore such countries research vermicomposting of kitchen waste [3, 11, 1]. Such research, as described above concerning the vermicompost from kitchen waste as an element of the substrate used in the yield-enhancing characteristics of peas, is therefore of utmost practical importance.

Vermicompost obtained from household kitchen waste and used in the cultivation of peas had a relatively low pH (5.44) and also a high salinity (5.84 NaCl g·dm^{-3}). A high salinity is unfavourable for plants, because the surplus of salt ions from NaCl influences the intake of other ions such as K^+, Ca^{2+} and NO^{3-} in the plant cells. High salinity of Na^+ and Cl^- in the soil can trigger changes in the chemical composition of the soil solution, which in turn upsets the intake of nutritional elements such as P, Mg and N [13]. The inhibition of the growth of plants subjected to salt stress can also result from the lowered ability to transport assimilates, as indicated by experiments conducted on beans [17], raspberry [12] and strawberry [16]. The inhibition of the assimilate transport in the case of saline-influenced plants, can partly be conditional upon a shortage of potassium [6] or calcium [15].

In consideration of the above, whilst growing peas, numerous combinations of substrates were applied, in which significant differences in the sprouting of plants were not observed. The results do not correspond to those obtained by other authors [19, 14] researching the use of vermicomposts bought in retail outlets (Humex and BIOHUMUS). Similarly, Stompor-Chrzan [18], when analysing the influence of the vermicomposts from sheep, cow, horse and pig manure on leguminous plants, obtained results, which differ from observations herein discussed. Stompor-Chrzan [18] showed that in substrates with the addition of vermicomposts, the sprouting of seeds and the growth of beans and particularly peas and beans was significantly delayed. This author also demonstrated that the addition of the above vermicomposts to the substrates contributed to a decrease in the mass of peas and beans in comparison with plants cultivated on a standard substrate. This was not corroborated by the results of the present work, which showed that on the 21st day of cultivation, the average mass of peas grown with the addition of vermicompost, was 23% higher in comparison with the mass of plants grown on the control substrate (p<0.001). This example indicates the utility of vermicompost from kitchen waste but also the complexity of factors comprising the final production effect.

CONCLUSIONS

Cultivation of the pea *Pisum sativum* L, on mixture of garden soil and different addition of vermicompost from kitchen waste, showed no significant differences in the impact of all the analysed substrates on the sprouting of this plant. A 10% vermicompost addition to the growing media was shown to be the most favourable substrate. Its positive influence generated the biggest increase of total average mass (p<0.001) and length of plants (p<0.05) and increase of average mass (p<0.001) and length of stems (p<0.05) in comparison with the plants grown in the control substrate.

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