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INVESTIGATIONS ON THE EFFECTS OF MEDIA AND BAG VOLUME ON CUCUMBERS

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Abstract: In the studies made in autumn and spring seasons of 1992 and 1993 in an unheated glasshouse, the following 10 media; (1) peat (Bolu-Turkey), (2) peat (Litvania), (3) perlite, (4) volcanic tuff (Kula), (5) sand, (6) rice hull, (7) rice hull + perlite (1:1 v/v), (8) volcanic tuff (Ürgüp), (9) sawdust and (10) sawdust + perlite (1:1 v/v) were tested for cucumbers. Substrates were contained in horizontal plastic bags (1 m long) designed to hold 2 plants. Bag volumes were 8, 16 and 24 litres corresponding to 4, 8 and 12 litres per plant. Complete nutrient solution given daily via drip irrigation system was used to supply water and nutrient to the plants. Peat substrates gave the best result in both seasons. In addition to peat media, perlite, tuff from Kula, sand or rice hull + perlite increased yield in spring season; whereas, sand or tuff from Ürgüp in autumn. Higher yields were obtained by using 8 and 12 litres media per plant than 4 litres. It can be concluded that 8 litre volume per plant was sufficient for both seasons.

INTRODUCTION

After the energy crisis of the 1970's, as a consequence of the high cost of steam sterilization of soil, growers turned to methyl bromide as a soil fumigant or began to practice soilless cultivation in the greenhouses. In the 1980's, owing to increasing bromine residues in plants, soil and groundwater as a result of soil disinfection with methyl bromide, soilless cultivation has gained great significance in many countries (Jensen et Collins., 1985; Benoit., 1989).

Greenhouse production is an important sector in Turkey with an acreage of 11 771 ha (Anonymous, 1993). Studies on soilless culture in Turkey have advanced during the last decade. They concentrate mainly on testing the suitability of local materials as growing medium, and performed mostly on tomatoes (Gül., 1991; Çelikel., 1994; Paksoy., 1995) and cucumber (Baþ., 1991; Özgür., 1991; Gül et Sevgican, 1992b). In soilless culture, the cost of the medium per plant is an important factor in total production cost, therefore recent researchworks target mostly the reduction of the growing medium (Hall et al., 1988; Haghuis, 1990).

MATERIALS AND METHODS

Experiments were performed in an unheated glasshouse during autumn and spring seasons of 1992 and 1993. Cucumber cultivars Alara F_1 and Rawa F_1 were used as plant material in autumn and spring, respectively. The following media were tested: (1) peat (Bolu-Turkey), (2) peat (Litvania), (3) perlite, (4) volcanic tuff (Kula), (5) sand, (6) rice hull, (7) rice hull + perlite (1:1 v/v), (8) volcanic tuff (Ürgüp), (9) sawdust and (10) sawdust + perlite (1:1 v/v). Substrates were contained in horizontal plastic bags (1 m long) designed to hold 2 plants. Bag volumes were 8, 16 and 24 liters corresponding 4, 8 and 12 liters per plant, respectively. Seedlings for all treatments were grown in 1:1 peat + perlite mixture fertilized with 1400 g triplesuperphosphate (0-44-0), 800 g potassium sulfate (0-0-50), 1200 g ammonium nitrate (26-0-0) and 1000 g magnesium sulfate (10 % Mg) per m^3 before sowing. Growing dates summarized in table 1.

Table 1. Growing dates

Growing Season	Year	Date of Sowing	Date of Planting	Harvest period First	Harvest period Last
Spring	1992	6 Feb.	25 Mar.	20 Apr.	20 Jul.
	1993	21 Jan.	18 Mar.	22 Apr.	15 Jul.
Autumn	1992	18 Aug.	3 Sep.	1 Oct.	21 Dec.
	1993	16 Aug.	31 Aug.	24 Sep.	30 Dec.

Nutrient solution given daily via drip irrigation system was used to supply water and nutrients to the plants. It was prepared according to Adamson and Maas (1981) with the following content (ppm): N 168, P 37, K 208, Ca 167, Mg 49, Fe 1.53, Mn 1.16, B 0.46, Zn 0.09, Cu 0.03, Mo 0.02. Because of high water Ca content, no calcium was added into the nutrient solution. Amount of water applied was calculated according to the solar radiation (1litre.m²day/100 cal.cm²day).

Experimental design was randomized block with 3 replicates. Each plot had 8 plants. In every growing season, plants were also grown in soil in the same greenhouse to make comparisons.

RESULTS

1-Plant growth

1.1- Spring

Peat imported from Litvania gave the highest value (428.6 cm) for plant height, followed by local peat, rice hull + perlite, sand and perlite.which increased the height more than 400 cm. Rice hull (355.7 cm) and tuff from Ürgüp (345 cm) decreased plant height. It was determined that using 4 liters medium per plant decreased plant height, but there were no significant differences between 8 and 12 liters. Interaction between the kind and the volume of medium was found to be significant. Plants were longer in peat (Litvania) and tuff (Kula) at 4 litres; in peat (Turkey), perlite and rice hull at 8 liters and in rice hull + perlite, tuff (Ürgüp) and sawdust at 12 liters. 8 and 12 liters of sand, and 4 and 12 liters of sawdust + perlite mixture gave higher values than the other volume. Mean plant height of plants grown in soil was 392.5 cm (Table 2).

Using 8 liters medium per plant was found to increase stem diameter. Plants grown in imported peat (1.17 cm), rice hull (1.16 cm) and local peat (1.15 cm) were the thickest. Tuff from Ürgüp (1.06 cm) decreased stem diameter. Mean stem diameter of plants grown in soil was determined to be 1.07 cm.

Bag volume affected the number of nodes at a statistically significant level. Bags containing 8 or 12 liters medium per plant increased the number of nodes in comparison to 4 liters. Substrates were not effective on node numbers which ranged from 44.6 to 46.5 compared to the plants grown in soil having 48.3 nodes.

1.2-Autumn

Bag volume was found to be effective on plant height, stem diameter and node number. Decreasing volume to 4 liters per plant suppressed the plant growth. The longest plants were grown in imported peat (401 cm). Rice hull + perlite, local peat and sand also increased the height, on the other hand, rice hull when used alone decreased plant height (360.1 cm). Mean value belonging to the plants grown in soil was 430.4 cm.

Stem diameter did not vary according to the medium at a statistically significant level, values obtained from soilless media ranged from 0.95 to 1.02 cm, whereas averaged to 0.94 cm in the soil.

Plants having the highest number of nodes were determined to grow in imported peat (41.8) followed by local peat (41.2) and rice hull (41.1). Sawdust decreased node number (38.9). Plants grown in soil had 44.8 nodes.

Table 2. Plant growth characteristics

	Spring			Autumn		
Media No.	Height (cm)	Diameter (cm)	Node No.	Height (cm)	Diameter (cm)	Node No.
1	418.2	1.15	46.0	387.2	0.96	41.2
2	428.6	1.17	46.5	401.0	0.99	41.8
3	402.8	1.07	46.4	374.0	1.02	40.1
4	388.5	1.12	44.7	364.3	0.96	39.8
5	403.6	1.13	45.9	383.6	0.95	40.6
6	355.7	1.16	44.9	360.1	0.95	41.1
7	406.5	1.12	45.7	394.7	0.95	40.9
8	345.3	1.06	44.6	362.7	0.95	40.3
9	379.4	1.13	45.5	374.2	0.96	38.9
10	398.2	1.14	46.0	368.2	0.98	39.4
$LSD_{0.05}$	25.9	0.07	n.s.	20.9	n.s.	1.6
Soil	392.5	1.07	48.3	430.4	0.94	44.8
Volume (l/plant)						
4	369.8	1.09	44.5	366.7	0.92	39.8
8	402.6	1.15	46.1	379.5	0.97	40.2
12	405.6	1.13	46.3	384.8	1.00	41.2
$LSD_{0.05}$	14.2	0.04	1.2	11.5	0.04	0.9
Year						
1992	418.8	1.10	47.8	381.8	0.89	39.6
1993	366.5	1.15	43.4	372.2	1.04	41.2
$LSD_{0.05}$	11.6	0.03	1.0	9.4	0.03	0.7

3-Yield

3.1-Spring

Harvest period continued for 14 and 12 weeks in 1992 and 1993, respectively. Bag volumes of 8 and 12 liters per plant gave higher yields than 4-litres medium per plant (figures 1 and 2).

The best results in terms of early and total yields were obtained by peat substrates, whereas the media containing sawdust were ranked the lowest. In plants grown in soil, cumulative yield and fruit number were 0.939, 4.837, 10.953, 16.659 and 18.613 kg/m² and 7.0, 32.8, 72.7, 107.3, 120.8 per m², respectively, in each 3-week harvest period. These results show that cumulative

yield (fruit weight and number) was higher in soilless media than in soil up to the end of the first 6 weeks, whereas yield started to decrease in sawdust at the 9th week and continued to decrease in the other soilless media till the end of the harvest period (figures 1 and 2). However, increases in cumulative fruit weight and number in imported peat which gave the highest yield were 211, 82, 25, 5, 1 % and 169, 70, 4, -1 %, respectively, in each 3-week period compared with the soil. These ratios in imported peat at 8 l/plant, which is the best combination, were 272, 102, 37, 15, 10 % and 222, 89, 31, 14, 9 %. Sawdust, which gave the lowest yield, decreased the total fruit weight and number 25 and 24 %, respectively, compared with soil.

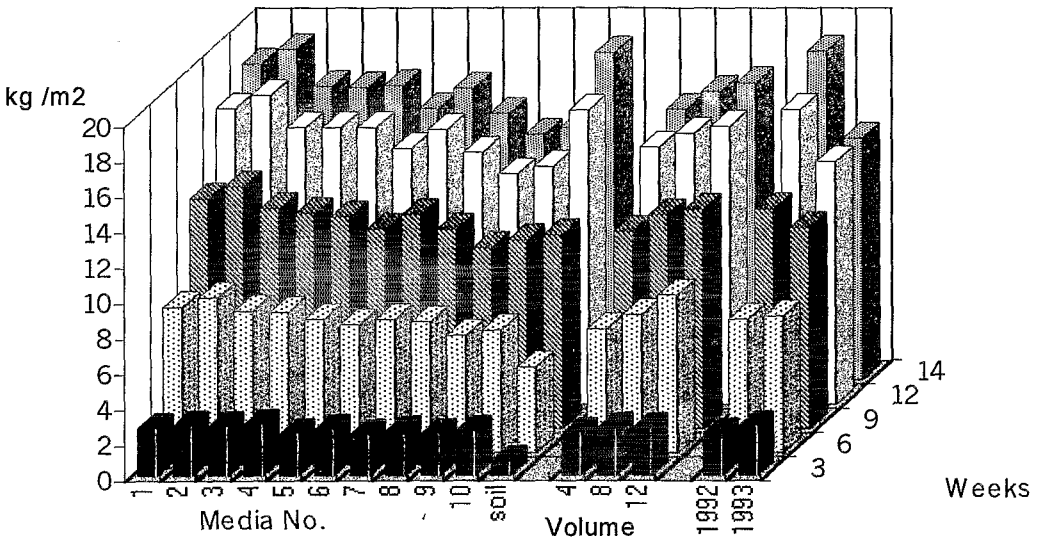

Figure 1. Cumulative fruit weight in spring

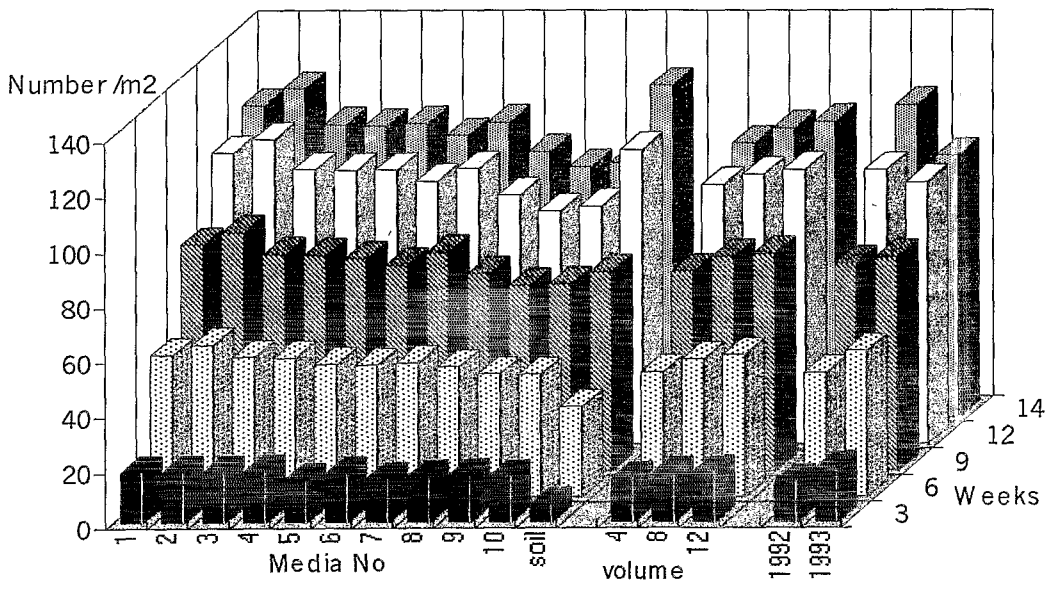

Figure 2. Cumulative fruit number in spring.

3.2-Autumn

Harvest period continued for 13 and 15 weeks in 1992 and 1993, respectively. Bag volume affected yield like in spring, using 4 liters medium per plant decreased yield (figures 3 and 4).

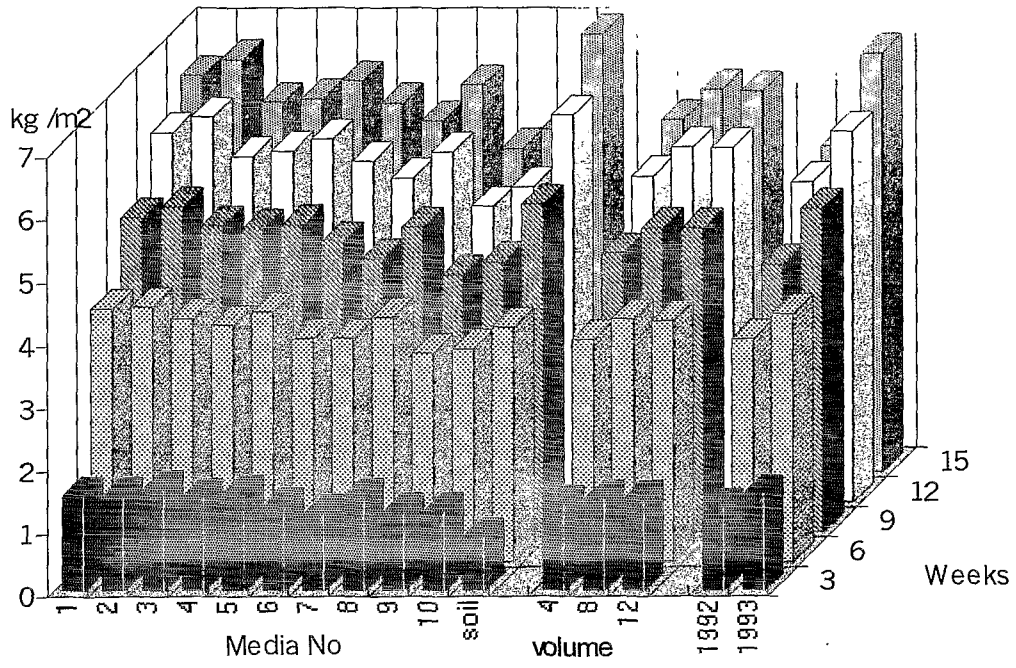

Figure 3. Cumulative fruit weight in autumn.

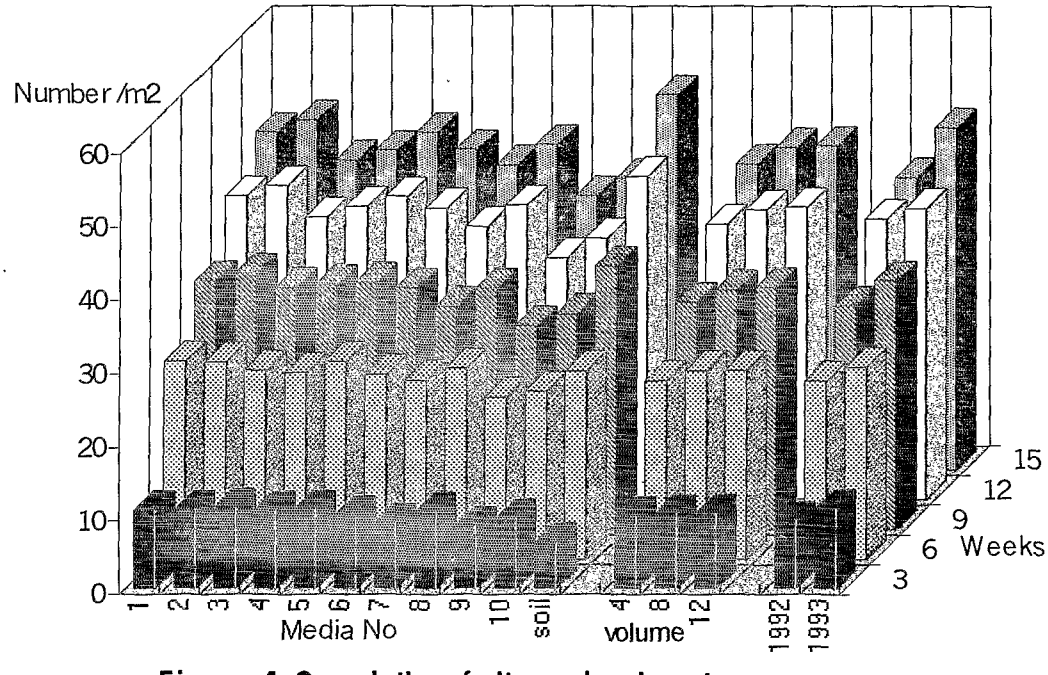

Figure 4. Cumulative fruit number in autumn.

Peat substrates, sand and tuff from Ürgüp increased fruit weight and number. Especially imported peat was the best medium from the point of cumulative yield reached at the 9th weeks of harvest and on. However, perlite and Kula tuff were among the high performing media up to the mid harvest period, yield started to decrease after 9th week in perlite, whereas total yield was decreased in Kula tuff (figures 3 and 4). Interactions between the kind and the volume of medium were found to be effective on yield. Yield increased in 4 litre sawdust + perlite; whereas peat substrates, rice hull, Ürgüp tuff and sawdust gave the highest yields at 8 litres and perlite, Kula tuff, sand and rice hull + perlite at 12 litres per plant. The best results were obtained in imported peat and rice hull at 8 litres per plant. Cumulative fruit weight and number of plants grown in soil were 0.833, 3.750, 5.217, 6.167, 6.981 kg/m^2 and 6.5, 25.7, 36.0, 44.2, 51.3 per m^2, respectively. In comparison to the results belonging to soil, increases in cumulative fruit weights and numbers in imported peat at 8 litres per plant, which was the best combination, were 79, 18, 7, 7, 1 % and 74, 12, 3, 3, -1.5 %, respectively.

DISCUSSION

Peat substrates gave the best results. Their high cation exchange capacity is an important advantage of such material (Verdonck, 1991). In addition to peat; perlite, tuff from Kula, sand, rice hull + perlite in spring and sand or tuff from Ürgüp in autumn increased plant growth and yield. Adding perlite to rice hull or sawdust gave higher yields compared with using these media alone. Verdonck (1984) reports that perlite may be useful for improving physical properties of the other substrates besides being used alone as a soilless medium. In contrast to another research made on decayed sawdust (Gül and Sevgican., 1992b), it was found that sawdust decreased the yield. This may result from the use of uncomposted sawdust. Although Adamson and Maas (1981), and Maree (1994) report that fresh sawdust could be used for soilless cucumber or tomato production, kind of tree should be taken into consideration to decide whether composting is necessary or not.

Using 8 or 12 liters medium per plant were better than 4 liters. Since there were no statistically significant differences between 8 and 12 liters, using 8 liters medium per plant is found to be suitable for both seasons.

It is found that soilless media give better results in respect to early yield compared with soil confirming the results determined in our earlier study (Gül and Sevgican, 1992b). Increases in the yield could not continue after mid harvest season similar to the results of the study on cucumber (Gül and Sevgican, 1992b) contrasted to the results obtained in tomato production (Gül & Sevgican, 1992a and 1994).

Although, the most marked effects of soilless media were observed in terms of early yield, total yield may also be increased in marginal land. In the light of the results obtained soilless media culture could be recommended for cucumber production in the non-climatized greenhouses in the Mediterranean Basin.

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