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EFFECT OF VARIOUS SUBSTRATE MIXTURES AND CONTAINER VOLUMES ON THE QUALITY OF GREENHOUSE PROPAGATED CUCUMBER, MELON AND WATERMELON TRANSPLANTS.

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ABSTRACT

The effect of six substrate mixtures 1) peat + perlite (M1), 2) Peat + Vermiculite (M2), 3) Peat + Sand (M3), 4) Peat + Perlite + vermiculite (M4), 5) Peat + Perlite + Sand (M5), and 6) Peat + vermiculite + Sand (M6) and three container volumes (100cm^3, 65cm^3 and 35cm^3) on the quality of cucumber, melon and watermelon transplants was studied through the two seasons 1999 and 2000. Results showed that M3 mixture was generally similar to, if not better than, M2 mixture for its effect on transplant growth. The two media followed by M6 significantly increased shoot height, leaf area, shoot FW and DW, root FW and DW and root length, for the three crops under investigation. The mixture M1 produced the least transplant growth. Results also showed that container with the largest volume presented the best results for all tested growth parameters. The best transplant quality in terms of shoot height, leaf area, shoot FW and DW, root length and root FW and DW was obtained with 100cm^3 containers compared with 65cm^3 and 35cm^3. Cucumber and melon transplants derived from 100cm^3 cells had 2 times and watermelon had almost 1.7 times greater shoot DW than those derived from 35cm^3 cells. In general containers of 100cm^3 in combination with M3 or M2 followed by M6 produced the best transplant growth. Transplant grown in M3 had the highest level of N in cucumber and melon, and the highest level of K, Fe, Mn in watermelon. It was also noted that the larger the container, volume, the higher the concentrations of most nutrients in cucumber, melon and watermelon transplants.

INTRODUCTION

The production of cucurbits transplants is important to establish field plantings of expensive hybrid cultivars and to improve grower's ability to meet early market demands (Ivanoff *et al.*, 1990). The use of plug trays or pots for transplant production is drawing much attention because of its advantages in shipping, handling and transplanting. In addition, containerized transplants have a media-enclosed root ball which retains moisture and root integrity at transplanting, reducing transplant shock.

Peat and peat-bast mixtures are the most widely used substrates for seedling production worldwide (Bunt, 1988). It was reported by Abou-Hadid *et al.* (1998) that cucumber seedling height, dry weight and nutrient uptake were significantly affected by substrate type, with substrate composed of peat +vermiculite +compost being the most effective than other mixtures. In other report, cucumber seedling development was faster in peatmass containing composted manure or grape marc compared with peat + vermiculite media (Inbar *et al.* 1986). Squash transplants produced in peat exhibited higher yield than those produced in perlite (Giustiniani *et al.*, 2001). Cucumber transplants with the highest fresh and dry weight, net assimilation rate and nitrogen content were recorded from peat + sand (1:1 v/v), while those from vermiculite + sand produced seedling with the highest carbohydrate content (Hellal *et al.*, 1996).

Container size can affect transplant characteristics. In cucumber, increasing cell volume from 16cm^3 to 72cm^3 increased seedling shoot and root dry weight and leaf area (Sawan *et al.*, 1998). In melon, practices that increase shoot and root dry weight, leaf area and shoot/root ratio, predisposed the transplants to recover from transplanting shock (Dufault, 1985). Larger holes in plastic trays produced better melon transplant growth, shoot and root dry weight and leaf area (D'Amore *et al.*, 1992 and Maynard *et al.*, 1996). It was shown that plugs of low volume need more frequent fertilization than larger cells (Folster, 1988). In watermelon, Liu and Latimer (1995) found no effect of cell size on root/shoot dry weight ratio, but transplant grown in large (80cm^3) cell produced the highest growth. Increasing cell volume also reduced the time to flowering (Graham *et al.*, 2000), increased transplant dry weight and yield (Hall, 1989; Marsh and Paul. 1988). Smaller cell size produced smaller and less vigorously growing transplants than those growing in larger cells (Dufault and Waters, 1985). Cell size also affected watermelon seedling survival and viene growth (Duval and NeSmith, 2000).

With the increasing demand for cucurbits transplant production under protected cultivations, the optimum transplant production system need to be determined. The objective of this study was to evaluate several substrate mixtures and container root cell volumes for their influence on cucumber, melon and watermelon transplant growth and nutrient contents.

MATERIALS AND METHODS

This study was conducted in the Greenhouse Facilities of the Experimental Farm, Faculty of Agriculture, Suez Canal University, Ismailia during the two winter seasons of 1999 and 2000.

Three crops belong to the family *Cucurbitaceae* were tested for transplant growth and development under different substrates and container volumes. These crops included cucumber (*Cucumis stativus* L. cv. Medinia F$_1$), melon, (*Cucumis melo* cv. Galia F$_1$) and watermelon (*Citrullus lanatus* cv. Giza21).

Treatments included six peat-based substrate mixtures and three container volumes in 6x3 factorial experiment. The six substrates were prepared from peatmoss (P) particle size of 0.3mm, pH 4.2; vermiculite (V) of particle size 0.75-1.0mm and pH 8.0; perlite (Pr) particle size 2-2.5mm and pH 6.7 and sand (S) of particle size 0.5mm, pH 8.2. The studied mixtures were:

1) Peatmoss + perlite (1:1 v/v).
2) Peatmoss + vermiculite (1:1 v/v).
3) Peatmoss + sand (1:1 v/v).
4) Peatmoss + perlite + vermiculite (1:1:1 v/v).

5) Peatmoss + perlite + sand (1:1:1 v/v).
6) Peatmoss + vermiculite + sand (1:1:1 v/v).

After being thoroughly mixed and watered, each mixture was covered with plastic sheet overnight. Samples were taken to determine pH, EC, in addition to water holding capacity (WHC) and bulk density (BD) according to Gardner (1986). These characters are shown in Table (1).

Table (1): Bulk density, water-holding capacity, pH and EC of the six substrate treatments.

Substrate mixture	BD (g/cm^3)	WHC (%)	pH	EC (ppm)
P+Pr (1:1 v/v)	0.17	72.6	5.2	20
P+V (1:1 v/v)	0.42	63.2	6.5	290
P+S (1:1 v/v)	0.89	10.2	5.6	70
P+Pr+V (1:1:1 v/v)	0.32	67.5	6.5	180
P+Pr +S (1:1:1 v/v)	0.64	15.3	5.8	90
P+V+S (1:1:1: v/v)	0.82	23.0	6.9	330

The container volume treatments included:
1) 30-cell plastic trays with cell volume = 100cm^2.
2) Black plastic pots (5cm diameter) each = 65cm^3.
3) 84- cell foam trays with cell volume = 35cm^3.

Trays and pots were filled with the substrate treatments and distributed on the greenhouse benches raised 100cm from the ground. On 20 Feb., 1999 and 15 Feb., 2000, seeds of cucumber, melon and watermelon were sown on all substrate mixes at a depth of 2cm, then misted. The emerged seedling were fertilized twice/week with Agrisol (19-19-19 NPK + trace elements) fertilizer. For each crop, treatments were arranged as 6 substrate x 3 container volume factorial experiment in randomized complete blocks design with 3 replications each of 21 plants.

Transplant growth measurements:

After 3 weeks from sowing cucumber and melon and 33 days for watermelon, three random samples were lifted for each crop from each substrate x cell volume combination. Roots were carefully washed with tap water then dried with kitchen paper. Transplants were separated into shoots and roots and data were recorded on leaf area (cm^2), shoot fresh weight (FW), shoot height (cm), root fresh weight, and root length (cm). After being dried in an oven for 48 hrs. at 70C°, shoot dry weight (DW) and root DW were recorded (mg) and the shoot: root DW rations (S/R) were calculated.

Nutrient elements determination:

Dried shoot tissue samples from each crop and treatment were analyzed for macro- and micro nutrient contents in the second season. Total nitrogen was determined using micro-Kjeldahl method (Page, 1982). Phosphorus was determined colorimetrically as described by John (1970), potassium by flame photometer (Pipper, 1950) and calcium as described by Johanson and Ulrich (1959). The micronutrients Fe, Mn, Zn and Cu were determined using Perkin-Elmer Model 3300 Atomic Absorption Spectrometer as outlined by Raw (1973).

The obtained data were subjected to the analysis of variance procedure using SAS computer programme (SAS Institute, 1982) and separation of means according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1- Effect of substrate and container volume on cucumber transplant:

1- a Effect on transplant growth:

Results of cucumber transplant growth during the two seasons are presented in Table (2) for main effects and Table (3) for the interactions. Significant differences among the 6 substrate mixtures were obtained for most growth parameters. Transplants grown on a mixture of P+S or P+V produced the highest leaf area, shoot height and shoot FW. The highest shoot DW was detected from P+S. substrate composed of P+V+S followed by P+V or P+S significantly produced the highest root length, while P+V produced the highest root FW and DW. The shoot: root DW ratios were the same for transplants grown on all substrates, except P+Pr which was significantly the less for S/R ratio in both seasons. Shoot DW was mostly affected by substrate type. The increase in shoot DW by P+S was 1.8 times in 1999 and 4.8 times in 2000 compared to P+Pr.

The obtained results generally indicated that the traditional P+V mix for cucumber transplants was similar in effect to P+S mix in increasing seedling leaf area, and height, shoot DW and root length. In fact, P+S outperformed all other media for shoot DW, and FW indicating the beneficial effect of sand as a good substitution for vermiculite or as a complementary material with P+V for better root development. In accordance with our results, Hellal *et al.* (1996) obtained the highest quality in cucumber seedlings using P+S (1:1 v/v) as substrate. They also obtained seedling with the highest carbohydrate with V+S mixture. A mixture of pine bark and sand was also better than Pr+V for shoot growth in *Salvia* (Knowles *et al.*, 1993). The addition of sawdust (Sawan *et al.*, 1998), or compost (Abou-Hadid *et al.*, 1998) and Inbar *et al.* (1986) to P+V media were more effective for better cucumber transplant growth than P+V alone. Although its high water content (Table 1), the P+Pr mix was exposed to dryness faster than any other mixture which may explain the less performance of seedling grown in this medium. This observation agree with the finding of Heiskanen (1995) who found that the higher the water content of the growth medium, the higher the evaporation was from the container. Perlite was also less effective on squash transplant growth (Giustiniani *et al.*, 2001).

Table 2. Main effects of substrate and container volume on cucumber transplant growth during 1999 and 2000 seasons.

*Substrate	Vol. (cm^3)	Leaf area (cm^2)	Shoot			Root			S/R ratio
			Height (cm)	FW (g)	DW (mg)	Length (cm)	FW (g)	DW (mg)	
(1999 season)									
P + Pr		42.1	6.37	1.27	115.24	11.03	0.93	82.66	1.39
P + V		73.1	9.39	1.83	158.71	15.06	1.16	76.69	2.07
P + S		71.8	8.11	1.88	214.72	14.23	1.51	96.47	2.23
P + Pr + V		50.2	7.98	1.42	166.91	12.60	0.93	59.23	2.82
P + Pr + S		52.8	6.18	1.37	161.62	13.89	1.10	62.01	2.60
P + V + S		59.1	7.73	1.51	167.62	17.72	1.19	57.17	2.93
LSD (0.05)		12.42	2.59	0.37	34.84	4.38	0.35	25.96	1.03
	100	72.5	8.97	1.89	205.49	16.64	1.57	108.78	1.88
	65	53.5	6.95	1.42	131.58	14.87	0.96	61.43	2.14
	35	48.6	6.95	1.33	155.34	10.76	0.88	46.91	3.31
LSD (0.05)		11.10	1.27	0.31	28.28	3.53	0.42	28.62	0.91
(2000 season)									
P + Pr		36.9	1.84	0.64	65.17	10.16	0.92	23.67	2.77
P + V		66.3	4.31	1.41	316.56	18.78	1.43	58.54	5.40
P + S		63.3	4.11	1.31	283.81	16.33	1.66	56.12	5.05
P + Pr + V		52.6	3.26	1.08	213.50	15.17	1.29	35.24	6.06
P + Pr + S		45.6	3.33	1.11	148.87	15.61	1.27	37.19	4.00
P + V + S		64.5	3.89	1.42	239.92	17.22	1.58	57.84	4.15
LSD (0.05)		9.4	0.87	0.20	55.76	4.50	0.39	12.64	1.37
	100	77.5	4.15	1.66	281.87	21.00	2.12	57.00	4.94
	65	51.5	3.03	0.96	222.08	14.19	1.14	43.79	5.07
	35	39.2	3.18	0.90	129.96	11.44	0.80	33.52	3.90
LSD (0.05)		16.22	0.53	0.39	30.35	2.82	0.19	10.20	NS

*** P = peatmoss, Pr = perlite, V = vermiculite, S = sand.**

Regarding the effect of container volume, the use of 100cm^3 cell tray significantly produced higher leaf area, shoot height, shoot FW and DW than 65cm^3 or 35cm^3 cells (Table 2). Root length, root FW and DW were also higher in 100cm^3 than 65cm^3 or 35cm^3 cells. However, the later two cell volumes did not significantly differ for shoot and root parameter tested. On the other hand, shoot: root DW ratio was significantly less in larger container than the smaller one in 1999 but not in 2000. The increase in transplant growth by large cell size agrees with the results of Sawan *et al.* (1998) on cucumber and NeSmith (1993) on squash. The reduced growth and quality of transplant grown in small cell sizes was attributed to the effect of light intensity on the microclimate inside the canopy (Yoshida *et al.*, 1992). In addition, low volume container may need more frequent fertilization than larger one (Folster, 1998).

The effect of substrate x container volume interaction was significant for all transplant growth parameters (Table 3). The highest leaf area, shoot height and FW in cucumber transplants were obtained in 100 cm^3 cell size amended with P+S or P+V, followed by P+V+S mixture. Transplant grown on P+S in 100cm^3 cell container had the highest shoot DW, root DW and FW in 1999. Roots grown on P+V+S followed by P+V or P+S in 100cm^3 were significantly longer than those grown in other media mixtures with smaller volumes in 1999. A reduction in shoot: root DW ratio was noticed for large cell volumes, irrespective of substrate component in 1999, but this trend was not the same in 2000. The highest S/R ratios were recorded in transplants derived from P+Pr+V or P +Pr+S in 35cm^3 cell which were not significantly different than those on P+V+S or P+V in 35cm^3 cell during 1999. In the second season (2000), all growth parameters were significantly the highest in 100cm^3 container amended with P+V, P+S or P+V+S (Table 3).

1-b Effect on nutrient contents:

Substrate, container volume and their interactions significantly affected the nutrient levels in cucumber shoots as shown in Table (4). Shoots derived from a mixture of P+S had significantly the highest N, P and Zn levels, and those on P+V+S had the highest K. Transplants obtained from P+V had significantly more Ca, Fe and Mn, while those from P+Pr+S had the highest Cu. The difference among the three container volumes were significant for all nutrients in the order 100cm^3 > 65cm^3 > 35cm^3. When larger cells were compared with the smaller ones, the increase in N level was 50%, while the increases in Fe and Cu were 57% and 70%, respectively. All substrate x container volume interaction were significant (Table 4). The highest N level was obtained in transplant derived from P+S in 100cm^3 cell. The same combination, in addition to P+V+S in 100cm^3 cell produced the highest P level. Plants in 100cm^3 cell amended with P+V+S had higher K, and those in 65cm^3 cells amended with P+V had the highest Ca. The combination of P+Pr+S in 100 or 65cm^3 cell, in addition to P+V+S in 100cm^3 had higher Cu concentration than the other combinations. Previous works by Hellal *et al.* (1996) and Abou-Hadid *et al.* (1998) proved the effect of substrate composition on the nutrient content of cucumber transplants. Nutrient content of transplants may affects growth and yield in the field. Therefore, substrate and container types that improve the nutrient levels in the transplants will be reflected in their yield.

Table 3. Effects of substrate x container volume interactions on cucumber transplant growth during 1999 and 2000.

Substrate	Vol. (cm^3)	Leaf area (cm^2)	Shoot Height (cm)	Shoot FW (g)	Shoot DW (mg)	Root Length (cm)	Root FW (g)	Root DW (mg)	S/R ratio
(1999 season)									
P + Pr	100	43.2	7.77	1.40	133.00	11.83	1.30	122.80	1.10
	65	42.8	5.83	1.40	105.67	12.66	1.00	89.63	1.19
	35	40.3	5.50	1.00	107.07	8.60	0.50	35.63	3.00
P + V	100	94.2	10.33	2.10	183.57	17.50	1.57	112.40	1.63
	65	68.7	9.43	1.77	139.17	13.89	1.00	70.03	1.98
	35	56.5	8.40	1.63	153.40	13.77	0.90	47.63	3.22
P + S	100	98.5	10.87	2.60	317.27	16.90	2.18	146.27	2.16
	65	65.3	5.23	1.43	141.20	15.83	1.17	62.50	2.25
	35	60.3	8.23	1.60	185.70	9.96	1.20	80.63	2.30
P + Pr + V	100	58.7	9.27	1.67	160.43	14.17	1.20	76.70	2.10
	65	48.20	8.50	1.30	122.00	13.50	0.83	49.00	2.48
	35	43.70	6.17	1.30	218.30	10.13	0.77	52.00	4.20
P + Pr + S	100	64.20	6.17	1.63	212.77	16.13	1.60	98.43	2.16
	65	52.0	6.37	1.30	144.67	16.57	0.93	57.83	2.50
	35	42.20	6.00	1.17	127.43	8.97	0.77	29.77	4.27
P + V + S	100	76.20	9.43	1.93	225.93	23.33	1.57	96.10	2.35
	65	52.80	6.33	1.33	136.77	16.73	0.83	39.60	3.46
	35	48.40	7.43	1.27	140.17	13.10	1.17	35.80	3.90
LSD (0.05)		23.2	3.27	0.60	56.27	6.50	0.60	38.48	1.38
(2000 season)									
P + Pr	100	42.3	2.07	0.70	59.50	12.67	1.10	26.23	2.28
	65	36.4	1.83	0.66	77.07	10.33	1.12	23.97	3.19
	35	32.2	1.63	0.56	58.93	7.50	0.55	20.83	2.84
P + V	100	104.6	5.17	2.0	393.67	24.83	2.47	85.73	4.59
	65	52.6	3.60	1.30	324.33	17.50	0.90	53.37	6.10
	35	42.7	4.10	0.93	231.67	14.00	0.97	36.53	6.34
P + S	100	98.8	5.17	2.00	471.00	22.17	2.80	73.57	6.39
	65	52.2	4.10	1.10	257.67	15.83	1.17	53.07	4.85
	35	38.8	3.00	0.83	122.77	11.00	1.00	41.73	2.94
P + Pr + V	100	58.2	3.83	1.43	267.33	19.00	1.87	45.50	5.87
	65	36.0	2.77	0.87	254.67	14.67	1.23	36.23	7.03
	35	36.7	3.17	0.93	118.50	11.83	0.77	24.00	4.90
P + Pr + S	100	64.3	4.00	1.60	230.37	19.83	1.83	45.60	5.05
	65	34.8	2.67	0.83	173.50	11.33	1.20	41.79	4.15
	35	36.5	3.33	0.87	42.73	15.67	0.77	24.00	1.78
P + V + S	100	96.6	4.67	1.97	269.40	27.50	2.73	65.40	4.21
	65	48.7	3.17	1.00	245.27	15.50	1.23	54.10	4.53
	35	48.3	3.83	1.30	205.10	8.67	0.77	54.03	3.79
LSD (0.05)		26.19	1.02	0.43	78.75	8.11	0.60	26.50	2.88

Table 4: Effects of substrates and container volumes on nutrient contents of cucumber transplants (2000).

Substrate	Vol. (cm^3)	Macronutrients (%)				Micronutrients (ppm)			
		N	P	K	Ca	Fe	Mn	Zn	Cu
P+Pr		1.37	0.64	1.213	1.26	345	50.6	119.6	10.6
P+V		1.49	0.77	1.416	1.61	745	54.6	95.6	6.0
P+S		2.34	0.79	1.323	1.54	602	43.0	127.0	8.6
P+Pr+V		1.28	0.77	1.370	1.38	739	50.3	97.6	8.6
P+Pr+S		1.46	0.70	1.376	1.33	602	47.6	99.6	14.6
P+V+S		1.49	0.77	1.546	1.51	568	43.0	89.6	13.0
LSD (0.05)		0.06	NS	0.013	0.02	25.92	1.45	4.4	1.1
	100	1.93	0.787	1.445	1.55	722	52.3	141.8	12.3
	65	1.51	0.727	1.400	1.50	621	48.3	98.6	11.5
	35	1.28	0.700	1.283	1.26	457	44.0	90.6	7.0
LSD (0.05)		0.04	0.02	0.025	0.02	17.41	1.10	4.8	2.16
P+Pr	100	1.50	0.76	1.23	1.37	330	52	161	10
	65	1.37	0.60	1.23	1.20	465	52	105	12
	35	1.25	0.56	1.21	1.15	237	48	93	10
P+V	100	2.03	0.78	1.51	1.43	890	63	98	10
	65	1.34	0.76	1.41	1.83	714	51	101	4
	35	1.11	0.76	1.33	1.57	630	50	88	4
P+S	100	2.62	0.84	1.37	1.66	660	42	271	8
	65	2.47	0.78	1.33	1.48	658	46	114	12
	35	1.93	0.74	1.27	1.48	484	41	96	6
P+Pr+V	100	1.43	0.78	1.52	1.60	827	54	102	10
	65	1.26	0.78	1.35	1.33	727	48	97	10
	35	1.15	0.72	1.24	1.21	663	49	94	6
P+Pr+S	100	1.89	0.74	1.42	1.52	817	53	109	18
	65	1.34	0.68	1.48	1.69	603	50	93	18
	35	1.15	0.68	1.23	0.79	335	40	97	8
P+V+S	100	2.09	0.80	1.62	1.72	804	50	110	18
	65	1.29	0.76	1.60	1.42	555	43	83	13
	35	1.10	0.74	1.42	1.38	342	36	76	8
LSD(0.05)		0.10	0.05	0.02	0.04	27.1	4.0	5.4	1.8

2- Effect of substrate and container volume on melon transplants

2-a Effect on transplant growth

Substrate mixture, container volume and their interactions significantly affected most growth parameters of melon transplants in both seasons (Tables 5 and 6). Considering the main effect of substrates, melon seedling grown on a mixture of P+V and P+S in 1999 or P+S in 2000 had the highest leaf area. Shoot height was significantly higher with P+S and P+V+S during 2000. The same substrates, in addition to P+V or P+Pr+V during 1999 had the best effect on shoot high without significant differences among them. The highest shoot FW was obtained from transplant grown on P+V or P+S in 1999 and P+V followed by P+V+S and P+V in 2000. Shoot DW was the highest with P+S followed by P+V and P+V+S in both seasons.

Table 5. Main effects of substrate and container volume on melon transplant growth during 1999 and 2000 seasons.

Substrate	Vol. (cm^3)	Leaf area (cm^2)	Shoot			Root			S/R Ratio
			Height (cm)	FW (g)	DW (mg)	Length (cm)	FW (g)	DW (mg)	
(1999 season)									
P + Pr		32.4	4.62	1.23	80.50	10.56	0.41	23.71	3.40
P + V		48.7	6.59	1.54	122.06	12.06	0.52	56.88	2.14
P + S		50.6	6.39	1.53	138.23	12.89	0.48	60.47	2.29
P + Pr + V		40.3	6.49	1.37	104.63	12.94	0.38	40.49	2.58
P + Pr + S		39.9	5.98	1.22	101.22	11.00	0.36	44.26	2.29
P + V + S		42.3	6.98	1.33	128.74	13.17	0.46	43.78	2.94
LSD (0.05)		6.60	0.56	0.20	17.50	2.28	0.10	8.40	0.71
	100	57.2	7.01	1.81	147.47	15.16	0.56	57.55	2.56
	65	37.8	5.58	1.17	98.62	11.86	0.42	41.46	2.38
	35	32.2	5.94	1.14	94.48	9.29	0.32	35.78	2.64
LSD (0.05)		2.64	0.49	0.08	15.90	2.42	0.05	5.00	NS
(2000 season)									
P + Pr		20.3	1.89	0.58	159.66	7.67	0.56	36.67	4.29
P + V		37.4	3.00	1.05	268.21	13.17	1.03	75.37	3.55
P + S		51.3	3.56	1.46	350.13	20.28	0.88	89.31	3.92
P + Pr + V		34.6	2.83	0.99	243.36	17.17	0.80	58.51	4.15
P + Pr + S		34.6	2.39	0.72	185.79	12.00	0.74	46.78	3.97
P + V + S		36.3	3.67	1.01	316.04	18.11	1.10	73.20	4.31
LSD (0.05)		10.73	0.56	0.29	32.13	6.01	0.33	12.88	NS
	100	48.1	3.33	1.56	396.20	18.44	1.26	88.79	4.20
	65	28.0	2.64	0.76	219.20	14.06	0.73	55.57	3.51
	35	27.6	2.69	0.78	146.33	11.70	0.56	44.55	3.18
LSD (0.05)		7.22	0.45	0.22	26.60	2.98	0.15	9.40	0.76

Table 6. Effects of substrate x container volume interaction on melon transplant growth during 1999 and 2000.

Substrate	Vol. (cm^3)	Leaf area (cm^2)	Shoot Height (cm)	Shoot FW (g)	Shoot DW (mg)	Root Length (cm)	Root FW (g)	Root DW (mg)	S/R Ratio
(1999 season)									
P + Pr	100	42.8	5.33	1.60	94.40	13.50	0.53	24.30	3.88
	65	30.6	3.67	0.97	85.43	10.50	0.43	27.37	3.15
	35	23.8	4.87	1.13	76.67	7.67	0.27	19.47	3.94
P + V	100	72.2	6.77	2.13	150.00	13.33	0.70	62.60	2.39
	65	39.6	5.67	1.20	106.83	11.67	0.43	58.57	1.82
	35	34.3	7.33	1.30	111.57	11.17	0.43	49.47	2.37
P + S	100	67.0	8.17	2.07	192.10	15.17	0.53	78.03	2.47
	65	49.5	5.83	1.50	129.13	15.83	0.53	61.13	2.11
	35	34.5	5.17	1.03	93.47	7.67	0.37	42.23	2.30
P + Pr + V	100	54.3	7.40	1.80	128.10	14.83	0.60	56.20	2.25
	65	32.3	5.57	0.97	97.33	10.33	0.30	32.63	3.08
	35	34.4	6.50	1.33	88.47	13.67	0.23	32.63	3.05
P + Pr + S	100	48.6	6.33	1.47	131.10	15.93	0.40	62.37	2.12
	65	38.6	6.00	1.20	88.00	8.83	0.33	33.87	2.64
	35	32.4	5.60	1.00	84.57	8.23	0.33	36.53	2.51
P + V + S	100	58.2	8.03	1.77	189.10	18.17	0.60	51.80	2.93
	65	36.2	6.73	1.17	84.97	14.00	0.47	35.17	2.43
	35	32.6	6.17	1.07	112.17	7.33	0.30	34.37	3.26
LSD (0.05)		13.50	0.99	0.41	27.41	4.97	0.16	16.35	0.93
(2000 season)									
P + Pr	100	24.5	2.00	0.67	214.97	13.00	0.63	42.77	5.02
	65	18.4	1.83	0.53	149.40	6.17	0.63	36.20	4.12
	35	18.0	1.83	0.53	116.77	3.83	0.43	31.03	3.76
P + V	100	53.4	3.67	1.57	446.33	16.67	1.53	137.00	3.26
	65	30.3	2.67	0.85	216.93	10.67	0.83	50.80	4.30
	35	28.6	2.67	0.73	141.37	12.17	0.73	38.30	3.59
P + S	100	76.2	3.67	2.17	641.40	22.33	1.67	146.30	4.36
	65	33.3	3.33	0.93	237.17	20.83	0.63	60.77	3.90
	35	44.5	3.67	1.27	171.83	17.67	0.33	60.87	2.83
P + Pr + V	100	51.5	3.33	1.47	393.40	22.67	1.07	74.40	5.28
	65	24.4	2.67	0.67	188.57	15.67	0.70	61.70	3.05
	35	28.0	2.50	0.83	148.10	13.17	0.63	39.43	3.75
P + Pr + S	100	30.6	2.83	0.80	189.00	15.17	0.97	41.67	4.53
	65	26.0	2.33	0.73	211.53	12.83	0.67	50.17	4.21
	35	22.0	2.00	0.63	156.83	8.00	0.60	48.50	3.23
P + V + S	100	52.5	4.50	1.50	492.13	20.83	1.77	96.63	5.10
	65	32.0	3.00	0.83	311.67	18.17	0.93	73.80	4.22
	35	24.4	3.50	0.70	144.33	15.33	0.60	49.17	2.93
LSD (0.05)		16.46	0.73	0.47	73.82	7.75	0.44	14.09	0.87

Root length was best with the three mixtures P+V, P+S or P+Pr+V. The highest root FW was achieved from P+V and P+S in both seasons, in addition to P+V+S in 2000 where the difference among them was not significant. Root DW followed similar response to media type as root FW in 1999 while in 2000, P+Pr+V mixture was comparable to P+S and P+V+S. In general, transplant grown on P+Pr had significantly the least growth. The shoot: root DW ratio was the highest on P+Pr and the least on P+V mixtures in 1999, while the difference among substrates was not significant for S/R in

2000 (Table 5). The obtained results indicated that most growth parameters of melon transplants grown on a mixtures of P+S were generally similar to, if not better than those grown on P+V. These results showed that melon transplant growth had the same response to media type as cucumber. The mixture of P+S followed by P+V was also superior over other substrates as reported by Hellal *et al.* (1996).

The influences of container volume were significant for all growth parameters during the two seasons (Table 5). Melon transplants grown in 100cm^3 cells had significantly higher leaf area, shoot height, shoot FW and DW, root length and root FW and DW than those grown in 35cm^3 cells. The differences between 65cm^3 and 35cm^3 containers were not significant for shoot height, leaf area and shoot FW, in both seasons. Based on the average of two seasons, the largest (100cm^3) container increased leaf area, shoot FW, shoot DW, root DW and root FW by 75%, 79%, 100%, 100% and 80%, respectively as compared with the smallest (35cm^3) container. The advantages of large container sizes may be related to increased physiological maturity, and reduced root binding in these container, both characters may enhance the early establishment of plants in the field (Weston, 1988; Weston and Zandstra, 1988; and Dufault, 1986). The increase in melon transplant growth by large cell size went parallel with the results of D'Amore *et al.* (1992) and Maynard (1996).

The interactions of substrate x volumes for all growth parameters in melon transplants were significant in both seasons (Table 6). The highest leaf area and root FW were obtained in 100cm^3 cell amended with P+V or P+S. The combination of 100cm^3 cell filled with P+V or P+V+S also produced the highest shoot height and DW in both seasons. The previous combination, in addition to P+ Pr + S in 100cm^3 cell (1999) or P + Pr + V in 100cm^3 cell (2000) produced the longest roots. The highest root DW was obtained in a mixture of P+S in 100cm^3 cell (1999) followed by P+V in 100cm^3 cell (2000). The combination of P+Pr in 35cm^3 cell was generally the least effective in melon transplant growth. Due to the least dry weight obtained by P+Pr, this mixture in 100cm^3 cell produced transplants with the highest shoot: root ratio.

2-b Effect on nutrient contents.

Substrate, container volume and their interaction significantly affected the levels of nutrients in melon transplants (Table 7). Shoots from transplants grown on P+S substrate had the highest N, while those on P+V+S had the highest P, Ca, Fe and Mn. A medium of P+V produced plants with the highest K. Zinc level was the highest in shoots from both P+Pr+S and P+V+S, while those grown on P+Pr or P+Pr+V had more Cu than all other mixtures.

Transplants grown in larger cell volumes had significantly greater contents of nutrients than the smaller ones (Table 5). The differences between 100cm^3 and 35cm^3 cells were significant for all nutrients. However, the differences between 65cm^3 and 35cm^3 were not significant for K and Cu. Nitrogen was mostly affected by cell size. Melon transplants in 100cm^3 cells had 62% more N than those in 35cm^3 cells.

Table 7: Effects of substrate and container volume on nutrient contents of melon transplants (2000).

Substrate	Vol. (cm^3)	Macronutrients (%)				Micronutrients (ppm)			
		N	P	K	Ca	Fe	Mn	Zn	Cu
P+Pr		0.79	0.64	1.21	1.30	388	42.0	85.0	14.3
P+V		1.18	0.76	1.38	1.69	368	41.0	83.3	10.0
P+S		1.82	0.66	1.21	1.83	436	41.6	75.0	10.0
P+Pr+V		1.39	0.70	1.20	1.78	399	44.0	84.0	12.6
P+Pr+S		1.20	0.77	1.18	1.56	342	40.3	96.3	8.6
P+V+S		1.10	0.82	1.16	1.90	531	50.0	95.3	8.6
LSD (0.05)		0.10	0.03	0.02	0.04	16.0	2.9	2.3	1.8
	100	1.58	0.79	1.33	1.84	487	47.1	97.0	13.3
	65	1.19	0.73	1.16	1.71	414	42.3	84.8	9.6
	35	0.97	0.67	1.18	1.47	365	40.0	79.5	9.2
LSD (0.05)		0.17	0.02	0.012	0.03	17.6	1.0	2.7	1.7
P+Pr	100	0.97	0.76	1.32	1.54	471	45	89	15
	65	0.92	0.66	1.18	1.37	432	41	84	14
	35	0.49	0.52	1.14	0.99	312	40	82	14
P+V	100	1.46	0.80	1.48	1.82	460	43	100	14
	65	1.10	0.80	1.38	1.71	327	41	81	8
	35	0.97	0.68	1.32	1.54	318	39	69	8
P+S	100	2.21	0.70	1.33	1.95	516	46	79	12
	65	1.75	0.66	1.12	1.74	310	40	75	10
	35	1.49	0.62	1.20	1.81	337	39	71	8
P+Pr+V	100	2.04	0. 80	1.26	1.90	477	47	83	17
	65	1.20	0.66	1.20	1.76	405	44	90	10
	35	0.94	0.60	1.15	1.69	315	41	79	11
P+Pr+S	100	1.55	0.78	1.26	1.84	393	45	128	12
	65	1.14	0.76	1.09	1.66	261	36	84	8
	35	0.92	0.78	1.19	1.18	372	40	77	6
P+V+S	100	1.24	0.88	1.37	2.09	670	57	103	10
	65	1.04	0.84	1.04	1.99	600	52	95	8
	35	1.03	0.84	1.08	1.62	322	41	88	8
LSD(0.05)		0.19	0.04	0.034	0.05	27.9	4.5	4.7	5.0

The interactions of substrate x volume were also significant for all nutrients tested. The combination of P+S substrate in 100cm^3 cell produced the highest N level, while plants in 100cm^3 cell amended with P+V+S had the highest P, Ca, Fe and Mn. The combination of P+V in 100cm^3 cell produced plants with the highest K. Plants in 100cm^3 cell with P+Pr+S had higher Zn, while those on P+Pr or P+Pr+V in 100cm^3 cells had the highest Cu.

3- Effect of substrate and container volume on watermelon transplant.

3-a Effect on transplant growth

Substrate mixtures significantly affected all growth parameters of watermelon transplants except root DW, in both seasons (Table 8). Substrate composed of P+V, P+S or P+V+S produced transplants with the highest leaf area and shoot FW in both seasons. Shoot height was significantly the least with P+Pr substrate, while P+S, P+V and P+V+S increased it over the other substrates. Shoot DW was also increased using P+V or P+S in 1999, in addition to P+V+S in 2000. Root length was increased by P+V or P+V+S mixtures during 1999, but their effect was not significantly different with other mixtures. However, P+S was the best substrate to increase root length during 2000. The highest root FW was obtained with P+V followed by P+S in 1999 which were similar to P+V+S in 2000. The shoot: root DW ratio increased on P+V+S in addition to P+Pr+V in 1999 or P+S and P+Pr+S in 2000.

Table 8. Main effects of substrate and container volume on watermelon transplant growth during 1999 and 2000 seasons.

Substrate	Vol. (cm^3)	Leaf area (cm^2)	Shoot Height (cm)	Shoot FW (g)	Shoot DW (mg)	Root Length (cm)	Root FW (g)	Root DW (mg)	S/R ratio
(1999 season)									
P + Pr		41.6	10.51	1.60	103.78	13.17	0.79	25.66	4.04
P + V		62.3	12.39	2.34	168.89	13.79	1.19	71.66	2.35
P + S		58.4	13.19	1.90	220.44	15.26	0.98	56.56	4.10
P + Pr + V		46.7	12.80	0.87	163.22	13.30	0.83	20.44	5.36
P + Pr + S		43.0	10.67	1.73	126.00	11.67	0.74	33.66	3.74
P + V + S		60.0	11.67	2.26	206.67	14.39	0.81	45.89	4.5
LSD (0.05)		13.64	1.81	0.42	39.06	4.71	0.23	NS	1.02
	100	57.4	13.34	2.13	205.22	16.16	1.11	51.27	4.00
	65	47.8	12.01	1.78	159.39	13.28	0.86	50.55	3.15
	35	37.8	10.28	1.43	129.89	11.35	0.70	34.61	3.75
LSD (0.05)		10.20	2.40	0.41	43.40	2.01	0.08	19.19	NS
(2000 season)									
P + Pr		27.7	7.33	1.08	107.51	14.17	0.38	42.42	2.55
P + V		52.4	10.28	1.91	257.68	14.33	0.80	67.76	3.71
P + S		52.9	8.26	1.93	243.88	16.61	0.64	53.38	4.57
P + Pr + V		34.1	7.83	1.26	185.88	12.83	0.54	54.52	3.55
P + Pr + S		34.5	7.78	1.34	186.33	13.33	0.49	36.50	5.12
P + V + S		45.6	9.00	1.70	288.00	13.28	0.74	44.70	6.50
LSD (0.05)			2.53	0.17	84.33	2.85	0.18	NS	1.42
	100	52.2	9.72	1.93	292.77	15.83	1.03	64.11	4.31
	65	32.6	8.32	1.39	232.36	14.64	0.50	46.12	5.04
	35	33.6	7.19	1.32	167.00	11.97	0.70	39.41	4.51
LSD (0.05)			1.57	0.19	33.44	1.65	0.19	22.13	NS

In general, the obtained results indicated that watermelon transplants grown on P+S followed by P+V or P+V+S had superior growth over all other tested substrates. Shoot dry weight was the most affected parameter by substrate type. In both seasons, P+S produced transplants with more than two times greater shoot DW than those grown on P+Pr. The same trend was also true for root DW, but only in 1999. Although root length was not so much affected by media types, the increase in root DW by P+S over P+Pr would suggest the production of more dense and branched roots, and more partitioning of dry matter into roots by P+S. The previous results indicated that the response of watermelon transplants to the tested substrate mixtures was similar to the response of both cucumber and melon transplants. Thus, the discussion provided for the later crops would be valid for the former one.

All watermelon growth parameter were significantly affected by container volume (Table 8) except shoot: root DW ratio, in both seasons. In general, watermelon transplants grown in 100 cm^3 cells had greater leaf area, shoot height, shoot FW and DW than those grown in 35cm^3 cells. Root growth, including root length, root FW and DW were greater in the largest container. However, the differences between 100cm^3 and 65cm^3 cell sizes were not significant for leaf area, shoot height, shoot FW (1999), root length (2000) and root DW. Larger cells increased leaf area, shoot FW and DW by 50% and root DW by 60% compared to the smaller cells.

The increase in growth of watermelon transplants by raising them in large container was in agreement with the findings of Duval and NeSmith (2000), Graham *et al.* (2000), Liu and Latimer (1995), Hall (1989), Marsh and Paul (1988) and Dufault and Waters (1985).

The general lack of response to shoot: root DW ratio to cell volume is consistent with the results of Nesmith (1993). It was suggested by Liu and Latimer (1995) that the negative effect of root restriction on transplant growth may be related to the altered synthesis and transport of root-produced hormones. They noted that ABA level in root and xylum exudate of watermelon seedlings grown in 18-20cm^3 cells were consistently higher than those in larger cell volumes.

The interactions of substrate x container volume were significant for all watermelon transplant growth characters (Table 9). In 100cm^3 contain, the mixtures P + S, P+V or P+V+S were significantly the best combinations to produce transplants with greater leaf area, height, shoot FW and DW. A mixture of P+V or P+S in 100cm^3 cell (1999) and P+V or P+V+S in 100cm^3 cell (2000) significantly produced the highest root FW.

Root DW was the highest using P+V in any of the 3 volumes tested, in addition to P+S in 100cm^3 during 1999. The highest shoot: root DW ratios were obtained with the combination of P+Pr+V in any cell size or P+Pr+S in 35cm^3 cell (1999) and P+S in 65cm^3 cell or P+V+S in 35cm^3 cell (2000).

Table 9. Effects of substrate x container volume interactions on watermelon transplant growth during 1999 and 2000.

Substrate	Vol. (cm^3)	Leaf area (cm^2)	Shoot			Root			S/R Ratio
			Height (cm)	FW (g)	DW (mg)	Length (cm)	FW (g)	DW (mg)	
(1999) season									
P + Pr	100	48.4	12.33	1.90	126.00	17.71	0.87	21.33	6.09
	65	38.4	10.20	1.47	113.00	10.83	0.70	25.67	5.17
	35	37.6	9.00	1.43	72.33	11.50	0.80	24.00	2.87
P + V	100	72.6	13.17	2.60	199.33	14.83	1.60	116.00	2.53
	65	58.3	12.67	2.30	156.00	14.00	1.17	108.33	2.19
	35	56.1	11.33	2.13	151.33	12.53	0.80	24.67	6.54
P + S	100	70.2	14.47	2.60	274.33	17.60	1.40	71.67	3.84
	65	62.60	14.17	2.33	226.33	17.60	0.77	62.00	3.95
	35	42.40	11.00	0.77	160.67	10.67	0.77	36.00	4.50
P + Pr + V	100	52.1	14.07	1.00	179.33	16.33	0.93	26.33	6.89
	65	49.2	13.00	0.87	160.67	12.17	0.87	22.00	8.03
	35	38.80	11.33	0.73	149.67	11.40	0.70	11.51	8.23
P + Pr + S	100	48.30	13.00	2.00	151.67	13.83	0.83	38.00	4.14
	65	45.20	10.33	1.87	140.67	12.00	0.93	33.67	4.21
	35	35.60	8.67	1.33	85.67	9.17	0.47	9.33	9.01
P + V + S	100	72.80	13.00	2.70	300.67	17.17	1.03	47.33	6.35
	65	52.60	11.67	1.87	159.67	13.17	0.73	59.67	5.47
	35	56.60	10.33	2.20	159.67	12.83	0.67	30.67	5.31
LSD (0.05)		19.80	3.07	0.61	51.55	7.20	0.23	51.50	1.83
(2000 season)									
P + Pr	100	30.2	7.67	1.27	120.13	15.50	0.50	46.20	2.60
	65	26.3	8.00	0.90	94.70	15.50	0.30	44.20	2.14
	35	26.8	6.33	1.07	107.73	12.00	0.33	36.87	2.92
P + V	100	78.2	12.00	2.77	380.43	14.67	0.93	94.33	4.03
	65	42.3	10.00	1.53	240.93	14.67	0.80	59.87	4.00
	35	36.8	8.83	1.43	155.67	13.67	0.67	49.07	3.09
P + S	100	67.6	9.33	2.53	415.33	18.50	0.73	73.07	5.68
	65	48.6	7.63	1.70	291.87	16.67	0.63	49.73	6.86
	35	42.5	7.83	1.57	174.43	14.67	0.57	37.33	4.67
P + Pr + V	100	36.3	9.00	1.27	215.00	15.33	0.50	75.10	2.86
	65	35.6	7.83	1.30	182.47	13.17	0.60	40.17	4.50
	35	30.4	6.67	1.20	160.17	10.00	0.53	48.30	3.31
P + Pr + S	100	28.2	8.67	1.03	230.13	16.33	0.40	48.17	4.77
	65	42.8	9.00	1.77	195.83	15.00	0.60	33.70	5.81
	35	32.4	5.67	1.23	133.03	8.67	0.47	27.63	4.81
P + V + S	100	72.8	11.67	2.73	295.60	14.67	1.03	47.80	6.18
	65	30.8	7.50	1.13	293.33	12.33	0.50	49.07	5.96
	35	32.6	7.83	1.23	275.00	12.83	0.70	37.33	7.58
LSD (0.05)			4.41	0.48	118.26	6.96	0.45	NS	1.78

3-b Effect on nutrient contents

Nutrient concentration in the shoots of watermelon transplants was markedly affected by substrate mixtures, container volumes, and their interactions (Table 10).

The transplants grown in a mixture of P+V had significantly more N, while those on P+S had more K, Fe and Mn than the other substrates. Transplant derived from P+Pr+V had the highest Ca, while those on P+Pr+S had the highest P. The highest Fe and Zn were recorded in shoots from P+V+S. The same media, in addition to P+Pr+S had shoots with greater Cu than the other mixtures.

The differences among container volumes were significant for all nutrients. Transplants in larger cells ($100cm^3$) had greater contents of all nutrients than those grown in $65cm^3$ or $35cm^3$ cells. The combination of

100cm^3 cell amended with P+V had produced plants with the highest N level, while those derived from 100cm^3 cell amended with P+V+S had the highest K, Ca, Mn and Cu. Plants obtained from P+Pr in 35cm^3 cells had generally the least macronutrients and Fe contents.

Table 10: Effects of substrate and container volume on nutrient contents of watermelon transplants (2000).

Substrate	Vol. (cm^3)	Macronutrients (%)				Micronutrients (ppm)			
		N	P	K	Ca	Fe	Mn	Zn	Cu
P+Pr		1.22	0.77	0.996	1.78	386	56.6	122.6	10.6
P+V		2.31	0.75	1.060	1.54	464	56.6	92.0	10.0
P+S		1.48	0.80	1.120	1.97	503	59.0	113.3	9.3
P+Pr+V		1.37	0.88	0.993	2.14	471	56.6	100.0	7.3
P+Pr+S		1.33	0.92	1.030	1.94	400	58.6	95.0	12.0
P+V+S		1.44	0.82	1.093	1.74	550	56.3	151.0	11.3
LSD (0.05)		0.01	0.016	0.01	0.03	14.0	2.6	3.0	1.10
	100	1.73	0.91	1.115	1.89	535	63.5	128.8	12.3
	65	1.55	0.82	1.058	1.86	450	53.5	115.0	10.6
	35	1.30	0.79	0.980	1.49	402	55.0	93.2	7.33
LSD (0.05)		0.7	0.012	0.01	0.03	13.0	1.4	2.9	1.48
P+Pr	100	1.28	0.84	1.02	1.68	456	61	163	12
	65	1.24	0.76	1.09	1.63	363	49	102	10
	35	1.15	0.72	0.88	1.20	340	60	103	10
P+V	100	2.98	0.76	1.14	1.83	564	58	101	12
	65	2.38	0.74	1.10	1.73	486	58	88	10
	35	1.58	0.76	0.95	1.69	460	54	87	8
P+S	100	1.69	0.92	1.20	1.89	471	70	112	14
	65	1.49	0.77	1.10	1.72	463	56	124	10
	35	1.28	0.76	1.08	1.72	458	51	104	4
P+Pr+V	100	1.47	0.90	1.08	1.80	528	61	116	8
	65	1.40	0.90	0.93	1.68	466	52	99	8
	35	1.25	0.86	0.97	1.63	420	57	85	6
P+Pr+S	100	1.58	0.98	1.05	1.86	441	71	93	14
	65	1.25	0.90	1.03	1.79	397	54	95	12
	35	1.17	0.90	1.01	1.64	361	51	92	10
P+V+S	100	1.37	0.86	1.20	1.84	754	60	183	14
	65	1.56	0.86	1.10	1.86	523	52	182	14
	35	1.40	0.74	0.98	1.79	372	57	88	6
LSD(0.05)		0.15	0.03	0.01	0.05	7.0	4.6	4.8	1.8

In conclusion, the use of perlite as complementary substrate in cucurbits transplants is not justified for being the less effective in transplant quality when mixed with peatmoss. Perlite is also the most expensive component in any mixture. However, mixing sand with peat (1:1 v/v) or peat + vermiculite was shown to be comparable to, if not better than the control mixture (P+V) in producing transplants of better growth and nutrient content.

The cost per liter mixture was estimated to be 18.3, 12.3 and 12.6 (PT) for P+V, P+S and P+V+S mixtures, respectively. Therefore, the less costly P+S or P+V+S mixtures would be recommended. The study also revealed that plants in 100cm^3 cells outperformed those in 65cm^3 or 35cm^3 one. The number of cells per 1.0m^2 of the greenhouse bench were found to be 250, 380 and 350 cells for 100, 65 and 35cm^3 cell trays respectively. Therefore, the propagation bench will hold more plants when using 65 or 35cm^3 cells. In addition, the estimated costs of M+V media per 1.0m^2 bench were LE 4.58, 4.27 and 2.24 for 100cm^3, 65cm^3 and 35cm^3 cells, respectively compared was LE 3.07, 3.04 and 1.51 for 100cm^3, 65cm^3 and 35cm^3 cells when amended with P+S mixture. For economic reason, one would recommend the use of $35cm^3$ containers amended with P+S. However, larger container volume may be justified if the economic advantage of greater yield outweights added propagation cost associated with larger container volume, a subject that needs further studies.

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تأثير مخاليط متنوعة من البيئة وحجم الأوعية على جودة شتلات الخيار والقاوون والبطيخ المتكاثرة بالصوب.

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تم دراسة تأثير ستة مخاليط من البيئة وهى (١) بيت موس + برليت، (٢) بيت موس + فرمكيوليت، (٣) بيت موس + رمل، (٤) بيت موس + برليت + فرمكيوليت، (٥) بيت موس + برليت + رمل، (٦) بيت موس + فرمكيوليت + رمل وكذلك ثلاثة أحجام من أوعية النمو (١٠٠سم^٣، ٦٥سم^٣، ٣٥سم^٣) وذلك على جودة شتلات الخيار والقاوون والبطيخ خلال موسمى ١٩٩٩ و ٢٠٠٠. أظهرت النتائج أن مخلوط البيت موس مع الرمل كان بصفة عامة متساوياً مع - إن لم يكن أفضل من - مخلوط البيت موس مع الفرمكيوليت وذلك فى التأثير على نمو الشتلات. وقد أحدث كلا المخلوطين يليهما خليط البيت موس + فرمكيوليت + رمل زيادة معنوية فى ارتفاع الشتلة والمساحة الورقية والوزن الجاف والطازج للمجموع الخضرى والوزن الجاف والطازج للجذور وكذلك طول الجذور فى شتلات المحاصيل الثلاثة المختبرة. وكانت الشتلات الناتجة من مخلوط البيت موس مع البرليت الأقل فى النمو. كما بينت الدراسة أن الأوعية ذات الحجم الأكبر أعطت أحسن النتائج لجميع صفات النمو المختبرة حيث زادت جودة الشتلات من حيث الطول والمساحة الورقية والوزن الطازج والجاف للمجموع الخضرى والجذرى وطول الجذور باستخدام الأوعية ذات الحجم ١٠٠سم^٣ مقارنة بتلك ٦٥سم^٣ أو ٣٥ سم^٣. وكان الوزن الجاف للمجموع الخضرى أكبر بمقدار الضعف فى شتلات الخيار والقاوون وبمقدار ١,٧ مرة فى شتلات البطيخ الناتجة من الأوعية الكبيرة مقارنة بالأوعية الأصغر حجماً (٣٥سم^٣). وبصفة عامة فقد كانت أعلى الشتلات نمواً تلك الناتجة من الأوعية ذات الحجم ١٠٠سم^٣ المحتوية على مخلوط البيت موس والرمل أو البيت موس والفرمكيوليت يليها المحتوية على البيت موس مع الرمل مع الفرمكيوليت بنسب متساوية. وأظهر تحليل العناصر احتواء شتلات الخيار والقاوون الناتجة من بيئة البيت موس + الرمل على أعلى مستوى من النيتروجين وشتلات البطيخ على أعلى مستوى من البوتاسيوم والحديد والمنجنيز. ووضح أنه كلما زاد حجم أوعية النمو زادت تركيزات أغلب العناصر فى شتلات الخيار والقاوون والبطيخ.