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THE EFFECT OF SOME GROWING SUBSTRATE MEDIA ON YIELD AND FRUIT QUALITY OF EGGPLANT (*SOLANUMMELONGENA* L.) GROWN AND IRRIGATED BY DRIP IRRIGATION SYSTEM IN GREENHOUSE

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Summary

The soilless culture of vegetables in greenhouse has increased in Turkey. In recent years, bunch tomato has grown in soilless culture. However, bacterial cancer, virus (TMV, TYLVC) andTutaabsulta are limited tomato growing soilless culture as well. For this reason, others vegetables such as eggplant and pepper can be alternative crop for soilless culture. The aim of the research is determination of growing media such as cocopeat, split mushroom compost, perlite, volcanic tuff and sawdust on yield and fruit quality of eggplant. Our results suggest that mushroom compost and cocopeat media improve eggplant fruit quality more than other growing media.

Key words: Solanum melongena, substrate culture, fruit quality

INTRODUCTION

In Turkey, the greenhouse area is approximately 60 thousand ha and vegetable production occupies nearly 96% of this area. Tomato is an important vegetable grown in Turkey as well as cucumber, eggplant and pepper. Greenhouse vegetable production is conducted intensively near Mediterranean region in Turkey.

According to the data of FAO [2011], the most important eggplant producers are China (27 million tonnes), India (12 million tonnes), Iran (1.2million tonnes), Egypt (1.1 million tonnes), and the Turkey (821 thousand tonnes), respectively. Eggplant cultivation has been localized in the Mediterranean region.

Rockwool, cocopeat and perlite are the main substrate used by growers for soilless culture vegetable production because of its high yield. However, the greenhouse industry is seeking more environmentally substrates. These substitutes should ideally be made of industrial byproducts derived from locally produced renewable resources. Within this frame, wood fibers, wood sawdust and volcanic tuff and spent mushroom can be used with success. Although there have been many trials for tomato, physical properties of some of the substrates and their suitability for soilless culture eggplant production are not well known. The physical substrate properties affecting plant growth include air and water retention and movement.

Soilless growing media are easier to handle and may provide a better growing environment compared to soil [Bilderback et al., 2005; Mastouri et al., 2005]. The most common substrate used in soilless culture rock-wool, peat, perlite and coco-peat, and more research has focused on tomato [Celikel and Abak, 1994] but very little studies have been on eggplant. A good growing media should have some characteristics such as to provide aeration and water, allow for maximum root growth and support physically the plant [Bilderback et al., 2005].

Many different organic and in-organic matters are used as growing media [Olle et al. 2012]. Different growing materials are used to achieve the correct balance of air and water holding capacity for the plants to be grown as well as for the long-term stability of the medium [Nair et al., 2011]. Most of various materials are mixed substrate but recently modern growers do notlike mixed substrate because it is not easy to prepare a homogeneous substrate mix.

Productionof 60-70% of mushroom is located near the Antalya and Isparta region in Turkey. It is available in large quantities. Spent mushroom compost can be a potential alternative for peat. Also the world reserves of perlite are around 700 million tonnes. Turkey is the 3rd producer with 220 million tonnes, after Greece and Unites States.

The aim of the project was to evaluate the potential of different growing media for eggplant production, and to examine the effects on yield and fruit quality of eggplant under greenhouse conditions.

MATERIALS AND METHODS

Eggplant seedlings (*Solanum melongena* L.) cv. Faselis were grown in 1:1 (v/v) peat:vermiculite in polystyrene trays at the Histhtil Nurseries (Antalya, Turkey). The variety is very popular and suitable for spring season under tunnel and greenhouse production in Turkey. In the study, cocopeat, spent mushroom compost, perlite, volcanic tuff and oak sawdust were used as growing media. Oak sawdust was obtained from a frost product company in Isparta, Turkey. The material completed the separation has high cation exchange capacity, high capacity moisture and drainage. It has pH of 5.0-6.8 which is neutral to slightly acidic. Coco-peat fiber (Gartengold, Sri Lanka) with its pH of 6-6.5 has the ability to store and release nutrient to plants for extended periods of time. It also has great oxygenation properties which is important for healthy root development. Mushroom compost is made from horse manure, straw, chicken manure and gypsum. The spent mushroom compost was obtained from Serpil village (Isparta, Turkey) which is very important mushroom produce area. Perlite is a versatile and sustainable mineral. Its unique characteristics are lightweight, sterile, of high water and oxygen capacity. The perlite with pH of 6.5 was provided by Akper Perlite and Minning Co. (Cankiri, Turkey). Volcanic tuff which possesses a large amount of pores has very high capacity of air. The tuff which is size between 0.3-1.5 cm and pH of 7.5- 8.0 was obtained from Suleyman Demirel University, Volcanic Tuff Research and Practice Centre (Isparta, Turkey).

This experiment was performed under glass greenhouse conditions. Averageday and night temperatures in the greenhouse were 28ºC and 20ºC, respectively. The relative humidity varied between 60 % and 70 % and the lightregimen ranged from 500 to 700 μmol m^{-2} for a 12h photoperiod. Substrate were put in pillow type 0.05 mm thick inside black and outside white plastic which measured 35×20×10 (length-wide-high) cm (7 L).The packing was done by loosely filling and set up on a bench in ahorizontal position. The bags were spaced to achieve a density of 3.0 plants m^{-2}. The experimental design was a randomized block design with twelve replicates. The drainage holes were made about 2 cm above the bottom of the bags. Each eggplant seedlingwas transplanted to a plastic bag which measured containing7 L of growingmedium on 25 May 2011, and was watered every day with top water during the first week. After first week, all the growing media was irrigated with a nutrientsolution. Drip irrigation supplied a standard nutrient solution to the plants. The solution contained in ppm: 135 N, 48 P, 283 K, 128 Ca, 67 Mg, 1.8 Fe, 1.8 Mn, 0.6 Zn, 0.09 Cu, 0.05 Mo and 0.5 B. The electrical conductivity of solution was maintained from 1.8 to 2.1 mS cm^{-1}. The pH was maintained in the range of 5.5-6.0. The irrigation was set up according to 30 % drainagefor every irrigation. The volume of nutrient solution applied per irrigation varied 310 to 1050 mL per plant.

Theplants were irrigated 2-7 times a day with the same nutrient solution until the end of experiment. Irrigation frequency was based on solar radiation and stage of plant growth in greenhouse.

The number of total fruit for each plant was regularly counted during the harvested period. The total number of the leaves was counted during vegetative harvested period.

Fruit diameter (cm) was measured by a digital compass and fruit length (cm) was measured by the steel tape measure. Average of fruit weight (g) was calculated by marketable fruits weight divided to total number of the fruits. Fruit firmness was determined using a digital texture machine (LF PlusAmetec Ins.)

and measured via compression using a 50 N load cell and a stainless steel, 5.1 mm diameter cylindrical probe with a constant speed of 100 mm/min at harvest date.

Skin colours of eggplant fruit were determined using a Minolta CR-300 colorimeter (Minolta Ramsey, NJ, USA). A white calibration plate (Y = 92.3, x = 0.3136 and y = 0.3194) was used for calibration. The values were expressed by the CIE L^* (brightness-darkness), a^* ($+a^*$: red, $-a^*$: green) and b^* ($+b^*$: yellow, $-b^*$: blue) system. The soluble solid content (SSC) was measured using a digital refractometer (Atago Pocket PAL-1) and it was expressed as percentage of soluble solids per 100 g fresh weight.

The data were analysed using the ANOVA analysis of variance procedure and significant differences between treatments were determined using the Tukey's test.

RESULTS AND DISCUSSION

The plants were harvested after transplanted 4 months. In this study, plant height, number of leaves, fruit weight, fruit length, fruit size, fruit skin colour, fruit firmness, soluble solids content of fruit juices, such as the total number of fruits and yield parameters were determined. According to the results of the analysis of variance, plant height, number of leaves, fruit weight, fruit size, fruit skin colour, fruit firmness, and soluble solids content of fruit juice, total fruit number and yield were found statistically significant.

The highest plant length (82.2 and 78.7 cm) and number of leaves (51.1 and 51.4) was obtained with cocopeat and spent mushroom compost respectively. Mavrona et al., [2001] used as growing media; perlite, perlite+zeolite (1:1), cocopeat and perlite+cocopeat mixtures. They founded longer plant height and number of leaves in cocopeat than inperlite (Table 1). Same results showed on tulip and strawberry as well [Kahraman, 2006].

Table 1. Effect of substrates on plant height (cm) and number of the leaves (120 days after planting)

Substrate	**Plant height (cm)**	**Number of leaves (no/plant)**
Perlite	70.8 b	51.4 a
Volcanic tuff	68.3 bc	50.7 a
Mushroom compost	78.7 a	51.4 a
Cocopeat	82.9 a	51.1 a
Sawdust	62.8 c	46.6 b
LSD	0.000	0.007
Significance	**	**

*Significant at $P \leq 0.05$, ** Significant at $P \leq 0.01$; ^{ns} not significant (n = 12).
Values with different letters appended are statistically different from one another as indicated by *ANOVA* analysis

Fruit weight (226.7 g), fruit length (21.3 cm) and fruit diameter (6.1 cm) wereobtained with sawdust while the lowest fruit weight (208 g) was obtained with volcanic tuff and mushroom compost (Table 2).

Table 2. Effect of substrates on fruit weight (g), fruit length (cm) and fruit diameter (120 days after planting)

Substrate	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)
Perlite	216.2 ab	20.8	6.0 ab
Volcanic tuff	208.2 b	20.7	5.9 ab
Mushroom compost	208.3 b	20.7	5.6 b
Cocopeat	218.3 ab	20.8	5.9 ab
Sawdust	226.7 a	21.3	6.1 a
LSD	0.001	0.252	0.019
Significance	**	ns	*

*Significant at $P \leq 0.05$ ($n = 12$). ** Significant at $P \leq 0.01$; ns not significant
Values with different letters appended are statistically different from one another as indicated by ANOVA analysis

Fruit weight may depend on the number of fruit, because the lowest number of leaves (32) was obtained with sawdust media while the highest number of leaves was determined with the mushroom compost (42) and cocopeat (40) growing media (Table 3). The highest fruit yield was determined with cocopeat (8.5 kg) and mushroom compost (8.4 kg), while the lowest fruit yield was determined with volcanic tuff (7.0 kg) and sawdust (7.2 kg) (Table 3). The similar effects of these substrates on fruit yield, number of leaves and plant height of eggplant could be described to C:N ratio. Similar results showed on tomato by Ghehsareh et al. (2011). Fruit firmness is very important parameter for shelf life of vegetables, our studies showed that the highest fruit firmness was obtained with 67.6 N in cocopeat, the lowest data was obtained with 54.7 N in volcanic tuff. The highest soluble solid content (SSC) value was determined with 6.3 (%) in volcanic tuff, while other growing substrates showed similar SSC (Table 3). Organic growing media gave more yield and number of fruit then conventional growing system in greenhouse tomato production [Rippy et al., 2004; Olle et al., 2012]. These results are similar to our results.

Fruit colour is important parameter for marketing and eggplant skin colour changed from purple to dark black during the maturation. The effects of growing media on fruit colour L^*, a^* and b^* values were statistically significant (Table 4). The lowest colour value 25.8, 4.8 and 0.3 (L^*, a^*, b^* respectively) was found in sawdust, the highest value 26.8, 6.5 and 0.6 (L^*, a^*, b^* respectively) was found in cocopeat substrate. The change of colour values means that the eggplants in cocopeat substrate had more bright and displayed dark purple colour than the others growing media.

Table 3. Effect of substrates on total yield (kg), fruit firmness, number of fruits and fruit soluble solid content (SSC) (120 days after planting)

Substrate	Yield (kg)	Fruit firmness (N)	Number of fruit (no)	SSC (%)
Perlite	7.8 bc	62.3 ab	36.0 b	5.9 ab
Volcanic tuff	7.0 d	54.7 b	34.0 c	6.3 a
Mushroom compost	8.4 ab	57.8 b	42.0 a	5.3 b
Cocopeat	8.5 a	67.6 a	40.0 a	5.3 b
Sawdust	7.2 cd	60.6 ab	32.0 d	4.2 c
LSD	0,000	0.004	0.000	0.000
Significance	**	**	**	**

*Significant at $P \leq 0.05$. (n = 12). ** Significant at $P \leq 0.01$; ^{ns} not significant
Values with different letters appended are statistically different from one another as indicated by *ANOVA a*nalysis

Table 4. Effect of substrates on fruit skin colour (120 days after planting)

	Fruit skin colour		
Substrate	**L***	**a***	**b***
Perlite	26.1 ab	5.0 ab	0.4 ab
Volcanic tuff	26.1 ab	4.5 b	0.3 ab
Mushroom compost	26.5 ab	5.5 ab	0.4 ab
Cocopeat	26.8 a	6.5 a	0.6 a
Sawdust	25.8 b	4.8 b	0.3 b
LSD	0.008	0.008	0.047
Significance	**	**	*

*Significant at $P \leq 0.05$. (n = 12). ** Significant at $P \leq 0.01$; ^{ns} not significant
Values with different letters appended are statistically different from one another as indicated by *ANOVA* analysis

According to the results of this study, spent mushroom compost growing media can be alternative media to commercial cocopeat and perlite in eggplant growing under greenhouse conditions

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