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EFFECT OF PLANTING SYSTEM AND VERTICAL TRAINING ON GROWTH AND YIELD OF CUCUMBER PLANTS GROWN IN THE OPEN FIELD DURING THE SUMMER SEASON

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ABSTRACT

This work was carried out at Gharbia Governorate during the summer seasons of 1996 & 1997 to study the effect of planting system and vertical training on vegetative growth, flowering and fruit yield of cucumber plants cv. Amera II hybrid grown in the open field. Treatments included staked (vertically trained) or regular ground creeping planting, single or double rows planting and 15, 20 or 30 cm within row plant spacing. Plant population of these treatments ranged from 18, 648 to 55, 986 plants/fed.

The results indicated that vertically trained planting increased stem length and leaf area of the fifth leaf from the growing tip as well as its fresh and dry weight compared to the regular creeping planting. Vertically trained plants had higher content of nitrogen and potassium compared to ground creeping plants, while no significant differences in phosphorus were found among all treatments.

Decreasing plant population and also vertical training system increased the number of pistillate flowers and decreased the staminate ones. Concerning fruit yield, both treatments of vertical training with 34, 986 plants/fed. and that of creeping planting with 55, 986 plants/fed. had nearly equal values where they had the highest early and total yield per fed., with less weight of non marketable fruits in the former treatment and higher weight in the later one. The highest fruit yield per plant was produced from the vertical planting with the lowest plant population, while the lowest one was produced from the creeping planting with the highest plant population.

INTRODUCTION

The summer planting represents the main season for cucumber production in Egypt.

The heavy foliage cover formed by the vining habit of the fresh market cucumber restricts light and air penetration through the lower leaves, hence, reduces the photosynthetic activity and provides humid conditions favorable for fungi and fruit rot organisms which are spread in cucumber cultivation. Heavy foliage may also lessen the efficiency of applying foliar fertilization and pesticides.

Under the common method of growing plants (creeping planting), the cucumber canopy may be efficient in sunlight absorption if plants are positioned properly. On the other hand, vertical training or staking of cucumber plants seems to be a feasible cultural technique to overcome the aforementioned problems (in common culture). It has been reported that vertical training of cucumber can improve fruit yield and quality (Baker, 1977 and Hanna and Adams, 1987 & 1993). Moreover, Konsler and Strider (1973) found that the trellising enhanced the disease control of foliage and fruits, and simplified harvesting as fewer fruits were overlooked into oversize or cull

fruits. Consequently, trellised plants may remain more healthy and productive for a longer period.

In Egypt, staking (vertical training) is commonly used under plastic. However, it has not been applied to the outdoor summer production; and limited information are available for the best methods of application and the proper planting system to be used.

So, the main objective of this study was to investigate the effect of planting system and vertical training on growth, flowering and fruit yield of cucumber plants grown in the open field during the summer season under Gharbia governorate conditions.

MATERIALS AND METHODS

Two field trials were carried out in a private farm in Santa District, Gharbia Governorate during the summer seasons of 1996 & 1997 on cucumber plants cv. Amera II (a monoecious, highly female hybrid produced by Petoseed Co.).

This work was conducted to study the effect of planting system and vertical training on growth, flowering and fruit yield of cucumber plants grown in the open field. Treatments included vertically trained or regular creeping planting, single row (on 1.2 m ridge) or double rows (on 1.2 or 1.5 m ridges) planting and some plant spacings within the row (15, 20 or 30 cm).

Cucumber seeds were sown on March 22nd in the first season and March 17th in the second one. The regular agricultural practices (soil fertilization, irrigation and disease control, *etc*.) took place whenever necessary as usually done by local growers.

The experiment included 10 treatments which were a combination of different planting system and training, consequently, different plant population per feddan as illustrated in Table 1. Treatment 1 served as control.

The design used in this experiment was complete randomized blocks with four replications. Plot area was 36 m^2 for all treatments, i.e. five ridges (1.2 m wide x 6 m. long) for treatments 1 to 6 and four ridges (1.5 m wide x 6 m. long) for treatments 7 to 10.

A method for raising plants up wires (vertical training) was applied. Iron stakes, two meters long were fixed in the soil, six meters apart along of each row; wires were stretched over stakes, running parallel and directly over the row. A soft and strong twine was looped around the base of each plant by one of its two sides and the other was tied to the wire. Plants were directed around the twine until they reached the wires. Plants were raised up to the wires in one side of the ridge in treatments 3 & 6, and in both sides in treatment 4, 5, 7 & 8.

Vertically-trained plants were pruned as vegetative and flower buds were removed from the basal nodes to the height of 30 cm, then lateral shoots were raised at two leaves and both the main stem and side shoots were left to climb to the overhead wire as was recommended by Abo El-Nasr (1995). On the other hand, grown plants with the regular creeping planting were left without any pruning.

Table (1): Planting system, training and plant populations per feddan.

No.	Treatments		Plant population per feddan
	***Single row**:		
1-	120 x 30 cm	- regular creeping planting (control)	23,310
2-	120 x 20 cm	- regular creeping planting.	34,986
3-	120 x 15 cm	- one plant/hill (creeping planting) and the other (vertical training)	46,662
	****Double rows**:		
4-	50 + 70 x 30 cm	- vertically trained planting	23,310
5-	50 + 70 x 20 cm	- vertically trained planting	34,986
6-	50 + 70 x 30 cm	- one row/ridge (creeping planting) and the other (vertical training)	34,986
7-	50 + 100 x 30 cm	- vertically trained planting	18,648
8-	50 + 100 x 20 cm	- vertically trained planting	27,972
9-	50 + 100 x 30 cm	- regular creeping planting	37,296
10-	50 +100 x 20 cm	- regular creeping planting	55,986

*** Single row: 120 cm is the width of the ridge, while 30, 20 or 15 is the spacing between hills within the row.**

**** Double rows: 50 + 70 or 50+ 100 cm, i.e. 120 or 150 cm presents the width of the ridge where 50 is the distance between two adjacent rows of two consequent ridges; 70 or 100 cm is the spacing between rows in the same ridge, while 30 or 20 cm is the spacing between hills within the row.**

\- Two plants per hill were assigned to treatments of regular creeping planting and one plant per hill to those of vertically trained planting, except the case in treatment no. 3 as the two plants per hill, each was grown in a different planting type.

Sixty days after planting, vegetative growth parameters were determined on samples of ten plants randomly taken from each plot, and the following data were recorded: stem length (cm), number of leaves and lateral branches per plant and fresh and dry weight and area of the fifth leaf from the growing tip. Dry matter samples of the fifth leaf (dried at 70^{o}C) were finely ground and wet digested; and the total N, P and K were determined in the digestion product. Nitrogen was determined using the Micro-kjeldahl method (Piper, 1947). Phosphorus was estimated colorimetrically, using a spectrophotometer at 725 μm (King, 1951). Potassium was determined using a flame photometer (Jackson, 1967).

Data on flowering and fruiting were also taken on random samples. The total number of opened staminate or pistillate flowers per plant was counted. Pistillate/staminate flowers ratio was calculated. Fruit set % was also calculated.

At harvest, early and total fruit yield (as marketable and non-marketable) was calculated. Fruits of about 12-15 cm in length having a regular shape were classified as marketable fruits, and the diseased and malformed fruits as non-marketable. Early yield was determined from the first 5 pickings (as fruits were harvested at two days-intervals). Also fruit yield per plant was determined as weight and number.

Fruit quality parameters were determined 75 days after planting. They included total soluble solids (T.S.S.) and fruit dry weight percentage. T.S.S. was determined in fruit juice by a hand refractometer (Cox and Pearson, 1962).

Data were tested by analysis of variance (Little and Hills, 1972). Duncan's multiple range test was used for the comparisons among treatment means (Duncan, 1965).

RESULTS AND DISCUSSION

A. Vegetative growth:

Data in Table (2) show that vertically trained plants (Tr. 4, 5, 7 & 8) were, mostly, taller than those of regular creeping planting (horizontally grown plants) in both seasons. The shortest stems were obtained from the creeping planting having the highest plant population (Tr. 10). The highest number of leaves and branches were obtained from the regular creeping planting having the lowest plant population (Tr., 1- control), while those plants grown under higher population conditions (Tr. 3 & 10) had the lowest numbers in both years. Data on the fifth leaf from the growing tip (area and fresh and dry weight) show that the plants grown in double rows and vertically trained (Tr. 4, 5, 7 & 8) surpassed all the others. On the other hand, the lowest values were obtained from those plants horizontally grown at the highest plant population (Tr. 10) in both seasons.

These results agree with the early work indicating that vertical training of cucumber plants improve vegetative growth in terms of stem length (Dowedar, 1968 and Al-Harbi *et al.,* 1996) and leaf area (Al-Harbi *et al.,* 1996). Such response was expected since the vertical system provides better means for light needed for the photosynthetic activities of the leaves and improves air penetration through the foliage, and that would limit disease problems. Also, plant population affects the vegetative growth of plants through the competition phenomena for nutrients, light and other plant growth requirements. Such relationship was indicated earlier by some investigators (El-Habbasha, 1962; El-Aidy and Moustafa, 1977; Omran and El-Bakry, 1978 and Cook *et al.,* 1991).

Concerning the chemical analysis of the leaf, data in Table (3) show that planting system and training had significant effects on leaf content of nitrogen and potassium in both seasons. Treatments in which plants were grown in double rows with vertical training (Tr. 4, 5, 7 & 8) had, mostly, higher content of nitrogen and potassium than those of creeping planting treatments (1, 2, 9 & 10). On the other hand, leaf content of phosphorus was not significantly affected by all treatments. Similar conclusions were earlier reported by several researchers about the relationship between the planting system, training and plant population, and the nutritional status of the plants (O'Sullivan, 1980; El-Waraky, 1988 and Hanna and Adams, 1991).

B. Flowering and fruiting:

Data in Table (4) indicate that the production of high number of staminate flowers per plant resulted, mostly, from the treatments having high plant population regardless of planting system. Thus, the treatments having 55, 986 and 46, 662 plants/fed. (Tr. 10 & 3, respectively) had the highest values, while the treatment having 18, 648 plants/fed. (Tr. 7) had the lowest number of staminate flowers in both seasons. On the other hand, the higher number of pistillate flowers resulted from the plants grown in double rows and vertically trained at low or intermediate plant population (Tr. 4, 5 & 7) compared with the other treatments, while the treatments having the highest plant population (Tr. 3 & 10) produced the lowest pistillate flowers in both seasons. Pistillate/staminate flowers ratio was significantly affected by planting system and plant population. The treatment having the least plant population and vertically trained (Tr. 7) had the highest records compared to the other treatments. On the other hand, regular creeping planting at the highest plant population (Tr. 10) had the lowest records in both seasons. Percentage fruit set was significantly affected by planting system, training and plant population, and showed similar response as that of pistillate/staminate flowers ratio. Thus, it is obvious that planting system, training and plant population are effective in controlling flowering and fruiting. These conclusions are in agreement with those previously reported by some investigators on cucumber plants (El-Habbasha, 1962; El-Aidy and Moustafa, 1977; El-Zawily and Moustafa, 1980 and Al-Harbi *et al.,* 1996).

C. Fruit yield:

Data in Tables (5 & 6) indicate that significant differences were observed in fruit yield per feddan in both seasons. The highest early marketable fruit yield was produced from the double row planting with vertical training at intermediate plant population (34, 986 plants/fed.), while the lowest values resulted from the vertical training having the lowest plant population (18, 648 plants/fed.) in both seasons. Meantime, the creeping planting at the highest plant population (55, 986 plants/fed.) had the highest weight of the non-marketable fruits.

Concerning the total marketable fruit yield per feddan, the double rows planting with vertical training at plant population of 34, 986 plants/fed. had the highest yield followed by the creeping planting at the highest plant population (55, 986 plants/fed.), while the creeping planting at plant population of 23, 310 plants/fed. (control) had the lowest value in both seasons. As for the non-marketable fruits, creeping planting at intermediate plant population (Tr. 2) had the highest values while the vertical planting at the least plant population (Tr. 7) had the lowest values in both seasons.

Data, also show that the higher number and weight of fruits per plant were produced by plants grown in double rows with vertical training at the lowest plant population (Tr. 7), while the creeping planting at the highest plant population had the lowest values in both seasons.

Concerning some fruit characteristics, data show that planting system, training and plant population had no significant effect on total soluble solids and dry weight percentage of fruits in both seasons.

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It could be concluded from the data of this study that both planting type (creeping or vertical) and plant population are responsible for the production of early and total fruit yield per unit area and yield per plant. Increasing plant population increased early and total fruit yield per unit area, but decreased fruit yield per plant. On the other hand, vertical training increased vegetative growth, number of pistillate flowers per plant and percentage fruit set, hence, increased fruit yield per plant (number and weight). Thus, the beneficial effects of vertical training might compensate the unfavorable effects of heavy plant population on fruit production per plant. Similar conclusions were reported by several researchers on cucumber (El-Aidy and Moustafa, 1977; Hanna and Adams, 1987; El-Waraky, 1988 and El-Aidy, 1988; Al-Bahash and Jawad, 1991; Cook *et al.,* 1991; Russo *et al.,* 1991; Wann, 1993; Al-Harbi *et al.,* 1996 and Schultheis *et al.*, 1998) and on other cucurbites (Damarany and Farag, 1994; Reiners and Riggs, 1997; Botwright *et al.,* 1998 and Maynard and Scott, 1998).

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تأثير نظام الزراعة والتربية الرأسية على النمو والمحصول الثمرى لنباتات الخيار النامية فى الحقل المكشوف فى الموسم الصيفى

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- أجرى هذا البحث فى محافظة الغربية خلال الموسم الصيفى لعامى 1996 ، و 1997وذلك لدراسة تأثير نظام الزراعة والتربية الرأسية على النمو الخضرى ، والأزهار ، والمحصول الثمرى لنباتات الخيار ـ صنف هجين أميرة 2 فى الحقل المكشوف. وقد اشتملت المعاملات على نظامى التربية الرأسية للنباتات أو النمو بالوضع العادى (النباتات زاحفة) ، الزراعة على ريشة واحدة أو على ريشتين ، مع استخدام مسافات زراعة متغيره (15 أو 20 أو 30سم). وقد تراوحت الكثافة النباتية لهذه المعاملات ما بين 648 18 ، 986 55 نبات/فدان.
- أوضحت النتائج أن التربية الرأسية للنباتات قد زادت من طول النبات والمساحة الورقية للورقة الخامسة (من قمة النبات) ، إضافة إلى الوزن الطازج والجاف لهذه الورقة وذلك بالمقارنة مع النباتات النامية بالوضع العادى.
- احتوت أوراق النباتات المربـاة رأسيا علـى محتوى أعلـى من كل من النيتروجين والبوتاسيوم مقارنـة بالنباتات النامية بالوضع العادى ، بينما لم توجد فروق معنوية فى حالة الفسفور.
- أدت كل من الكثافة النباتية المنخفضة ونظام التربية الرأسية إلى حدوث زيادة فى عدد الأزهار المؤنثة ، ونقص فى عدد الأزهار المذكرة ـ وفيما يتعلق بالمحصول فقد تضمنت كل من المعاملتين (التربية الرأسية مع كثافة نباتية 986 34 نبات/فدان ، والنباتات النامية بالوضع العادى مع كثافة نباتية 986 55 نبات/فدان) قيما متقاربة وأنتجتا أعلى محصول مبكر وكلى/فدان ، مع وجود قدر أقل من الثمار غير القابلة للتسويق فى المعاملة الأولى وقدر أكبر فى المعاملة الثانية.
- تم الحصول على أعلى محصول/نبات من النباتات المرباة رأسيا مع أقل كثافة نباتية للفدان ، بينما نتج أقل محصول من النباتات النامية بالوضع العادى مع أكبر كثافة نباتية.

Table (2): Effect of planting system and training on vegetative growth parameters of cucumber plants[@] (1996 & 1997 seasons).

No.	Treatments	Plant population per feddan	Stem length (cm)	No. of Leaves/ plant	No. of branches/ plant	Area of 5th leaf (cm)	Fresh wt. of 5th leaf (g)	Dry wt. of 5th leaf (g)
	***Single row:**							
1-	120 x 30 cm - regular creeping planting (control)	23,310	83.3 cde	24.5 a	5.13 a	96.0 cd	3.14 bc	0.46 bcd
2-	120 x 20 cm - regular creeping planting.	34,986	79.0 ef	23.8 ab	4.38 b	91.2 d	3.31 bc	0.48 bc
3-	120 x 15 cm - one plant/hill (creeping planting) and the other (vertical training)	46,662	79.5 def	18.5 de	2.53 d	91.4 d	3.02 c	0.43 cd
	****Double rows:**							
4-	50 + 70 x 30 cm - vertically trained planting	23,310	90.0 ab	21.3 c	4.28 b	108.8 a	4.02 a	0.57 a
5-	50 + 70 x 20 cm - vertically trained planting	34,986	88.5 abc	20.8 cd	3.88 bc	103.2 abc	3.86 a	0.57 a
6-	50 + 70 x 30 cm - one row/ridge (creeping planting) and the other (vertical training)	34,986	79.5 def	22.3 abc	4.25 b	97.2 bcd	3.28 bc	0.48 bc
7-	50 + 100 x 30 cm - vertically trained planting	18,648	93.8 a	22.5 abc	4.35 b	107.2 a	3.75 ab	0.52 ab
8-	50 + 100 x 20 cm - vertically trained planting	27,972	89.0 abc	22.0 bc	3.35 c	104.1 ab	3.59 ab	0.52 ab
9-	50 + 100 x 30 cm - regular creeping planting	37,296	85.8 bc	20.3 cde	3.55 c	96.7 bcd	3.21 bc	0.44 cd
10-	50 +100 x 20 cm - regular creeping planting	55,986	75.9 f	18.0 e	2.65 d	90.2 d	2.88 c	0.39 d
F-test			**	**	**	**	**	**
	***Single row:**							
1-	120 x 30 cm - regular creeping planting (control)	23,310	82.0 e	27.8 a	5.18 a	96.2 bcd	2.88 bc	0.45 bc
2-	120 x 20 cm - regular creeping planting.	34,986	85.5 de	25.8 ab	4.45 bc	90.7 de	2.71 bcd	0.43 cd
3-	120 x 15 cm - one plant/hill (creeping planting) and the other (vertical training)	46,662	88.3 cde	19.3 c	2.80 f	92.7 cde	2.80 bcd	0.45 bc
	****Double rows:**							
4-	50 + 70 x 30 cm - vertically trained planting	23,310	95.5 ab	22.8 b	4.85 ab	105.0 a	3.32 a	0.54 a
5-	50 + 70 x 20 cm - vertically trained planting	34,986	99.0 a	20.3 bc	4.50 bc	101.9 ab	2.97 b	0.49 b
6-	50 + 70 x 30 cm - one row/ridge (creeping planting) and the other (vertical training)	34,986	90.8 bcd	22.8 b	4.63 bc	98.2 abc	2.99 b	0.49 b
7-	50 + 100 x 30 cm - vertically trained planti	18,648	96.3 ab	22.3 b	4.08 cd	101.9 ab	2.89 bc	0.45 bc
8-	50 + 100 x 20 cm - vertically trained planting	27,972	93.8 abc	21.3 bc	3.85 d	101.0 ab	2.83 bc	0.45 bc
9-	50 + 100 x 30 cm - regular creeping planting	37,296	84.8 de	21.8 bc	3.63 de	91.3 cde	2.56 cd	0.43 cd
10-	50 +100 x 20 cm - regular creeping planting	55,986	83.0 e	21.0 bc	3.13 ef	87.7 e	2.47 d	0.38 d
F-test			**	**	**	**	*	**

[@]All measurements were taken 60 days after planting.
**** and * indicate P < 0.01 and P < 0.05 according to F. test.**
Means having the same alphabetical letters within each column are not significantly different at the 0.05 level according to Duncan's test.

Table (3): Effect of planting system and training on leaf content of N, P and K in cucumber plants@ (1996 & 1997 seasons).

No.	Treatments	Plant population per feddan	Total N, P and K (as % of dry weight)					
			1996			1997		
			N	P	K	N	P	K
	***Single row:**							
1-	120 x 30 cm - regular creeping planting (control)	23,310	3.78 bc	0.49	4.43 ab	3.80 cde	0.33	4.31 a-d
2-	120 x 20 cm - regular creeping planting.	34,986	3.91 bc	0.45	4.21 bc	3.65 de	0.48	4.15 bcd
3-	120 x 15 cm - one plant/hill (creeping planting) and the other (vertical training)	46,662	3.40 c	0.37	4.01 c	3.53 e	0.33	3.98 d
	****Double rows:**							
4-	50 + 70 x 30 cm - vertically trained planting	23,310	4.16 ab	0.35	4.34 ab	4.54 a	0.42	4.50 a
5-	50 + 70 x 20 cm - vertically trained planting	34,986	4.03 ab	0.43	4.20 bc	4.16 abc	0.39	4.43 abc
6-	50 + 70 x 30 cm - one row/ridge (creeping planting) and the other (vertical training)	34,986	4.28 ab	0.46	4.35 ab	4.41 ab	0.38	4.29 a-d
7-	50 + 100 x 30 cm - vertically trained planting	18,648	4.54 a	0.39	4.53 a	4.41 ab	0.33	4.54 a
8-	50 + 100 x 20 cm - vertically trained planting	27,972	4.03 ab	0.43	4.38 ab	4.03 bcd	0.36	4.29 a-d
9-	50 + 100 x 30 cm - regular creeping planting	37,296	3.90 bc	0.41	4.20 bc	3.65 de	0.33	4.09 cd
10-	50 +100 x 20 cm - regular creeping planting	55,986	3.78 bc	0.39	4.21 bc	3.78 cde	0.35	4.05 cd
F-test			*	N.S	*	**	N.S	*

@ Chemical determinations were conducted 60 days after planting, on the fifth leaf from the grown tip.

****, * and N.S. indicate P < 0.01, P < 0.05 and not significant, respectively, according to F. test.**

Means having the same alphabetical letters within each column are not significantly different at the 0.05 level according to Duncan's test.

Table (4): Effect of planting system and training on flowering and fruit set of cucumber plants (1996 & 1997 seasons).

No.	Treatments		Plant population per feddan	No. of staminate flowers/ plant	No. of pistillate flowers/ plant	Pistillate/ staminate flowers ratio	Fruit set %	No. of staminate flowers/ plant	No. of pistillate flowers/ plant	Pistillate/ staminate flowers ratio	Fruit set %
				1996				1997			
	***Single row**:										
1-	120 x 30 cm	- regular creeping planting (control)	23,310	1.90 c	21.7 c	11.4 e	38.2 d	1.93 b	22.9 c	11.8 d	37.4 e
2-	120 x 20 cm	- regular creeping planting.	34,986	1.93 c	21.7 c	11.2 e	36.0 f	1.98 b	22.3 d	11.3 d	37.2 e
3-	120 x 15 cm	- one plant/hill (creeping planting) and the other (vertical training)	46,662	2.03 ab	19.5 e	9.6 g	37.1 e	2.08 a	20.4 e	9.8 f	38.8 d
	****Double rows**:										
4-	50 + 70 x 30 cm	- vertically trained planting	23,310	1.68 e	23.4 a	13.9 b	43.1 b	1.70 d	23.6 b	13.8 b	44.2 b
5-	50 + 70 x 20 cm	- vertically trained planting	34,986	1.80 d	22.9 ab	12.7 c	41.6 c	1.83 c	23.2 bc	12.7 c	44.6 b
6-	50 + 70 x 30 cm	- one row/ridge (creeping planting) and the other (vertical training)	34,986	1.90 c	22.3 bc	11.7 de	38.6 d	1.95 b	22.2 d	11.4 d	40.1 c
7-	50 + 100 x 30 cm	- vertically trained planting	18,648	1.45 f	23.3 a	16.1 a	45.1 a	1.50 e	26.1 a	17.4 a	46.9 a
8-	50 + 100 x 20 cm	- vertically trained planting	27,972	1.78 d	21.8 c	12.3 cd	43.6 b	1.80 c	22.3 d	12.4 c	46.6 a
9-	50 + 100 x 30 cm	- regular creeping planting	37,296	1.98 bc	20.3 d	10.3 f	36.0 f	1.98 b	20.7 e	10.5 e	33.3 f
10-	50 +100 x 20 cm	- regular creeping planting	55,986	2.10 a	18.9 e	9.0 g	33.4 g	2.10 a	20.3 e	9.7 f	32.2 g
F-test				**	*	**	**	*	**	**	**

**** and * indicate P < 0.01 and P < 0.05 according to F. test.**

Means having the same alphabetical letters within each column are not significantly different at the 0.05 level according to Duncan's test.

Table (5): Effect of planting system and training on fruit yield and quality of cucumber plants (1996 season).

No.	Treatments		Plant population per feddan	Early fruit yield/fed. @ (ton)			Total fruit yield/fed. (ton)			Fruit yield/plant		T.S.S.# (%)	Fruit dry weight# (%)
				Market-able	Non-Market-able	Total	Market-able	Non-Market-able	Total	Number	Weight (g)		
	***Single row:**												
1-	120 x 30 cm	- regular creeping planting (control)	23,310	5.86 g	0.42 e	6.28 e	12.28 h	2.54 d	14.82 h	8.29 d	702 cd	4.20	5.62
2-	120 x 20 cm	- regular creeping planting.	34,986	8.68 c	0.61 c	9.29 b	16.82 f	3.55 a	20.37 d	7.82 e	643 de	4.40	5.70
3-	120 x 15 cm	- one plant/hill (creeping planting) and the other (vertical training)	46,662	7.66 d	0.70 b	8.36 c	21.50 bc	2.21 e	23.71 b	7.24 f	562 e	4.05	5.77
	****Double rows:**												
4-	50 + 70 x 30 cm	- vertically trained planting	23,310	7.19 e	0.33 f	7.52 d	17.09 e	1.71 g	18.80 f	10.09 b	900 a	4.20	5.80
5-	50 + 70 x 20 cm	- vertically trained planting	34,986	10.60 a	0.28 f	10.88 a	23.24 a	2.07 f	25.31 a	9.53 c	804 b	4.60	5.86
6-	50 + 70 x 30 cm	- one row/ridge (creeping planting) and the other (vertical training)	34,986	9.06 b	0.52 d	9.58 b	21.06 c	2.42 d	23.48 c	8.61 d	742 bc	4.25	5.59
7-	50 + 100 x 30 cm	- vertically trained planting	18,648	4.94 h	0.20 g	5.14 f	14.11 g	1.09 h	15.20 g	10.50 a	903 a	4.20	5.65
8-	50 + 100 x 20 cm	- vertically trained planting	27,972	6.12 g	0.49 de	6.61 e	18.22 d	2.22 e	20.44 d	9.50 c	808 b	4.60	5.77
9-	50 + 100 x 30 cm	- regular creeping planting	37,296	5.58 f	0.44 e	7.02 d	17.07 e	2.80 c	19.87 e	7.31 f	589 e	4.35	5.71
10-	50 +100 x 20 cm	- regular creeping planting	55,986	9.10 b	0.97 a	10.07 b	22.20 b	3.26 b	25.46 a	6.34 g	503 f	4.10	5.60
F-test				**	**	**	**	**	**	*	**	N.S	N.S

@Early yield was determined as yield of the first 5 pickings.

#Fruit quality parameters were determined 75 days after planting.

****, * and N.S. indicate P < 0.01, P < 0.05 and not significant, respectively, according to F. test.**

Means having the same alphabetical letters within each column are not significantly different at the 0.05 level according to Duncan's test.

Table (6): Effect of planting system and training on fruit yield and quality of cucumber plants (1997 season).

No.	Treatments		Plant population per feddan	Early fruit yield/fed. @ (ton)			Total fruit yield/fed. (ton)			Fruit yield/plant		T.S.S.# (%)	Fruit dry weight # (%)
				Market-able	Non-Market-able	Total	Market-able	Non-Market-able	Total	Number	Weight (g)		
	***Single row:**												
1-	120 x 30 cm	- regular creeping planting (control)	23,310	5.30 h	0.88 b	6.18 g	3.10 g	3.38 b	16.48 j	8.57 d	780 d	4.55	5.26
2-	120 x 20 cm	- regular creeping planting.	34,986	7.66 e	0.72 d	8.38 d	18.35 d	4.75 ab	23.10 f	8.31 e	733 e	4.60	5.36
3-	120 x 15 cm	- one plant/hill (creeping planting) and the other (vertical training)	46,662	7.98 d	0.80 c	8.78 c	23.84 b	2.07 c	25.91 c	7.94 f	621 g	4.75	5.46
	****Double rows:**												
4-	50 + 70 x 30 cm	- vertically trained planting	23,310	6.34 g	0.26 f	6.60 f	16.93 ef	2.18 c	19.11 h	10.43 b	914 bc	4.70	5.77
5-	50 + 70 x 20 cm	- vertically trained planting	34,986	9.84 a	0.13 g	9.97 a	26.10 a	2.48 c	28.58 b	10.35 b	903 c	4.90	5.65
6-	50 + 70 x 30 cm	- one row/ridge (creeping planting) and the other (vertical training)	34,986	8.10 c	0.89 b	9.00 b	21.21 c	3.09 b	24.30 d	8.91 c	768 d	4.80	5.40
7-	50 + 100 x 30 cm	- vertically trained planting	18,648	4.64 i	0.14 g	4.78 h	1.01 f	1.49 d	17.50 i	12.26 a	1041 a	4.85	5.62
8-	50 + 100 x 20 cm	- vertically trained planting	27,972	6.56 f	0.25 f	6.81 e	21.27 c	2.02 cd	23.29 e	10.40 b	920 b	4.75	5.57
9-	50 + 100 x 30 cm	- regular creeping planting	37,296	8.09 c	0.66 e	8.75 c	17.89 de	3.44 b	21.33 g	.6.90 g	634 f	4.75	5.55
10-	50 +100 x 20 cm	- regular creeping planting	55,986	8.82 b	1.10 a	9.92 a	24.81 b	5.13 a	29.94 a	6.53 h	593 h	4.80	5.42
F-test				**	**	**	**	**	**	**	**	N.S	N.S.

@Early yield was determined as yield of the first 5 pickings.
#Fruit quality parameters were determined 75 days after planting.
**** and N.S. indicate P < 0.01 and not significant, respectively, according to F. test.**
Means having the same alphabetical letters within each column are not significantly different at the 0.05 level according to Duncan's test.