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EFFECT OF SOME IRRIGATION METHODS AND TRANSPLANTS TRAY CELL SIZES ON GROWTH, YIELD AND QUALITY OF TOMATO

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ABSTRACT: ***The experiments of this study were carried out under both plastic houses and open field conditions at the experimental farm of Faculty of Agriculture, Kafrelsheikh University in two successive summer seasons of 2009 and 2010. The main objective of this work was to study the effect of some irrigation systems (shower and mist irrigation) and different cell sizes of transplants tray (28, 30 and 45 cm^3) on growth of seedlings grown in plastic houses. After transplanting the effect of such treatments on growth, fruit yield and quality of tomato plants grown up from treated seedling were also studied.***

The results indicated that shower irrigation system significantly increased stem length, leaf area, seedling fresh and dry weights and root fresh weight as well as total chlorophyll content in leaves of seedling.(at 40days after sowing). Shower irrigation also enhanced stem length, number of branches, number of leaves, leaf area of the 5th leaf and total chlorophyll content in leaves, number of flowers and number of clusters (at 60days after transplanting), total fruits yield and quality (marketable yield and vitamin C of fruits) of plants compared with those irrigated by mist. However, stem diameter and number of leaves/seedling, number of fruits set/plant, early fruits yield, non-marketable fruits yield, TSS% and pH of fruits were not significantly affected by irrigation system.

Using larger cell size (45 cm^3) of tray gave the highest values of vegetative growth of seedling (stem diameter, number of leaves, seedling leaf area, seedling fresh and dry weights, root fresh weight and total chlorophyll content in leaves) and plant (stem length, number of leaves, number of branches, leaf area of the 5th leaf and total chlorophyll content in leaves), number of flowers and number of clusters, number of fruits set, early yield, total yield and quality (marketable yield, vit.C and pH of fruits compared with smaller size (28 cm^3). However, cell size of 30 cm^3 gave the second values of the previous characters and gave the longest stem and the highest number of leaves/seedling. On the other hand, plant stem diameter, non-marketable yield and TSS% of fruits were not significantly affected by cell sizes of tray. The combined interaction between irrigation system and tray cell size caused non-significant effects on growth of seedling and plant, flowering, fruits set, fruits yield and quality, although the tomato seedling grown in cell size of 45 cm^3 (followed by cell size of 30 cm^3) and watered by mist irrigation were the best treatments of the interaction.

Key words: ***Tomato, irrigation methods, shower and mist irrigation systems, tray cell size, growth, yield, quality.***

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular vegetables in many countries especially in Egypt for fresh consumption, cooking and industrialization and it is a major source of vitamins, minerals and antioxidant. It is widely employed in cannery, and made in soups, conserves, pickles, ketchups, juice, …, etc. Tomato crop considers the first vegetable crop in Egypt, where the total cultivated area was 571844 feddans according to statistics of M.A.L.R. (2009).

Increasing productivity and improving fruit quality of vegetable crops depend, principally on using healthy seedlings. Moreover, growth, development, establishment and production of seedling are markedly related to agricultural practices used, e.g., container size, irrigation system, fertilization, soil or media conditions, cold protection,…, etc.

Irrigation system, under plastic houses, is of a more importance and sensibility for vegetable seedling production. In that respect, manual shower irrigation technique is, nowadays more common in most nurseries under plastic houses. Recently, mist irrigation system has been used in some nurseries for its profitable effects, specially in improving of both seedling growth and micro-environments under adverse conditions inside plastic houses (Omran, 1998 and El-Aidy *et al*., 2000), which in turn reflect on fruit yield and quality of plants after transplanting. There is little information available about the effect of shower and mist irrigation methods on tomato seedlings (Fath El-Bab, 2006).

Vegetable transplants produced from the classic seed beds faces in most cases, some problems like the bare roots of seedlings, transplanting shock and diseases of soil. Recently, the technique of plug tray-grown seedling has been applied more commonly, whether in the open field planting or under plastic houses, especially in tomato plantings. This technique ensures the productivity of seedlings of a better establishment and higher earliness and quality, since their roots can grow in a separate medium of ideal growing conditions. Peat-moss and vermiculite have long been used as basic materials in culture media of trays for growing vegetable seedlings under plastic houses. Nowadays, the plug tray-grown seedling cover the demand of all protected cultivated and a part of open field areas of vegetable crops in Egypt.

Cell size of tray is a major factor affecting transplants growth of many vegetable plants (Vavrina, 2001).

Many researchers have been reported that increasing cell size (volume) of tray increased vegetative growth of tomato seedlings before transplanting (Weston and Zandstra, 1986; NeSmith and Duval, 1998; Lee and Kim, 1999 and YeongBong *et al*., 1999), i.e., increased root growth (Peterson *et al*., 1991), stem diameter and height, leaf area and shoot dry weight of tomato transplants (Weston and Zandstra, 1986). Also, increasing cell size of tray increased vegetative growth of tomato transplants (Vavrina, 2001) after transplanting in the field and fruits yield (Weston and Zandstra, 1986).

Therefore, the main objective of this research to study the influence of some irrigation methods and tray cell sizes on seedling and plant growth, flowering, fruits yield and quality of tomato.

MATERIALS AND METHDOS

The experiments were carried out at the Farm of Faculty of Agriculture, Kafrelsheikh University in the summer season of the years 2009 and 2010 under plastic houses for transplants production in different trays cell sizes and in the open field for production of tomato yield. The main objective of this research was to study the effect of some irrigation systems for seedling grown in different tray cell sizes on vegetative growth of seedling and plant, flowering, fruits yield and quality of tomato cv. Madeer. The soil of experiments had a clay texture in both seasons and pH 8.1 and 7.9 (in 1:2.5 soil-water suspension) in the first and the second year, respectively. The soil was contained 38 and 35 ppm N, 42 and 40 ppm P_2O and 70 and 65 ppm K_2O (as available) in the first and second year, respectively. Determination of available N, P_2O_5 and K_2O and pH of soil was done according to Piper (1950) and Jackson (1967).

Treatments used:

Treatments included two factors, the first was irrigation methods: 1) mist irrigation system, this system provide the water in the form of very fine spray. The mist is produced from sprinklers fitted with nozzles having very fine nano pores polythene tubing, 2) shower irrigation system (hand watering). The amount of water used in shower irrigation system was the same amount of water used in mist irrigation. The second was tray cell sizes, i.e, 28, 30 and 45 cm^3, these trays had 209, 260 and 84 cells, respectively.

The trays having cell sizes of 28 and 45 cm^3 made of white foam, but the trays having cell sizes of 30 cm^3 made of black plastic.

Seeds of tomato were sown on March 15th in seedling trays with different cell sizes (28, 30 and 45 cm^3) which were filled with a mixture of pet-moss and vermiculite media (1:1 v/v), such media consisted of 25 kg peat-moss, 25 kg vermiculite, 100 g potassium sulphate (50% K_2O), 200 kg calcium superphosphate (15.5% P_2O_5), 200 kg ammonium sulphate (20.5% N), 75 g magnesium sulphate, 75 g micro - elements (as Megamelon), 50 g Rizolex (fungicide) and 2 kg calcium carbonate. After the seedlings reached to the proper size for transplanting (at 45days after sowing) , the seedlings were transplanted to the field plots.

The treated seedlings were transplanted in the field on May 1st on ridges of six meters in long and 120 cm width and at spacing of 40 cm within the ridge. Number of plants per feddan was about 8400 plants. All cultural practices for tomato cultivation in the field were followed, e.g., fertilization, irrigation tilling, insects and diseases control management,…, etc. They were applied as commonly carried out in tomato production field.

The experiment included 6 treatments which were arranged in a split -plot design with four replications. The two irrigation systems (shower irrigation system and mist irrigation system) were arranged at random in the main - plots and the three cell sizes of trays were assigned at random in the sub-plots. Each sub-plot (14.4 m^2) consisted of two ridges.

Data were tested by analysis of variance according to Little and Hills (1975). Duncan's multiple range test was used for comparison among treatments means (Duncan, 1955).

Data recorded:

Vegetative growth characteristics:

Vegetative growth characters of tomato seedling such as stem length (cm) and diameter (mm), number of leaves, leaf area (cm^2), root fresh weight, seedling fresh and dry weights (root , stem and leaves) and total chlorophyll content of leaves were determined. They were measured and determined at 40 days after sowing in samples of ten seedlings per each experimental unit.

Vegetative growth characters of tomato plant (after transplanting in the field), i.e., stem length and diameter, number of branches, number of leaves/plant, leaf area of the fifth leaf from the growing tip and total chlorophyll content in the leaves were measured at 60 days after transplanting on samples of five plants per each sub-plot. Leaf area of the fifth leaf was determined using the leaf area meter. Total chlorophyll content in leaves(mg/100cm^3) was determined using leaf chlorophyll meter apparatus (SPDA-So1). Dry weights of seedling and the fifth leaf were recorded after drying fresh material at 70^oC until constant weight.

Flowering characters:

Flowering characters were recorded at 60 days after transplanting as number of flowers, number of clusters and number of fruits set/plant.

Fruits yield and quality:

Tomato fruits picking started at 75 days after transplanting. Early yield (the first two pickings), total yield, marketable yield and non-marketable yield (fruits malformation) were determined as weight of fruits per plant (kg) and feddan (ton). The percentages of marketable and non-marketable yields from the total fruits yield were calculated.

Total soluble solids percentage (TSS%), pH and vitamin C were determined in juice of tomato fruits as follows: TSS% was determined by a hand refractometer according to A.O.A.C. (2000). pH was measured by pH meter according to A.O.A.C. (2000). Vit. C (as ascorbic acid) was determined by titration with 2,6dichlorophenol indophenol blue dye according to method of Cox and Pearson (1962).

RESULTS AND DISCUSSION

Effect of irrigation systems:

Vegetative growth of seedling:

Data in Table (1) show that using the shower irrigation system significantly increased stem length, leaf area and fresh and dry weights of tomato transplant (at age of 40 days after sowing) in both seasons , also shower system significantly increased number of leaves and roots fresh weight/transplant in the first season compared with the mist irrigation system. On the contrary, stem diameter was not significantly affected by any of the irrigation systems in both seasons. These results are in agreement with those obtained by Fath El-Bab (2006), who found that application of shower irrigation system gave the highest values of most vegetative growth characteristics of seedling tomato (stem length and diameter number of leaves, seedling leaf area, shoot fresh and dry weights, root fresh and dry weights and seedling fresh and dry weights). Superiority of shower irrigation system over mist irrigation system might be due to water loss by evaporation and evapotranspiration under shower irrigation conditions were lower than those under mist irrigation system.

Vegetative growth of plant:

Data in Table (2) indicate that application of shower irrigation system significantly increased stem length (in the first season), number of branches and number of leaves/plant and chlorophyll content of leaves (in the second season) and leaf area of the fifth leaf (in both seasons) higher than those of mist irrigation. However, plant stem diameter not significantly affected by irrigation system in both seasons. The trends of vegetative growth characteristics of tomato plant at 60 days after transplant were identical with trends of vegetative growth characteristics of transplant at age of 40 days after sowing (before transplanting in the open field).

Table (1): Effect of some irrigation systems on vegetative growth characters and leaves chlorophyll content of tomato seedling at age of 40 days after sowing (before transplanting in the field) in 2009 and 2010 seasons.

Characters / Irrigation system	Vegetative growth characters of tomato seedling							
	Stem length (cm)	Stem diameter (mm)	No. of leaves/ seedling	Leaf area / seedling (cm^2)	Fresh weight (g)	Dry weight (g)	Roots fresh wt. (g)	Total chlorophyll (mg/100 cm^2)
2009 season								
Mist	7.8 b	4.1	2.4 b	4.87 b	1.46 b	0.17 b	0.62 b	5.44 b
Shower	8.8 a	4.0	2.6 a	5.93 a	1.78 a	0.21 a	0.68 a	6.07 a
F. test	*	NS	*	*	*	*	*	*
2010 season								
Mist	8.5 b	3.7	3.3	5.00 b	1.70 b	0.15 b	0.67	5.81
Shower	10.0 a	3.6	3.4	6.25 a	2.20 a	0.19 a	0.70	6.03
F. test	**	NS	NS	*	*	*	NS	NS

**, * and NS indicate significant differences at P<0.01, P<0.05 and not significant, respectively, according to F test.
Values having the same alphabetical letter within each column are not significantly different at the 5% level according to Duncan's test.

Table (2): Effect of irrigation systems on vegetative growth characters and leaves chlorophyll of tomato plants (at 60 days after transplanting) in 2009 and 2010 seasons.

Characters / Irrigation system	Stem length/ plant (cm)	Stem diameter / plant (cm)	No. of branches/ plant	No. of leaves/ plant	Leaf area of the 5th leaf (cm^2)	Total chlorophyll in leaves (mg/100 cm^2)
2009 season						
Mist	44.9 b	2.5	11.3	42.4	213.7 b	5.65
Shower	46.4 a	2.6	11.7	42.7	216.2 a	5.88
F. test	*	NS	NS	NS	*	NS
2010 season						
Mist	45.7	2.5	10.2 b	42.3	211.2 b	5.59 b
Shower	45.7	2.5	11.4 a	43.0	215.4 a	5.88 a
F. test	NS	NS	*	*	*	*

* and NS indicate significant differences at P<0.05 and not significant, respectively, according to F test.
Values having the same alphabetical letter within each column are not significantly different at the 5% level according to Duncan's test

Flowering and fruits set:

Data presented in Table (3) reveal that using shower irrigation system caused significant increases in number of cluster and number of flowers/plant compared with the mist irrigation in both seasons. However, number of fruits set/plant was not significantly affected by irrigation systems in both seasons.

Fruits yield (early and total yields):

Data in Table (3) indicate that early fruits yield was not significantly affected by irrigation system. On the other hand, shower irrigation system significantly increased total fruits yield higher than that of mist irrigation system in both seasons. The increase in total fruits yield of tomato by shower irrigation might be due to increase the roots growth of seedling (Table 1) which in turn increased uptake of nutrients resulting in increased vegetative growth of seedling (Table 1) and plant (Table 2) and chlorophyll content of leaves (Tables1&2) subsequently increased photosynthesis and translocation of carbohydrates which led to accelerated and increased flowering (Table 3) and enhanced assimilates accumulation in fruits, those might finally increased total fruits yield of tomato.

Table (3): Effect of some irrigation systems on flowering, fruits set early fruits yield and total fruits yield of tomato plant in 2009 and 2010 seasons.

Characters / Irrigation system	No. of clusters/ plants	No. of flowers/ plant	No. of fruits set/ plant	Early fruits yield/		Total fruits yield	
				g /plant	ton /fed.	kg /plant	ton /fed.
2009 season							
Mist	23.4 b	34.2 b	18.2	398	3.343	2.177 b	18.287 b
Shower	24.0 a	35.50 a	18.4	426	3.578	2.297 a	19.295 a
F. test	*	*	NS	NS	NS	*	*
2010 season							
Mist	22.6 b	33.6 b	17.4	387.7	3.357	2.100 b	17.640 b
Shower	23.6 a	35.3 a	18.1	404.3	3.396	2.150 a	18.060 a
F. test	*	*	NS	NS	NS	*	*

* and NS indicate significant differences at P<0.05 and not significant, respectively, according to F test.
Values having the same alphabetical letter within each column are not significantly different at the 5% level according to Duncan's test

Fruits quality:

Data in Table (4) indicate that application of shower irrigation system significantly increased marketable fruits yield in the first season and vit.C content of fruits in the second season, compared with the mist irrigation system. However, non-marketable fruits yield, TSS% and pH of fruits juice were not significantly affected by irrigation system in both seasons.

Effect of tray cell size:

Vegetative growth of transplant:

Data in Table (5) demonstrate that there were significant increases in stem diameter, leaf area, fresh and dry weights, root fresh weight of tomato transplant and total chlorophyll of leaves with increasing cell size of tray from 28 cm^3 up to 45 cm^3 in both seasons, where using tray cell size of 45 cm^3 gave the highest values of the previous characteristics, followed by tray cell size of 30 cm^3 compared with tray cell size of 28 cm^3 which recorded the lowest values of them. However, tray cell size of 30 cm^3 led to significant increases in stem length and number of leaves of transplant, followed by tray cell volume of 45 cm^3 compared with the smaller cell volume (28 cm^3) which had the shortest stem and the lowest number of leaves in both seasons.

Table (4): Effect of some irrigation systems on tomato fruits quality in 2009 and 2010 season.

Characters / Irrigation system	Marketable fruit yield/			Non-marketable fruit yield/			TSS of Fruits (%)	pH of fruits	Vit.C (mg/100 fresh wt)
	kg /plant	ton /fed	% from the total yield	kg /plant	ton /fed	% from the total yield			
2009 season									
Mist	1.983 b	16.657 b	91.1	194	1.630	8.9	5.75	4.67	18.82
Shower	2.104 a	17.674 a	91.6	193	1.621	8.4	5.82	4.69	19.27
F. test	*	*		NS	NS		NS	NS	NS
2010 season									
Mist	1.914	16.078	91.1	186	1.562	8.9	5.59	5.24	20.37 b
Shower	1.975	16.590	91.7	175	1.470	8.3	5.65	5.27	22.72 a
F. test	NS	NS		NS	NS		NS	NS	*

* and NS indicate significant differences at P<0.05 and not significant, respectively, according to F test.
Values having the same alphabetical letter within each column are not significantly different at the 5% level according to Duncan's test.

Table (5): Effect of tray cell size on vegetative growth characters and leaves chlorophyll content of tomato seedling at age of 40 days after sowing (before transplanting in the field) in 2009 and 2010 seasons.

Characters / Tray cell sizes	Vegetative growth characters of tomato seedling							
	Stem length (cm)	Stem diameter (mm)	No. of leaves/ seedling	Leaf area / seedling (cm^2)	Fresh weight/ seedling (g)	Dry weight/ seedling (g)	Roots fresh wt. (g)	Total chlorophyll (mg/100 cm^2)
2009 season								
28 cm^3	7.2 b	3.2 b	2.2 b	3.93 b	1.35 b	0.17 b	0.59 b	5.42 b
30 cm^3	9.9 a	4.3 a	2.8 a	4.01 b	1.73 a	0.20 a	0.67 a	5.88 b
45 cm^3	7.8 b	4.7 a	2.7 a	6.28 a	1.79 a	0.21 a	0.70 a	6.48 a
F. test	**	**	*	**	*	*	*	*
2010 season								
28 cm^3	7.9 c	3.1 b	2.7 b	5.21 b	1.65 c	0.13 c	0.61 b	5.75 b
30 cm^3	10.5 a	3.9 a	3.7 a	5.70 a	1.95 b	0.17 b	0.71 a	5.73 b
45 cm^3	9.4 b	4.0 a	3.6 a	5.98 a	2.25 a	0.21 a	0.74 a	6.56 a
F. test	**	**	*	*	**	**	*	*

**, * and NS indicate significant differences at P<0.01, P<0.05 and not significant, respectively, according to F test.
Values having the same alphabetical letter within each column are not significantly different at the 5% level according to Duncan's test

These results are in agreement with those obtained by Weston and Zandstra (1986), Fath El-Bab (2006) and Singh *et al*. (2007), on tomato seedlings and Filkovic *et al*. (2009) on pepper transplants. The increase in vegetative growth of tomato seedlings or transplants with increasing cell size of tray might be due to increases in root growth and size which enhanced nutrient uptake and water absorption, which in turn increased leaf chlorophyll content, photosynthesis, hormone synthesis (gibberellin and cytokinin) and allocation of assimilates translocate to the root (Ismail and Dalia, 1995 and NeSmith and Duval, 1998), subsequently increase in vegetative growth of seedlings.

Vegetative growth of plant:

Data in Table (6) reveal that using tray cell size of 45 cm^3 significantly increased stem length, number of branches, number of leaves, leaf area of the 5th leaf and chlorophyll content in leaves, followed by tray cell size of 30 cm^3 (without significant differences between them) compared with the tray cell size of 28 cm^3 in both seasons. However, plant stem diameter was not significantly affected by cell size of tray in both seasons. In the same trend, Hall (1989) noted that the rate of vine growth was greater in plants grown in larger cells than in smaller ones once transplanted to the field. Moreover, Vavrina (2001) showed that, after field planting, plants grown in the larger cells were considerably larger than those grown in the smaller cells. However, NeSmith *et al*. (1992) reported that branching or lateral shoot growth of bell pepper plants decreased due to root restriction in small plug cells.

Flowering and fruits set:

Data in Table (7) show that application of tray cell size of 45 and 30 cm^3 caused significant increases in number of clusters, number of flowers and number of fruits set/plant, compared with the smaller tray cell size (28 cm^3) which recorded the lowest values of the previous characters in both seasons. In this concern, there is no information about the effect of tray cell size on number of flowers, clusters and fruits set, but there are some information about the effect of it on tomato flowering time. Kemble *et al*. (1994) showed that as rooting volume increased resulting from larger size of tray, the time from sowing to anthesis was shortened for tomato.

Table (6): Effect of tray cell size on vegetative growth characters and leaves chlorophyll content of tomato plant (at 60 days after transplanting) in 2009 and 2010 seasons.

Characters / Tray cell sizes	Stem length/ plant (cm)	Stem diameter / plant (cm)	No. of branches/ plant	No. of leaves/ plant	Leaf area of the 5th leaf (cm^2)	Total chlorophyll in leaves (mg/100 cm^2)
2009 season						
28 cm^3	43.5 b	2.4	10.6 b	41.7 b	212.4 b	5.51 b
30 cm^3	46.3 a	2.6	11.6 ab	42.6 ab	214.5 b	5.79 a
45 cm^3	47.2 a	2.6	12.3 a	43.5 a	217.5 a	6.00a
F. test	**	NS	*	*	*	*
2010 season						
28 cm^3	44.7 b	2.4	9.9 b	40.9 b	207.1 b	5.45 b
30 cm^3	45.7 ab	2.5	11.0 ab	43.3 a	215.6 a	5.80 a
45 cm^3	46.9 a	2.7	12.6 a	43.9 a	217.2 a	5.98 a
F. test	*	NS	*	*	**	*

**,* and NS indicate significant differences at $P<0.01$, $P<0.05$ and not significant, respectively, according to F test.

Values having the same alphabetical letter within each column are not significantly different at the 5% level according to Duncan's test

Table (7): Effect of tray cell size on flowering, fruits set early fruits yield and total fruits yield of tomato plant in 2009 and 2010 seasons.

Characters / Tray cell sizes	No. of clusters/ plants	No. of flowers/ plant	No. of fruits set/ plant	Early fruits yield/		Total fruits yield	
				g /plant	ton /fed.	kg /plant	ton /fed.
2009 season							
28 cm^3	20.1 b	32.3 b	17.3 b	336.5 b	2.827 b	1.855 b	15.582 b
30 cm^3	24.1 a	35.7 a	18.6 a	444.0 a	3.730 a	2.400 a	20.160 a
45 cm^3	25.0 a	36.6 a	19.0 a	455.5 a	3.826 a	2.455 a	20.622 a
F. test	**	*	*	*	*	**	**
2010 season							
28 cm^3	21.5 b	32.1 b	16.6 b	337.5 b	2.835 b	1.760 b	14.784 b
30 cm^3	23.4 a	35.0 a	18.0 a	420.0 a	3.528 a	2.300 a	19.320 a
45 cm^3	24.4 a	36.3 a	18.6 a	430.5 a	3.616 a	2.315 a	19.446 a
F. test	*	*	*	*	*	**	*

** and* indicate significant differences at $P<0.01$ and $P<0.05$, respectively, according to F test.
Values having the same alphabetical letter within each column are not significantly different at the 5% level according to Duncan's test

Fruits yield (early and total yields):

Data in Table (7) show that applying tray cell size of 45 and 30 cm^3 caused significant increases in early and total fruits yields compared with the tray cell size of 28 cm^3 which produced the lowest early and total fruits yields in both seasons. Similar results were obtained by Weston and Zandstra (1986), Vavrina and Arenas (1997) and Alsadon (2000) on tomato, Graham *et al*. (2000) on watermelon, YoungMi *et al*. (2002) and Junior *et al*. (2004) on cucumber. They found that early and total yields were increased as transplant container size increased. On the other hand, SukWoo *et al*. (1996) noted that early and total yields of tomato fruits were not significantly affected by plug cell size. The favorable effects resulting from increasing cell size of transplants tray on increasing early and total yields might be due to general reduction in stress greater availability of water and fertilizer, unrestricted root growth and greater shoot development and root: shoot weight ratio (Vavrina, 2001 and Grazia *et al*., 2002). Also, more rapid field growth of the plants from larger cells aids in their ability to combat and resist insects, diseases and other mechanical or physical stresses (Vavrina, 2001). Leading to earlier and higher yields (Grazia *et al*., 2002).

Fruits quality:

Results in Table (8) reveal that using tray cell size of 45 and 30 cm^3 significantly increased marketable fruits yield (per fed and percentage from the total yield) and vit.C in both seasons and pH of fruits in the first season compared with the cell volume of 28 cm^2. However, non-marketable yield and TSS% of tomato fruits were not significantly affected by tray cell size in both seasons. Similar response was obtained by some researchers such as YoungMi *et al*. (2002) who found that number of early marketable fruits yield of cucumber increased with increasing the plug cell size.

Moreover, Alsadon (2000) showed that tomato fruits produced from plants grown in larger container size had higher vit.C and TSS% content and pH compared with the small size which had the lower vit.C, TSS% and pH of fruits.

Effect of combined interaction between irrigation system and tray cell size:

Data presented in Tables (9, 10, 11 and 12) indicate that the combined interaction between irrigation system and tray cell size had non-significant effect on vegetative growth of transplants (stem length and diameter, number of leaves, leaf area, root fresh weight, fresh and dry weights of transplant and total chlorophyll contents of leaves) and plant (stem length and diameter, number of branches and leaves, leaf area of the fifth leaf from the growing top and total chlorophyll contents of leaves), flowering and fruits set (number of clusters, flowers and fruits set), fruits yield (early and total yields), fruit yield quality (marketable and non-marketable yields, TSS%, pH and vit.C).

Table (8): Effect of tray cell size on tomato fruits quality in 2009 and 2010 seasons.

Characters / Tray cell sizes	Marketable fruit yield/			Non-marketable fruit yield/			TSS of fruits (%)	pH of fruits	Vit.C (mg/100 fresh wt)
	kg /plant	ton /fed	% from the total yield	kg /plant	ton /fed	% from the total yield			
2009 season									
28 cm^3	1.674 b	14.062 b	90.2	181.0	1.520	9.8	5.56	4.53 b	18.62 b
30 cm^3	2.191 a	18.404 a	91.3	209.5	1.760	8.7	5.85	4.67 ab	19.57 a
45 cm^3	2.265 a	19.026 a	92.3	190.0	1.596	7.7	5.94	4.85 a	19.73 a
F. test	**	**		NS	NS		NS	*	*
2010 season									
28 cm^3	1.598 b	13.423 b	90.8	162.5	1.365	9.2	5.47	5.21	20.32 b
30 cm^3	2.099 a	17.632 a	91.3	201.0	1.688	8.7	5.59	5.27	21.82 ab
45 cm^3	2.137 a	17.951 a	92.3	178.0	1.495	7.3	5.82	5.30	22.50 a
F. test	**	**		NS	NS		NS	NS	*

**,* and NS indicate significant differences at $P<0.01$, $P<0.05$ and not significant, respectively, according to F test.
Values having the same alphabetical letter within each column are not significantly different at the 5% level according to Duncan's test

Table (9): Effect of the combined interaction between irrigation systems and tray cell size on vegetative growth characters and leaves chlorophyll content of tomato seedling at age of 40 days after sowing (before transplanting in the field) in 2009 and 2010 seasons.

Treatments	Characters	Stem length (cm)	Stem diameter (mm)	No. of leaves/ seedling	Leaf area / seedling (cm^2)	Fresh weight/ seedling (g)	Dry weight/ seedling (g)	Roots fresh wt. (g)	Total chlorophyll (mg/100 cm^2)
2009 season									
Mist	28 cm^3	6.5	3.1	2.2	3.25	1.15	0.15	0.55	5.11
	30 cm^3	9.3	4.3	2.6	5.62	1.60	0.18	0.65	5.81
	45 cm^3	7.5	4.9	2.5	5.75	1.62	0.19	0.67	6.40
Shower	28 cm^3	7.8	3.3	2.1	4.60	1.55	0.19	0.62	5.72
	30 cm^3	10.5	4.2	2.9	6.40	1.85	0.22	0.68	5.95
	45 cm^3	8.1	4.5	2.8	6.80	1.95	0.23	0.73	6.55
F. test		NS	NS	NS	NS	NS	NS	NS	NS
2010 season									
Mist	28 cm^3	8.2	2.9	2.7	4.81	1.55	0.11	0.60	5.80
	30 cm^3	9.5	4.0	3.6	4.95	1.75	0.16	0.68	5.92
	45 cm^3	7.9	4.1	3.5	5.25	1.80	0.17	0.72	6.25
Shower	28 cm^3	7.5	3.2	2.6	5.61	1.75	0.15	0.62	5.70
	30 cm^3	11.5	3.8	3.8	6.44	2.15	0.18	0.73	5.94
	45 cm^3	10.9	3.9	3.7	6.70	2.70	0.25	0.76	6.85
F. test		NS	NS	NS	NS	NS	NS	NS	NS

NS indicate not significant, according to F test.

Table (10): Effect of the combined interaction between irrigation systems and tray cell size on vegetative growth characters and leaves chlorophyll content of tomato plant (at 60 days after transplanting) in 2009 and 2010 seasons.

Treatments \ Characters		Stem length/ plant (cm)	Stem diameter / plant (cm)	No. of branches/ plant	No. of leaves/ plant	Leaf area of the 5th leaf (cm^2)	Total chlorophyll in leaves (mg/100 cm^2)
2009 season							
Mist	28 cm^3	42.7	2.3	10.3	41.5	212.2	5.54
	30 cm^3	45.2	2.5	11.3	42.6	213.3	5.66
	45 cm^3	46.7	2.6	12.2	43.1	215.5	5.75
Shower	28 cm^3	44.3	2.4	10.8	41.8	212.5	5.48
	30 cm^3	47.3	2.6	11.8	42.6	216.7	5.92
	45 cm^3	47.7	2.7	12.4	43.8	219.5	5.25
F. test		NS	NS	NS	NS	NS	NS
2010 season							
Mist	28 cm^3	44.8	2.3	9.7	40.2	203.5	5.41
	30 cm^3	45.5	2.5	10.2	43.0	214.5	5.62
	45 cm^3	46.9	2.6	10.8	43.8	215.5	5.75
Shower	28 cm^3	44.5	2.4	10.1	41.5	210.7	5.48
	30 cm^3	45.8	2.5	11.6	43.6	216.7	5.95
	45 cm^3	46.9	2.7	12.4	43.9	218.8	6.20
F. test		NS	NS	NS	NS	NS	NS

NS indicates not significant according to F test.

Table (11): Effect of the combined interaction between irrigation systems and tray cell size on flowering, fruits set (at 60 day after transplanting), early fruits yield and total fruits yield of tomato plant in 2009 and 2010 season.

Treatments \ Characters		No. of clusters/ plants	No. of flowers/ plant	No. of fruits set/ plant	Early fruits yield/		Total fruits yield	
					g /plant	ton /fed.	kg /plant	ton /fed.
2009 season								
Mist	28 cm^3	21.5	31.5	17.5	311	2.612	1.820	15.288
	30 cm^3	23.8	35.2	18.3	433	3.637	2.350	19.740
	45 cm^3	24.9	36.0	18.8	450	3.780	2.360	19.824
Shower	28 cm^3	22.6	33.1	17.1	362	3.041	1.890	15.876
	30 cm^3	24.3	36.2	18.9	455	3.822	2.450	20.580
	45 cm^3	25.1	37.2	19.2	461	3.872	2.550	21.420
F. test		NS		NS	NS	NS	NS	NS
2010 season								
Mist	28 cm^3	20.4	30.6	16.2	331	2.780	1.750	14.700
	30 cm^3	23.2	34.5	17.8	410	3.444	2.270	19.068
	45 cm^3	24.1	35.7	18.2	422	3.545	2.280	19.152
Shower	28 cm^3	22.5	33.5	17.0	344	2.890	1.770	14.868
	30 cm^3	23.6	35.4	18.2	430	3.612	2.330	19.572
	45 cm^3	24.6	36.9	19.0	439	3.688	2.350	19.740
F. test		NS		NS	NS	NS	NS	NS

NS indicates not significant, according to F test.

Table (12): Effect of the combined interaction between irrigation systems and tray cell size on tomato fruits quality in 2009 and 2010 seasons.

Treatments \ Characters		Marketable fruit yield/			Non-marketable fruit yield/			TSS of fruits (%)	pH of fruits	Vit.C (mg/100 fresh wt)
		kg /plant	ton /fed	% from the total yield	kg /plant	ton /fed	% from the total yield			
2009 season										
Mist	28 cm^3	1.638	13.759	90.0	182	1.529	10.0	5.53	4.51	18.23
	30 cm^3	2.139	17.968	91.0	211	1.772	10.0	5.83	4.67	18.33
	45 cm^3	2.171	18.236	92.0	189	1.588	8.0	5.90	4.84	19.90
Shower	28 cm^3	1.710	14.364	90.5	180	1.512	9.5	5.60	4.55	19.00
	30 cm^3	2.242	18.833	91.5	208	1.747	8.5	5.87	4.66	19.25
	45 cm^3	2.359	19.816	92.5	191	1.604	7.5	5.98	4.85	19.55
F. test		NS	NS		NS	NS		NS	NS	NS
2010 season										
Mist	28 cm^3	1.575	13.230	90.0	175	1.470	10.0	5.46	5.20	19.10
	30 cm^3	2.066	17.391	91.0	204	1.714	9.0	5.57	5.26	20.80
	45 cm^3	2.100	17.940	92.5	180	1.512	7.5	5.75	5.27	21.20
Shower	28 cm^3	1.620	13.608	91.5	150	1.260	8.5	5.47	5.21	21.53
	30 cm^3	2.132	17.909	91.5	198	1.663	8.5	5.60	5.28	22.83
	45 cm^3	2.174	18.262	92.5	176	1.178	7.5	5.88	5.32	23.80
F. test		NS	NS		NS	NS		NS	NS	NS

NS indicate not significant, according to F test.

Although, tomato seedling irrigated with shower system and cultivated in tray cell size of 45 and 30 cm^3 tended to give the highest values of all previous characters compared with those irrigated with mist system and cultivated in smaller cell size (28 cm^3) which recorded the lowest values in both seasons.

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تأثير بعض طرق الرى وأحجام مكعب صوانى الشتلات على النمو والمحصول والجودة لنبات الطماطم

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أجريت تجربتان تحت الصوب البلاستيكية لإنتاج الشتلات واجريت ايضا تجربتان حقليتان لإنتاج المحصول فى الحقل التجريبى بكلية الزراعة . جامعة كفرالشيخ خلال الموسمين الصيفيين المتتاليين لعامى ٢٠٠٩م ، ٢٠١٠م وكان الهدف الرئيسى لهذا البحث هو دراسة تأثير بعض نظم الرى (ري بالرش ، ورى بالتضبيب) على شتلات الطماطم النامية فى أحجام مختلفة من مكعبات صوانى الشتلات (٢٨ ، ٣٠ ، ٤٥سم^3) على نمو الشتلات والنباتات ، والمحصول والجودة.

ولقد أوضحت النتائج أن:

تسبب الرى بالرش فى زيادة معنوية لكل من النمو الخضرى للشتلات (المتمثل فى طول الساق ، والمساحة الورقية للشتلة ، والوزن الطازج ، والوزن الجاف للشتلة والوزن الطازج للجذر ، ومحتوى أوراق الشتلة من الكلوروفيل الكلى) والنمو الخضرى للنبات (المتمثل فى طول الساق وعدد الفروع الخضرية ، وعدد الأوراق ، والمساحة الورقية للورقة الخامسة ومحتوى الأوراق من الكلوروفيل الكلى) ، والتزهير (عدد الأزهار ، وعدد الفروع الثمرية) ، ومحصول الثمار الكلى وجودة الثمار (المحصول المسوق ، ومحتوى الثمار من فيتامين "ج")، وذلك بالمقارنة بنظام الرى بالتضبيب ، بينما وجد أن سمك الساق وعدد أوراق الشتلة ، عدد الثمار العاقدة ، المحصول المبكر للثمار ، والمحصول غير المسوق للثمار ومحتوى الثمار من المواد الصلبة الذائبة الكلية ، pH الثمار لم يتأثر معنويا بنظام الرى.

ولقد تسبب استخدام الحجم الأكبر من مكعب صوانى الشتلة (٤٥سم^3) فى اعطاء أعلى قيم لكل من النمو الخضرى للشتلة (قطر الساق ، ووزن الجذر الطازج ، ومحتوى الأوراق من الكلوروفيل الكلى) ، والنمو الخضرى للنبات (طول الساق ، وعدد الأوراق ، وعدد الفروع الخضرية ، والمساحة الورقية للورقة الخامسة ، ومحتوى أوراق النبات من الكلوروفيل الكلى) ، والتزهير (عدد الأزهار وعدد الفروع الثمرية) ، وعدد الثمار العاقدة ، والمحصول المبكر ، والمحصول الكلى ، وجودة الثمار (المحصول المسوق ، ومحتوى الثمار من فيتامين "ج" ، pH الثمار) ، وذلك بالمقارنة بحجم المكعب الأصغر (٢٨سم^3). بينما تسبب حجم المكعب (٣٠سم^3) فى اعطاء أطول ساق وأعلى عدد من الأوراق للنبات أما بقية الصفات السابقة فتسبب هذا الحجم (٣٠سم^3) فى اعطاء الترتيب الثانى للقيم.

ومن ناحية أخرى وجد أن سمك ساق النبات ، والمحصول الغير مسوق ، ومحتوى الثمار من المواد الصلبة الذائبة الكلية لم يتأثروا بأحجام مكعب صوانى الشتلات.

تسبب التفاعل المشترك بين نظام الرى وحجم مكعب الجذر بالصينية فى تأثير غير معنوى على كل من نمو الشتلة والنبات والتزهير والعقد والمحصول والجودة ، وبالرغم من ذلك وجد أن الشتلات النامية فى حجم مكعب الجذر (٤٥سم^3) (يتبعه مكعب الجذر ٣٠سم^3) والتى رويت بنظام الرى بالرش هى أفضل معاملات التفاعل.