Menoufia J. Plant Prod., Vol. 2 October (2017): 395 - 406

EFFECT OF GIBBERELLIC ACID CONCENTRATIONS AND RUNNERS' REMOVAL RATES ON YIELD AND QUALITY OF FRIGO STRAWBERRY PLANTATIONS

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Received: May 17 , 2017 Accepted: Jul. 10, 2017

ABSTRACT: *This experiment was carried out at a private farm in Shoney Village, Tanta, El-Gharbia Governorate, Egypt, during the two successive seasons of 2014/2015 and 2015/2016 to study the effect of runners' removal rates beside mothers full removal "no runners", five runners left, ten runners left and Without runners' removal and foliar spray of gibberellic acid 0 ppm, 25 ppm and 50 ppm and their interactions on vegetative growth, chemical properties, physiological traits, yield and quality of strawberry "Fortuna cv." planted under mixed planting system which fixed many runners beside mother plant with different density. Gibberellic acid (GA_3) was sprayed three time in 30 days intervals. The experimental design was a split plot in a randomized complete block design with three replications. The result indicated that foliar application of 25 ppm of gibberellic acid (GA_3) with removing all runners caused an increase in plant height, size, weight and shape index of the fruits. gibberellic acid (GA_3) at 25 ppm gave also the highest number of early fruits and early yield during both seasons, GA_3 also gave the highest value of TSS, vitamin C, number of leaves, number of fruits and the yield too. The study shows that it's better to use gibberellic acid (GA_3) with 25 ppm to spray the strawberry fruits with removing all the runners that exist beside the mother plant and that's to increase the vegetative growth and to improve the yield qualities.*

Key words: *Strawberry, Gibberellic acid (GA_3), Runners, Yield, Fruit quality, Frigo.*

INTRODUCTION

Strawberry (*Fragaria x ananassa* Duch.) is an interspecific hybrid between the two species, *Fragaria chiloensis* and *Fragaria virginiana* (Darrow, 1965). Several cultivated forms of strawberry can be grouped as June bearing, overbearing and day-neutral (Hancock *et al.*, 2005). It has traditionally been a popular delicious fruit for its flavor, taste, fresh use, freezing and processing. They are rich in ascorbic acid, secondary metabolites, simple sugars and acids (Pe´Rez *et al.,* 1997). But are highly worsening, with soft texture, high softening rate and are highly susceptible to fungal attack (Shin *et al.,* 2008). Carbohydrates in strawberry fruit are known to participate in many pathways related to fruit ripening, flavor development and color development (Souleyre *et al.*, 2004). Total sugar contents of different strawberry cultivars vary, the ratio of each specific sugar to total sugars is constant (Bood and Zabetakis, 2002). Strawberry is a good source of phenolics, which function as antioxidants and are highly valued in the human diet for their role in prevention of cardiovascular disease (CVD) and cancer (Kris-Etherton *et al.,* 2002). The production of strawberry in Egypt is 435506 kg/ha, according to (FAO, 2014).

Foliar application of gibberellic acid at 50, 200 mg/l had increased petiole length and leaf area of the strawberry plants (Paroussi *et al*., 2002 a). In another study Kumar *et al*., (2012) showed that strawberry plants which is treated with 75 ppm of gibberellic acid showed an increase in all vegetative growth characteristics *viz*., plant height, petiole length, number of leaves, plant spread and leaf area Index. Foliar application of

strawberry plants with GA_3 increased TSS and Vitamin c in their fruits (Sharma and singh, 2009, Kazemi *et al.* 2014, and Thakur *et al.* 2015).

Regarding the effect of foliar application of gibberellic acid on yield and its components and fruit quality, Rasheed (2010) indicated that treating strawberry with GA_3 at 150 mg/l gave the longest fruits, while concentration of 300 mg/l gave the highest yield. Similar results were found by Uddin *et al.,* (2012) who showed that GA_3 at 75 ppm gave the best growth and yield of strawberry plants.

The negative effect of GA_3 at its higher concentration (200 mg/l) on total yield may be attributed to an increase in the percentage of aborted flowers and malformed fruit (nubbins), itself a consequence of the negative effect GA_3 at 200 mg/l may have on pollen germination (Voyiatzis and Paroussi, 2002 a).

Number and growth of tips were higher on plants without defoliation, and decreased 44.7% on twice-defoliated mother plants. The two-defoliation management did not reduce runner tip and the dry matter mass only on plants with rooted stolons, which produced runner tips 50% heavier Defoliation of mother plants bearing rooting stolons can be used to reduce their growth, without reducing the resurrection and growth of runner tips (Picio *et al.,* 2014).

(Klaas *et al*., 2009) demonstrated that keeping the runners from plants has negative effect on the total yield in the first year. On the average over three years, there is a decrease in berry weight and an increase in the amount of grade two berries. In order to obtain a high quality yield, runners must be removed during harvest.

Therefore, this study was carried out to investigate the effect of GA_3 concentrations and number of runners left beside mother plants on growth yield and quality of strawberry.

MATERIALS AND METHODS

This study was conducted at a private farm in Shoney Village, Tanta, El-Gharbia Governorate, Egypt during the two successive seasons of 2014/2015 and 2015/2016, to study the effect of foliar application of GA_3 and runners' removal rates and their interaction on growth, yield and fruit quality of strawberry " *Fragaria* × *ananassa* " var. *Fortuna*. Soil was clay in texture, physical and chemical properties of experimental are presented in Table (1).

Strawberry plants were planted on September 8th and 10th in the first and the second seasons, respectively. The experimental unit area was 12 m^2. It contained 5 rows with 3 m^2 in length and 80 cm wide. The frigo transplants were planted 25 cm between each other. Seedlings were transplanted in such a way that the crown dos not go much under the soil or doesn't remain in shallow. All agricultural practices for cultivation were performed as recommended by Ministry of Agriculture and land Reclamation.

Table (1): Some chemical and physical properties of the experiment soil according to Ryan *et al.* (1996)

Chemical analysis												Physical analysis	
Cations (meq^{-1})				Anions (meq^{-1})				Macro nutrient (ppm)			(meq^{-1})		
Na^+	K^+	Mg^{++}	Ca^{++}	Hco_3^-	Co_3^{--}	Cl^-	So_4^-	N	P	K	$Caco_3^-$	pH	E.C
2.6	0.1	0.1	0.2	0.1	---	1.5	1.4	80	45	640	1.7	7.8	0.3

The experimental design was a split-plot design with 3 replications. Runners' removal rates were in the main plots 4 treatments; full removal "no runners", five runners left, ten runners left and without runners' removal and the sub plot consisted of three different concentrations of gibberellic acid (without GA_3, 25 and 50 ppm) was sprayed after one month from transplant for three time in 30 days intervals.

Data recorded

The following data were recorder

Vegetative growth:

Six plants were taken from each experiential plot to determine plant height (cm) and number of leaves plant^{-1} at 30 days from transplant.

Yield and it's components

Fruits from six plants were harvested to determine average of weight, length and diameter of fruit at 130 days from transplant. Total number of fruits. Fruits were harvested at 130 days from transplant, when the fruit reached at harvesting stage. In harvesting period the fruits turn red in color with waxy layer. Marketable fruits were harvested at 2-3 day intervals during the growing season, counted, and weighed to record average fruit weight. The early yield/plant was determined as weights of all harvested fruit during the first four harvests. Total yield/ plant was calculated for all fruits harvested all one the season.

Chemical constituents

Six full mature fruits were collected randomly from each treatments in the middle of the growing season at 130 days from transplant to determine the chemical fruits quality i.e. Vitamin C (mg/100 g) that was determined in juice using 2, 6-dichlorophenol indophenol and it was expressed as mg/100 ml juice as described by (A.O.A.C., 1990), and TSS (%) was determined using a hand refractometer (abb model) and the results were expressed as brix (Cheour *et al*., 1991).

Statistical analysis

Data were analyzed by MSTATC computer software program adopted by Bricker, (1991) using ANOVA with the least significant difference (LSD) at the $P \leq 0.05$.

RESULTS AND DISCUSSION

Vegetative growth

Form data of Table (2) it could noticed that, runner's removal rates had significant increase on the plant height and number of leaves. The highest plant and number of leaves were obtained by full removal "runners" for mother, in both seasons. And the highest plant height was recorded with five runner's left for runners, in both seasons. While, the highest of leave number was with ten runner's left or without runner's, in the season only. These trends of results are similar with (Klaas *et al*., 2009).

Data presented in Table (2) showed that the effects of gibberellic acid (GA_3) on vegetative growth characters, Application of GA_3 at 25 ppm had significant effect on plant height and number of leaves. Plant height for mother or runners was significantly increased, in both seasons. While, number of leaves was significantly increased in the first season for runners and in the second season for mother. The result were in accordance with Kumar *et al*., (2012) and Kazemi *et al.* (2014). Dale *et al*., (2008) found that may be caused by GA_3, which can induce stolons formulation by activating dormant buds to grow or by preventing the flower but initiation. Waithika *et al.,* (1978) also reported that leaf number was also increased with increasing the concentration of Gibberellic acid. This might be attributed to the fact that GA_3 supply induces cell elongation and cell division Rademabher, (2000). The increase may be due to the effect GA_3 promotes shoot growth by stimulating rapid cell division and elongation of plant stem and shoots Turner, (1963).

Data tabulated in Table (2) show also that, interactions between runners' removal

Table (2): Effect of runners' removal, GA_3 and their interactions on plant height and number of leaves during 2014/2015 and 2015/2016 seasons.

Characters	Treatments	Plant height (cm)		Plant height (cm)		Number of leaves		Number of leaves	
		2014/2015 season		2015/2016 season		2014/2015 season		2015/2016 season	
		Mother	Runners	Mother	Runners	Mother	Runners	Mother	Runners
Runners' removal	Full removal "no runners"	11.91a	0.00d	14.37a	0.00d	9.41a	0.00c	7.27a	0.00
	Five runners left	9.12b	7.45a	12.90b	4.38a	6.21b	1.55b	5.83bc	1.91
	Ten runners left	8.22c	6.86b	11.18c	3.81b	4.98c	2.00a	5.58c	2.00
	Without runners' removal	7.42c	6.50b	10.91c	3.342c	4.74c	2.33a	6.16b	1.91
	L. S. D at 0.05 %	0.813	0.298	0.532	0.167	0.412	0.384	0.444	N. S
Gibberellic acid	Without GA_3	8.82b	5.00b	11.70b	2.76c	6.27	1.30a	5.90b	0.87c
	GA_3 at 25 ppm	9.36a	5.30a	13.00a	3.06a	6.35	1.20b	6.28a	1.31b
	GA_3 at 50 ppm	8.79b	4.97b	12.23b	2.88b	6.39	1.75a	5.86b	2.18a
	L. S. D at 0.05 %	0.526	0.256	0.489	0.100	N. S	0.144	0.399	0.218
Full removal "no runners"	Without GA_3	12.30a	0.00d	13.88b	0.00g	9.73a	0.00e	7.75a	0.00f
Full removal "no runners"	GA_3 at 25 ppm	12.30a	0.00d	15.15a	0.00g	9.30a	0.00e	6.75bc	0.00f
Full removal "no runners"	GA_3 at 50 ppm	11.13b	0.00d	14.07b	0.00g	9.20a	0.00e	7.32ab	0.00f
Five runners left	Without GA_3	9.16c	7.53a	12.25cd	4.20b	5.60cd	1.33c	5.75de	1.25de
Five runners left	GA_3 at 25 ppm	9.36c	7.56a	13.82b	4.52a	6.63bc	1.33c	6.50c	1.75bc
Five runners left	GA_3 at 50 ppm	8.83c	7.26a	12.63c	4.42a	6.66b	2.00b	5.25e	2.70a
Ten runners left	Without GA_3	8.50cd	7.16ab	10.80ef	3.65de	5.00d	3.00a	5.75de	1.00e
Ten runners left	GA_3 at 25 ppm	8.50cd	7.10ab	11.65cde	3.97c	4.93d	1.00d	5.50e	2.00b
Ten runners left	GA_3 at 50 ppm	7.66de	6.33c	11.07ef	3.82cd	5.03d	2.00b	5.50e	3.00a
Without runners' removal	Without GA_3	7.43de	6.66bc	10.20f	3.22f	4.76d	3.00a	6.75bc	1.25de
Without runners' removal	GA_3 at 25 ppm	7.30e	6.53c	11.38de	3.52e	4.80d	1.00d	6.37cd	1.50cd
Without runners' removal	GA_3 at 50 ppm	7.53de	6.30c	11.15ef	3.27f	4.66d	3.00a	5.37e	3.00a
	L. S. D at 0.05 %	1.050	0.513	0.977	0.206	0.837	0.289	0.698	0.437

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

rates and foliar application of GA_3 was found to be significant effect for vegetative growth for mother and runners, in both seasons. The highest values of plant height and number of leaves for mother were in treatment full removal "no runners" + without GA_3 with no significant difference in treatment full removal "no runners" + GA_3 at 25 ppm in the first season. While the maximum values of plant height for runners was in treatment five runners left + with GA_3 with no significant effect difference in treatments five runners left + GA_3 at 25 + 50 ppm, in addition to number of leaves for runners increased in treatment ten runners left + without GA_3, in the first season. On the other hand the plant height and number of leaves for mother increased in treatments full removal "no runners" + GA_3 at 25 ppm and full removal "no runners" + without GA_3, in the second season, respectively. And treatments five runners left + GA_3 at 25 + 50 ppm gave highest value on plant height for runners, in the second season. As for number of leaves for runners the maximum value was in treatment five runners left + GA_3 at + 50 ppm, in the second season.

Yield and it's components

It is clear from data tabulated in Table (3 and 4) reflect the effects of runners' removal rates on yield and it's components for mother and runners in both seasons. Fruit volume for mother in the first season, fruit weight for the runners, fruit shape index and number of fruits in both seasons were no significant effect. While treatment ten runners left gave the highest values, fruit volume for runners in the first season, fruit volume for mother in the second season, fruit weight for mother in both seasons and fruit shape index for mother in the first season without significant difference between treatments five runners left and without runners' removal, were highly significant effect. Conversely, the maximum values were in treatment full removal' "no runners" for number of fruits and early yield for mother in both seasons, whatever total yield for mother in the first season. In addition to early and total yield for runners gave maximum value in treatment five runners left in both seasons and total yield for mother were highly significant effect in the second season. The results are in agreement Portz and Nonnecke, (2009) and Picio *et al.,* (2014). In general among all cultivars, average berry size and total berry yield were higher when runners and flowers were removed until the end of July, mother plant weights were generally highest for Tribute. Due to smaller plants with Seascape and Albion, producers may want to plant the strawberry plants closer together, such as 6 in. to 9 in. instead of 12 in. to increase overall production within an area Portz and Nonnecke, (2009).

Data tabulated in Tables (3 and 4) showed that, there was no significant effect, fruit volume for runners in the first season and shape index for mother in the first season and the runners in the second season. While the highest values for foliar application GA_3 at 25 ppm were highly significant effect on fruit volume without significant difference between treatment without GA_3, in addition to number of fruits and total yield for runners. Whatever the foliar application without GA_3 were highly significant effect on fruit weight and early yield for the mother and runners in both seasons, in addition to, number of fruits and total yield for mother in both seasons. While the highest values on fruit volume for mother and runners, shape index for the mother in the second season and the runners in the first season. These results are similar with Hossan *et al.*, (2010). GA_3 stimulated rapid cell division and elongation in plant stems and shoots Turner, (1963). El-Shabasi *et al.,* (2008) reported that GA_3 application increased petiole length. Thompson and Guttride, (1959) found an increase in length and upright growth of petioles and concluded that GA_3 can substitute for growth promoting substances that are produced normally under long days, the increase in size and weight with the

Table (3): Effect of runners' removal, GA_3 and their interactions on fruit volume, weight and shape index during 2014/ 2015 and 2015/ 2016 seasons.

Characters	Treatments	Fruit volume (cm^3)				Fruit weight (g)				Fruit shape index (T/d)			
		2014/2015 season		2015/2016 season		2014/2015 season		2015/2016 season		2014/2015 season		2015/2016 season	
		Mother	Runners	Mother	Runners	Mother	Runners	Mother	Runners	Mother	Runners	Mother	Runners
Runners' removal	Full removal "no runners"	26.76	0.00c	23.22d	0.00b	28.56b	0.000	25.31b	0.000	1.167b	0.00	1.18b	0.00
	Five runners left	25.11	18.89b	27.42c	19.17.c	20.02c	52.72	17.69c	41.83	1.31a	1.36	1.35a	1.40
	Ten runners left	26.67	20.89a	42.53a	23.98b	50.13a	52.89	31.61a	43.47	1.33a	1.41	1.30a	1.40
	Without runners' removal	25.11	19.58b	38.75b	25.35a	25.51b	50.00	19.80c	42.68	1.31a	1.42	1.35a	1.33
	L. S. D at 0.05 %	N. S	1.072	1.411	0.556	3.825	N. S	3.687	N. S	0.089	N. S	0.101	N. S
Gibberellic acid	Without GA_3	25.48b	15.08	31.27c	16.85b	35.59a	44.28a	26.04a	35.30a	1.28	1.00b	1.29ab	1.03
	GA_3 at 25 ppm	26.67a	14.58	32.76b	16.60b	32.37b	36.15b	24.83b	31.01b	1.29	1.06ab	1.25b	1.05
	GA_3 at 50 ppm	25.58b	14.85	34.90a	17.92a	25.21c	36.28b	19.94b	29.65b	1.26	1.08a	1.35a	1.01
	L. S. D at 0.05 %	1.032	N. S	1.084	0.515	3.029	3.911	2.259	0.922	N. S	0.077	0.061	N. S
Full removal "no runners"	Without GA_3	28.27ab	0.00d	24.75e	0.00f	35.40c	0.000e	30.67b	0.000e	1.13d	0.00c	1.17cd	0.00c
Full removal "no runners"	GA_3 at 25 ppm	29.33a	0.00d	26.05e	0.00f	27.83d	0.000e	25.00cde	0.000e	1.17cd	0.00c	1.12d	0.00c
Full removal "no runners"	GA_3 at 50 ppm	22.67d	0.00d	18.85f	0.00f	22.43de	0.000e	20.25efg	0.000e	1.20bcd	0.00c	1.25bcd	0.00c
Five runners left	Without GA_3	22.67d	17.67c	18.45f	17.20e	28.30d	53.00c	24.88cde	40.80c	1.26abcd	1.23b	1.30abc	1.35ab
Five runners left	GA_3 at 25 ppm	25.67c	19.33abc	23.90e	17.80e	13.23f	35.10d	12.43h	29.60d	1.30abcd	1.40ab	1.35ab	1.47a
Five runners left	GA_3 at 50 ppm	27.00bc	19.67abc	39.90bc	22.50d	18.53ef	70.07a	15.78gh	55.08a	1.36abc	1.46a	1.40a	1.40a
Ten runners left	Without GA_3	26.00bc	21.00ab	41.40bc	24.30c	53.00b	63.97ab	28.42bc	51.00ab	1.46a	1.43a	1.30abc	1.42a
Ten runners left	GA_3 at 25 ppm	27.00bc	21.00ab	41.75b	23.15d	59.97a	56.73bc	40.10a	47.53b	1.30abcd	1.36ab	1.25bcd	1.35ab
Ten runners left	GA_3 at 50 ppm	27.00bc	20.00ab	44.45a	24.50bc	37.43c	37.97d	26.30bcd	31.88d	1.23bcd	1.43a	1.37ab	1.45a
Without runners' removal	Without GA_3	25.00c	21.67a	40.50bc	25.90a	25.67d	60.13bc	20.20efg	49.42b	1.26abcd	1.33ab	1.40a	1.37ab
Without runners' removal	GA_3 at 25 ppm	24.67cd	18.00c	39.35c	25.45ab	28.43d	52.77c	21.77def	46.95b	1.40ab	1.50a	1.30abc	1.40a
Without runners' removal	GA_3 at 50 ppm	25.67c	19.00bc	36.40d	24.70bc	22.43de	37.10d	17.42fg	31.67d	1.26abcd	1.43a	1.37ab	1.22b
	L. S. D at 0.05 %	2.065	2.288	2.168	1.031	6.059	7.822	4.519	1.844	0.181	0.154	0.122	0.145

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

Table (4): Effect of runners' removal, GA_3 and their interactions on number of fruits, early and total yield during and 2014/2015 and 2015/2016 seasons.

Treatments	Characters	Number of fruits/ m²				Number of fruits/ m²		Early yield (g/m²)		Early yield (g/m²)		Total yield (g/m²)		Total yield (g/m²)	
		2014/2015 season				2015/2016 season		2014/2015 season		2015/2016 season		2014/2015 season		2015/2016 season	
		Mother	Runners	Mother	Runners	Mother	Runners	Mother	Runners	Mother	Runners	Mother	Runners	Mother	Runners
Runners' removal	Full removal "no runners"	180.7a	0.000	185.10a	0.000	518.0a	0.000c	961.9a	0.000d	2743.0a	0.000c	2833b	0.000c		
	Five runners left	101.6b	120.6	106.69b	125.91	313.0b	29.68a	335.7ab	34.46a	1816.0b	411.0a	1920a	429.8a		
	Ten runners left	78.09c	120.3	83.46c	125.39	248.2c	19.63b	257.2ab	21.91b	1077.0c	195.3b	1170c	188.7b		
	Without runners' removal	77.22c	120.2	82.39c	125.08	166.5d	20.03b	191.8b	20.46c	1007.0d	198.7b	1109d	193.9b		
	L. S. D at 0.05 %	6.104	N.S	4.229	N.S	27.00	2.40	680.30	0.72	62.13	21.41	14.74	31.87		
Gibberellic acid	Without GA_3	132.4a	86.09b	137.40a	89.82b	385.9a	18.39a	657.1a	20.54a	2037a	188.9c	2140a	188.3b		
	GA_3 at 25 ppm	104.9b	100.3a	109.90b	104.16a	318.4b	16.73b	397.3b	19.01b	1606b	214.4a	1704b	219.5a		
	GA_3 at 50 ppm	90.89c	84.51b	95.93c	88.30b	230.0c	16.89ab	255.5a	18.06b	1339c	200.4b	1430c	201.5ab		
	L. S. D at 0.05 %	3.433	2.164	2.533	1.657	18.90	1.52	528.9	1.01	52.69	9.36	41.31	18.26		
Full removal "no runners"	Without GA_3	231.4a	0.000g	234.60a	0.000h	591.4a	0.000f	610.9b	0.000f	2876a	0.000f	2975.0a	0.000e		
Full removal "no runners"	GA_3 at 25 ppm	175.7b	0.000g	181.01b	0.000h	567.0a	0.000f	1847.0a	0.000f	2786a	0.000f	2879.0b	0.000e		
Full removal "no runners"	GA_3 at 50 ppm	135.0c	0.000g	139.69c	0.000h	395.7c	0.000f	427.6b	0.000f	2568b	0.000f	2644.0c	0.000e		
Five runners left	Without GA_3	108.1d	81.15f	113.20d	85.62g	528.9b	27.47b	547.0b	31.70b	2355c	347.8c	2456.0d	366.9b		
Five runners left	GA_3 at 25 ppm	101.1e	144.8a	106.32e	150.15a	212.1e	22.37c	239.2b	26.52c	1777d	452.5a	1873.0e	471.5a		
Five runners left	GA_3 at 50 ppm	95.52ef	135.9b	100.54f	141.95b	198.0ef	39.20a	220.9b	45.15a	1317f	432.7b	1432.0h	451.0a		
Ten runners left	Without GA_3	96.67ef	129.6c	102.65ef	134.68d	210.7e	23.77c	199.9b	25.85c	1500e	204.0d	1615.0f	208.3c		
Ten runners left	GA_3 at 25 ppm	71.04g	132.2bc	75.93g	137.19cd	326.7d	23.80c	344.2b	26.08c	978.4g	201.6d	1070.0i	200.4c		
Ten runners left	GA_3 at 50 ppm	66.56g	99.27e	71.78g	104.29f	207.3ef	11.33e	227.4b	13.80e	753.1h	180.2e	826.3j	157.3d		
Without runners' removal	Without GA_3	93.65f	133.6bc	99.14f	138.98bc	212.7e	22.33c	231.4b	24.63cd	1417ef	204.0d	1516.0i	178.2cd		
Without runners' removal	GA_3 at 25 ppm	71.56g	124.3d	76.33g	129.30e	167.9f	20.73c	197.8b	23.45d	884.4g	203.6d	817.5j	205.9c		
Without runners' removal	GA_3 at 50 ppm	66.46g	102.8e	71.72g	106.95f	119.0g	17.03d	146.1b	13.30e	719.2h	188.6de	82.62	197.6c		
	L. S. D at 0.05 %	6.866	4.329	5.065	3.314	37.80	3.04	1058	2.03	105.40	18.73	82.62	36.52		

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

application of GA_3 may be due to increased size of plant and leaf, and higher chlorophyll content which in turn may have enhanced the photosynthetic activities.

From the obtained data Table (3 and 4) it could noticed that, the interactions between runners' removal rates and foliar application of GA_3. The highest values on fruit volume for mother in the first season and early yield for mother in treatment full removal "no runners" + GA_3 at 25 ppm in the second season, moreover there found highly significantly effect on fruit volume and number of fruits for runners in the second season. Number of fruits for mother in both seasons and total yield for mother in the second season in treatment full removal "no runners" + without GA_3. Early yield and total yield was significant effect in treatment full removal "no runners" + without GA_3 without significant difference between this treatment full removal "no runners" + GA_3 at 25 ppm, in the first season. In addition to the treatment ten runners left + GA_3 at 25 ppm gave the maximum values on fruit weight for mother in both season. While fruit weight and early yield for runners was highly significant effect in treatment five runners left + GA_3 at 50 ppm in both seasons. Finally fruit weight, number of fruits and total yield for runners, in both seasons and fruit shape index for runners, in the second season was highly significant effect in treatment five runners left + GA_3 at 25 ppm. While fruit shape index for mother was highly significant effect in treatment ten runners left + without GA_3, in both season. In addition to fruit weight for runners was highly significant in treatment without runners' removal + without GA_3, in both season. While fruit shape index for runners gave highest value in treatment without runners' removal + GA_3 at 25 ppm, in the first season.

Chemical constituents

Data presented in Table (5) clearly show that the effects of runners' removal rates chemical constituents. The highest values on vitamin C and TSS for mother was recorder with treatment full removal "no runners" in both seasons, in addition to for runners on vitamin C it's no significant effect in both seasons. While TSS for runners was highly significant in treatment, five runners left in the first season, while the runners it's no significant in the second season. The result were accordance with Klaas *et al*., (2009).

It is quite clear from data in Table (5) that vitamin C content of fruit for mother and runners were significant effect with application of water in both seasons. While TSS was no significant for mother and runners in both seasons. The result are confirmed with Sharma and Singh, (2009), Ouzounidou *et al.,* (2010), Kazemi *et al.,* (2014) and Thakur *et al.*, (2015). Perkins-Veazie, (1995) reported that SSC (soluble solid content) of strawberry fruits varied from 4-11% depending on cultivars and environment. The combined application of GA_3 with plant growth promoting rhizobacteria can produce effects on ascorbic acid contents of strawberries and that may be due to their synergetic effect.

As for interaction between runners' removal rates and foliar application of GA_3 on vitamin C and TSS. When treated the mother by treatment full removal "no runners" + without GA_3 on vitamin C and TSS was highly significant effect, in both seasons. While vitamin C for runners gave highest value in treatment five runners left + without GA_3, in the both seasons. In addition to TSS for runners was height significant effect in treatment five runners left + GA_3 at 25 ppm.

Table (5): Effect of runners' removal, GA_3 and their interactions on vitamin C and TSS during 2014/2015 and 2015/2016 seasons.

Treatments	Characters	Vitamin C - (mg/100 g)		Vitamin C - (mg/100 g)		TSS (%)		TSS (%)	
		2014/2015 season		2015/2016 season		2014/2015 season		2015/2016 season	
		Mother	Runners	Mother	Runners	Mother	Runners	Mother	Runners
Runners' removal	Full removal "no runners"	47.82a	0.000	61.28a	0.000	4.54a	0.000c	9.317a	0.00
	Five runners left	36.16c	57.71	53.91b	57.71	4.21ab	4.34a	8.80ab	9.02
	Ten runners left	41.33b	57.12	63.78a	57.12	4.04ab	4.12ab	8.417b	8.86
	Without runners' removal	38.50c	56.69	56.47b	56.69	3.94b	3.89b	8.275b	8.73
	L. S. D at 0.05 %	2.462	N. S	4.567	N. S	0.524	0.239	0.672	N. S
Gibberellic acid	Without GA_3	47.45a	44.47a	59.75a	44.47a	4.20	3.092	8.875	6.581
	GA_3 at 25 ppm	39.77b	42.88ab41.	59.23ab	42.88ab	4.15	3.217	8.631	6.756
	GA_3 at 50 ppm	35.64c	29b	57.60b	41.29b	4.10	2.958	8.606	6.631
	L. S. D at 0.05 %	2.813	2.158	1.941	2.158	N. S	N. S	N. S	N. S
Full removal "no runners"	Without GA_3	72.07a	0.000d	62.55a	0.000d	5.13a	0.000c	9.400a	0.00c
Full removal "no runners"	GA_3 at 25 ppm	31.13e	0.000d	61.13ab	0.000d	4.10b	0.000c	9.275a	0.00c
Full removal "no runners"	GA_3 at 50 ppm	40.27bcd	0.000d	60.15abc	0.000d	4.40ab	0.000c	9.275a	0.00c
Five runners left	Without GA_3	39.70cd	50.00a58.08a	54.08de	60.00a	4.26ab	4.333a	9.125ab	8.900ab
Five runners left	GA_3 at 25 ppm	35.60e	bc	56.63cd	58.08abc	4.43ab	4.500a	8.625abcd	9.250a
Five runners left	GA_3 at 50 ppm	33.17e	55.05bc	51.03e	55.05bc	3.93b	4.200a	8.675abc	8.925ab
Ten runners left	Without GA_3	42.53bc	59.68ab57.42	64.15a	59.68ab	3.60b	3.867ab	8.325bcd	8.850ab
Ten runners left	GA_3 at 25 ppm	46.33b	abc	63.03a	57.42abc	4.13b	4.200a	8.825abc	8.925ab
Ten runners left	GA_3 at 50 ppm	35.13de	54.25c	64.18a	54.25c	4.40ab	4.300a	8.100cd	8.25ab
Without runners' removal	Without GA_3	35.50de	58.22abc56.0	56.15cd	58.22abc	3.80b	4.167a	8.650abcd	8.575b
Without runners' removal	GA_3 at 25 ppm	46.00b	0abc55.85abc	58.22bcd	56.00abc	3.96b	4.167a	7.800d	8.850ab
Without runners' removal	GA_3 at 50 ppm	34.00de	4.316	55.05de	55.85abc	4.06	3.333b	8.375bcd	8.775ab
	L. S. D at 0.05 %	5.625		3.882	4.316	0.831	0.584	0.758	0.466

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

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تأثير تركيزات حمض الجبريليك ومعدلات إزالة المدادات على محصول وجودة زراعات الفرولة المبردة

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الملخص العربى

أجريت هذه الدراسة خلال موسمى 2015/1014 و 2016/2015 فى مزرعة خاصة بقرية شونى – مركز طنطا – محافظة الغربية لدراسة تأثير الرش الورقى بحمض الجبرلين ومعدل إزالة المدادات على النمو الخضرى والمكونات الكميائية وكذلك الفيزيائية والمحصول ومكوناته وجودة الثمار لنبات الفراولة (صنف فورتونا) وتضمنت التجربة 12 معاملة ناتجة من التوافيق بين 3 معاملات من حمض الجبريليك هى صفر – 25 – 50 جزء فى المليون و4 معاملات من المدادات هى (صفر – 5مدادات – 10مدادات – ترك جميع المدادات) واستخدام تصميم القطع المنشقة لمرة واحدة.

وكانت أهم النتايج المتحصل عليها هى:-

بالنسبة للرش بالجبرلين فقد أدى الرش بتركيز 25 جزء فى المليون إلى الحصول على أعلى زيادة معنويه فى عدد الثمار و المحصول المبكر خلال موسمى النمو.

وبالنسبة لإزالة المدادات فقد أدى إزالة جميع المدادات إلى الحصول على أعلى لقيم المعنوية بالنسبة لصفات إرتفاع النبات و حجم و وزن وشكل الثمار.

وبالنسبة للتفاعل بين إستخدام الجبرلين وإزالة المدادات أشارت النتائج إلى أن المعاملة برش بحامض الجبريليك بتركيز 25 جزء فى المليون مع إزالة جميع المدادات أعطت أفضل النتائج فى معظم الصفات المدروسة.