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THE EFFECT OF VERMICOMPOST TREATMENTS ON YIELD AND YIELD COMPONENTS OF PEANUT (*Arachis hypogaea* L.)

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ABSTRACT

This study was conducted to determine the effects of vermicompost treatments on yield and yield components of peanut (*Arachis hypogaea* L.) under Osmaniye ecological conditions, in Türkiye, in 2020-2021. It was designed according a complete randomized block with three replications. The NC-7 peanut variety was treated with eight different treatments of vermicompost plus a control. The treatments T_1 through T_4 included soil and leaves applications at different plant development stages, and treatments T_5 through T_8 were similar to the previous four but included only application to leaves. The number of pods per plant, pod weight per plant, 100-pod and seed weight, shelling percentage, first quality pod ratio, first quality pod weight ratio, protein content, and pod yield were determined. The number of pods per plant varied between 23.3 (control) and 33.4 (T_1). The lowest pod weight per plant was 37.7 g in control treatment, and the highest in T_1 (51.4 g). Pod yield was between 3579 kg·ha^{-1} (control) and 4873 kg·ha^{-1} in T_1. The 100-pod weight was the lowest from the control treatment (208.4 g) and the highest from the T_6 treatment (254.2 g); the weight of 100 seeds was minimum in the control treatment with 88.5 g and maximum in T_5, with 102.3 g. The protein content varied between 24.11% (control) and 26.01% (T_5). These results indicate that under the ecological conditions of Osmaniye province, there is a significant effect of vermicompost on most productive and quality variables of peanut.
Additional keywords: Number of pods, Osmaniye, pod weight, protein content

RESUMEN

Efecto de la vermicomposta sobre el rendimiento y sus componentes en el cultivo de maní (*Arachis hypogaea* L.)

Este estudio se realizó para determinar los efectos de tratamientos con vermicomposta en el rendimiento y los componentes del rendimiento del maní (*Arachis hypogaea* L.) en las condiciones ecológicas de Osmaniye, en 2020-2021. El estudio se diseñó según un ensayo en bloques completos al azar con tres repeticiones. La variedad de maní NC-7 fue tratada con ocho dosis diferentes de vermicomposta más un tratamiento testigo. Los tratamientos T1 al T4 incluyeron aplicaciones al suelo y a las hojas en diferentes etapas de desarrollo de la planta, y los tratamientos T5 al T8 fueron similares a los cuatro anteriores, pero solo incluyeron la aplicación a las hojas. Se determinó el número de vainas por planta, peso de vainas por planta, peso de 100 vainas y de semilla, porcentaje de descascarillado, proporción de vainas de primera calidad, proporción de peso de vainas de primera calidad, contenido de proteína y rendimiento de vainas. El número de vainas por planta varió entre 23,3 (testigo) y 33,4 (T1). El menor peso de vainas por planta fue de 37,7 g en el tratamiento testigo y el mayor en el T1 (51,4 g). El rendimiento de vainas estuvo entre 3.579 kg·ha^{-1} (testigo) y 4.873 kg·ha^{-1} en T1. El peso de 100 vainas fue el más bajo en el tratamiento control (208,4 g) y el más alto del tratamiento T6 (254,2 g); el peso de 100 semillas fue mínimo en el tratamiento control con 88,5 g y máximo en T5, con 102,3 g. El contenido de proteína varió entre 24,11% (control) y 26,01% (T5). Estos resultados indican que, bajo las condiciones ecológicas de la provincia de Osmaniye, existe un efecto significativo de la aplicación de vermicomposta en la mayoría de las variables productivas y de calidad del maní.
Palabras clave adicionales: Contenido de proteínas, número de vainas, Osmaniye, peso de la vaina

INTRODUCTION

Peanut (*Arachis hypogea* L.) is a summer annual plant of the leguminous family, and holds a significant role in the world because of its high oil content (Akhtar et al., 2014). According to Arioglu (2014) and Yilmaz (2022) seeds may contain 44-56% oil, depending on the cultivar. It is an important food source because it also contains protein, carbohydrates, and vitamins, all of which are vital in human and animal nutrition (Yasli et al., 2020).

Organic fertilizers, which play a major role in sustainable agriculture, improve soil properties, compensate for an insufficiency of organic matter in the soil, and support in soil quality maintenance (Santhoshkumar et al., 2017). Organic fertilizers are expected to be applied to the soil in order to improve its fertility and consistency (Stewart et al., 2020). Vermicomposts are one of the substances that can help to conserve the soil by maintaining its natural structure (Sridevi et al., 2016).

For nearly 40 years, most European countries and the United States, have used vermicompost in

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agricultural activities (Sorathiya et al., 2014). The California red worm, one of 3000 worm species, plays an important role in the production of vermicompost (Ahmad et al., 2021). The ruminant manures used in vermicompost, as well as these materials, are used as a good soil improver as well as a nutrient element for plants (Yuldasheva and Soyibnazarov, 2021).

In the production of vermicompost, worms feed on natural manure and plant materials such as bark parts of trees, leaves, straw, vegetables and fruit residues, and as a result of passing the organic material through their bodies and excreted, an organic composting results which comes out as a high-value fertilizer (Kaushal et al., 2018).

Vermicompost may contain *Rhizobium* and *Azotobacter,* bacteria usually found in the structure of the compost, along with mychoriza fungi, which are microorganisms that fix nitrogen from the atmosphere; thus, they also benefit the living part of the soil (Pathma and Sakthivel, 2012). Micro-organisms break down the nutrients that are in the soil parts and cannot be used by the plant, and have the ability to convert them into forms that can be taken by plants (Wang et al., 2021).

Organic matter content is generally insufficient in the soils of Türkiye, and it should be ensured that the existing organic wastes are recycled and returned to the soils, where vermicompost can contribute to waste cycling and play an important role in the protection of nature (Hemalatha, 2012; Bellitürk, 2018). Use of vermicompost also may provide significant benefits in the future of organic agriculture (Chavan et al., 2019).

This research was conducted to determine the effects of vermicompost applied to soil and leaves in different development periods on yield, yield components and quality of peanut.

MATERIALS AND METHODS

The study was carried out in the experimental fields of Oil Seed Research Institute in Türkiye (37°07′ N, 36°11′ E) during the growing seasons of 2020 and 2021. Peanut cultivar NC-7 was used as plant material.

Liquid organic vermicompost obtained from red California culture worms (*Eisenia foetida*) was used in the experiment. The compost pH ranged from 4.2-6.2, with 20 % organic matter, and 1.5 % total nitrogen content.

During both growing periods the average temperatures were close to 25 ^{o}C, the total precipitation was lower in 2021 than in 2020, and the mean relative humidity was slightly above 60 % (Table 1).

Table 1. Climatic data of the research field (years 2020 and 2021)

Months	Precipitation (mm)		Temperature (°C)		Relative humidity (%)	
	2020	2021	2020	2021	2020	2021
April	123.9	32.3	17.1	17.7	69.4	64.8
May	83.5	4.6	22.1	22.9	62.4	59.8
June	5.5	1.8	24.0	25.0	68.7	65.9
July	2.0	15.7	28.4	28.9	71.7	64.6
August	21.5	19.7	28.6	29.3	64.0	62.8
September	0.9	14.0	28.7	25.9	61.8	60.8
Total/Average	237.3	88.1	24.8	25.0	66.3	63.1

Experimental soils are low to moderately saline (1.99 dS m^{-1}), calcareous, pH 8.19, with high water holding capacity and heavy textured (1 % sand, 79 % clay), nearly flat slope. They are low in organic matter (1.67 %), high in potassium (592 kg·ha^{-1}) and low in phosphorus content (52 kg·ha^{-1}). The soil was deeply tilled using a plow in autumn, and reworked with a cultivator in the first week of april, and seed beds prepared before sowing. Previously, 250 kg·ha^{-1} of 18-46 fertilizer was applied. Each trial plot consisted of four rows spaced 0.7 m with 5 m long, 15 cm plant spacing, so each plot area was designed as 14 m^{2}.

The experiment was set up in a randomized complete block design with three replications. Vermicompost was applied in two different ways (to soil or foliar), and were planned by selecting the periods that are important for peanuts, as well as the dose recommended by the dealer (https://n9.cl/6l50t). The treatment to soil was applied in a single treatment, while the foliar treatment was applied at five different development stages of the plant (V3, R1, R2, R3 and R4). Nine treatments were established including the control (Table 2). It is noted that the plants in treatments from T_1 through T_4 received vermicompost in both soil and leaves, while treatments from T_5 through T_8 received vermicompost only in the leaves. The first year of the experiment the seeds were sown on April 25, 2020, and the second year on May 2, 2021. During the growing periods, the necessary plant maintenance was carried out on time in accordance with the technique. Harvest was done on September 10, 2020 in the first year and on September 15, 2021 in the second year.

The following variables were evaluated by selecting 20 plants in the middle two rows for each plot (for pod yield, all plants were harvested): Number of pods per plant, 1st quality pod ratio as the percentage of large, fully mature pods containing two seeds, pod weight per plant, 1st quality pod weight ratio as the percentage of pod weight containing two seeds, 100-pod weight, 100-seed weight, shelling percentage and protein content (Kjeldahl nitrogen multiplied by 6.25).

The experimental results were analyzed by ANOVA using the SPSS 22 software. Duncan's multiple range test was used to compare means.

Table 2. Soil and foliar treatment vermicompost time, amount and applications

Treatment time	Applied to	T1	T2	T3	T4	T5	T6	T7	T8	T9 (Control)
Pre-sowing	Soil*	X	X	X	X					
V3 stage	Leaves	X	X	X	X	X	X	X	X	
R1 stage	Leaves	X	X	X	X	X	X	X	X	
R2 stage	Leaves		X				X			
R3 stage	Leaves			X				X		
R4 stage	Leaves				X				X	

*Volumetric concentration of 2 % for soil and 0.5 % for leaves

RESULTS AND DISCUSSION

Except for the first quality weight pod ratio, the application of vermicompost applied at various doses and times produced highly significant effects ($P \leq 0.01$) on all the variables evaluated (Table 3). On the other hand, there were no differences between the results obtained in the two years of the experiments.

Number of pods per plant. The control treatment (T_9) resulted in the lowest average value of pods per plant (23.3), while the T_1 treatment resulted in the highest average value (33.4) (Table 4). The positive response of the plant to applications of vermicompost are similar to those found by Kumar et al. (2014a), Ravikumar et al. (2019) and Bekele et al. (2019) in peanut. In other crops, Kumar et al. (2014b) and Ucar et al. (2020) reported that vermicompost applications increased the number of pods in chickpea. In the same way, vermicompost applications by Filiz and Topal (2021) produced an increased in the number of pods per plant in corn. Moreover, the response was found to be more contundent in experiments with mung beans (*Vigna radiata*) (Biswash et al., 2014). In addition to the plant genetic differences, this result could also be attributed to the varied climatic conditions and vermicompost doses used in those trials.

First quality pod ratio. The lowest value for the 1st quality pod ratio was obtained in the T_9 control treatment (72.0 %), while the highest was obtained in the T_2 (78.3 %) application (Table 4) with significant differences between them. Having a high 1st quality pod ratio is desirable in peanuts as it represents an increase in the yield of the crop (Arioglu et al., 2018).

Pod weight per plant. The mean values of the influence of vermicompost on peanut pod weight per plant show that the control treatment yielded the lowest value (37.7 g). Vermicompost treatments T_1, T_8 and T_4 were found to be statistically higher than the control with values of 51.4 g, 50.6 g and 50.4 g, respectively (Table 4). One of the most important yield components influencing pod yield is pod weight per plant (Magagula et al., 2019). The plant growth and yield increase produced by vermicompost applications has been observed in different species like papaya (Acevedo and Pire, 2004), onion (Bai and Malakout, 2007) and cauliflower (Jahan et al., 2014).

Table 3. Results of the analysis of variance for characteristics studied in the experiment.

Source of Variation	df	NP	FQP	PW	PQWP	HPW	HSW	SP	PY	PC
Block	2	ns	ns	ns	ns	ns	ns	ns	ns	ns
Year (Y)	1	ns	ns	ns	ns	ns	ns	ns	ns	ns
Treatment (T)	8	**	**	**	ns	**	**	**	**	**
Y*T	8	ns	ns	ns	ns	ns	ns	ns	ns	ns

df: Degrees of freedom, ** $p \leq 0.01$, NP: Number of pods per plant, FQP: First quality pod ratio, PW: Pod weight per plant, FQWP: First quality weight pod ratio, HPW: 100-pod weight, HSW: 100-seed weight, SP: Shelling percentage, PY: Pod yield, PC: Protein content, ns: no significant

First quality pod weight ratio. The lowest mean value of 1st quality pod weight ratio was obtained as 66.8 % from the control treatment, and the highest as 78.8 % from T_1 treatment (Table 4). In parallel with the increase in the 1st quality pod ratio in peanuts, it is desirable to have a high 1st quality pod weight ratio. However, no statistical differences were detected (P>0.05) among the treatments.

Table 4. Average values of number of pods per plant, 1st quality pod ratio, pod weight per plant, 1st quality pod weight ratio, and 100-pod weight

Treatments	Number of pods per plant	1st quality pod ratio (%)	Pod weight per plant (g)	1st quality pod weight ratio (%)	100-pod weight (g)
T1	33.4 a	76.2 ab	51.4 a	78.8	221.6 bc
T2	26.5 bc	78.3 a	43.1 ab	78.4	243.9 ab
T3	24.3 c	73.3 ab	39.9 b	76.1	226.9 abc
T4	31.2 a	74.9 ab	50.4 a	76.9	238.1 abc
T5	25.5 bc	74.1 ab	45.1 ab	75.7	247.8 ab
T6	26.2 bc	73.4 ab	43.8 ab	76.5	254.2 a
T7	27.5 b	73.3 ab	40.1 b	76.7	231.9 abc
T8	31.7 a	76.7 ab	50.6 a	74.7	238.6 abc
T9 (control)	23.3 c	72.0 b	37.7 b	66.8	208.4 c
Average	27.7	74.7	44.7	75.6	234.6
CV (%)	9.2	4.4	10.7	14.1	6.5

CV: Coefficient of variation. Values with different letters in each column mean statistical differences according to Duncan test ($P \leq 0.01$)

100-pod weight. The highest average value of 100-pod weight was found the T_6 treatment (254.2 g), which along with the treatments T_5 (247.8 g) and T_2 (243.9 g) were statistically superior to the control (208.4 g) (Table 4). Das et al. (2015) found a maximum value of 93.22 g in this variable, a difference that could be attributed to the different varieties used in the experiments.

100-seed weight. The lowest average value of 100-seed weight was obtained from the control treatment with 88.5 g, while the highest was obtained from the T_5 treatment with 102.3 g (Table 5). In this variable, all treatments were statistically higher than the control and T_1 treatment. Findings of the positive effect of vermicompost on 100-seed weights in peanut have been extensively reported (Das et al., 2015; Magagula et al., 2019; Ravikumar et al., 2019).

Vermicompost applications have also increased the seed weight in crops like sunflower (Devi and Agarwal, 1999), corn (Zaremanesh et al., 2017) and chickpea (Kumar et al., 2014b; Ucar et al., 2020). Even, Cihangir and Oktem (2019), Filiz and Topal (2021), and Ozel and Oktem (2021) reported that with vermicompost applications in corn, the 1000-kernel weight increased as the dose of the compost increased.

Shelling percentage. The lowest mean value in the shelling percentage was obtained from the control (68.8 %) treatment, while the highest mean value was determined in the T_1 treatment (71.8 %) (Table 5). In general, the control treatment (T_9) was found to be statistically lower than the majority of the total treatments. Shelling percentage in peanuts is a desirable feature for both producers and consumers, making it easier to process with the machine. As the shelling percentage increases, there is an increase in yield per hectare (Arioglu et al., 2018). The shelling percentage reported in our study is similar to those found by Das et al. (2015), Gabisa et al. (2017) and Ravikumar et al. (2019).

Table 5. Average values of 100-seed weight, shelling percentage, pod yield and protein content

Treatments	100-seed weight (g)	Shelling percentage (%)	Pod yield (kg·ha^{-1})	Protein content (%)
T1	89.6 d	71.8 a	4873 a	24.63 bc
T2	95.7 c	71.3 a	4089 ab	24.38 bc
T3	97.0 bc	69.9 bc	3792 b	24.62 bc
T4	100.4 ab	71.2 a	4779 a	24.84 b
T5	102.3 a	70.6 ab	4276 ab	26.01 a
T6	102.0 a	70.9 ab	4155 ab	24.89 b
T7	95.3 c	69.7 bc	3806 b	24.63 bc
T8	96.4 bc	69.5 bc	4798 a	24.22 bc
T9	88.5 d	68.8 c	3579 b	24.11 c
Average	96.4	70.4	4239	24.70
CV	3.0	1.0	10.6	1.5

CV: Coefficient of variation. Values with different letters in each column mean statistical differences according to Duncan test ($P \leq 0.05$)

Pod yield. The highest mean value was obtained from T_1 with 4873 kg·ha^{-1}, while the control treatment exhibited the lowest value (3579 kg·ha^{-1}), being statistically lower than T_1, T_4 and T_8 (Table 5). Pod yield is one of the most important productive parameters, so breeders and agronomists do many studies to increase it (Choudhary et al., 2011). Our findings are comparative to those from Gabisa et al. (2017), Bekele et al. (2019) and Ravikumar et al. (2019), but differed from Biswash et al. (2014), Oroka (2015) and Chavan et al. (2019). The differences in the trial findings may be due to the differences in cultivars, ecological conditions, vermicompost doses and application methods.

Protein content. Protein plays a fundamental role in human and animal nutrition (Bekele et al., 2019). The lowest mean value of protein content was obtained from the control treatment with 24.11 % (Table 5). The highest mean protein content was determined as 26.01 % from T_5; this treatment, along with T_4 and T_6, were statistically higher than the control. Kumar et al. (2014a) noted an increment on the protein content in maize as the dose of applied vermicompost increased.

CONCLUSIONS

There was a significant effect of vermicompost on most productive and quality variables of peanut, including the number of pods per plant, 1st quality pod ratio, pod weight per plant, 1st quality pod weight ratio, pod weight, seed weight, shelling percentage, pod yield, and protein content. The vermicompost treatments used in the study increased the yield components and quality of peanuts as compared to the control. The lowest values always came from the control. Most variables showed higher values when treatments included applications to both soil and leaves Also, when vermicompost was applied at R4 stage of the plants. As a result of the study, it is thought that the use of vermicompost can be a sustainability source in agriculture.

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