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The Effects of Vermicompost and Phosphorus on the Development of Soybean Plant

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Authors' contributions

This work was carried out in collaboration among all authors. Author SŞ designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors MC and HK reviewed the study design and all drafts of the manuscript. All authors managed the analyses of the study and performed the statistical analysis. Authors SŞ and MC managed the literature searches. All authors read and approved the final manuscript

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ABSTRACT

Aims: Vermicompost (worm manure), which has gained importance in the last quarter of the century among innovative agricultural practices, has positive effects on both plant development and soil structure. The shortage of organic matter in soil reduces the productivity of agricultural production and hampers its continuity. Vermicompost products confer plant nutrient elements, various hormones, enzymes, humic substances and especially organic matter to the soil. This study aimed to study the effects of vermicompost application and phosphorus fertilizer rates on soybean in limy soil conditions.
Study Design: The affect of vermicompost applications was evaluated with four doses of vermicompost (Control, 1.5, 3, and % 6) in three doses of phosporus applications. So, 0, 50 ppm and 100 ppm phosporus blocks had all four doses of vermicompost. Optimum level (100 ppm N and 100 ppm K) of N and K fertilisers were applied to all plants tested. Total plant biomass, leaf wet and dry weights, bean wights, plant height and nitrogen compositions of leaf and bean were measured.
Results: The results were detected significant at % 1 on all parameters. As control plants' leaf +

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scape wet and dry weights were measured 3.29 and 1.23 g respectively, they were measured 8.6 and 5.22 g at plants used vermicompost and phosphorus together. With vermicompost and phosphorus aplications, the phosphorus and nitrogen uptakes increased too. While control plants' leaves have % 0.38 phosphorus content, it was measured % 0.84 at plant aplicated vermicompost and phosphorus.

Coclusion: As a result, we observed increased P uptake levels with increased doses of vermicompost application in limysoils.

Keywords: Vermicompost; plant growth; phosphorus uptake; microbial activity; soybean.

1. INTRODUCTION

With the rapidly increasing world population, meeting nutrient needs stands out as a global problem. Considering that most of the nutrient needs are met from plant sources, increasing the yield and quality in plant production is of vital importance. Soybean, which is one of the 5-6 important herbal products that feeds the world, is very nutritious after the removal of oil and the meal is very rich in protein. Because of this feature, it is used in food industry in abundance. Soybean seeds contain % 40-45 protein and % 18-20 fat. The most produced and consumed oil in the world is soybean oil and the most used raw material in the feed industry is soybean meal.Today, the largest share in World Soybean Production, which reached 170-180 million tons, is the USA with % 50 production, followed by Brazil, Argentina and China [1].

Vermicompost (worm manure), which has gained importance in the last quarter of the century among innovative agricultural practices, has positive effects on both plant development and soil structure. Vermicompost is the name given to organic material in which almost any organic material is transformed into a rich source of nutrients and an effective soil conditioner. Organic substances passed through the digestive system of a number of special worm species (Eisenia foetida, Lumbricus rubellis etc.) are transformed into humus-rich, high-quality fertilizer containing certain hormones and enzymes, containing plant vitamins and some vitamins. The basic principle is to provide a mesolithic composting [2].

Vermicompost products are also a very effective method for the evaluation of all kinds of waste materials. This is because the increasing population not only brings consumer problems but also brings about the problems of waste disposal. For this reason, the problem of organic based wastes is solved and transformed into a useful form with proper installation and appropriate methods. Although many ecological factors are important in agricultural production, soil is the most important source. Therefore, it is inevitable to develop soil structure and composition in order to achieve quality in agricultural production and to obtain important results in plant development. As long as the plant to be grown cannot get the nutrients it needs and the substances that will contribute to its development, it cannot reach the desired yield and quality. There are many factors (nutrients, organic matter, microbial activity, etc.) that restrict this situation in the soil [3,4,5]. In general the rate of organic matter is ground Turkey, the ratio is less than % 2 indicating a weak organic matter. Therefore, vermicompost, which is a material rich in organic matter, has the potential to be an important alternative in the improvement of soil structure.

One of the factors limiting agricultural productivity is the lack of nutrients or lack of available form. Because nutrients are trapped by soil particles and in some cases it is difficult for them to be taken up by plants. One of the factors that make this difficult is the increase in pH and alkaline properties. Because the intake of nutrients for plants in calcareous soils becomes difficult, the uptake of ions by the soil increases. Phosphorus is an element which must be taken in sufficient level in order to perform vital functions in the plant.

It has a direct effect on many events such as breakdown of carbohydrates, cell division, transmission of inheritance characters, effective root development, acceleration of ripening, increase of seed production and increase of yield [6]. The main problem with the phosphorus element is not the lack of sufficient levels of phosphorus compounds in the form of deficiency.

One of the factors that decrease the usefulness of phosphorus is the high pH value in the soil, low organic matter content, insufficient moisture, high clay content, the amount of lime contained in the soil [7]. It is estimated that calcareous soils are 600 million hectares worldwide [8]. In these soils, phosphorus is retained by carbonate minerals and precipitation of Ca and P results in

a decrease in the percentage of the plant's utilization from phosphorus, and the plants grown on it grow as phosphorus deficient [4]. In such soils, only 10-20% of the phosphorus applied with fertilizer can be taken up by the plants during the application year and a large amount is kept rapidly or forms sediment which cannot be taken [9].

In order to increase the usefulness of phosphorus in calcareous soils, it is aimed to increase the usefulness of phosphorus by adding organic matter to the soil. Organic matter increases the production capacity of calcareous soils by improving their chemical, physical and biological properties [10].

The application of compost, rested animal fertilizers and vermicompost, which has increased production in recent years and has high nutritional and biochemical properties, is one of the solutions for both phosphorus utilization and correction of other properties. The aim of this study is to investigate the effects of vermicompost applications on the development of soybean plants. The effects of phosphorus uptake on calcareous soils were also investigated. Understanding whether vermicompost may be an alternative to eliminate factors limiting the intake of plant nutrients is provided.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was carried out in 2018 in Gaziosmanpaşa University Faculty of Agriculture. The experiment was planned as a potted study. The randomized block were designed with a total of 48 pots with 4 replications. The trial soil was taken from Gaziosmanpaşa University Research and Application Site on April 20, 2017 at a depth of 0-30 cm and dried in the greenhouse.

2.2 Soil Materials

It was removed from the field and passed through a 4 mm sieve and dried and prepared for trial after solarization in the greenhouse for a month.The properties of soil material to be used in the experiment are given in Table 1. In soil selection, a soil with a lime content of 16.80% was chosen in accordance with the subject of the experiment. The soil weighed 5 kg from dry soil. Five soybean seeds were planted in each pot, and after dilutions, dilutions were made and homogenized to three plants per pot.

Table 1. Chemical composition and properties of soil used in the experiment

Lime (%)	**16.80**
pH (1 : 2.5)	7.92
Total Salt %	0.044
Organic matter (%)	1.17
Total N (%)	0.14
Useful P (kg/da)	1.37
Texture	Clay loam
Iron (ppm)	1.86
Zinc (ppm)	0.32

2.3 Study Design

The aim of this study was to investigate the effects of vermicompost on nutrient uptake and early development, not on total yield. Therefore, it was terminated after 45 days from the exits. In the experiment, a total of 4 doses of vermicompost (control, 1.5, 3 and 6 %) were applied to the total 5 kg soil by mixing with percent. Inorganic phosphorus application as phosphoric acid which is another factor, was applied in 3 doses (0, 50 and 100 ppm) and at 2 different times. The nitrogen and potassium requirements for each pot were given at optimum level as potassium sulfate and urea (100 ppm N and 100 ppm K) 100 ppm N and K were applied twice. In addition to this fertilization, 4 ppm Fe iron sulfate and 4 ppm Zn zinc sulfate were applied to soil. The water needs of the plants were given equally to the pots with the help of scaled irrigation materials. The vermicompost used in the study was procured from a private manufacturer. The chemical properties of the solid vermicompost used are given in Table 2.

Table 2. Chemical composition of the vermicompost used in the experiment

pH	6,5 - 8,5
Organic matter (%)	48,95
Maximum EC (dS/m)	5
Organic N (%)	1,34
Total N (%)	1.90
C/N	12.15
Total P (%)	2.05
Total K (%)	0.8

2.4 Data Collection

The plants were harvested on the 45th day from the start. In each replicate, 2 soybean plants were selected and the leaf + stem formed in the soybean plant was collected and the age weights were calculated and recorded. Wet weights recorded soybean materials were dried at 68ºC

Table 3. Dry weights of soybean plants, wet and dry weights of beans the amount of N and P concentrations of leaves and grains of soybean plants

Aplications	Biomas wet weight (gr/plant)**	Biomas dry weight (gr/plant)**	Beans wet weight (gr/plant)	Beans dry weight (gr/bitki)**	Leaves N (%)**	Bean N (%)**	Leaves N (%)**	Bean N (%)**
P0V0	3.29 e	1.23 e	2.21 e	0.95 e	2.84 bc	3.72 d	0.38 d	0.33 d
P0V1	5.43 cd	2.58 c	5.02 cd	2.65 c	2.98 bc	4.10 b	0.42 c	0.34 d
P0V2	4.41 de	2.27 d	5.21 cd	3.02 bc	3.13 a	4.19 a	0.43 c	0.36 d
P0V3	6.20 c	2.43 c	4.33 d	2.04 cd	3.14 a	4.17 a	0.44 c	0.38 d
P1V0	4.91 d	2.44 c	3.26 de	1.75 d	3.07 b	3.82 c	0.65 bc	0.55 c
P1V1	4.99 d	2.42 c	5.17 cd	2.74 c	2.87 bc	3.97 c	0.68 bc	0.53 c
P1V2	5.70 cd	2.30 c	6.05 bc	2.88 bc	3.22 a	4.28 a	0.71 b	0.61 b
P1V3	6.08 c	3.25 bc	5.75 c	2.67 c	2.70 c	4.01 bc	0.65 bc	0.62 b
P2V0	5.88 cd	2.36 c	6.15 bc	2.95 bc	3.12 a	4.06 bc	0.79 a	0.65 b
P2V1	6.83 bc	3.39 bc	6.43 b	3.93 b	2.86 bc	4.18 a	0.75 b	0.71 a
P2V2	8.24 b	4.03 b	5.50 c	3.76 b	2.65 c	4.29 a	0.79 a	0.73 a
P2V3	8.60 a	5.22 a	7.75 a	4.10 a	2.55 cd	4.11 b	0.84 a	0.74 a

The differences between the means in each column were determined by Duncan test.
*Ö.D: Not important; * P <0.05; ** P <0.01 is important;*

and their dry weights were calculated. The beans of the soybean plants taken from each pot were separated and their dry weight was determined first. Samples taken from plants were burned by Khejhdal method and their nitrogen content was determined.

3. RESULTS AND DISCUSSION

As a result of statistical evaluations, phosphorus applications on all investigated characteristics of soybean were found to be significant at % 1 significance level. The vermicompot application to the soil in the pots caused the increase in the properties of soybean plants. In the study, interactions of phosphorus and vermicompost application were also examined. There was a statistical increase in the data with increasing phosphorus doses and vermicompost doses. In the control application, stem + leaf wet weight was 3.29 g / plant while phosphorus dose was increased from 6.20 to 5.88 g / plant. When 50 ppm application of phosphorus to soybean plant was not applied to vermicompost, 4.91 g / plant, while wet weights were measured as 5.70, 6.08 g / plant, respectively. The same tendency to increase was obtained at 100 ppm doses of phosphorus.

Phosphorus is claimed to be the second most often limiting plant nutrient. It is an essential component of deoxyribonucleic acid (DNA), the seat of genetic inheritance, and of ribonucleic acid (RNA), which directs protein synthesis in both plants and animals. Sufficient phosphorus in the plant provides good root growth. Root growth increases uptake of water and nutrients. Therefore, there is an increase in vegetative growth. The amount of dry matter produced also gave results parallel to the increase in wet weight. Several researchers have also reported that [11,12,13].vermicompot and phosphorus applications reported that the increase in plant yield. Leaf N and grain N concentrations increased as plant growth increased the amount of N (exploited nitrogen) removed from the soil. In Table 3, only the leaf and grain N concentrations of the plant are given. The point to be taken into consideration is the amount exploited from the soil depending on the dry matter generated. The amount of N used will increase as the amount of dry matter increases. When the leaf P and grain P concentrations are examined, the leaf and grain P concentrations of the plant increase as the amount of phosphorus applied increases. This increase was significant at % 1 level. Leaf P content was % 0.38 in P0 application, % 0.65 in P1 application and % 0.79 in P2 application. Vermicompost reduced the amount of lime in the soil, increased the water retention capacity of the soil and increased the viability in the soil with the help of the plants to benefit from the amount of phosphorus applied.

4. CONCLUSİON AND RECOMMENDA-TION

The increase in biomass caused by vermicompost and phosphorus doses is one of the most important results in our study. As the doses of vermicompost added into the soil increased, the amount of phosphorus taken from the soil increased. The vermicompost, which is

added to the soil, forms an attachment surface for inorganic substances in the soil. This increased the percentage of the plant's utilization of phosphorus.The vermicompost material contains a composition that contributes to plant growth and regulates the soil structure. In the study and many other studies, it is seen that vermicompost increases nutrient uptake from the soil, promotes plant growth, increases the proportion of organic matter and humic substances in the soil and contributes to the increase of microbial activity. In addition, it can be said that ecological balance will be positively affected by the use of vermicompost. Both the effect of vermicompost on waste disposal and its role in reducing the use of synthetic fertilizers are effective on this situation. It is one of the important results of our study that the usefulness of synthetic fertilizers increased with the use of vermicompost material. However, vermicompost should not be considered as a replacement material for synthetic fertilizers, but as an important support material and an environmentally friendly soil conditioner.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mounts TL, Wolf WJ, Martinez WH. Processing and Utilization. In Soybeans: Improvement, Production, and Uses, Second Edition, J.R. Wilcox, Madison, Wisconsin, USA; 1987.
2. Edwards CA, Bohlen PJ. Biology of earth-worms. In: P. J. Bohlen and C. A. Edwards, Biolo-gy and Ecology of Earthworms, 3rd edn., Hall, New York, s. 426. Edwards CA, Burrows I. 1988. The potential of earthworm composts as plant growth media, In Netherlands. SPC Academic Pub-lishing. 1996;211-219.
3. Erdal İ, Bozkurt MA, Çimrin KM, Karaca S, Sağlam M. Kireçli bir toprakta yetiştirilen mısır bitkisi (*Zea mays* L.) gelişimi ve fosfor alımı üzerine humik asit ve fosfor uygulamasının etkisi. Turkish Journal of Agriculture an Foresty. 2000;24(6):663-668.
4. Bai Z, Li H, Yang X, Zhou B, Shi X, Wang B, Li D, Shen J, Chen Qin W, Oenema O, Zhang F. The critical soil P levels for crop yield, soil fertility and environmental safety in different soil types. Plant Soil. 2013;372: 37-37.
5. Mehrizi MH, Sarcheshmehpour M, Ebrahimi Z. The effects of some humic substances and vermicompost on phosphorus transformation rate and forms in a calcareous soil. Journal of Science and Plant Nutrition. 2015;15(1):249-260.
6. Kacar B, Katkat V. Bitki Besleme. Nobel Yayınları; 2009.
7. Kacar B, Katkat V. Bitki Besleme. Uludağ Üniversitesi Güçlendirme Vakfı Yayını, Yayın No: 127, 595 s, Bursa; 1998.
8. Leytem AB, Mikkelson RL. The nature of phosphorus in calcareous soil. Better Crop. 2005;89:11-13.
9. Alamgir M, McNeill A, Tang C, Marschner P. Changes in soil P pools during legume residue decomposition. Soil Biology and Biochemistry. 2012;49:70-77.
10. Nardi S, Pizzeghello D, Muscolo A, Vianello A. Physiological effect of humic substances on higher Plants. Soil Biology and Biochemistry. 2002;34:1527-1536.
11. Arancon NQ, Edwards CA, Bierman P, Welch C, Metzger JD. Influences of vermicomposts on field strawberries: 1. Effects on growth and yields. Bioresource Technology. 2004;93:145-153.
12. Hyder SI, Farooq M, Sultan T, Ali A, Ali M, Kiani MZ, Ahmad S, Tabssam T. Optimizing yield and nutrients content in tomato by vermicompost application under greenhouse conditions. Natural Resources. 2015;6:457-464.
13. Amyanpoori S, Ovassi M, Fathinejad E. Effect of vermicompost and triple superphosphate on yield of Corn (Zea Mays L.) in Behbahan. Journal of Experimental Biology and Agricultural Science. 2015;3(VI).

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