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EFFECT OF PLANTING DATE AND SHADING NURSERY ON THREE STRAWBERY CULTIVARS 1. GROWTH OF THE PLANTS IN THE NURSERY AND IN THE FIELD

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ABSTRACT: This study aimed to investigate the response of three strawberry *cvs*; Camarosa, Sweet Charlie and Rosalinda, to nursery shading (0, 60, 75 and 90 days), and the behaviour of the shaded transplants under three planting dates (1*st* Sept., 15*th* Sept. and 1*st*. Oct.) in the crop field. Data on plant growth traits in the nursery as well as in the field were recorded.

Camarosa *cv* produced the highest significant No. of both the runners and transplants and the dry matter (DM) of the shoots and roots of the transplants (Types A and B), in the nursery. Whereas, *cv*. Sweet Charlie gave the highest C/N ratio. Unshaded mother plants in the nursery gave the highest No. of runners, but shading, in general, produced the highest No. of transplants from types A and B. Moreover, 60 days shading, in the 1*st* season, and 75 days shading, in the 2*nd* one, significantly favoured C/N ratio. While, cultivar x shading interaction had no effect on the DM of transplants, but significantly affected C/N ratio.

Camarosa and Sweet Charlie *cvs* produced maximum No. of crowns and leaves / plant, especially in the early plantations (Sept. 1st or 15th) and shading for 75 and / or 90 days. However, the effect of planting date on leaf No. /plant, in the 2*nd* season, was insignificant. In addition, the cvs responded differently to planting date x shading treatments in the 2*nd* season, but they were not in the first one. Moreover, *cv* Camarosa had the highest leaf area and DM content / plant at the early plantations in Sept. On the other hand, shading had no effect on leaf area and DM content / plant in the 1*st* season, but the effect was significant in the 2*nd* one. The effect of the three way interaction on leaf area and DM content / plant was significant and the cultivars responded differently.

INTRODUCTION

A great attention has been drawn to strawberry cultivations in Egypt, in the last two decades. This is due to its importance, as an exportation crop. Because, a great demand for foreign markets supplying by strawberry was needed during winter season. The market price at this period of the season is very high. It reaches the highest price in European market in Nov. and Dec. and medium price in Jan. and Feb. ATUT. (1999)*.Getting early flowering and fruiting from strawberry plant, could be achieved through using the early cultivars or promoting the available cultivars for early flowering.

Strawberry is a s
Such phenomenon could be manipulated through adjusting the planting date or through modifications of this factor; using low light intensity to initiate flowering buds. Growth and flowering of the plants that

reported by several authors on different plants. Kramer and Decker (1944), compared pine and deciduous trees stands in forests, found that the undestroy of young stands consists largely of deciduous trees, and overstory pines eventually are thinned out by the time reached over maturity. They pointed out that, the important factor in the success of the deciduous trees is that they achieve maximum photosynthetic rate at one-third or less of full sun light, but the pines require full sunlight for maximum photosynthesis.

The effect of shading the nursery on strawberry growth was reported by Ferre and Stang (1988) mentioned that plants, which shaded during July and Aug. produced fewer runners, but their leaf, crown and root dry weight did not differ from sun exposed plants. Chandler *et al.* (1992) when subjected strawberry plant to 60% shade from 1 July to 31 Aug., and found the shaded plants produced fewer runners and accumulated less dry matter than exposed plants (unshaded). Svension (1995) found that the stem of strawberry plants which grown under 80% shading were longer than stem length of plants grown under 60% shade. But the dry weight of shoot was higher under 60 % shade than under 80% shade. Awang and Atherton (1995) reported that shading strawberry plants caused a reduction in leaf area, number of leaves and crown and shoot dry weight. While, Ragab *et al.* (2002) reported that shading strawberry

*Ministry of Agric. And Land Reclamation, ATUT.1999 Strawberry Export Market Analysis and Potential

nursery produced a positive effect on increasing runner formation and early fresh transplants production. However, shading decreased crown diameter, dry weights and total carbohydrates in roots and crown transplants. Khalafalla *et al.* (2001), reported that shading *Euphorbia milii* plants with 47% shading increased number and weight of leaves and total chlorophyll, but decreased number of branches as well as fresh and dry weight of branches and roots. Percentage of total carbohydrate in leaves of full- sun plants was more than the shaded plants.

For the effect of planting date Chercuitte *et al.* (1991) mentioned that the earlier planting (15 May) of strawberry encouraged the development of large multi-crowns plants.

Therefore, the present work aimed to study the effect of shading the nursery of three strawberry cultivars on the transplants growth in the nursery and on the growth of those shaded and unshaded transplants in the crop field, after-effect. Also, to study the effect of planting data on the growth of these cultivars.

MATERIALS AND METHODS

The present investigation was carried out on three strawberry (*Fragaria* x *ananassa* Duch) cultivars, during 1999 / 2000 and 2000/2001 growing seasons, at South Tahreer, El-Behera Governorate. This work aimed to study the response of some strawberry cultivars to nursery shading, and the behaviour of the shaded transplants in the crop field.

Soil preparation of the nursery took place in February every season, basic fertilizers were broadcasted before tillage. prior to planting. The kind and amounts of fertilizers per feddan were:

1. Farm yard manure 40 m^3,
2. Calcium superphosphate (15.5% P_2O_5), 200 kg,
3. Sulphur, 250 kg,
4. Ammonium sulphate (20.6% N), 100 kg,
5. Potassium sulphate (48% k_2O) 100 kg, and
6. Magnesium sulphate (50 kg)

Soil was fumigated by methyl promid at 70 gm/m^2 soil area. Drip irrigation tubes and overhead sprinklers were positioned at space 1.5 and 6m respectively. The used strawberry cultivars were Camarosa, Sweet Charlie and Rosalinda. Super Elite mother plants were planted on rows at 1.00 m apart and 1.5m spacing between rows on 15 March every season; that means one mother plant, of each cultivar, occupied 1.5 m^2. The experimental layout

was split plot in randomized complete blocks design with five replications. Shading treatments were arranged as the main plots; two treatments (shading for 60 days, from first July, and unshading), in the first season, but there were four shading treatments; 60, 75 and 90 days shading beside unshading, in the second season, and the three cultivars were randomly taken as the sub-plots. Each sub-plot area was $9m^2$ containing 6-mother plants.

The shading treatments were obtained through using shading net, which gave a reduction in light intensity by 63 %.

In both seasons, air temperature were recorded daily of both shaded and unshaded area, then averaged as monthly temperature, also light intensity was measured by luxmeter under shaded and unshaded area at three times daily; i.e., 8AM, 12PM and 5 PM (Table 1). During the growing season. N, P and K fertilizers were applied via irrigation at 180, 30 and 100 kg/feddan, respectively. These were taken into account the residual soil N, P and K which were applied prior, as a basic fertilization. Fungicides and insecticides were applied during the growing season when needed.

For field experiment, soil preparation took place in July, every season as mentioned before in nursery. The raised beds top surface was 120 cm in width and 40cm height, then they were fumigated with methyl bromide at the rate of 70 gm/m^2 soil, two weeks before planting. Drip irrigation system was positioned. Fresh transplants were planted in rows on the beds at 30 cm between the rows and 25 cm between plants in the row. The beds were mulched by white plastic sheet when the transplants had 2-3 new leaves. Also, tunnels were covered with white plastic sheets.

The experiments included 18 and 36 treatments in the first and second season, respectively. These represented the combinations among three planting dates (1*st* Sept.,15*th* Sept. and 1*st* Oct.), three cultivars (Camarosa, Sweet Charlie and Rosalinda) and two shading treatments (unshaded and 60 day shading), in the first season and four shading treatments (60, 75 and 90 days shading besides the unshaded one) in the second season.

The experimental design in the randomized complete blocks with three replications. Planting dates

Table 1 . Average monthly temperature (oC) and illumination (lux) during nursery per in 1999/2000 and 2000/2001 season .

	July		Augest		Septemper	
	Shading	Unshading	Shading	Unshading	Shading	Unshading
	First season (1999/2000)					
Temperatur C:						
Maximum	34.69	36.58	36.56	38.02	34.07	35.84
Minimum	17.98	19.6	21.7	19.87	18.08	17.55
Illumination (lux)						
8.00 AM	8464	34883	7878	41073	4491	24526
12.00 PM	37690	102840	37838	106273	33468	96096
5.00 PM	5253	24780	3812	12477	5537	17356
	Second season (2000/2001)					
Temperatur C:						
Maximum	36.13	38.12	33.01	35.19	33.27	33.01
Minimum	22.11	19.07	21.06	19.79	19.2	18.08
Illumination (lux)						
8.00 AM	8414	33079	6259	25725	11552	44260
12.00 PM	39510	106290	38355	102600	37560	104640
5.00 PM	5908	26645	5490	25610	6481	23350

were arranged in the main plots, cultivars were assigned at random in sub-plots, cultivars and the shading treatments were distributed in sub-sub plots. The sub-sub plot area was 4.2 m^2 containing 48 plants each. The plants were fertilized with N, P and K fertilizers at the rates of 150, 60 and 200 kg/feddan, respectively during the growing season. In addition, Ca (chelated calcium) Mg (Magnesium sulphate) and micronutrients were applied as foliar application. Fungicides and insecticides were applied during the growing season when needed.

Data recorded:

1. Plant growth traits in the Nursery.

a. Number of runners / mother plant.

b. Number of different types of transplants; i.e., type A had more than 0.7 cm of crown diameter, type B had less than 0.7 cm of crown diameter, and type C (the unrooted one).

c. Dry matter (DM) of both shoots and roots (gm) for transplants (type A and type B),

d. C/N ratio of transplants (type A)

Total nitrogen was determined according to Evenhuis (1976), while carbohydrates was determined according to Dubois *et al.* (1956).

2. Plant growth traits in the field

A random sample of 5 plants were labled in every experimental unit to measure the following parameters at three dates; i.e., 1*st* Dec., 1*st* Feb. and 1*st* April.

i. Crown number / plant.

ii. Leaf number /plant.

iii. Non distructive leaf area / plant were determined by plane-meter, after drawing the leaves of each plant.

iv. Dry matter /plant, at the end of the growing seasons.

Statistical Analysis

The recorded data were statistically analyzed for each season separately. Analysis of variance and L.S.D. were done according to Snedecor and Chochran (1980).

RESULTS AND DISCUSSION

The results of the effect of shading the nursery and planting date on the growth of strawberry cultivars; i.e., Camarosa, Sweet Charlie and Rosalinda, in the nursery and in the field will be discussed below.

1. Plant growth traits in the nursery

1.1 Number of the runners and transplant type /mother plant.

a. Main effect

Results in Table 2 clarify significant differences among the

studied cultivars, regarding number of runners, and transplants types produced per mother plant in the two seasons. For number of the runners / mother plant, *cv* Camarosa produced the highest significant number of the runners, followed by *cvs* Sweet Charlie and Rosalinda in the two growing seasons. Regarding transplants types (Table 2), the cvs Camarosa and Sweet Charlie produced the highest number of the transplants of the three types; i.e., type A, B and C with insignificant differences between them, except transplants of type A, in the first season, but *cv* Rosalinda gave the lowest significant number from those transplants types.

Regarding the effect of shading treatments (Table 2), unshaded mother plants in the nursery gave the highest number of the runners compared with the shading treatments, but it was insignificant, in the 2*nd* season. For transplants types, 60 days shading significantly increased number of the transplants of the three types in the 1*st* season, but this was insignificant for type B: In the 2*nd* season, 90 and 75 days shading had the highest number of transplants from types A and B, but type C transplants was not affected by shading treatments.

b. Interaction effect

Data in Table 3 indicate insignificant effect of the cultivars x shading the nursery treatments on the number of the runners in the 1*st* season. On the other hand, it had a significant effect on the number of runners/ mother plant in the 2*nd* season. Regarding the effect of shading treatments on each cultivar, the results revealed significant increase in the number of runners with unshaded Camarosa nursery, but the other two cultivars were not affected by shading treatments. For transplants types number (Table 3), shading treatments had significant effect on the number of type A transplants, and both A and B types in the 1*st* and 2*nd* seasons, respectively. Nevertheless, the highest significant numbers of A and B types, in the second season, were observed with 90 and 75 days for *cv* Sweet Charlie, but such an increase did not reach to the level of significance for the other two cultivars, when compared the effect of shading under the same cultivars. These results agree with those of Chandler *et al.* (1992), who reported that the strawberry plant which subjected to shade produced fewer runners; and with Ragab *et al.* (2002), who found a positive effect for shading on increasing fresh transplants

Table 2 : Average effect of the cultivar and shading the nursery on numbers of runners and transplants types /strawberry mother plant

Treatment	1999 Runners No.	1999 Transplants Types Type A No.	1999 Transplants Types Type B No.	1999 Transplants Types Type C No.	2000 Runners No.	2000 Transplants Types Type A No.	2000 Transplants Types Type B No.	2000 Transplants Types Type C No.
Effect of the cultivar								
Camarosa	11.60	86.70	136.50	84.70	13.30	98.70	84.50	54.40
Sweet Charlie	8.90	64.30	134.50	95.70	12.30	121.30	117.40	84.10
Rosalinda	7.90	31.20	69.10	52.70	9.40	28.20	25.70	25.10
LSD at 0.05	2.90	21.40	46.70	NS	3.70	42.30	52.50	46.30
Effect of the shading days								
Unshaded	10.30	53.10	102.90	61.30	12.30	64.90	64.70	46.70
60 days shading	8.60	68.40	123.80	92.10	12.10	61.70	58.50	40.90
75 days shading					10.70	99.60	95.70	62.30
90 days shading					11.10	104.60	84.50	68.10
LSD at 0.05	1.70	15.10	NS	26.20	NS	25.80	29.40	NS

NS,insignificant at the 0.05 level of probability.
Type A,B transplants that had more and less than 0.7 cm. of crown diameter,respectively
Type C the unrooted one .

Table 3 :Effect of the interaction between cultivar and shading the nursery on the numbers of runners and transplants types /strawberry mother plant

Treatment	1999 Runners No.	1999 Transplants Types Type A No.	Type B No.	Type C No.	2000 Runners No.	2000 Transplants Types Type A No.	Type B No.	Type C No.
Camarosa								
Unshaded	12.30	93.00	154.20	78.00	15.20	95.40	102.40	59.60
60 days shading	10.80	80.40	118.80	91.40	12.60	82.20	80.10	48.90
75 days shading					10.90	106.20	84.90	56.60
90 days shading					9.60	111.00	70.50	52.30
Sweet Charlie								
Unshaded	10.00	86.80	114.00	78.80	11.40	80.20	79.60	65.80
60 days shading	7.20	41.80	155.00	106.00	12.30	81.20	73.00	56.80
75 days shading					14.60	159.80	167.30	104.80
90 days shading					14.90	163.80	149.80	109.10
Rosalinda								
Unshaded	8.60	25.40	40.00	27.00	10.40	19.00	12.20	14.80
60 days shading	7.20	37.00	97.00	78.40	11.30	21.60	22.40	17.00
75 days shading					7.00	32.90	35.00	25.50
90 days shading					8.80	39.10	33.60	42.90
LSD AT 0.05 for comparing :								
two interaction means	NS	26.10	NS	NS	1.40	44.70	50.90	NS
two shade means (under the same cultivar)	NS	26.90	NS	NS	5.70	63.30	77.90	NS

NS,insignificant at the 0.05 level of probability

Type A,B transplants that had more and less than 0.7 cm. of crown diameter,respectively,

Type C the unrooted one .

production. Also, Ferre and Stang (1988) reported that shading strawberry transplants during July and Aug. produced fewer runners.

1.2 Dry matter and C/N ratio

Since the transplants of type C has no roots, the DM and C/N ratio are not presented.

a. Main effect

Regarding the difference among the cultivars studied (Table 4), the results indicated significant difference among the three cultivars in the transplants shoots and roots dry matter and C/N ratio, in the two growing seasons, except that of the shoots and roots DM for transplants of type B in the 1*st* and 2*nd* seasons, respectively. Dry Matter of the shoots and roots of the *cv* Camarosa transplants (types A, B) reflected the highest values compared with the other two cultivars. Whereas, for C/N ratio, *cv* Sweet Charlie gave the highest value.

Regarding the effect of shading (Table 4), shading treatments, in the 1*st* season, had significant effect on roots DM of the transplants of type A and C/N ratio, which scored the highest value with 60 days shading in the nursery. In the 2*nd* season (Table 4), 75 days shading favoured insignificant shoots DM for both transplants types (A and B) and significant C/N ratio compared with unshaded treatment. Whereas, 90 days shading gave the highest values of roots DM, for both transplants types. Chandler *et al.* (1992), Awang and Atherton (1995), Khalafalla *et al.* (2001) and Ragab *et al.* (2002), reported that shading plants has a negative effect on dry matter of plants, which agreed with this study.

b. Interaction effect

Results in Table 5 clarify that cultivar x shading interaction had no effect on the DM of the transplants shoots and roots, of both types, in the two seasons, except that for roots DM of transplants of both types in the 1*st* season, which gave the highest root DM with Camarosa x unshaded and with Sweet Charlie x 60 days shading of the 1*st* type only. While, C/N ratio was significantly affected by this interaction, in the two seasons. For the effect of shading on each cultivar, in the 1*st* season, the highest C/N ratio was obtained with 60 days shading, unshaded and 60 days shading, and in the 2*nd* season, it was at the maximum values with 75 days shading, unshaded and 75 days shading, for the *cvs* Camarosa, Sweet Charlie and Rosalinda, respectively. Therefore, it could be concluded that both the factors; cultivar and

Table 4 : Average effect of the cultivar and shading the nursery on dry matter and C/N ratio /strawberry transplants

Treatment	1999					2000				
	DM of the transplants(gm)				C/N ratio	DM of the transplants(gm)				C/N ratio
	Type A		Type B			Type A		Type B		
	Shoots	Roots	Shoots	Roots		Shoots	Roots	Shoots	Roots	
Effect of the cultivar										
Camarosa	3.18	0.60	1.09	0.31	12.28	3.63	1.23	1.14	0.50	13.28
Sweet Charlie	1.85	0.36	0.76	0.15	13.35	2.48	0.77	0.95	0.39	13.61
Rosalinda	1.84	0.24	0.80	0.15	12.79	1.77	0.32	0.87	0.25	12.67
LSD at 0.05	0.79	0.15	NS	0.08	0.50	0.76	0.69	0.26	NS	0.50
Effect of the shading days										
Unshaded	2.32	0.46	0.92	0.22	12.30	2.92	0.56	1.59	0.24	13.08
60 days shading	2.26	0.34	0.86	0.20	13.32	2.48	0.66	0.85	0.31	12.18
75 days shading						2.59	0.66	1.13	0.31	14.03
90 days shading						2.53	1.22	0.87	0.63	13.46
LSD at 0.05	NS	0.09	NS	NS	0.48	NS	0.56	0.21	0.31	0.9

NS,insignificant at the 0.05 level of probability

Type A,B transplants that had more and less than 0.7 cm. of crown diameter,respectively ;

Table 5 : Effect of the interaction of cultivar x shading the nursery on dry matter and C/N ratio /strawberry transplants

Treatment	1999 DM of the transplants (gm) Type A Shoots	Type A Roots	Type B Shoots	Type B Roots	1999 C/N ratio	2000 DM of the transplants (gm) Type A Shoots	Type A Roots	Type B Shoots	Type B Roots	2000 C/N ratio
Camarosa										
Unshaded	3.32	0.84	1.18	0.43	11.42	4.05	0.77	1.42	0.34	12.06
60 days shading	3.04	0.36	0.99	0.19	13.13	2.97	0.73	0.96	0.26	12.85
75 days shading						3.98	1.23	1.30	0.49	14.99
90 days shading						3.53	2.21	0.86	0.93	13.50
Sweet Charlie										
Unshaded	2.00	0.31	0.77	0.14	13.92	2.89	0.64	1.09	0.25	16.02
60 days shading	1.69	0.41	0.75	0.16	12.77	2.80	0.89	0.82	0.40	11.35
75 days shading						1.90	0.53	1.02	0.30	12.53
90 days shading						2.34	1.04	0.87	0.59	14.53
Rosalinda										
Unshaded	1.64	0.23	0.74	0.07	11.50	1.82	0.26	0.75	0.15	11.16
60 days shading	2.04	0.24	0.85	0.23	14.07	1.86	0.41	0.76	0.26	12.60
75 days shading						1.87	0.21	1.09	0.14	14.58
90 days shading						1.72	0.41	0.90	0.36	12.34
LSD at 0.05 for comparing :										
two interaction means	NS	0.15	NS	0.12	0.69	NS	NS	NS	NS	1.56
two shade means (under the same cultivar)	NS	0.18	NS	0.19	0.45	NS	NS	NS	NS	0.90

NS,insignificant at the 0.05 level of probability

*Type A,B transplants that had more and less than 0.7 cm. of crown diameter,respectively .

shading the nursery, are acting independently on DM of the transplants, but C/N ratio depends on the interaction of the cultivars with shading period.

2. Plant Growth Traits in the Field

In this portion, it was an attempt to study the behaviour of the transplants in the field, which were produced under shading treatments and to which extent this effect; shading the nursery; continued on the growth of the plants in the field. Plants stressed by low irradiance or under low light and those under shortened days are both responding to the total quanta received during the light period, i.e., to the integrated daily irrdiance (Bunce *et al.*, 1977on soybean; Chabot *et al.*, 1977 on sun and shade plants),Jurik *et al.*, 1979 on strawberry;. They also stated that when plants are stressed by low irradiance, their carbon status declines; they acclimate through a number of morphological and physiological adjustments, and shortened the photosynthetic period, similarly do the same set of acclimation responses. Boardman (1977) mentioned that sun leaves exhibited higher rates of photosynthesis per unit of leaf area became light saturated at a higher light intensity than shade leaves do. At low light intensities, however, sun leaves have lower rates of photosynthesis than shade leaves (Kramer and Kozlowzki, 1979).

2.1 Crown number per plant

a. Main effect

The results showed significant differences among the studied cultivars, regarding the crown number produced per plant in the field, at the three sampling dates. The cultivars that produced significantly more number of crowns /plant in Dec. were Sweet Charlie and Camarosa and in both Feb. and Apr. maximum crown numbers were recorded for cvs Camarosa and Sweet Charlie. But, cv Rosalinda had the lowest crown number/plant in all sampling dates in the two seasons.

For the effect of planting date (Table 6), it also had significant effect on number of crowns/ plant at all sampling dates in the 1*st* season, and in Dec., only, in the 2*nd* one. Planting strawberry on Sept. 1 and Sept. 15 showed the highest number of crowns / plant, followed significantly by Oct. 1 planting date, which was the lowest one.

This means that early plantation favoured the formation of crowns. This result agrees with Chercuitte *et al.* (1991) who

Table 6 . Average effect of the cultivar,planting date and shading the nursery on crown number/strawberry plant, in the field at three sampling dates

Treatments	1999/2000			2000/2001		
	Dec.	Feb.	Apr.	Dec.	Feb.	Apr.
			Effect of the cultivar			
Camarosa	2.08	3.80	4.27	3.78	4.83	5.86
Sweet Charlie	2.17	2.80	3.93	3.55	3.52	4.74
Rosalinda	1.01	2.29	3.14	2.33	2.99	3.75
LSD at 0.05	0.02	0.47	0.55	0.63	0.55	0.74
			Effect of the planting date			
1st Sept.	2.27	3.43	4.50	3.44	3.79	4.94
15th Sept.	1.80	3.18	4.04	3.39	3.87	4.75
1st Oct.	1.20	2.28	2.80	2.81	3.69	4.67
LSD at 0.05	0.29	0.90	0.79	0.32	NS	NS
			Effect of the shading days			
Unshaded	1.82	2.80	3.88	2.87	3.46	3.43
60 days shading	1.68	3.15	3.68	3.27	3.78	3.81
75 days shading				3.26	3.92	4.89
90 days shading				3.46	3.97	5.01
LSD at 0.05	0.10	NS	NS	0.24	0.30	0.40

NS,insignificant at the 0.05 level of probability

reported that earlier planting encouraged the development of large multicrown plants.

For shading the nursery (Table 6), it had significant effect in the 1*st* sample and its effect was extended in the field beyond this date in the 1*st* season. It is also quite clear that crown number / plant at the three sampling dates was increased with the increase in shading days of the nursery, in the 2*nd* season. It was significantly high for 75 and 90 days shading compared with unshaded one.

b.Interaction effect

Results in Table 7 clearly show a significant effect of the three way interaction, namely, cultivar x planting date x shading, on the crown number /plant at the three sampling dates. By comparing the effect of planting date x shading treatments under the same cultivar, *cv* Camarosa gave the highest crown number with Sept. 1 x unshaded and with Sept. 1 x 60 days shading in the 1*st* season. Moreover, it gave the highest number of the crowns with Sept.1 or 15 x unshaded or 90 days shading, in the 2*nd* season. For *cv* Sweet Charlie (Table 7), it produced the highest crown number with Sept. 1 x 60 days shading or unshaded, in the 1*st* two samples, or with Sept. 15 x unshade in Feb., and with Sept. 1 x unshaded in April, in the 1*st* season. In the 2*nd* season, it reflected the highest crown number with Sept. 1 x 75 days shading, in Dec. and with Sept., 15 x 75 days shading at the last two samples, with insignificance in the third sample on Sept.1 planting date x all shaded treatments. Regarding to *cv* Rosalinda (Table 7), it was not affected by planting date x shading of the 1*st* sample, but Sept. 1 x 60 days shading in the 2*nd* sample and Sept. 15 x unshaded or 60 days shading showed the highest crown number in the 1*st* season. Moreover, in the 2*nd* season, this cultivar produced more number of the crowns with Sept. 1 x 60 days shading in the 1*st* sample and with Oct. 1 x 60 days shading in the last two samples, which were insignificant with Sept. 15 x 90 days shading and Sept. 1 x 60 or 90 days shading in those sampling dates. The obtained results disagree with those of Ferre and Stang (1988) who clarified no significant effect for shading strawberry plant on crown numbers. However, Awang and Atherton (1995) reported that shading strawberry plants reduced crown number / plant.

2.2 Leaf number /plant

a. Main effect

Data in Table 8 show that, the cultivars significantly differ in

Table 7 : Effect of interaction of the planting date x cultivar x shading the nursery on crown number/strwbbery plant, in the field at three sampling dates

Treatments	December			February			April		
	Camarosa	Sweet Charlie	Rosalinda	Camarosa	Sweet Charlie	Rosalinda	Camarosa	Sweet Charlie	Rosalinda
				First season (1999/2000)					
D1 Unshaded	3.40	3.00	1.00	4.53	3.13	1.47	5.00	5.60	2.87
60 days shading	2.13	3.00	1.00	4.87	3.40	3.20	5.33	4.33	3.67
D2 Unshaded	2.07	2.47	1.00	3.87	3.13	1.73	4.80	4.47	3.67
60 days shading	2.07	2.20	1.00	4.67	2.73	2.93	4.20	3.93	3.20
D3 Unshaded	1.33	1.13	1.00	2.53	2.60	2.00	3.27	2.60	2.67
60 days shading	1.47	1.13	1.07	2.33	1.80	2.40	3.00	2.67	2.60
				Second season (2000/2001)					
D1 Unshaded	4.40	3.33	0.67	5.43	3.33	1.67	6.83	5.20	2.40
60 days shading	3.73	3.67	3.20	4.47	3.47	3.31	5.47	5.23	4.98
75 days shading	3.57	4.47	2.47	4.38	3.93	3.11	5.35	5.23	4.01
90 days shading	4.75	4.20	2.88	5.07	3.80	3.47	6.03	5.07	4.53
D2 Unshaded	4.40	3.20	1.93	4.97	3.60	2.20	6.00	4.27	2.60
60 days shading	3.93	3.07	2.67	4.53	3.20	3.00	5.67	4.40	3.40
75 days shading	4.27	3.93	2.53	4.97	4.27	3.27	5.80	5.27	3.80
90 days shading	4.40	3.40	2.93	5.40	3.27	3.93	6.26	4.87	4.67
D3 Unshaded	3.00	3.33	1.53	4.40	3.37	2.40	5.33	4.00	3.27
60 days shading	3.40	2.80	2.93	5.20	2.96	3.93	5.93	3.93	5.27
75 days shading	2.67	3.45	2.20	4.60	3.95	2.87	6.37	4.90	3.47
90 days shading	2.73	3.93	1.93	4.80	3.27	2.73	5.40	4.67	3.60

LSD at 0.05 level for comparing :	1999/2000			2000/2001		
	Dec.	Feb.	April	Dec.	Feb.	April
any two means of the interaction	0.30	1.22	1.55	0.72	0.90	1.19
any two planting date x shade interaction means under the same cultivar	0.17	0.69	0.90	0.42	0.82	0.69

D1,D2,D3 = Planting dates ; D1 : Sept. 1 ,D2 : Sept. 15 , D3 : Oct. 1 .

Table 8 . Average effect of the cultivar,planting date and shading the nursery on leaf number /strawberry plant, in the field at three sampling date

Treatments	1999/2000			2000/2001		
	Dec.	Feb.	Apr.	Dec.	Feb.	Apr.
			Effect of the cultivar			
Camarosa	16.38	20.80	39.40	20.23	28.29	31.68
Sweet Charlie	16.68	21.13	26.52	18.03	17.85	17.46
Rosalinda	19.28	13.62	28.40	13.44	14.77	13.73
LSD at 0.05	NS	4.22	7.84	3.99	3.42	3.84
			Effect of the planting date			
1st Sept.	24.60	21.88	39.04	19.29	18.12	20.10
15th Sept.	17.49	20.05	32.66	16.61	21.48	20.57
1st Oct.	10.24	13.63	22.58	15.81	21.32	22.20
LSD at 0.05	4.48	7.03	11.19	NS	NS	NS
			Effect of the shading days			
Unshaded	16.79	18.37	31.24	15.84	18.67	21.97
60 days shading	18.10	18.67	31.61	17.05	20.15	20.85
75 days shading				17.27	19.93	18.99
90 days shading				18.79	22.46	22.02
LSD at 0.05	NS	NS	NS	1.99	243.00	2.60

NS,insignificant at the 0.05 level of probability

their leaf number/ plant at all sampling dates in the two seasons, except that of Dec. sample in the 1*st* season. The highest number of leaves/plant were produced by *cv* Camarosa followed by Sweet Charlie, but Rosalinda *cv* was the least one in this respect.

Planting date had significant effect on leaf number /plant at all sampling dates, in the 1*st* season, Sept. 1 planting date showed the highest leaf number/plant, followed insignificantly by Sept. 15 planting date in Feb. and April samples and significantly by Oct. 1 planting date, at the three sampling dates. In 2*nd* season, the results did not show any significant effect of the planting date on leaf number at all sampling dates.

As for the effect of shading the nursery (Table 8), it had no effect on the leaf number /plant, in the 1*st* season. However, in the 2*nd* season, 90 days shading of the nursery gave maximum leaf number/ strawberry plant in comparing with other shading or unshaded treat-ments. This effect was extended till April sampling date. Awang and Atherton (1995) reported that shading strawberry plants caused a reduction in leaf number. But, Khalafalla *et al.* (2001) reported that shading *Euphorpia milii* plant by 47% shading net increased number of leaves /plant.

b. Interaction effect

Data in Table 9 show insignificant effect of the interaction treatments on strawberry leaf number /plant at the three sampling dates, in the 1*st* season, On the other hand, the interaction treatments had significant effect on the leaf number and the cultivars responded differently to planting date x shading treatments, in the 2*nd* season (Table 9). In this respect, *cv* Camarosa produced the highest leaf number /plant with Sept. 15 x 90 days shading; Sept. 1 x unshaded; and Sept. 15 x unshaded and Oct. 1 x unshaded, 60 or 75 days shading, respectively with the 1*st*, 2*nd* and the 3*rd* sampling dates. For *cv* Sweet Charlie, it favoured Sept.1 x 90 days shading and unshading, if the planting took place on Sept. 15 or Oct. 1 in Dec. sample; Sept. 1 x 90 days shading, Sept. 15 x 75 days shading and Oct. 1 x unshaded in Dec. sample; and unshaded x Sept. 15 or Oct.1 plantations, Sept. 15 x 75 days shading and Oct. 1 x 90 days shading in April sample. With respect to *cv* Rosalinda, it generally produced the highest leaf number with Oct. 1 x 60 days shading treatment, at all sampling

Table 9 . Effect of interaction of the planting date x cultivar x shading the nursery on leaf number/strawberry plant in the field at three sampling dates

Treatments	December			February			April		
	Camarosa	Sweet Charlie	Rosalinda	Camarosa	Sweet Charlie	Rosalinda	Camarosa	Sweet Charlie	Rosalinda
First season 1999/2000									
D1 Unshaded	23.67	19.33	26.00	20.13	26.00	18.00	45.00	33.60	35.47
60 days shading	19.40	34.73	24.47	20.60	30.00	17.27	43.87	36.27	38.27
D2 Unshaded	18.07	15.83	18.53	24.00	26.20	14.68	43.07	31.23	31.93
60 days shading	19.87	13.40	19.27	23.00	20.13	12.27	40.53	21.20	27.99
D3 Unshaded	8.47	9.33	11.87	13.53	13.13	11.13	22.93	15.93	20.00
60 days shading	8.80	7.47	15.53	23.53	11.33	9.13	41.00	18.87	16.73
Second season 2000/2001									
D1 Unshaded	13.67	14.40	10.93	19.53	11.33	12.79	31.72	17.83	15.60
60 days shading	20.87	15.40	11.53	24.87	14.93	13.00	30.00	16.73	11.42
75 days shading	17.87	17.33	9.20	24.07	18.60	6.80	70.00	13.58	7.00
90 days shading	21.60	21.07	15.86	30.80	22.00	18.67	24.13	16.70	20.88
D2 Unshaded	23.80	23.93	8.60	36.47	18.33	8.27	34.91	19.93	8.13
60 days shading	20.80	16.60	16.06	26.87	15.93	15.80	35.60	16.80	13.40
75 days shading	21.47	20.40	16.67	28.13	21.27	16.93	26.07	20.00	15.13
90 days shading	27.93	18.40	16.87	31.73	19.33	18.67	26.27	18.47	15.80
D3 Unshaded	15.20	21.27	10.73	30.20	20.20	10.93	35.40	19.13	14.33
60 days shading	20.73	12.80	18.67	31.13	15.73	23.07	37.66	12.87	22.00
75 days shading	20.80	16.73	15.00	27.67	19.73	16.20	36.40	17.47	10.93
90 days shading	18.07	18.07	11.20	28.07	16.87	16.07	30.00	20.07	10.13

LSD at 0.05 level for comparing :	1999/2000			2000/2001		
	Dec.	Feb.	April	Dec.	Feb.	April
any two means of the interaction	NS	NS	Ns	5.93	7.27	7.78
any two planting date x shading interaction means under the same cultivar	Ns	Ns	NS	3.45	4.2	4.5

NS,insignificant at the 0.05 level of probability

D1,D2,D3 = Planting dates ; D1. Sept. 1 ; D2 .Sept. 15 ; D3 , Oct. 1 .

Table 10. Average effect of the cultivar,planting date and shading the nursery on leaf area (cm.2) /strawberry plant, in the field at three sampling dates

Treatments	1999/2000			2000/2001		
	Dec.	Feb.	Apr.	Dec.	Feb.	Apr.
			Effect of the cultivar			
Camarosa	1925.90	1105.70	1726.10	2018.20	1468.20	1570.20
Sweet Charlie	1605.90	773.30	971.10	1797.10	877.50	712.10
Rosalinda	1322.70	550.40	893.90	946.00	604.00	552.70
LSD at 0.05	NS	269.70	433.67	501.68	342.12	219.88
			Effect of the planting date			
1st Sept.	2229.20	862.00	1382.30	1324.60	776.00	842.34
15th Sept.	1809.10	1047.40	1249.00	1755.30	995.00	964.64
1st Oct.	816.30	520.00	959.70	1681.50	1178.80	998.07
LSD at 0.05	631.79	485.87	NS	NS	NS	NS
			Effect of the shading days			
Unshaded	1536.00	776.54	1290.50	1360.40	759.20	829.80
60 days shading	1700.00	843.07	1103.50	1487.00	996.10	10.13.0
75 days shading				1734.60	982.30	799.90
90 days shading				1766.40	1195.30	1097.30
LSD at 0.05	NS	NS	NS	275.90	272.73	211.17

NS,insignificant at the 0.05 level of probability

dates, which was insignificant with some other few cases.

2.3 Leaf area plant

a. Main effect

The data in Table 10 indicate that the cultivars were significantly differed in their leaf area / plant, in the two growing seasons, except that in Dec. sample in the 1*st* season. Moreover, *cv* Camarosa plants had the highest leaf area compared with the other two *cvs* ; i.e., Sweet Charlie and Rosalinda. Planting date, in this respect, had significant effect only, at the first two samples in the 1*st* season. The plantations of strawberry on Sept. 1st and Sept. 15th produced the highest values of the leaf area / plant in Dec. and Feb. sampling dates, respectively.

For shading effect (Table 10) it is quite clear that shading treatments had no effect on strawberry leaf area, in the 1*st* season. While in the 2*nd* one they reflected significant effect on plant leaf area. In this season, the highest values of leaf area were obtained with 75 or 90 days shading in Dec. sample, with 90 days shading at Feb. sample and with 90 or 60 days shading in April, when these treatments were compared with their respective unshaded ones. Generally, 90 days shading of the nursery was the most favourable treatment on strawberry plant leaf area and its effect was extended till the end of the growing season. Opposite results were obtained by Awang and Atherton (1995), who reported that shading strawberry plants caused a reduction in leaf area.

b. Interaction effect

Results in Table 11 show interaction on strawberry plant leaf area at the three sampling dates in the two growing seasons, except that of Dec. sample in the 1*st* season. By comparing the effects of planting date x shading treatments on the same cultivar, in the 1*st* season, *cv* Camarosa leaf area favoured Sept. 15th x unshaded, 60 days shading in Feb. sample and with Sept. x unshaded or with Sept. 15th x 60 days shading in April sample . The same results showed that *cv* Sweet Charlie, generally, gave the highest leaf area with Sept. 15th x unshade in Feb. and Apr. samples and / also with Sept. 1st b x 60 days shading and with Sept. 1st x unshade at the later two samples, respectively. For *cv* Rosalinda, the highest leaf area / plant favoured Sept. 15 unshade or Sept. 1st x 60 days shading in Feb. Sample and Sept.1st x unshade or Sept. 15th x unshade in April sample.

In the 2*nd* season, *cv* Camarosa leaf area / plant favoured Sept. 15th

Table 11 : Effect of interaction of the planting date x cultivar x shading the nursery on leaf area (cm2.) /strawberry plant , in the field at three sampling dates

Treatment	December			February			April		
	Camarosa	Sweet Charlie	Rosalinda	Camarosa	Sweet Charlie	Rosalinda	Camarosa	Sweet Charlie	Rosalinda
First season (1999/2000)									
D1 Unshaded	2573.30	1158.05	1944.40	998.88	761.17	415.43	2120.58	1392.86	1211.13
60 days shading	2317.62	3527.28	1854.71	1207.73	1001.25	787.60	1647.25	1086.86	835.63
D2 Unshaded	2335.28	2230.52	1279.50	1373.58	1157.25	863.86	1644.76	1469.29	1158.36
60 days shading	2534.05	1185.08	1289.88	1539.37	882.68	467.72	1878.72	576.21	766.48
D3 Unshaded	887.68	879.99	535.65	504.86	449.75	464.04	1220.86	623.76	773.10
60 days shading	907.63	654.77	1032.00	1009.84	387.64	303.77	1844.56	677.60	318.44
Second season (2000/2001)									
D1 Unshaded	1431.95	982.26	466.40	79.65	555.82	338.70	1654.39	474.63	311.15
60 days shading	1777.00	1374.95	797.58	1212.62	530.57	405.50	1385.44	722.01	398.83
75 days shading	1496.82	1763.20	718.15	905.95	830.14	233.68	934.22	304.95	395.54
90 days shading	2321.96	1953.64	811.92	1266.26	1402.32	838.86	1980.52	656.86	889.52
D2 Unshaded	2765.05	2243.69	293.73	1552.52	870.70	96.29	1225.32	862.45	148.90
60 days shading	1834.12	1597.60	952.35	1432.69	865.49	416.73	1693.58	952.81	286.17
75 days shading	1831.26	1937.50	1510.59	1640.13	755.90	549.52	1257.36	714.92	682.64
90 days shading	2745.89	1988.60	1363.21	1483.32	1027.53	1249.89	2093.46	735.67	922.35
D3 Unshaded	1442.12	2031.87	587.01	1523.48	934.57	170.40	1753.16	691.16	346.75
60 days shading	2224.03	1264.42	1561.65	2007.35	850.20	1243.94	2028.28	608.69	1046.57
75 days shading	2394.88	2080.55	1679.59	1999.66	989.36	942.49	1386.70	1020.74	502.25
90 days shading	1753.49	2347.99	610.97	1808.25	918.24	762.08	1450.20	805.24	342.21

LSD at 0.05 level for comparing :	1999/2000			2000/2001		
	Dec.	Feb.	April	Dec.	Feb.	April
any two means of the interaction	NS	564.12	934.51	825.70	816.21	631.97
any two planting date x shading interaction means under the same cultivar	NS	337.12	534.54	476.72	471.24	364.87

D1,D2,D3 = Planting dates ; D1 : Sept. 1 ,D2 : Sept. 15 , D3 : Oct. 1 .

x unshade or 90 days shading, Oct. 1st x 60 or 75 days shading, and Sept. 15th x 90 days shading or Oct. 1st x 60 days shading at the three sampling dates, respectively. For *cv* Sweet Charlie, it was mostly favoured Oct. 1st x 90 days shading, Sept. 1st x 90 days shading, and Oct. 1st x 75 days shading, for leaf area /plant, respectively with the three sampling dates. For *cv* Rosalinda, it produced the highest leaf area /plant with Sept. 15th x 75 days or Oct. 1st x 60 or 75 days shading, with Sept.15th x75 days or Oct. 1st x 60 or 75 days shading, with Sept. 15th x 90 days or Oct. 1st x 60 days shading, and with Oct. 1st x 60 days shading, respectively with the three sampling dates. Moreover, there were some other cases, which were not significantly differed from these mentioned treatments for each cultivar.

2.4 Dry matter per plant

a. Main effect

The results in Table 12 show significant differences in dry matter /plant among the studied three cultivars. The significant highest DM values in the two growing seasons were yielded by *cv* Camarosa, followed significantly by *cv* Sweet Charlie and *cv* Rosalinda which showed the least DM values, in both seasons.

For planting date, it had, also, significant effect on the yield of the DM /plant in the two growing seasons. The highest DM values were obtained with Sept. 1st planting date followed significantly by Sept. 15th and Oct. 1st planting dates, with insignificance between the later two planting dates. Such a result could be attributed to that, this planting date, i.e., Sept. 1st , provides the plants more days to grow more than the other two planting dates, and that may led the plant to produce more number of both the crowns and leaves, which subsequently reflected on DM content.

For shading days (Table 12), the results reveal that shading treatments did not reflect any significant effect on DM /plant in the *1st* season, but they had significant effect in the *2nd* one. The highest significant value was obtained with 75 days shading. Meantime, there was insignificant difference between 90 days shading and the unshaded one. Similar results were obtained from Sevenson (1995), who reported that the shoot dry matter of strawberry plant, which subjected to 60%, was higher than under 80%. But Ferre and Stang (1988) reported that shading strawberry plants showed non significant

Table 12 . Average effect of the cultivar,planting date and shading the nursery on dry matter (gm) /strawberry plant, in the field at June.

Treatments	1999/2000	2000/2001
	Effect of the cultivar	
Camarosa	66.23	68.36
Sweet Charlie	40.20	51.37
Rosalinda	34.00	42.78
LSD at 0.05	5.69	5.12
	Effect of the planting date	
Sept.1st	64.97	67.56
Sept.15th	37.63	49.66
Oct.1st	37.81	45.28
LSD at 0.05	8.98	7.61
	Effect of the shading days	
Unshaded	46.06	51.21
60 days shading	47.58	53.88
75 days shading		59.80
90 days shading		51.21
LSD at 0.05	NS	5.37

NS,insignificant at the 0.05 level of probability

Table 13 : Effect of interaction of the planting date x cultivar x shading the nursery on drymatter(gm) /strawberry plant, in the field in June

Treatments	Cultivar		
	Camarosa	Sweet Charlie	Rosalinda
	First season 1999/2000		
D1 Unshaded	92.67	67.59	34.81
60 days shading	109.63	41.96	43.14
D2 Unshaded	55.48	28.90	20.12
60 days shading	43.76	32.39	45.21
D3 Unshaded	46.34	35.41	33.21
60 days shading	49.48	34.95	27.49
	Second season 2000/2001		
D1 Unshaded	141.53	73.65	37.19
60 days shading	71.25	47.19	64.18
75 days shading	68.25	69.78	36.42
90 days shading	142.85	41.02	47.47
D2 Unshaded	61.06	29.58	22.71
60 days shading	75.40	69.21	35.87
75 days shading	53.42	77.38	52.20
90 days shading	29.61	34.16	54.69
D3 Unshaded	50.10	38.87	36.18
60 days shading	37.05	43.25	40.49
75 days shading	65.04	56.34	59.39
90 days shading	54.75	35.39	28.08

LSD at 0.05 level for comparing :	1999/2000	2000/2001
any two means of the interaction	12.52	10.06
any two planting date x shading interaction means under the same cultivar	7.23	9.28

D1,D2,D3 = Planting dates ; D1 : Sept. 1 ,D2 : Sept. 15 , D3 : Oct. 1 .

differences in dry weight between shaded and sun exposed plants.

b. Interaction effect

Results in Table 13 reveal significant effect of all interaction treatments on DM contents of strawberry plants, in the two growing seasons. The results showed the response of each cultivar to planting date x shading. It is clear that the highest DM yield, in the 1*st* season, for *cv* Camarosa was obtained with Sept. 1st x 60 days shading or unshade ones; For *cv* Sweet Charlie, it was obtained with Sept.1st x unshaded or x 60 days shading, and for cv Rosalinda, it was obtained with Sept. 15 or Sept. 1 x 60 days shading. In the 2*nd* season, the highest DM yield for *cv* Camarosa was obtained with Sept. 1st x 90 days shading or into unshade one with Sept. 15th x 75 days shading, Sept.1st x unshaded or x 75 days shading and with Sept.15th x 60 days shading for Sweet Charlie and with Sept. 1st x 60 days shading and with Oct. 1st x 75 days shading for *cv* Rosalinda, with insignificance between those treatments for each cultivar.

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تأثير موعد الزراعة والتظليل بالمشتل على ثلاثة أصناف من الفراولة
١- نمو النباتات فى المشتل والحقل

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**معهد الكفاية الانتاجية جامعة الزقازيق - مصر

يهدف هذا البحث إلى دراسة استجابة ثلاثة أصناف (كاماروزا سويت شارلى،وروزا لندا) للتظليل فى المشتل (صفر ، ٦٠ ، ٧٥ ، ٩٠ يوما) وسلوك هذه الشتلات المظللة تحت ثلاثة مواعيد زراعة (أول سبتمبر ، ١٥ سبتمبر ، أول أكتوبر) فى الحقل.

ولقد سجلت القياسات الخاصة بصفات النمو الخضرى بالمشتل وفى الحقل أعطى صنف الكاماروزا فى المشتل أعلى نمو فى كل من عدد المدادات / نبات أم وعدد الخلفات / نبات أم وكذلك أكبر وزن جاف للمجموع الخضرى والجذرى للشتلات طراز أ ، ب .

بينما أعطى صنف سويت شارلى أعلى نسبة كربوهيدرات / نتروجين بالشتلات . كما أعطت الأمهات التى لم تظلل بالمشتل أكبر عدد من المدادات، وعموماً فإن معاملة التظليل أعطت أكبر عدد من الشتلات طراز أ ، ب علاوة على ذلك فإن التظليل لمدة ٦٠ يوم فى الموسم الاول و ٧٥ يوم فى الموسم الثانى كانت أفضل فى نسبة الكربون / نتروجين بالشتلات.

وتفاعل الاصناف مع معاملة التظليل لم تكن معنوية بالنسبة للوزن الجاف للشتلات بينما كان هناك تأثير معنوى لهذه التفاعل فى نسبة ك / ن للشتلات . وفى قياسات الحقل أعطى الصنفين كامازورا وسويت شارلى أعلى عدد تيجان وعدد أوراق / نبات خاصة فى الزراعات المبكرة (١، ١٥ سبتمبر) إذا زرعت بشتلات مظللة بالمشتل لمدة ٧٥ أو ٩٠ يوم تظليل واستجابة تفاعل الاصناف مع مواعيد الزراعة وتظليل الشتلات بالمشتل كانت معنوية فى الموسم الثانى فقط . علاوة على ذلك فإن صنف كاماروز سجل أعلى مساحة ورقية / نبات وأعلى وزن جاف للنبات مع ميعاد الزراعه المبكر ١ سبتمبر.

ومن ناحية أخرى فإن التظليل لم يكن له تأثير معنوى على المساحة الورقية والوزن الجاف للنبات فى الموسم الاول بينما كان التأثير معنوياً فى الموسم الثانى . والتفاعل الثلاثى بين الاصناف ومواعيد الزراعة وتظليل الشتلات على المساحة الورقية والوزن الجاف للنبات كانت معنوية.