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GROWTH AND YIELD BEHAVIOR OF TOMATO PLANTS GROWN UNDER HOT WEATHER CONDITION IN RELATION TO SOME NURSE AND FIELD TREATMENTS

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ABSTRACT: *This study was conducted to show to what extent the exposure of tomato transplants in the nurse to tow hardening treatment, namely irrigation with saline water and drought conditions besides spraying adult plants in the field by some chemical compounds can make it resist the high temperature in the summer growing seasons. Result elucidate that both hardining treatments significantly increased leaf area index, relative growth rate and net assimilation rate but reduced relative leaf growth rate and leaf area ratio. In addition, purshade and prolina exhibited, in general, a positive effect on leaf area indix, relative leaf growth rate and net assimilation, but they were found to depress leaf area ratio and relative growth rate . It is worthwhile to mention that both nurse treatments positively affect both early and total yield parameters. Besides, purshade at both tested concentrations attained superior early and total yield values, followed by prolina at the lowest and highest concentrations. Several interactions between nurse treatments and spraying plants in the field were recorded.*

Key words: *Hot stress, Saline water irrigation, Drought condition, Purshade, Prolina.*

INTRODUCTION

High temperatures during summer growing season have been reported to be detrimental to growth, reproductive development and yield of tomato (Singh *et al. ,* 2007). Thus, it is important to find an efficient practice that can protect tomato seedling from being injured with high temperature. Exposing transplants in the nursery to drought or irrigation with saline water may increase transplants tolerance to the high temperature after transplanting. The drought ameliorates the adaptation of adult plants to high temperature (Malash and Khattab, 2008). However, transplant irrigated in the nursery with saline water, as a stress, show tolerance to other stresses after transplanting (Takahaski *et al,* 1994). In this connection, spraying plants with purshade or prolina is a recommended practices that support tomato growing under the hot weather condition (Abdel-Aziz *and Gaafer,* 2012).

Thus the goal of this research was to find out ways to increase tomato transplants adaptability to hot weather condition after transplanting on one hand and to improve flowering and fruiting of plants on the other hand.

MATERIALS AND METHODS

This study was carried out under the hot weather conditions of 2011 and 2012 summer seasons at the Experimental Form of Faculty of Agriculture, Minufiya University, Shebin El-kom. The aim of this study is to show to what extent the exposure of tomato transplants to hardening treatments either as drought conditions and or irrigation by saline water solution as well as spraying adult plants in the field by purshade and or prolina, can make plants resist the high temperature of the hot weather. Tomato seeds Elisa variety were sown on March, 29 in both seasons, in foam trays (84 holes) filled with mixture of peatmoss, vermiculite (1:1) and mixed with macro and micro-nutrients. After seedling establishment (20 days from seed sowing), seedlings were exposed to hardening treatments either by subjecting it to drought by withholding irrigation for the maximum period that permitted subsequent recovery of at least 90% of the pretreated plants, this procedure was followed according to that described by Gonzalez-Fernandez (1996), or by irrigation with saline water at the concentration of 100 mM of NaCl. To avoid chock of plants, saline solution was applied gradually; i.e. irrigation

with saline water at the concentration of 100 mM of NaCl every 3 days. Fresh water was used as control. Irrigation was applied when soil moisture depleted to 60% field capacity. At 45 days from seed sowing, transplants were transplanted in the open field. Transplants were set on one side of the rows with 70 cm between transplants. At 55 days plant age, purshade and prolina were foliar sprayed four times with 10 days intervals at two concentrations for each; i.e, 5 and 10 cm/L. Thus, the experimental design was split-plot with for replicates in which drought condition and irrigation with saline water were arranged as main plots whereas purshade and prolina were assigned as sub-plots. The plot area was 16.80 m^2 that consisted of 4 rows, 6 m in long and 0.7 m in width.The normal cultural practices of growing tomato were done according to the recommendation of ministry of agriculture, Egypt.

During growth period three plant samples, were taken for growth analysis at 15 days intervals started 60 days from transplanting; i.e., 5 days after the first spray with purshade and prolina treatments. Each sample consisted of 5 plants, which were undertaken randomy from the two outer rows of each experimental unit (sub-plot).

Some parameters of growth analysis were calculated as follows:

1. Leaf area index (LAI):

$$LAI = \frac{leaf\ area / plant}{land\ area / plant}$$

(watson, 1947)

2. -Relative growth rate (RGR):

Expressed as dry weight accumulated per unit of plant dry weight per unit of time.

$$RGR = \frac{InW_2 - InW_1}{t_2 - t_1} \quad (g/day)$$

(cited after Richords, 1969)

Where: W_1 and W_2 are the total dry weight of plant at times t_1 and t_2, respectively, and $t_1 - t_2$ equals periods in unit of time between the two consecutive samples.

3. Relative leaf growth rate (RLGR):

Which is leaf area per unit of times determined by the formula.

$$RLGR = \frac{in L_2 - In L_1}{t_2 - t_1} \quad (cm^2/day)$$

(Thorne, 1960)

Where: L_1 and L_2 are total leaf area at times t_1 and t_2 are total lea are at times t_1 and t_2, respectively.

4. leaf area ratio (LAR):

Leaf area ratio could be defined as the leaf area per unit of plant dry weight.

$$LAR = \frac{(L_2 - L_1)(InW_2 - InW_1)}{(In L_2 - In L_1)(W_2 - W_1)} \quad (cm^2/g)$$

(Radford, 1967)

Where : L_1 and L_2 are the total leaf area / plant at the times t_1 and t_2, while W_1 and W_2 are plant dry weight at t_1 and t_2.

5. Net assimilation rate (NAR):

Dry weight accumulated per unit of leaf area per unit of time.

$$NAR = \frac{(W_2 - W_1)(\ln L_2 - \ln L_1)}{(L_2 - L_1)(t_2 - t_1)} \quad (g/\ cm^2/day)$$

(Mc Collum, 1978)

Where : W_1 and W_2 are dry weight at t_1 and t_2 , L_1 and L_2 are leaf area at t_1 and t_2 but t_1 and t_2 are times of sampling.

Fruit yield:

The ripe tomato fruits were harvested weekly at 105 days after transplanting and the following measurements were carried out:

1- Number of fruits / plant.

2- Weight of fruits per plant.

3- Early yield. It was considered as the sum of the weight of fruits picked at the first three pickings.

4- Total yield. It was determined as the sum of the weight of all harvested fruits that picked at the red ripe stage throughout the entire season.

Statistical analysis:

The collected data were subjected to statistical analysis of using the F-test and means were compared by the LSD at 0.05 level of probability as described by Snedecor and Cochran (1967) and using Costat Softwere (1985).

RESULTS AND DISCUSSION

Growth analysis:

1. leaf area index (LAI):

1.1. Effect of hardening treatments in the nurse:

It could be easily noticed from data in Table (1) that, plants irrigated with saline water in the nurse or their exposing to drought condition showed a general increase in leaf area index comparing to control. This result was insistently observed in all sampling dates of both season. Results could be explained, again, on the base of plant pushing to grow after growth arresting in the nurse. This results goes along with those of Khattab (2010) who reported that some growth attributes analysis of plants pretreated and irrigated later with saline water was higher than that of plants which unpretreated and irrigated with fresh water. Besides, leaves of the unwatered plants showed greater water reataining capacity and heat resistance, factors that may led to good leaf growth.

1.2. Effect of adult plant spraying in the field:

Data in Table (1) show also that, purshade, especially at the lowest concentration, gave the highest record in leaf area index followed by prolina at both tested concentration. This results being true in all sampling dates of both studied seasons.

Purshade was frequently reported to reduce plant stress and ensure optimum crop growth, thus its favourable effect on leaf area attributes is easily explained. This suggestion was previously drawn by Creamer *et al.* (2005) working on chile pepper.

As for proline it was reported in the literature of Kavi Kishor *et al.* (2005) to improve plant growth. The author added that proline seams to have diverse roles under osmotic stress condition, such as stabilization of proteins, membranes and sub cellular structures.

1.3. The interactive effect:

As for the interactive effects, data in Table (1) show that plants received saline water irrigation in the nurse and purshade at the highest concentration showed superior record in this concern. The lowest record being obtained in plants received no treatments neither in the nurse nor in the field.

2. Relative growth rate (RGR):

2.1. Effect of hardening treatments in the nurse:

This parameter shows the dry weight accumulated per unit of plant dry weight per unit of time. So, this parameter was assessed at two periods; i.e., 60-75 and 75-90 days from transplanting. Both saline water irrigation of seedling in the nurse or their exposing to drought condition showed significant increase in RGR at both periods (Table 2). This results is true in both growing seasons.

Obtained results matched well with thus of Gonzalez-Fernandez (1996) who found that salt or drought conditioned tomato seedlings seem to grow better than non-conditioned plants. Further confirmation was done by Flowers *et al.* (2005) who noted that tomato plants treated by drought (halo conditioned) produced more shoots biomass than non-treated control plants.

2.2. Effect of adult plant spraying in the field:

As for relative growth rate as affected by prolina and purshade, data in Table (2) show that, excepting for the first period of the second season, prolina or purshade at one or either tested concentrations gained, in general, inferior records comparing to control. Results could be explained as proline results in massive changes in partitioning of carbon and nitrogen as reproductive organs usually import amino acids to support growth and development, consequently it may depress vegetative

Table 1

Table 2

growth. The same conclusion was previously drown by Kavi Kishor *et al.* (2005).

2.3. The interactive effect:

As for the interactive effects of the two studied factors, data in Table (2) show that plants received no treatments neither in the nurse nor in the field gained, in general, superior records in relative growth rate.

3.Relative leaf growth rate (RLGR):

3.1. Effect of hardening treatments in the nurse:

Relative leaf growth rate is the difference between two successive leaf area-natural logarithm per time unit. This parameter of growth analysis was calculated for two time periods; i.e., from 60 to 75 and from 75 to 90 days after transplanting.

Pertinent data record on relative leaf growth rate (Table 3) showed that control plants, that received no treatments neither in the nurse nor in the field, gained the highest values. With a slight exception, this results being true in the first and second periods of both growing season. Similar results were obtained by Khattab (2010) on tomato. The author found that RLGR was negatively affected by irrigation with saline water and drought treatments each of aduit.

3.2. Effect of adult plant spraying in the field:

Prolina at the first or second period of both season achieved superior records in relative leaf growth rate (Table 3). In this context purshade achieved no superiority comparing to the other treatments.

Results may be explained, again, on the base that proline improved plant leaf area (Kavi Kishor, 2005) and protects membranes and proteins against temperature extremes and functions as a

hydroxyl radical scavenger, consequently it gives optimum conditions to leaves growth (Sanampudi *et al.,* 2011).

Further confirmation was figured out by Yan *et al.* (2011) who noted that tobacco cells suspension-cultured under salt stress is promoted by exogenous proline which seams due to proline mediated protection of enzymes and membranes.

3.3. The interactive effect:

As for the interaction between drought pretreatments or irrigation with saline water in the nurse and spraying plants with purshade and prolina in the field, data in Table (3) show that prolina at the highest concentration; i.e., with no treatments in the nurse or with saline water irrigation gave, in general, the highest records in relative leaf growth rate.

4. Leaf area ratio (LAR):

4.1. Effect of hardening treatments in the nurse:

Leaf area ratio was defined as the leaf area per unit of plant dry weight. It is easily concluded from data in Table (4) that both prohibiting irrigation water to plants in the nurse or their irrigation with saline water, reduced leaf area ratio. This results holds true at both studied periods of both growing seasons.

Results could be explained due to increasing plant dry weight the dominator of the fraction in the used equation, thus the less value obtained being an expecting result. These results go along with those of Khattab (2010) who noticed that LAR was negatively affected by irrigation with saline water.

4.2. Effect of adult plant spraying in the field:

As for purshade and prolina effect on LAR, data in Table (4) show that both compounds at both tested concentrations depressed this growth index. Results could be explained, again, on the base of increasing the dominate in the used equation.

4.3. The interactive effect:

The combination of the two studied factors seemed to affect LAR. Thus, plants received no treatments neither in the nurse nor in the field exhibited the highest LAR values (Table 4). This result being true in both studied periods.

Table 3

Table 4

5. Net assimilation rate (NAR):

Net assimilation rate in this study was expressed as dry weight accumulated per unit of leaf area per unit of time. It is important to note that NAR is not an exact measure of photosynthesis, but rather a measure of the net dry weight gained by photosynthesis over loss by respiration.

5.1. Effect of hardening treatments in the nurse:

It is quite evident from the data listed in Table (5) that net assimilation rate was positively responded to both hardening treatments, since saline water irrigation gave the highest values followed by drought , while check plants ranked at the latest position. This result hold true in both assessing periods at both growing seasons.

Obtained results go along with those of Khattab (2010) who noted, that tomato plants subjected to saline water irrigation or drought in the nurse showed higher NAR than those unpretreated. It is worthy to mention herein that the changes in growth and physiological responses induced by hardening treatments in the nurse are maintained throughout the plant life cycle (Cayuela *et al.*,2001).

5.2. Effect of adult plant spraying in the field:

The net assimilation rate seems to positively respond to both prolina and purshade sprayings at both utilized concentration (Table 5). In this concern, purshade at the lowest concentration, followed by that at the highest one and prolina at the highest concentration followed by that at the lowest one gave superior records, comparing to control. These results were insistently observed in both assessing periods of both growing seasons.

Results may be explained on the basis of improving photosynthesates accumulation due to prolina or purshade sprayings, thus the net metabolites after consumption some of it in the physiological processes within plant being large.

Going with this drawn conclusion, Sathya *et al.* (2010) assumed that spraying tomato plants with CaCl improves tomato photosynthesis and chlorophyll content. Besides, amino acids and purshade were reported by Abdel-Aziz and Gaafer (2012) to enhance total soluble solids, ascorbic acids and dry matter accumulation in tomato plant tissues.

5.3. The interactive effect:

With an exception of purshade at the lowest concentration in combination with saline water irrigation at the second period of the first season, that of purshade at the highest concentration in combination with saline water irrigation gave the highest record of net assimilation rate at both periods of both growing seasons (Table 5). In this connection, the lowest record being obtained in treatments received neither nurse treatments nor sprayings one in the field.

Yield and yield components:

Yield components in the present research were considered as early yield and total yield, which expressed as number of fruit/ plant as well as weight of fruit kg/ plant and ton/feddan. Therefore, the affect of studied factors on these yield components was studied

1. Early yield:

The early yield was considered as the sum of fruit yield of the first three pickings.

1.1. Effect of hardening treatments in the nurse:

Both treatments of hardening in the nurse seemed to positively affect all early yield parameters as saline water irrigation showed the priority followed by drought treatments since control plants came at the latest rank. These results were insistently observed in both growing seasons.

Results may be interpreted as nursery treatment attained their favourable effects on early yield via their affect on plant growth. Obtained results are in harmony with those of Cayuela *et al.* (2001) who noted that tomato seedlings grown for 15 days in 35 mM NaCl showed up to 29 % more fruit yield

Table 5

than non adapted plants. Furthermore, Ojemakinde and Onwueme (1980) reported that subjecting tomato seedlings to drought hardening caused an increase in fruit weight and number. Further confirmation was figured out by Flowers *et al.* (2003) and khattab (2010). They noted that drought pretreatment enhanced yield of field grown tomato.

1.2. Effect of adult plant spraying in the field:

Results of early yield measurements of tomato as influenced by purshade and prolina spraying in the field show clearly that purshade at both tested concentrations gave the highest values of early yield, followed by prolina at the lowest and highest concentrations respectivelly (Table 6). This result hold true at both growing seasons.

Such results could be explained as proline protects membranes and proteins against temperature extremes, thereby favoured plant flowering as well as fruit set and yield. This interpretation was previously drawn by Sanampudi *et al.* (2011) . They added that proline content of anthers plays important role in acquiring heat tolerance in tomato, consequently it enhances fruit set.

Our obtained results regarding purshade effect on yield go along with those of Nour *et al.* (2010) who found a promotive influence of calcium carbonate spraying on tomato fruit yield.

Another confirmation was done by Creamer *et al.* (2005) who reported on pepper that reducing plant stress is important in ensuring optimum crop growth and yield.

Besides, a single spray of 5% Kaolinite was found by Kahn and Damicone (2008) to improve the water status and yield of tomato plants comparing with those sprayed with distilled water only.

1.3. The interactive effect:

The combined effect of saline water irrigation and purshade at both tested concentrations exerted the highest records of all early yield parameters (Table 6).

In this context, the lowest value being obtained from plants received neither nurse treatments nor sprayings one.

2. Total yield:

2.1. Effect of hardening treatments in the nurse:

It is obviously clear from the data presented in Table (7) that saline water irrigation in the nurse gained the highest value of all total yield components followed by exposing plants to drought condition, whereas check plants occupied the latest rank. This result holds true at both growing seasons. Going with the above mentioned results, Cayuela *et al.* (2001) mentioned that tomato seedlings grown for15days in 35 mM NaCl showed up to 29% more fruits yield.

As for drought treatments, our obtained results are in harmony with those of Ojemakinde and Onwueme (1980) who noted that subjecting tomato seedlings to drought hardening by allowing them to wilt for 2-3 days before being watered, the fruits weight and number of fruits / ha were increased by hardening treatments.

Another confirmation was figured out by Flowers *et al.* (2003) who indicated that drought pretreatment enhanced yield of field grown tomato. Furthermore, Malash and Khattab (2008) reported that fruits yield of tomato plants was higher in drought pre-treated plants. However, khattab (2010) confirmed our obtained result as she showed that saline water irrigation in the nurse or exposing plants to drought treatments enhanced tomato fruits yield. The favourable effect of such pre-treatments could be inferred, as these treatments enhanced some growth and flowering parameters observed in this study, thus it is expected to favour fruits yield.

2.2. Effect of adult plant spraying in the field:

It is quite clear from the data listed in Table (7) that purshade, at both experimented concentrations, exhibited the greatest values of all studied total yield parameters, followed by prolina at one or the other tested concentration meamwhile

Table 6

Table 7

control plants achieved, in general, inferior values . This result was insistently observed in the two growing seasons .

Parshade exerted its favourable affect on tomato fruit yield due to one or two basis .The first one in its containg calcium (62.5% calcium carbonate) as a nutritive element and the other base is its protective effect against the effects of light and thermal stresses, reflecting harmful wavelengths of solar radiation such as ultraviolet and infra-red light, while allowing transmissions of sufficient sunlight for photosynthesis (Creamer *et al*., 2005).

Reffering to purshade, similar results were obtained by Diaz-Perez (2005) on pepper, Kahn and Damicone (2008) and Fiassal *et al*. (2011), both on tomato .

Proline, as amino acid, was frequently reported to improve flowering and pollen viability (Claussen, 2005), thus it is expected to increase fruit yield. Further explanation could be done ,as proline protects membranes and proteins against temperature extremes, thereby it improved plant metabolism , that positively reflected on fruit yield (Sanampudi *et al*. ,2011) working on tomato. Similar increase in plant yield due to proline spraying were obtained by Shehata *et al*. (2011) working on celeriac plant and Abdel-Aziz and Gaafer (2012) working on tomatoes.

2.3. The interactive effect:

As it could be seen from data in Table (7), that plants received saline water irrigation in the nurse and purshade spraying in the field ,at both tested concentrations, showed the highest values of all studied total yield parameters . This result being true in both growing seasons .In this context the least values were obtained in plants received neither nurse treatments nor sprayings ones in the field.

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سلوك نمو ومحصول نباتات الطماطم النامية تحت ظروف الجو الحار وعلاقتها ببعض المعاملات في المشتل والحقل

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الملخص العربي

أجريت هذه الدراسة لإظهار مدى تحمل نباتات الطماطم لدرجات الحرارة العالية أثناء نموها في الحقل خلال موسم الصيف وذالك أولا بتعريض الشتلات في المشتل لمعاملات الإجهاد سواء بتعريضها للجفاف أو بمعاملتها بالملوحة وثانيا برش النباتات البالغة هذه بعد نقلها للحقل المكشوف ببعض المواد الكيميائية.

وقد أظهرت النتائج أن جميع معاملات الإجهاد التي أجريت في المشتل أدت إلي زيادة معنوية في دليل المساحة الورقية ومعدل النمو النسبي وصافي معدل التمثيل الضوئي لكنها أحدثت نقصا معنويا في معدل النمو النسبي للورقة ونسبة المساحة الورقية. بالإضافة إلى ذلك، فأن البيورشيد والبرولينا وبشكل العام كان لهم تأثير إيجابي على دليل المساحة الورقية ومعدل النمو النسبي للورقة وصافي معدل التمثيل الضوئي، ولكنهم خفضوا معدل النمو النسبي ونسبة مساحة الورقة.

ومن الجدير بالذكر أن كل من معاملات الإجهاد في المشتل كان لها تأثيراً إيجابيا على المحصول المبكر والمحصول الكلي إلى جانب ذلك، فأن البيورشيد عند أدني وأعلي تركيز حقق أعلى النتائج في المحصول المبكر والكلي، يليه في ذلك البرولينا عند أدنى وأعلى تركيز علي التوالي.

عديد من التفاعلات بين معاملات الإجهاد في المشتل ورش النباتات في الحقل المكشوف تم تسجيلها.

Table (1). Effect of nurse hardening treatments and plant spraying in the field on leaf area index (LAI).

Spraying treatments (B) / Nurse treatments (A)	2011/2012						2012/2013					
	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means
	1 st sample (60 days from transplanting)											
Control	2.30	3.46	2.54	3.41	3.00	2.94	2.13	2.54	1.94	2.61	2.54	2.35
Saline water irrigation	2.41	2.78	2.69	3.82	3.96	3.13	2.59	2.31	1.86	2.71	2.72	2.44
Drought	2.47	3.44	2.74	3.44	3.43	3.11	2.49	2.36	2.22	2.35	2.32	2.35
Means	2.39	3.23	2.66	3.56	3.46		2.40	2.40	2.01	2.55	2.53	
LSD at 0.05	A= 0.04		B = 0.04		A×B= 0.08		A= 0.01		B = 0.03		A×B= 0.05	
	2 nd sample (75 days from transplanting)											
Control	3.44	4.19	3.84	4.18	3.84	3.90	3.36	4.21	3.34	4.05	3.94	3.78
Saline water irrigation	3.21	3.54	3.63	4.59	5.00	3.99	3.75	3.89	3.34	4.47	4.51	3.99
Drought	3.41	4.12	3.74	4.25	4.38	3.98	3.56	4.21	3.66	3.98	3.78	3.84
Means	3.35	3.95	3.74	4.34	4.41		3.56	4.10	3.45	4.17	4.08	
LSD at 0.05	A= 0.03		B = 0.03		A×B= 0.05		A= 0.02		B = 0.02		A×B= 0.04	
	3 ed sample (90 days from transplanting)											
Control	2.23	2.73	2.20	2.77	2.87	2.56	2.87	3.47	3.13	3.87	3.80	3.43
Saline water irrigation	2.73	2.87	2.40	3.10	3.03	2.83	3.30	3.70	3.00	4.00	4.13	3.63
Drought	2.63	2.63	2.37	2.73	2.77	2.63	3.17	3.73	3.03	3.57	3.57	3.41
Means	2.53	2.74	2.32	2.87	2.89		3.11	3.63	3.06	3.81	3.83	
LSD at 0.05	A= 0.04		B = 0.05		A×B= 0.09		A= 0.09		B = 0.05		A×B= 0.09	

*Prolina1 and purshade 1 at the lowest concentration:(5 cm/L), Prolina 2 and purshade 2 at the highest concentration: (10 cm/L).

Table (2). Effect of nurse hardening treatments and plant spraying in the field on relative growth rate (RGR as g/day).

Nurse treatments (A) \ Spraying treatments (B)	2011/2012						2012/2013					
	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means
	60- 75 days from transplanting											
Cont rol	0.0371	0.0175	0.0245	0.0202	0.0155	0.0229	0.0390	0.0317	0.0433	0.0379	0.0368	0.0377
Saline water irrigation	0.0289	0.0159	0.0244	0.0271	0.0335	0.0259	0.0374	0.0377	0.0441	0.0441	0.0444	0.0416
Drought	0.0208	0.0210	0.0273	0.0231	0.0184	0.0221	0.0360	0.0449	0.0434	0.0442	0.0380	0.0413
Means	0.0289	0.0181	0.0254	0.0235	0.0225		0.0375	0.0381	0.0436	0.0421	0.0397	
LSD at 0.05	A= 0.0003 B = 0.0003 A×B= 0.0006						A= 0.0007 B = 0.0006 A×B= 0.0009					
	75- 90 days from transplanting											
Control	0.0375	0.0204	0.0285	0.0206	0.0229	0.0259	0.0511	0.0446	0.0511	0.0450	0.0454	0.0474
Saline water irrigation	0.0282	0.0292	0.0306	0.0215	0.0122	0.0243	0.0493	0.0409	0.0473	0.0378	0.0348	0.0420
Drought	0.0314	0.0184	0.0261	0.0182	0.0292	0.0247	0.0468	0.0423	0.0482	0.0453	0.0446	0.0454
Means	0.0324	0.0227	0.0284	0.0201	0.0214		0.0491	0.0426	0.0489	0.0427	0.0416	
LSD at 0.05	A= 0.0003 B = 0.0002 A×B= 0.0004						A= 0.0007 B = 0.0009 A×B= 0.0017					

* The same footnote in Table (1).

Table (3). Effect of nurse hardening treatments and plant spraying in the field on relative leaf growth rate (RLGR as cm^2/day).

Spraying treatments (B) / Nurse treatments (A)	2011/2012						2012/2013					
	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2	Means	Control	Prolina 1*	Prolina 2	Purshade 1*	Purshade 2*	Means
	60- 75 days from transplanting											
Control	0.0269	0.0128	0.0276	0.0133	0.0164	0.0194	0.0309	0.0315	0.0366	0.0293	0.0287	0.0314
Saline water irrigation	0.0191	0.0156	0.0201	0.0119	0.0155	0.0165	0.0248	0.0342	0.0379	0.0319	0.0323	0.0322
Drought	0.0211	0.0130	0.0207	0.0139	0.0162	0.0169	0.0255	0.0332	0.0342	0.0322	0.0332	0.0317
Means	0.0224	0.0138	0.0228	0.0129	0.0161		0.0271	0.0329	0.0361	0.0312	0.0314	
LSD at 0.05	A= 0.0002		B = 0.0003		A×B= 0.0005		A= 0.0003		B = 0.0008		A×B= 0.0013	
	75- 90 days from transplanting											
Control	0.0237	0.0109	0.0240	0.0117	0.0137	0.0168	0.0258	0.0265	0.0312	0.0244	0.0247	0.0265
Saline water irrigation	0.0162	0.0139	0.0168	0.0104	0.0128	0.0140	0.0173	0.0290	0.0319	0.0262	0.0274	0.0264
Drought	0.0180	0.0109	0.0179	0.0126	0.0143	0.0148	0.0205	0.0251	0.0293	0.0272	0.0276	0.0259
Means	0.0193	0.0119	0.0196	0.0116	0.0136		0.0212	0.0269	0.0308	0.0259	0.0266	
LSD at 0.05	A= 0.0003		B = 0.0003		A×B= 0.0006		A= 0.0005		B = 0.0008		A×B= 0.0014	

* The same footnote in Table (1).

Table (4). Effect of nurse hardening treatments and plant spraying in the field on leaf area ratio (LAR as cm^2/g).

Spraying treatments (B) / Nurse treatments (A)	2011/2012						2012/2013					
	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means
	60- 75 days from transplanting											
Control	53.60	50.70	53.03	50.70	48.90	51.39	49.93	45.27	44.90	45.13	44.03	45.85
Saline water irrigation	49.50	46.30	50.30	47.00	46.17	47.85	45.80	42.40	40.10	43.13	40.67	42.42
Drought	46.23	49.40	45.00	48.60	51.40	48.13	46.07	44.30	46.60	40.87	41.00	43.77
Means	49.78	48.80	49.44	48.77	48.82		47.27	43.99	43.87	43.04	41.90	
LSD at 0.05	A= 0.12		B = 0.19		A×B= 0.34		A= 0.19		B = 0.31		A×B= 0.54	
	75- 90 days from transplanting											
Control	42.40	38.80	40.60	39.90	37.60	39.86	40.90	39.70	39.93	39.77	38.57	39.77
Saline water irrigation	33.50	38.50	40.10	36.90	32.10	36.22	38.87	37.30	35.63	37.20	34.90	36.78
Drought	38.20	38.00	35.60	35.80	38.20	37.16	39.60	38.97	39.30	35.13	36.90	37.98
Means	38.03	38.43	38.77	37.53	35.97		39.79	38.66	38.29	37.37	36.79	
LSD at 0.05	A= 0.13		B = 0.26		A×B= 0.45		A= 0.27		B = 0.19		A×B= 0.33	

* The same footnote in Table (1).

Table (5). Effect of nurse hardening treatments and plant spraying in the field on net assimilation rat (NAR as g/cm^2/day).

Spraying treatments (B) / Nurse treatments (A)	2011/2012						2012/2013					
	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means
	60- 75 days from transplanting											
Control	0.00031	0.00037	0.00035	0.00044	0.00038	0.00037	0.00082	0.00087	0.00083	0.00084	0.00087	0.00085
Saline water irrigation	0.00037	0.00037	0.00037	0.00047	0.00053	0.00042	0.00085	0.00111	0.00098	0.00011	0.00122	0.00104
Drought	0.00035	0.00035	0.00040	0.00042	0.00039	0.00038	0.00080	0.00103	0.00091	0.00106	0.00095	0.00095
Means	0.00034	0.00036	0.00037	0.00045	0.00043		0.00082	0.00100	0.00091	0.00099	0.00101	
LSD at 0.05	A= 0.000007 B = 0.00001 A×B= 0.00002						A= 0.000007 B = 0.00001 A×B= 0.00002					
	75- 90 days from transplanting											
Control	0.00004	0.00014	0.00004	0.00009	0.00010	0.00008	0.00007	0.00011	0.00013	0.00015	0.00017	0.00012
Saline water irrigation	0.00016	0.00016	0.00004	0.00022	0.00017	0.00015	0.00012	0.00011	0.00012	0.00016	0.00020	0.00014
Drought	0.00015	0.00011	0.00004	0.00017	0.00017	0.00013	0.00008	0.00015	0.00010	0.00014	0.00019	0.00013
Means	0.00012	0.00014	0.00004	0.00016	0.00015		0.00009	0.00012	0.00012	0.00015	0.00019	
LSD at 0.05	A= 0.0000003 B = 0.000002 A×B=0.000003						A= 0.000001 B =0.000002 A×B= 0.000003					

- The same footnote in Table (1).

Table (6). Effect of nurse hardening treatments and plant spraying in the field on early yield indices.

Spraying treatments (B) / Nurse treatments (A)	2011/2012						2012/2013					
	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means
	Early yield (No. fruits / plant)											
Control	10.40	13.53	11.03	12.40	13.56	12.18	9.80	12.53	9.77	12.47	13.40	11.59
Saline water irrigation	11.50	13.13	11.27	14.13	14.23	12.85	10.10	13.33	10.67	14.37	13.87	12.47
Drought	11.90	12.13	11.53	13.47	12.90	12.38	10.63	12.20	10.3	12.67	12.60	11.68
Means	11.27	12.93	11.28	13.33	13.57	12.47	10.18	12.69	10.24	13.17	13.29	11.91
LSD at 0.05	A= 0.29		B =0.22		A×B=0.37		A=0.11		B =0.20		A×B=0.35	
	Early yield (kg / plant)											
Control	1.139	1.364	1.197	1.327	1.370	1.279	1.092	1.325	1.098	1.327	1.355	1.239
Saline water irrigation	1.274	1.339	1.238	1.434	1.429	1.343	1.121	1.327	1.184	1.444	1.424	1.299
Drought	1.269	1.324	1.266	1.365	1.324	1.310	1.130	1.311	1.139	1.346	1.324	1.250
Means	1.227	1.343	1.234	1.375	1.375	1.311	1.114	1.321	1.140	1.372	1.368	1.263
LSD at 0.05	A= 0.010		B = 0.010		A×B=0.018		A= 0.0052		B =0.010		A×B=0.018	
	Early yield (ton / fed.)											
Control	3.987	4.775	4.188	4.645	4.795	4.478	3.790	4.638	3.842	4.645	4.744	4.332
Saline water irrigation	4.459	4.687	4.334	5.018	5.004	4.700	3.924	4.645	4.143	5.058	4.983	4.550
Drought	4.458	4.635	4.431	4.779	4.635	4.588	3.955	4.587	3.987	4.711	4.634	4.375
Means	4.301	4.699	4.318	4.814	4.811	4.588	3.889	4.623	3.990	4.805	4.787	4.419
LSD at 0.05	A= 0.0097		B =0.011		A×B=0.019		A= 0.013		B =0.018		A×B=0.032	

* The same footnote in Table (1).

Table (7). Effect of nurse hardening treatments and plant spraying in the field on total yield indices.

Spraying treatments (B) / Nurse treatments (A)	2011/2012						2012/2013					
	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means	Control	Prolina 1*	Prolina 2*	Purshade 1*	Purshade 2*	Means
	Total yield (No. fruits / plant)											
Control	14.50	17.40	14.73	16.40	17.60	16.13	13.23	16.63	13.47	16.33	17.40	15.41
Saline water irrigation	15.93	17.27	15.23	18.37	18.43	17.05	14.07	17.27	14.13	18.13	17.93	16.31
Drought	16.27	16.63	15.13	17.20	17.00	16.45	14.70	16.67	13.97	17.50	17.00	15.97
Means	15.57	17.10	15.03	17.32	17.68	16.54	14.00	16.86	13.86	17.32	17.44	15.89
LSD at 0.05	A= 0.12		B = 0.18		A×B= 0.31		A= 0.25		B = 0.11		A×B= 0.18	
	Total yield (kg / plant)											
Control	1.747	2.000	1.796	1.933	2.008	1.897	1.608	1.965	1.661	1.924	1.990	1.830
Saline water irrigation	1.893	1.974	1.847	2.094	2.093	1.980	1.698	1.979	1.734	2.063	2.044	1.904
Drought	1.899	1.952	1.862	2.001	1.953	1.934	1713	1.954	1.724	1.997	1.961	1.869
Means	1.846	1.976	1.835	2.009	2.018	1.937	1.673	1.966	1.706	1.995	1.998	1.867
LSD at 0.05	A= 0.004		B = 0.008		A×B= 0.014		A= 0.008		B = 0.007		A×B= 0.013	
	Total yield (ton / fed.)											
Control	6.116	7.001	6.286	6.764	7.027	6.639	5.628	6.877	5.814	6.734	6.965	6.404
Saline water irrigation	6.624	6.910	6.466	7.330	7.327	6.931	5.945	6.927	6.069	7.221	7.145	6.663
Drought	6.647	6.833	6.517	7.002	6.837	6.767	5.996	6.839	6.034	6.989	6.864	6.544
Means	6.463	6.915	6.423	7.032	7.063	6.779	5.856	6.881	5.972	6.981	6.994	6.537
LSD at 0.05	A= 0.011		B = 0.022		A×B= 0.037		A= 0.022		B = 0.013		A×B= 0.022	

* The same footnote in Table (1).