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The Effects of Organic and Inorganic Fertilizer Applications on Yield and Plant Vegetative Growth of Eggplant (*Solanum melongena* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. Author MAA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors CG and SG managed the analyses of the study. Authors CG and SG managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted to evaluate the effects of organic and chemical fertilizers on yield and plant vegetative growth of eggplant (*Solanum melongena* L.) between 22.05.2018 and 12.09. 2018 under field conditions in Bandırma, Turkey. Treatments were control with no fertilizer (CONT), developed organic fertilizer (DOF), organic fertilizer (OF) chemical fertilizer (CHF), each treatment has 3 replicates with 360 plants. Developed organic fertilizer and OF were applied in (2000) kg.da-1, chemical fertilizer (15%N, 15%P, 15%K, 20%SO3) was applied in 40 kg/da. Yield and plant vegetative growth weight were determined. Organic and chemical fertilizer applications had a significant effect (P<0.05) on yield and plant vegetative growth. The eggplant yield at CONT, DOF, OF, CHF were 3922, 4593, 4375, 4579 kg.da-1 respectively. The plant vegetative growth (Plant organs fresh weight) at CONT, DOF, OF, CHF were 3548, 4018, 3818, 3882 kg.da-1 respectively. The difference between fertilizers (DOF, OF, and CHF) was not significant so that organic fertilizers are competitive and may be a suitable replacement for chemical fertilizer.

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Keywords: Organic fertilizer; vegetative growth; fruit yield; eggplant.

1. INTRODUCTION

Eggplant (*Solanum melongena L.*), also known as aubergine, brinjal or guinea squash is one of the non-tuberous species of the night shade family Solananceae [1]. The varieties of Solanum melongena L. show a wide range of fruit shapes and colors, ranging from oval or egg-shaped to long club shaped; and from white, yellow, green through degrees of purple pigmentation to almost black. It is an economically important crop in Asia, Africa and the sub-tropics (India, Central America) and it is also cultivated in some warm temperate regions of the Mediterranean and South America [2]. Eggplant fruits are known for being low in calories and having a mineral composition beneficial for human health. They are also a rich source of potassium, magnesium, calcium and iron [3]. According to the reports released in 2015, in 179 countries, global sales of organic food and drink reached 81.6 billion US dollar and 50.9 million ha in the field of organic farming [4]. According to the data obtaind from [5], in 2013 there are 213 kinds of products at 769014 hectares, 60797 producers, 1.620.466 tons of organic vegetable production in Turkey. The amount of organic vegetable production in Turkey around 30,000 tons. The major share respectively tomatoes, cucumber, beans, pepper, lettuce and eggplant [6]. Fertilizers are used to improve soil fertility but intensive inorganic fertilizer usage in agriculture causes so many health problems and unrecoverable environmental pollution. Thus, to reduce and eliminate the adverse effects of synthetic fertilizers on human health and environment, nowadays a new agricultural practice have been developed called as organic agriculture, sustainable agriculture or ecological agriculture [7,8]. Inorganic fertilizers are known for their high cost and their negative environmental effects if managed poorly [9]. In a particular experiment, the authors found that application of organic amendments has potential to increase the growth and chemical composition of two cultivars of safflower and therefore, might be a good alternative to chemical fertilizers [10]. The effect of different organic manures and inorganic fertilizer levels in soil were observed on growth performances and yield of eggplant [11]. Louisa and Taguiling [12] reported that compost stimulates plant growth in terms of total height, number of leaves, fresh weight of plant biomass, and initial yield of green pepper (*Capsicum annuum*), eggplant (*Solanum melongena*), and Okra (*Abelmoscus esculentus*).

This study aims to determine the effect of organic and developed organic fertilizers as compared to inorganic fertilizers on plant growth and yield of eggplant.

2. MATERIALS AND METHODS

2.1 Materials

Research area: The experiment carried out in a field near Akcapınar village which located at 40°16 '44.4252' 'North and 28°4'18.9552 '' Eastern latitudes and longitudes. The altitude from the sea level is 41 m).

Climate: Bandirma is under the climate of the Mediterranean Sea and the Black Sea. In addition, due to the fact that is located on the transition area of the terrestrial climate of the Balkans, various climate features are observed in the district., the lowest temperature according to 52-year climate data is -14.6ºC (January 15, 1954), while the high temperature was recorded as 42.4ºC (July 9, 2000). The average annual temperature is 14ºC. The dominant wind direction is North-Northeast. The average wind speed is 15 km/h. The average annual rainfall in the district is 703.3 mm. The annual relative humidity average is 73% [13].

Properties of the experimental area soil: From the soil profile opened in the experiment area, disturbed and undisturbed soil samples were taken from 0-30, 30-60 and 60-90 cm soil layers and physical and chemical analyses were performed on these samples. The pH of the test soil was pH 8-8.1, salt content 0.76-0.84 ds/m, organic matter % 0.68-1.2, total nitrogen 9.4-9.7 $kg.da^{-1}$, phosphorus 1.44 -1.69 $kg.da^{-1}$, potassium 59.8-83.8 $kg.da^{-1}$, calcium varied from 1971 to 2230 $kg.da^{-1}$, and volume weight (As) ranged from 1.28 to 1.31 g.cm-3. The Soil texture in the first layer (0-30 cm) is sandy tin; in the second layer (30-60 cm) is sandy clay Tin; the third layer (60-90 cm) has clayey texture.

Properties of irrigation water: Irrigation water was taken from a deep well near the experiment field. The water from the deep well was pumped into a pool. A sample was taken from irrigation water and analyzed. Irrigation water was in C3S1

class. The water was hired class in salinity and first class in sodium.

Class A pan evaporation: Class A pan evaporation used in the experiment was 121 cm in diameter and 25 cm in height and was made of 2 mm thick galvanized steel plate. The wooden base was put at the bottom of the pan allowing air flow 10 cm height. Changes in the water level at the surface are measured. It was covered on a wire mesh to prevent the water intake by the insects and animals.

Fertilizers: Three different fertilizers were used in the study. 1-Inorganic fertilizer (CHF), 2-Organic fertilizer (OF), and 3- Developed organic fertilizer (DOF). Inorganic fertilizer (CHF); N, P, K, SO_3 (15-15-15 + 20), OF; DOF; 75% cow manure and 25% poultry manure (developed organic fertilizer DOF differs from organic fertilizer OF in that it is mixed with small particles of OF it's about 50 microns in volume). In both organic fertilizers, the organic matter content is 33%, the humic + volvic content was 18.4% and the pH is 7.4. The organic fertilizers both were prepared in an aerobic fermentation method (windrow), whereas the level of humidity, oxygen and temperature were monitored. The humidity at the beginning of fermentation was 60% and the process of flipping and aeration were performed when the temperature reached about 60 degrees Celsius and when the oxygen rate reduced above 5% for 45 days. This process called composting which is a naturally occurring process in which bacteria, fungi, and other microorganisms convert organic material into a stabilized product termed as compost.

2.2 Methods

Fertilizer treatment: Three fertilizer treatments were applied: the first treatment is organic fertilizer (OF) applied at 2000 $kg.da^{-1}$, the second fertilizer is developed organic fertilizer (DOF) applied at 2 2000 $kg.da^{-1}$ and the third treatment is inorganic fertilizer (CHF) applied at 40 $kg.da^{-1}$. Each treatment has 3 replicates.

Soil preparation and planting: First, the experimental area was tilled and then parcels were created. Then the fertilizers applied according to the experiment plan. After that, the drip irrigation system was established. The eggplant seedlings were planted according to the experiment plan on 02/06/2017, the spacing between row was 70 cm, the spacing within rows is 40 cm, each parcel contains 6 rows, in each row 20 plants and each plot contains 120 plants, the plot dimensions were: 8 m*4.2 m=33.6 m^2. The parcels were separated from each other's 2 m space and the total area of the experiment was 659.2 m^2, the total number of seedling was 1080.

Calculation of Irrigation Water Amount: The amount of irrigation water was calculated according to the method given by Gençoğlan et al. [14], evaporation quantities were measured at 09:00 a.m. in class A evaporation pan. These measured values were used to calculate the amount of irrigation water. The amount of irrigation water was calculated by the equation given below.

$$V = E\,(pan) * A * P * IR$$

where,

V: Water volume / L
E: A Pan-Evaporation / mm
A: Parcel area / m^2
P: Percentage of coverage

IR: Irrigation Applied rate (100%). Drip irrigation method was used, irrigation was applied as 100% of evaporation from Class A pan evaporating, and the calculated irrigation water amounts were applied to the parcels by using water meters. The experiment was irrigated 12 times. The total amount of irrigation water applied to the experimental area was 305 mm/da, in addition to 143 mm rainfall.

Evaluation of data: The experiment was established according to randomized locks design. Each treatment was replicated 3 times with 120 plants for each replication. ANOVA one way statistical analyses were performed by using SPSS (24.0v) Program.

3. RESULTS AND DISCUSSION

Eggplant plant began to fruiting one month after planting (22.06.2018). It was harvested 5 times, the first harvest was in 19.07.2018, and the last harvest was in 12.09.2018. According to the results of variance analysis conducted in order to determine the effects of the kind of fertilizer on the yield, it was found significant at 5% level ($p<0.05$). [15,16], also reported significant differences in yield with the application of different fertilizer sources. According to the LSD test there are 2 groups, DOF, OF and CHF treatment, in A group, the control in B group. The

heights yield at DOF (4593 kg.da^{-1}) and the lowest yield was at control (3922 kg.da^{-1}). There were no significant differences between the three fertilizers treatments (DOF, OF, CHF) (Table 1). These results can be explained that adding organic fertilizer to the soil make mineral more available in the soil in addition to what organic fertilizer contain from mineral.

Plant vegetative growth: According to the results of variance analysis conducted in order to determine the effects of the kind of fertilizer on the plant vegetative growth of eggplant it was found significant at 5% level ($p<0.05$). [17,18,19,15] also reported significant differences in vegetative growth with the application of different fertilizer sources. According to the LSD test there are 2 groups, DOF, OF, CHF treatment, in A group and the control in B group. The heights plant vegetative growth at DOF (4018 kg.da^{-1}), the lowest plant vegetative growth was at control (3548 kg.da^{-1}). There were no significant differences between the three fertilizers treatments (DOF, OF, CHF) (Table2). These results can be explained that organic fertilizer contains Azote which is important to vegetative growth.

Table 1. Total yield results (kg.da^{-1})

Replicates	Treatments			
	DOF	OF	CHF	Control
R1	4630	4827	4539	3886
R2	4713	3987	4561	3828
R3	4437	4311	4638	4051
Average	4593[a]	4375[a]	4579[a]	3922[b]

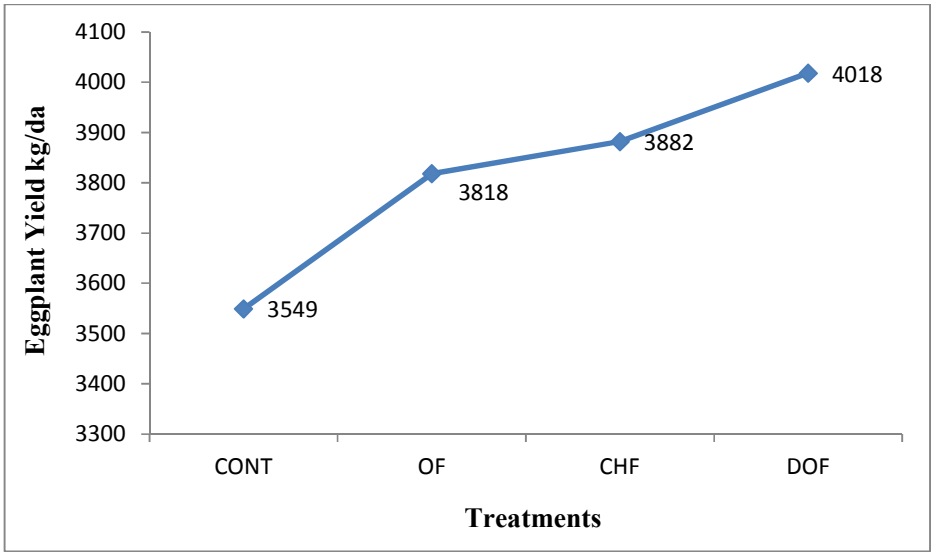

Fig. 1. Effect of three different fertilizers on yield

Table 2. Total vegetative growth results (kg.da^{-1})

Replicates	Treatments			
	DOF	OF	CHF	Control
R1	3991	3869	3957	3592
R2	3987	3895	4083	3571
R3	4077	3690	3606	3483
Average	4018[a]	3818[a]	3882[a]	3548[b]

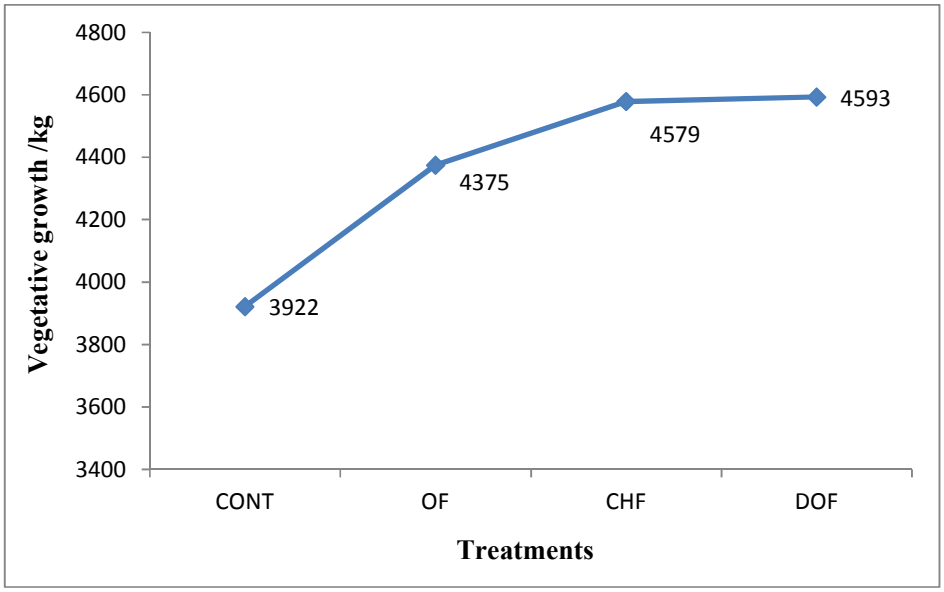

Fig. 2. Effect of three different fertilizers on plant vegetative growth

4. CONCLUSIONS

According to Bandırma Akçapınar conditions, during the growing period of the eggplant it was found as fertilizers application there were significant differences between the control treatment and the other treatments ($P<0.05$)., in yield and plant vegetative growth. No significant differences were found between the three fertilizers treatments (DOF, OF, CHF) in yield and plant vegetative growth ($P>0.05$). The highest fruit yield of the experiment (4593 kg. da^{-1}) was obtained at DOF treatment; the lowest yield in the experiment (3562 $kg.da^{-1}$) was obtained at control. The heights plant vegetative growth at DOF treatment (4018 $kg.da^{-1}$), and the lowest vegetative growth was at control (3548 $kg.da^{-1}$).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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