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EFFECT OF DIFFERENT GROWING MEDIA ON QUALITY, GROWTH AND YIELD OF PEPPER (*CAPSICUM ANNUUM* L.) UNDER GREENHOUSE CONDITIONS

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Abstract

The objective of this study was to determine the effects of peat and mixture (peat:perlite:sand (1:1:1 v:v:v) growing media on length, diameter, weight of fruit, fruit number per plant, yield, ascorbic acid content and total soluble solid of fruit of some pepper cultivars under greenhouse conditions. Pepper cultivars (Charliston 52, E9383A, E1988 and Topepo Rosso) were grown in peat or peat+perlite+sand (1:1:1) media in polyethylene bags. The fruits of four pepper cultivars were harvested in two maturation stage eg., green and red stages, and some quality parameters such as ascorbic acid and total soluble solids were determined. The results of the study showed that mixture media significantly increased length, diameter and weight of fruit in all cultivars grown compared to peat. On the other hand, ascorbic acid content, total soluble solids of fruit, the fruit number per plant and yield were higher at peat grown plants than the mixture. Furthermore, different maturing stage significantly affected ascorbic acid content and total soluble solids of pepper cultivars. It results from the study that peat growing media could be successfully used to obtain better quality and yield.

Introduction

Greenhouse area in Turkey reached 54216 ha in 2008, consisting low plastic tunnels with 33.4% (18126.5 ha) while the high tunnel (6696.0 ha), glass (8225.3 ha) and plastic (21168.0 ha) greenhouse areas are rest. Vegetable crops are grown in 96% of total greenhouse growing, and pepper is grown in the ratio of 8.4% (Anon., 2009).

In Turkey, studies on soilless culture have gained speed towards the end of 1980's. In the 1990's big companies have started to use soilless culture techniques via technology transfer from abroad. It is estimated that soilless culture is being practiced on a commercial basis only on 180 ha (Engindeniz & Gul, 2009). Soilless culture is widely used to grow plants in greenhouse in many countries at present. Monoculture results in a lot of problems when soil is used as growing media (Sevgican, 1999a). Rapid evaporation under greenhouse due to high temperature causes salinity at upper layers of soil.

It is suggested to improve soil characteristics the supplement of organic matter, soil disinfection and soil change (Sevgican, 1999a; Grangvist, 1981). Soilless culture techniques have been developed to avoid monoculture plant growing problems (Alan, 1990). Different media for soilless culture have different water and nutrient capacity and aeration. For this reason, the most suitable media should be selected for different species.

It is well known that soilless culture offers an alternative to soil culture when serious soil and water problems (i.e., soil born pests, soil and water salinity, chemical residues in soil, water salinity, lack of fertile soil, water shortage), create difficulties in traditional soil-based production. The main advantages of soilless culture are the most accurate control over the supply of water, nutrients, pH, root temperature, etc., increase productivity due to easier and more accurate control of production factors, reduction of labour requirement, no need for soil sterilization, more crops per year, etc. Tuzel *et al*., (2008).

Substrate culture is generally used as a soilless technique (Tuzel & Gul, 1999). Peat, wood shaving, bark, sand, gravel, perlitee, vermiculite, rockwool, pumice, glasswool, expanded clay, zeolite, volcanic tuff, cocopeat etc. are used as organic and inorganic media (Sevgican, 1999b). Perlite, peat and volcanic tuff are abundant in Turkey. These media can be used alone or mixed with peat or the others.

Pepper (*Capsicum annuum* L.) is an important vegetable as well as spice crop, used worldwide for domestic and commercial purposes (Khan *et al*., 2012). One of the most important cultural inputs involved in greenhouse crop production, perhaps the most important is the type of growing media used (Angin *et al*., 2011). It has been shown peat as growing media increased the yield of pepper compared to the rockwool (Cadahia *et al*., 1988). Albaho *et al*., (2009) reported that peatmoss, perlitte, vermicompost and cocopeat or mixture of these substrates in different ratio had significant effects on cultivars heights, number of leaves, chlorophyll index and total yields of pepper. In a study which were used soil, perlite, peat, sand and pumice as growing medium it was determined that growing media statistically affected yield, fruit weight, ascorbic acid values and TSS of pepper cultivars (Padem & Alan, 1994). Khan *et al.*, (2006) found that sand +peat (1:1) proved to be a superior potting medium followed by sand + peat + spent compost of Button mushroom (1:1:1) for growth of rough lemon (*C. jambhiri*) nursery stock.

Different substrates have several materials which could have direct and/or indirect effects on plant growth and development. Therefore selecting the best substrate between the various materials is imperative to plant productivity. This study was conducted to determine the effects of peat and mixture (peat : perlite : sand (1:1:1 v:v:v) growing media on length, diameter, weight of fruit, fruit number per plant, yield, ascorbic acid content and total soluble solids of fruit of some pepper cultivars under greenhouse conditions.

Materials and Methods

Growth conditions and plant materials: The objective of this study was to determine the effects of peat and mixture (peat : perlite : sand (1:1:1 v:v:v) growing media on length, diameter, weight of fruit, fruit number per plant, yield and, ascorbic acid content, total soluble solids (TSS) of fruit of some pepper cultivars under greenhouse conditions. Pepper (*Capsicum annum* L.) cvs. Carliston 52, E9383A, E1988 and Topepo Rosso were used as plant materials. Plants were maintained under natural light conditions, approximate day/night temperatures of 25/18ºC and 75% relative humidity during the span of the experiment.

Treatments, harvest, measurements and statistical analysis: Seeds of pepper cultivars were initially sown in trays filled with mixture of peat : perlitee (1:1, v:v). Forty five days after planting (DAP) they were transplanted to 12 l polyethylene bags filled with peat or mixture of peat : perlite : sand (1:1:1 v:v:v). The plants were grown on full strength nutrient solution, including all macro and micro nutrient elements. Bags were placed randomly in the greenhouse. Some properties of media used in the study are presented in Table 1.

Pepper fruits were harvested when they had reached at full maturity (red) or green maturity. In the study, vitamin C (ascorbic acid; AA), total soluble solids (TSS) in fruit, fruit length, fruit diameter, fruit weight, fruit number, and total yield per plant were determined.

Ten fruits per plot were collected randomly as subsamples for quality assessments in both maturities. Fruits were homogenized in a blender, and portions of the homogenate were taken to determine TSS and AA. TSS was determined using a hand refractometer (JENA 178512). AA was measured with a classical titration method using 2,6-dichlorophenol indophenol solution, and expressed as mg (100 mL)–1 (Miller, 1998).

The statistical analysis was made using the GLM procedure of SAS (Anon., 1985). The experimental design was hierarchical with respect to two factors arranged in a completely randomized design with three replications. Data were subjected to analysis of variance (ANOVA) to compare the effects of cultivar and media treatments. The differences between the means were compared using the least significant difference test (LSD, $p<0.05$). There were 3 replicates per treatment and 6 plants per replicates.

Results and Discussion

The effect of different growing media on fruit length, fruit diameter, fruit weight and fruit number of pepper cultivars are given in Table 2. The mixture growing media increased statistically ($p<0.05$) the fruit weight in all cultivars, increased the fruit length in Carliston 52 and E 1988, and the fruit diameter in E9383A, E1988 and Topepo Rosso. The differences between mixture and peat media were significantly ($p<0.05$) important in terms of fruit number except for Topepo Rosso. The highest fruit number was obtained from E9383A, the lowest from Topepo Rosso cv. in both media (Table 2). The temperature, moisture capacity, aeration etc. of growing media can affect especially root growth, water and mineral uptake. Sand and perlite which quickly heat up and cool down, are good media in regard to drainage and aeration. It was reported that the water holding of peat is better than those of sand and perlite (Ozgumus, 1985). These factors can effect of growth and yield and quality of pepper cultivars.

Table 1. Some preperties of media used in study.

Media	Organic matter (%)	Available P (ppm)	Available K (ppm)	pH
Peat	33.50	13.50	584	7.76
Mixture	16.97	7.42	305	7.63

Table 2. Effect of different growing media on some fruit characteristics in pepper cultivars.

Media	Cultivars				Media mean
	Carliston 52	E9383A	E1988	Topepo Rosso	
			Fruit length (cm)		
Peat	16.00 b*	9.60 NS	8.25 b	2.43 NS	9.07 b
Mixture	17.37 a	9.90	9.00 a	2.75	9.75 a
			Fruit diameter (cm)		
Peat	7.50 NS	8.00 b*	13.00 b	12.25 b	10.18 b
Mixture	7.87	8.65 a	15.50 a	14.00 a	11.50 a
			Fruit weight (g)		
Peat	19.80 b	8.20 b	27.00 b	9.00 b	16.00 b
Mixture	21.00 a	9.50 a	28.00 a	9.80 a	17.05 a
			Fruit number (per plant)		
Peat	49 a	67 a	40 a	26 NS	45.66 a
Mixture	30 b	46 b	23 b	20	27.83 b

NS: Non-Significant

*: Numbers with the same letters are not statistically different according to LSD ($p<0.05$)

TSS in fruits of plants grown in peat was higher than that of the mixture in both maturity stages with the exception of Carliston 52 and E1988 (Table 3). When cultivars are compared, the highest TSS value was determined in E1988, and there were significant differences between cultivars as regard to TSS.

The peat as growing medium has been observed to increase the amount of vitamin C in both maturities in all cultivars used in the experiment when Table 4 is examined. The highest vitamin C was obtained from Topepo Rosso in green maturity stage while E1988 gave the highest value in red maturity stage. The lowest vitamin C values were determined in Carliston 52 in both maturities (Table 4). These results showed that maturity stage in addition to the media and cultivar also could affect vitamin C content. Aydemir & Ince (1988) reported that media with high K could increase the vitamin C content. This finding is accordance with our findings, which K amount of peat medium is higher than that of the mixture (Table 1).

The effect of different growing media on yield of some pepper cultivars is given in Table 5. It will be seen that the highest and the lowest yield occurred in E1988 and Topepo Rosso respectively in both media when Table 5 is studied. Peat media statistically elevated the yield of the pepper cultivars compared to the mixture media. Peat contains high organic matter (Table 1) and it has been reported that pepper likes organic matter (Gunay, 1992). Furthermore, peat contains higher phosphorus and potassium content than mixture (Table 1). These elements have been suggested to promote fruit set of crops such as pepper (Aydemir & Ince, 1988). The results of the study agree with these reports. Similarly, Padem & Alan (1994) reported that yield, fruit weight, ascorbic acid values, total soluble solid and composition of leaf of pepper were significantly influenced by cultivars and growing media. They found that TSS and total yield were the highest in peat medium, whereas the lowest yield was obtained in plants grown in pumice. Riaz *et al.,* (2008) reported that different growing media can be used to grow zinnia while the physical and chemical properties of media, like structure, texture, pH as well as nitrogen, phosphorus and potassium are the dominant factors for the growth and development of plant. Furthermore, Ahmad *et al*., (2012) suggested that incorporation of rice hulls and press mud in traditional substrates improved the growth and quality indices and increased flower yield of Rosa hybrid L. cvs. 'Kardinal', 'Anjlique' and 'Gold Medal'.

Table 3. Effect of different growing media on TSS of fruits of pepper cultivars in different mature stage.

Media			Cultivars		Media Mean
	Carliston 52	E9383A	E1988	Topepo Rosso	
			TSS in green mature (%)		
Peat	4.70^{NS}	4.80 a *	5.00 ^{NS}	4.90 a	4.85 a
Mixture	4.60	4.50 b	4.80	4.20 b	4.52 b
Cultivar mean	4.65 b	4.65 b	4.90 a	4.55 b	
			TSS in red mature (%)		
Peat	6.80 a	9.00 a	9.70 a	8.20 a	8.42 a
Mixture	5.55 b	7.00 b	9.00 b	7.20 b	7.17 b
Cultivar mean	6.15 a	8.00 c	9.35 a	7.70 b	

^{NS}: Non-Significant

*: Numbers with the same letters are not statistically different according to LSD ($p<0.05$)

Table 4. Effect of different growing media on Vitamin C of fruits of pepper cultivars in different mature stage.

Media	Çarliston 52	E9383A	E1988	Topepo Rosso	Media mean
			Vit. C in green mature (mg/100ml)		
Peat	23.0 a*	33.0 a	31.2 a	36.0 a	30.80 a
Mixture	19.0 b	30.4 b	28.0 b	30.9 b	27.07 b
Cultivar mean	21.0 d	31.7 b	29.6 c	33.45 a	
			Vit. C in red mature (mg/100ml)		
Peat	255.0 a	376.4 a	732.6 a	465.0 a	457.25 a
Mixture	240.0 b	362.5 b	681.0 b	420.0 b	425.87 b
Cultivar mean	247.50 d	369.45 c	706.8 a	442.50 b	

*: Numbers with the same letters are not statistically different according to LSD ($p<0.05$)

Table 5. Effect of different growing media on yield of pepper cultivars (g/plant).

Media	Carliston 52	E9383A	E1988	Topepo Rosso	Media mean
Peat	970 a*	549 a	1080 a	234 a	708.25 a
Mixture	630 b	436 b	643 b	196 b	493.83 b
Cultivar mean	800 b	527 c	862 a	215 d	

^{NS}: Non-Significant

*: Numbers with the same letters are not statistically different according to LSD ($p<0.05$)

Conclusions

Many organic or inorganic ingredients have been used to obtain growing media for vegetable production. The raw materials used vary according to their local availability in the world. Different substrates have several materials which could have direct and/or indirect effects on plant growth and development. Therefore selecting the best substrate between the various materials is imperative to plant productivity. Based on findings obtained from the study peat growing media may be advised to obtain better quality and yield for pepper cultivars.

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