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The effects of chemıcal fertılızer and vermıcompost applıcatıons on the development and productıon of cauliflower (*Brassica oleracea var. botrytis* L.)

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Abstract

This study was carried out in open field conditions in Mersin/Silifke district of Turkey. As a result of excessive use of chemical fertilizers to increase yield in cauliflower farming, yield and quality losses increase in soils with poor organic matter content. For this purpose, in order to increase the lost yield and quality, vermicompost and increasing chemical fertilizer (KG) doses, which are well compatible with the soil microorganism, were applied together in the study. Some parameters (crown length, crown diameter, stem diameter, stem length, crown weight, marketable yield, number of leaves, leaf length and diameter) were measured in the plots harvested after about 120 days in cauliflower. According to the measurements made on the samples taken on plot basis, the average plant crown weight was VK+1/2KG (1.97 kg), VK+KG (2.05 kg) and VK+2KG (2.34 kg) applications were included in the same group. According to the measurements made on the samples in marketable yield, VK+1/2KG (40970 kg/ha), VK+KG (42460 kg/ha) and VK+2KG (42730 kg/ha) applications were included in the same group. According to these results, there was no increase in yield in parallel with the increase in fertilizer. The results of other measured parameters are similar to the yield results. While increasing fertilizer doses and vermicompost applications throughout the study showed the effect on the nutrient uptake of cauliflower, it provided a significant increase compared to the control application. The rate of increases in the dose of chemical fertilizers did not affect yield and yield factors. In cauliflower fertilization, average yield can be obtained as a result of the use of chemical fertilizers reduced by 50% in chemical fertilizer applications with the addition of vermicompost.

Keywords: Cauliflower; vermicompost; reduced chemical fertilizer; yield

Introduction

Cauliflower (*Brassica oleracea* var. botrytis), which is formed by combining the Latin names Caulis (cabbage) and flower, is one of the important vegetable species of the Brassicaceae family. In addition to its vitamins A and C, it also contains many nutrients with phytochemical compounds. It is a very important type of vegetable in terms of its contribution to human health (Vural *et al*., 2000; Kirsh *et al*., 2007). Cauliflower is among the cabbage group vegetables. In our country, it can be cultivated in temperate regions in autumn and winter. While it has been observed that the demand for cauliflower has increased in recent years, we can explain this situation with the reasons such as high prices in the markets and high yield per unit area. According to statistical data, the regions where cauliflower cultivation is common in our country; It has been reported as the Marmara, Aegean, Mediterranean and Black Sea Regions (Günay, 1984). It is reported that all vegetables included in the cabbage group produce high yields in organic fertilizer applications (Vural *et al*. 2000). In addition, if organic and chemical fertilizers are used together, it allows more successful vegetable cultivation (Kaplan *et al*. 2008).

The content of vermicompost can be more easily taken up by the plant due to the slow release of nutrients covered with earthworm mucus. Due to the slow dissolution of these nutrients, there is no loss in any way. Vermicompost creates a suitable environment for soil micro-organism activity due to its aeration and high water holding capacity due to its structure. As another feature, this material protects the roots of plants from extreme heat, while preventing the development of weeds and the effect of erosion. After the aerobic decomposition of vermicompost, it has a rich content in terms of nutrients that are more beneficial to the plant, since the nutrients that the

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worm takes in liquid form become more convenient while passing through the digestive system.

Physical, chemical and biological properties of the soil are regulated as a result of the application of vermicompost, which is enriched in nutrients while metabolizing organic wastes, to the soil, and therefore more efficient plant cultivation can be made (Arancon *et al*., 2003; Jat and Ahlawat, 2006; Alam *et al*., 2007; Ali *et al*., 2007; Singh *et al*. 2008; Rangarajan *et al*., 2008). In another study, they concluded that vermicompost application significantly increased plant growth and yield in spinach plant and that it could be an alternative to synthetic chemical fertilizers. In a study on lettuce, the effects of vermicompost and compost on plant growth and nutrient content were investigated by comparing them with inorganic fertilization. According to the results of this study, it was determined that there were differences in terms of yield and N and K contents, the highest values were obtained from urea application, Ca, Mg and Mn contents were found to be higher than organic fertilizer applications. As a result of vermicompost applications, Mg, Fe, Zn and Cu reached the highest values (Hernandez *et al*., 2010). In our study, the effects of different ratios of inorganic and organic fertilizers on yield and quality in cauliflower cultivation were investigated. It is aimed to determine the appropriate doses according to the results of the study by using different fertilizer forms and doses, to find solutions to the environmental problems caused by incorrect fertilizer applications, as well as to find solutions to the studies to achieve high efficiency and quality.

Material and Method

Climatic features of silifke

Silifke District is geographically located between 36° 22' north latitude and 33° 56' east longitude. The average height above sea level is 15m. Silifke is located in the semi-arid climate zone and the Mediterranean climate is observed in the region. Summers are hot and dry, winters are mild and rainy. Considering the long-term average temperatures, the annual average temperature is 19.1°C. The coldest month is January (10.2°C) and the hottest month is August (28.1°C). The annual average precipitation is 532.50 mm. The highest precipitation falls in December with 120.1mm. Considering the seasonal distribution of precipitation, the rainiest season is winter, while the least precipitation is in summer.

Soil properties of the trial area

Soil characteristics of the field where the study was carried out; The soil pH was found to be 6.97, salinity 0.10 %, lime 1.7 %, organic matter 2.1% soil texture sandy/loamy. Vermicompost Properties Used in the Study; The pH of the vermicompost fertilizer used in the study was 6.9, the electrical conductivity (EC) was 3.7 dS m^{-1}, the organic matter rate was

Table 1: The effects of different fertilizer and vermicompost applications on the plant growth and development of the cauliflower plant

Applications	Crown length (cm)	Crown diamete r(cm)	Body diameter (mm)	Body length (cm)	Crown weight (kg)
Control	13.04c	14.18c	35.93b	14.05b	1.25b
KG	13.72c	15.64b	36.14ab	13.72b	1.87a
VK+1/2KG	14.85b	16.32a	36.48a	15.03a	1.97a
VK+KG	15.29ab	16.38a	36.53a	15.63a	2.05a
VK+2KG	15.45a	16.51a	36.42a	15.65a	2.34a
Average	**14.47**	**15.80**	**36.5**	**14.8**	**1.89**

LSD 0,05: $p<0,05$. VK: vermicompost, KG. chemical fertilizer

Table 2: The effects of different fertilizer and vermicompost applications on the plant growth and development of the cauliflower plant

pplications	Marketable yield (kg da^{-1})	leaf length(cm)	Leaf diameter (cm)	Number of leaves (piece $plant^{-1}$)
Control	2574b	48.65c	20.08b	27.43c
KG	4058a	50.67b	21.83b	30.37b
VK+1/2KG	4097a	51.18ab	22.60a	30.14b
VK+KG	4264a	51.85ab	22.89a	31.00a
VK+2KG	4273a	52.04a	23.01a	31.66a
Average	**3853**	**50.87**	**22.08**	**30.12**

20%, the nitrogen content was 1.2%, the phosphorus content was 1.09%, and the potassium amount was 6.51 %.

Treatments

Control: (Vermicompost and Fertilizer application has not been made)

VK: Liquid vermicompost; "EkosolFarm Liquid Vermicompost"

Chemical fertilizer (KG): Nitrogen fertilizer source $(NH4)_2SO_4$ was used, phosphorus source Triple super phosphate (P_2O_5) and potassium fertilizer source K_2SO_4 were used.

Method

This study was carried out in field conditions in Mersin University Silifke Vocational School in the fall semester of 2020-2021. Cauliflower variety Mervan F1 (*Brassica oleracea* var. Botrytis) was used as plant material. In addition to vermicompost, varying doses of chemical fertilizers were used as fertilization material in the research, and the study subjects were formed as follows: control, KG, VK+1/2KG (400mL/100L water/da VK+%50 KG), VK+KG (400 mL/100Lwater/da VK + 0%100 KG), VK+2KG (400mL/100L water/da VK +200% KG). The basic fertilizers applied in the study were ammonium sulfate, triple super phosphate and potassium nitrate fertilizers at varying rates and the fertilizer applications were 200 kg/ha N. 100 Kg/ha P and 200 Kg/ha K. The applied fertilizer doses were created in the form of decreasing and increasing doses in the trial (0% KG, 50% KG, 100% KG and 200% KG) . The liquid form of the vermicompost used in the study was given by drip irrigation. The study was established with 4 replications according to the randomized plots experimental design, and the planting spacing was 90 cm and the row spacing was 50 cm. Cultural processes related to the cauliflower variety included in the experiment were carried out regularly from planting to the end of the harvest. The cauliflower plant was harvested when it completed its development (approximately 120 days), plant growth and some quality characteristics were determined. The data obtained from the experiment were evaluated according to the ANOVA analysis of variance using "IBM SPSS statiscids 23" statistical software programs. Duncan Multiple Comparison Test was used to compare the differences between the means.

Results and Discussion

Crown length, crown diameter, minimum and maximum crown weight, average crown weight and yield per decare, leaf length and diameter, number of leaves, which are important quality characteristics of cauliflowers with varying doses of manure and vermicompost, are given in Table 1. In the study, the effect of varying fertilizer and vermicompost applications on plant crown length was found to be statistically significant ($p<0.001$). As a result of the measurements made on the harvested cauliflower plants, the lowest crown length was obtained in the control (13.04cm) application, while the highest crown size was obtained from the VK+2KG (15.45cm) application, followed by VK+KG(15.29cm), VK+1/ 2KG(14.85cm) follow the applications. The difference in crown length development between the highest and lowest two applications was determined as 18.5%. In a study using different organic and synthetic chemical fertilizers, it can be said that organic fertilizers give statistically better results in terms of plant growth and development criteria in cauliflower cultivation. These results are compatible with our study (Farahzety and Aishah, 2013; Kıl and Paksoy, 2016).

The difference between the measurements made in terms of plant crown diameter was found to be statistically significant ($p<0.01$). According to the measurements obtained, the highest crown diameter value was obtained from the VK+2kg (16.51 cm) application, followed by the VK+KG (16.38cm), VK+1/2kg(16.32cm) applications. The lowest crown diameter value in the same parameter was taken from the control (14.18cm) application, and an increase of 11.64 % was achieved in the plant crown diameter development between applications. The effect of fertilizer and vermicompost applications at varying doses on plant crown weight was found to be statistically significant. When the values obtained as a result of the study were examined, the highest value was obtained from the VK+2KG(2.34 kg) application, followed by the VK+1/2KG(1.97 kg), VK+KG(2.05kg) applications. In the same parameter, the lowest value was obtained from the control (1.25 kg) application, and an increase of 87% in plant crown weight was achieved between the applications with the lowest and highest values. Other applications were located between these two groups. In Turkey, varieties with a small crown size are not preferred in cauliflower production in recent years. (Eşiyok *et al*., 2003). In addition to this preference, the tendency for varieties with small crown size, more cauliflower planting per unit area and easier cultural practices are shown as other reasons for preference. As a matter of fact, when the results obtained from varying fertilizer and vermicompost applications in our study are examined, it can be said that cauliflowers show parallelism in terms of crown diameters and crown lengths, especially according to the results obtained from VK+2KG, VK+KG and VK+1/2KG applications. In a study using different organic and synthetic chemical fertilizers, it can be said that organic fertilizers give statistically better results in terms of plant growth and development criteria in cauliflower cultivation. These results are compatible with our study (Farahzety and Aishah, 2013; Kıl and Paksoy, 2016).

Table 3: The effect of different fertilizer and vermicompost applications on the nutrient content of the plant (leaf)

Gübre dozları	(N%)	(P%)	(K%)	(Ca%)
Kontrol	3.5 e	0.326 b	2.606 c	1.056 c
KG	3.8 d	0.442a b	2.642 c	1.128 b
VK+1/2KG	4.3c	0.479 a	3.204 b	1.295 a
VK+KG	4.5b	0.479 a	3.414 a	1.294 a
VK+2KG	4.6a	0.473 a	3.468 a	1.323 a
Ortalama	**4.12**	**0.44**	**3.06**	**1.22**

p<0,05. VK: vermicompost, KG.chemical fertilizer, N: Nitrogen, P: Phosphorus: K: Potassium, Ca:calcium, Mn: Manganese, F: İron, Zn: Zinc, Mn: Mg: Magnesium

Table 4: The effect of different fertilizer and vermicompost applications on the nutrient content of the plant (leaf)

Gübre dozları	Mg(%)	(Fe) (mg Kg^{-1})	(Zn) (ppm)	(Mn) (ppm)
Kontrol	0.235 c	81.38 c	71.54d	61.74d
KG	0.250 b	119,41bc	78.37c	74.43a
VK+1/2KG	0.251 b	123.54b	84.81b	71.12 b
VK+KG	0.254 b	132.09ab	84.41ab	71.40b
VK+2KG	0.262 a	134.75a	84.70 a	73.46a
Ortalama	**0.25**	**118,23**	**80,76**	**70.43**

When the effects of the applications on the stem diameter were examined, the values obtained were found to be statistically significant (p<0.001). According to the data obtained in the study, the highest value was obtained from the VK+KG(36.53mm) application, while the lowest value was obtained from the control (35.93mm) application, and an increase of 5% was achieved between the applications. The highest value obtained in terms of the effect of the applications on the trunk diameter was VK+2KG(15.62cm), while the lowest value was taken from the control (13.89 cm) application, and an increase of 16.7% was achieved between the applications. İn the table 2. According to the results obtained when the effect of the applications on the marketable yield per decare was examined, the highest value was obtained from the VK+2KG (4273 kg da^{-1}) application, while the control (2574 kg da^{-1}) application received the lowest value. When the effect of varying fertilizer and vermicompost applications used in the experiment on the marketable yield per decare was examined, the yield differences obtained compared to the control were found to be statistically significant (p<0.001). In the trial, the highest yield value was obtained from the VK+2KG (4273 kg da^{-1}) application, while the lowest yield value was obtained from the control (2574 kg da^{-1}) application, and an increase of 66 % in marketable yield was achieved among the applications. When the effect of the applications on the leaf length was examined, an increase of 7 % was achieved in the VK+2KG application compared to the control application. The effect of the applications on the leaf diameter increased by 14.6% with VK+2KG application compared to the control application. In a study using different organic and synthetic chemical fertilizers, it can be said that organic fertilizers give statistically better results in terms of plant growth and development criteria in cauliflower cultivation. These results are compatible with our study (; Farahzety and Aishah, 2013; Kıl and Paksoy, 2016).

Leaf nutrient content values of different fertilizer doses and vermicompost applications are given in table 3. The macro mineral content of the cauliflower leaves was found to be statistically significant and the highest nitrogen (N) content was obtained from the VK+2KG (4.6%) application, while the lowest nitrogen content was obtained from the control (3.5%) application. The average effect of applications on leaf N content was 4.12%. When the effects of the applications on the phosphorus (P) contents in the leaves were examined, the highest value was obtained from VK+KG, VK+1/2KG (0.479%) applications, while the lowest value was obtained from the control (0.326%) application. The average effect of applications on leaf phosphorus (P) contents was obtained as 0,44 %. The highest value obtained in terms of potassium (K) content was obtained from the application of VK+2KG (3.06 %), while the lowest value was measured in the control (2.606%) application. The average effect of the applications on leaf calcium (Ca) contents was 1.22 %. When the effects of the applications on the leaf manganese (Mg) contents were analyzed, the highest value was obtained from the VK+2KG (0,25) application, while the lowest value was obtained from the control (0,24 %) application. İn the table 4. The average effect of applications on leaf manganese (Mg) content was 0.250 %. It was determined that the VK used in the study increased the Ca

and Mg ratios in the cauliflower leaf contents. As a matter of fact, Barley (1961) and Kale (1996) reported in their study that plants grown using VK did not encounter negative results in terms of Ca and Mg elements. While the highest value obtained in the effect of applications on leaf iron (Fe) contents was obtained from VK+ 2KG (134.75mg Kg^{-1}) application, the lowest value was obtained from control (81.38ppm) application. The average effect of the applications on the leaf iron (Fe) contents was obtained as 118.2 mg Kg^{-1}. It was argued that the increase in Fe concentrations of cauliflower caused the VK used in the experiment to be a good source of Fe. In parallel, it has been reported that VK helps plants to feed Fe (Hashemimajd, 2004). When the effects of the applications on zinc (Zn) contents were examined, the highest value obtained was obtained from the VK+1/2KG (84.81 mg Kg^{-1}) application, while the lowest value was obtained from the control (71.54 mg Kg^{-1}) application. The average effect of applications on leaf zinc (Zn) contents was 80.76. The highest value obtained in terms of manganese (Mn) contents was obtained from the KG(74.43%) application, while the lowest value was obtained from the control (61.74%) application. The average effect of applications on leaf manganese (Mn) content was 70.43%. According to Tavali *et al*.(2013), in a study conducted in Cauliflower, they reported that different vermicompost applications contained significantly higher levels of N, P, K and Fe compared to the control.

Conclusion

When the data of all application plots were examined, an increase in plant growth and yield was observed due to the increase in the dose of vermicompost added chemical fertilizer. VK+1/2KG, VK+KG and VK+2KG applications were valued at the same level of importance in terms of crown length, crown diameter, crown weight, marketable yield and trunk length. Vermicompost and regularly applied cultural processes have been effective in obtaining these results. The highest nitrogen content was obtained from VK+2NPK application, while phosphorus and calcium contents were obtained from VK+1/2NPK, VK+NPK and VK+2NPK applications. In particular, the 1/2KG+VK dose was in the same group with the highest doses in terms of efficiency, and this practice came to the fore; It is concluded that reducing chemical fertilizers and adding vermicompost will reduce the dependency on chemical fertilizers, increase productivity, as well as reduce the negative effects of chemicals for sustainable agriculture and environmental health.

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