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EFFECT OF SOME MICRONUTRIENTS FOLIAR APPLICATION, PLANTING DATE AND SPACING ON CHEMICAL COMPOSITION AND YIELD OF GERANIUM.

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ABSTRACT

This investigation was carried out at Demo location El – Fayoum, Egypt during two successive seasons (1999 – 2000) and (2000 – 2001).

The design of the experiment was split-split plot, the main plot was planting dates (1st. November, 15th. November and 1st. December), sub – plot was plant spacing (20 and 40 cm. between plants) and sub - sub plots was micronutrient treatments ($CuSO_4$.$5H_2O$, Mn – EDTA, and Fe – EDTA) as a foliar spray applied twice, for each season.

The main results are summarized as follows :

1. Statistical analysis of the results indicated that fresh weight of yield and oil yield / feddan were significantly affected by sowing dates and spacings among plants in the two seasons. The highest fresh weight / feddan was recorded for plants planted on Nov. 15th. and spaced at 20 cm. among plants, followed by early November in the two seasons. Fresh weight of yield was decreased by delaying planting date at first December.
2. Data also indicated that the highest value (ton / feddan) and oil yield / fed were obtained when plants were grown at the narrow distance (20 cm.) among plants.
3. The average fresh weight of yield was significantly increased by foliar applications with all micronutrients. The order of increases was Fe > Mn > Cu > untreated.
4. Fe, Mn and Cu – concentration in leaves was increased on 15 – November sampling date in the two seasons.
5. All micronutrient treatments increased Fe, Mn and Cu – concentration in leaves compared to the untreated plants.

Keywords: Planting dates, Spacings, Micronutrients, fresh yield and oil yield

INTRODUCTION

Medicinal and aromatic plants are very important economical plants. Nowadays, there is a return to use the natural products in pharmaceuticals and cosmetics.

In Egypt, geranium essential oil is one of the most important ingredients in perfumery due to its agreeable and very pronounced strong rose - like odour. Also the essential oil is used as cosmetic compounds, scenting of soaps, flavouring agent foods and in pharmaceutical industries. It can be used externally as antiseptic, antalgic, parasiticide and mosquito repellent. On the other hand, it can be used internally as tonic, astrigent, antiseptic, antidiabetic and anticancer.

The only region where pelargonium grows wild is the cape province (Union of South Africa), at which there are about 600 species of the genus pelargonium in the cape province. Many of them possess an agreeable odour. According to Marais (1991), there are four new species of pelargonium are from the western cape province. Pelargonium is native to South Africa, and is cultivated in some African countries such as Egypt, Algeria, Morocco, Kenya, Tanganyika and Congo.

Yan et al. (1994) working on the chemical compositions of essential oils from scented leaves of *Pelargonium hybrids* found that geraniol contents continously increased between May and Oct., and citronellol contents slightly decreased. They noticed that the geraniol concentration of plants differed according to the climatic conditions.

Rao et al. (1988) found that the highest herb and essential oil yields of *Pelargonium graveolens* were obtained by using 240 kg N / ha. They recommended the spacing of 60 x 45 cm.

Lima and Haag (1981) showed that levels of N , P , K and Fe in the leaves of normal plants (*Pelargonium zonale*) were 2.18 , 0.35 , 2.14 % and 265 ppm., respectively;

Mohamed (1999) found that the application of NPK fertilization in combination with micronutrients (Fe and Zn) at concentration ranging from 50 to 150 ppm on three geranium species increased plant height, number of branches / plant, number of leaves / plant, fresh and dry weights of the herb. Also, essential oil percentage and oil yield / plant was increased compared to untreated plants and the main components of *P. graveolens* oil were geraniol and citronellol.

Therefore, the aim of this investigation is to study the effect of climatic factors and micronutrients fertilization (iron, manganese and copper), on the chemical composition and yield of geranium.

MATERIALS AND METHODS

Field experiments were conducted during two seasons (1999 / 2000 and 2000 / 2001) at the Demo farm in Fayoum Governorate, to study the effect of climatic factors and micronutrients fertilization on the chemical composition and yield of geranium, plants (*Pelargonium graveolens* L´ Her.)

The experimental design used was split – split – plot design, 3 x 3.5 m, (10.5 m^2) for each plot with three treatments. The first treatment consisted of three sowing dates (1^{st} . November, 15^{th} . November and 1^{st} . December), this treatment represented the main treatment. The second treatment was distances (20 and 40 cm.) among plants, as the sub treatment. Sowing date and plant distance treatments were chosen so as to furnish, among other variables, relatively wide variations in temperature and light variables within the range used by Egyptian farmers. The third treatment was foliar spray with micronutrients. It represented the sub – sub treatment. The treatments were replicated four times.

Micronutrients were added twice as a foliar spray. The first addition was at 65 days from planting and the second was at 60 days from the first.

The results of the mechanical and chemical analysis and the nutrients contents of the two soil samples are reported in Table (1).

All experimental plots at the two seasons received basal fertilization of nitrogen, phosphorus and potassium. Nitrogen fertilizer was added at the rate of 70 kg N / fed., as anhydrous ammonia (82 % N). The anhydrous ammonia was injected directly into the moderately moisted soil at 15 cm., depth with 30 cm spacing between points of injection before planting. Phosphorus was applied as calcium super phosphate (15 % P_2O_5) before planting at the rate of 30 kg P_2O_5 / fed., whereas potassium was added as potassium sulphate (48 % K_2O) one month before planting at the rate of 48 kg K_2O / fed.

Micronutrients used were as follow: -

1- Fe – EDTA 12 % Fe at the rate of 0.6 gm. / L.
2- Mn – EDTA 12 % Mn at the rate of 0.6 gm. / L.
3- Copper sulphate at the rate of 1 g / L.

The chemical analysis of Soil and Plant were carried out according to the standard methods described by Jackson (1973), Richardss (1954), British Pharmacopeia (1963) and Rawe (1973). Statistical analysis was applied according to snedecor and Cochran (1982).

The plants in the two seasons were harvested at June 25th. At each seasons samples of geranium shoots were taken and the following growth characters were recorded:

1- Fresh weights of yield (ton / fed.).
2- Essential oil yield (L./fed.) Yan *et al.* (1994)
3- Micronutrients (Fe, Mn and Cu) concentration (ppm).

RESULTS AND DISCUSSION

Effect of planting dates, spacings and micronutrients on fresh weights of yield as (ton / feddan) during the two seasons (1999 – 2000) and (2000 – 2001) in geranium :

Table (2) shows the data for fresh weights of yield. The data indicated that fresh weights of yield / feddan was affected by sowing dates and distances in the two seasons. The observed differences were of significant value. Planting on 15 – Nov. and 1 - Nov. gave the highest fresh weights / feddan, respectively. The narrow spacing of 20 cm. apart among plants gave the highest yield fresh weights in all the planting dates in the two seasons. It can be concluded that the 1 – November and 15 – November planting dates were most suitable time for planting. The results agreed with those obtained by Abd El - Aziz (1996) on some medicinal plants who reported that decreasing the spacing among plants to 20 cm. increased yield fresh herb per plot.

Table (1): Some physical and chemical characteristics of the studied soil.

Mechanical fractions %										Anions and Cations (m.e. /L.)							
Soil Sample	Coarse Sand %	Fine Sand %	Silt %	Clay %	Soil texture	Ca CO_3 %	O.M %	PH 1: 2.5	MEc m hos / cm (Soil paste)	$Co_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
1	35.44	40.11	5.35	11.80	sandy loam	6.0	1.30	7.4	1.23	-	5.5	2.0	2.98	2.77	1.42	6.0	0.29
2	25.40	46.33	7.85	10.55	sandy loam	8.5	1.37	7.8	1.50	-	6.5	7.0	2.55	7.55	0.93	7.2	0.37

Nutrients content of the soil samples used

Soil Sample	Available (ppm)					
	N	P	K	Fe	Mn	Cu
1	43.5	28.41	107	3.291	2.550	1.181
2	38.5	23.0	102	2.460	1.920	0.408

Table (2): Effect of planting dates, spacings and micronutrients fertilization on fresh weights of yield (ton / fed.) during (1999 – 2000) and (2000 - 2001) seasons in Geranium.

Planting dates		20 cm					40 cm				
		Un-treated	Cu	Mn	Fe	Mean	Un-treated	Cu	Mn	Fe	Mean
01 - Nov.	1999 - 2000	11.73	12.48	12.89	13.38	12.62	9.83	10.34	10.69	10.80	10.42
	2000 - 2001	10.18	10.73	11.32	12.17	11.10	9.53	10.02	10.34	10.59	10.12
15 - Nov.	1999 - 2000	11.86	12.57	13.37	13.54	12.84	9.89	10.46	10.95	11.02	10.58
	2000 - 2001	10.42	11.25	12.01	12.34	11.51	9.68	10.10	10.46	10.71	10.24
01 - Dec.	1999 – 2000	11.17	12.28	12.69	13.11	12.31	9.54	10.13	10.64	10.77	10.27
	2000 - 2001	10.12	10.68	11.08	11.92	10.95	9.30	9.92	10.27	10.50	10.00

L.S.D. at 0.05							
Planting dates		Spacings	Micronutrients	Dat. X spa.	Dat.XMic.	Spa. X mic.	DatXspa. X mic.
1999 – 2000	0.087	S	0.093	0.127	0.162	0.132	N.S
2000 – 2001	0.039	S	0.660	0.11	0.114	0.093	0.162

The fresh weights / feddan was significantly affected by foliar application of micronutrient treatments during both seasons, regardless of planting dates and spacingsThe fresh weights of yield was greater in the 1st than in the 2nd season. The addition of Fe treatment gave the highest values of yield fresh weights per feddan over the control. The lowest increase was produced with $CuSO_4$ foliar application over the control plants. The present results are in harmony with those obtained by El – Halwagy (1981) on *Pelargonium graveolens*.

On the other hand, fresh weights of yield / feddan was affected by the interaction between (planting dates x micronutrient treatments) in both seasons.

The highest values of yield fresh weights / feddan were obtained for plants planted on 15 – November and treated with Fe in the 1st . and 2nd . seasons, while the lowest one was recorded for 1 – December planting date for untreated plants in the 2nd . season.

Data in Table (3) also shows that the average fresh weights of yield / fed. was influenced by the interaction between (plant spacings x micronutrient treatments) in the two seasons. The highest yield fresh weights were recorded for 20 cm. apart among plants and foliar addition of iron in the 1 st. and 2nd. seasons, respectively. The least values were recorded for plants spaced at 40 cm. apart among the untreated plants in the first and second seasons.

Table (3):Effect of planting dates, spacings and micronutrients fertilization on fresh weight of yield (ton) / fedd. during (1999-2000) and (2000 – 2001) seasons in Geranium.

Seasons Planting Dates	1999 - 2000													
	Spacings							Spacings		Micronutrients				
	20	40	untreated	Cu	Mn	Fe	Mean	20	40	Untreated	Cu	Mn	Fe	Mean
01 - Nov.	12.62	10.42	10.78	11.41	11.79	12.09	11.52	11.10	10.12	9.86	10.38	10.83	11.38	10.61
15 - Nov.	12.84	10.58	10.87	11.51	12.16	12.28	11.71	11.51	10.24	10.05	10.68	11.24	11.53	10.87
01 - Dec.	12.31	10.27	10.35	11.20	11.66	11.94	11.29	10.95	9.99	9.71	10.30	10.68	11.21	10.47
Mean	12.59	10.42	10.67	11.38	11.87	12.11		11.19	10.12	9.87	10.45	10.91	11.37	

Seasons Spacings	1999-2000					2000 -2001				
	Micronutrients					Micronutrients				
	Untreated	Cu	Mn	Fe	Mean	Untreated	Cu	Mn	Fe	Mean
20	11.58	12.44	12.98	13.35	12.59	10.24	10.89	11.47	12.14	11.19
40	9.75	10.31	10.76	10.87	10.42	9.50	10.01	10.36	10.60	10.12
Mean	10.67	11.38	11.87	12.11		9.87	10.45	10.91	11.37	

The interaction between (planting dates x spacings x application of micronutrients) had no significant effect on fresh weights of yield in the first season, while it had a significant effect in the second season,

It was evident that 15 – November and early planting proved to be the best planting dates for geranium. Also, spacing at 20 cm. apart and foliar application of iron gave the highest fresh weights / feddan.

Essential oil yield (L. / fed.):

Data illustrated in Tables (4 and 5) shows that oil yield L. / feddan was affected by planting dates, spacings and micronutrients fertilization during 1999 – 2000 and 2000 – 2001 seasons.

The different planting dates had a significant effect on essential oil yield / feddan during the two seasons. The highest oil yield was obtained from the second planting date compared to the first and third planting dates in the two seasons. Contrarily, Sushil and Muni (1996) found that the optimum planting time for geranium was in late October or November as it gave the highest essential oil yield kg / ha.

Means of essential oil yield / fed., were significantly affected by plant spacing in the first season, however, the differences were not significant in the second season. Oil yield / fed., was increased by decreasing distances between plants. The highest oil yield was obtained from planting at 20 cm. among plants compared with 40 cm. apart in the first season.

The interaction effect between (planting dates x spacings) was not significant in both seasons.

The data indicated that oil yield (L. / fed.) was significantly affected by foliar application with micronutrients in the two seasons. The maximum oil yield / fed., was obtained with iron treatment compared to the other treatments in the 1^{st} . and 2^{nd} . seasons. Generally, it could be concluded that application of the three micronutrient treatments as foliar spray led to an increase in oil yield / fed., by 14.03 % , 21.70 % and 28.95 % over the untreated treatment in the 1^{st} . season. The corresponding data in the 2^{nd} . season were 13.69 % , 23.19 and 31.31 %, respectively.

The interaction effect between (planting dates x micronutrient treatments), (plant spacings x micronutrient treatments) and (planting dates x spacings x micronutrient treatments) on the same measurements were not significant during both seasons.

From the above results, it can be indicated that the maximum values of essential oil yield per feddan was recorded (17.80 L. / fed.) from mid – November planting date plants, spaced at 20 cm., spacing among plants and foliarly sprayed with Fe in the first season. Oil yield / fed., was higher in the first season than in the second season. This variation in oil yield / fed., may be due to the difference in the fresh weight of leaves, and also to the best climatic conditions prevailing during the first growing season. In this respect, Korezawa (1961) and Rao et al. (1995) on *Pelargonium* species, found that essential oil content was affected by weather parameters either positively or negatively.

Table (4):Effect of planting dates, spacings and micronutrients fertilization on oil yield(L. / fed). during (1999-2000) and (2000 - 2001) seasons in Geranium .

Planting dates		20 cm					40 cm				
		Un-treated	Cu	Mn	Fe	Mean	Un-treated	Cu	Mn	Fe	Mean
01 - Nov.	1999 - 2000	11.63	13.73	13.57	15.03	13.49	10.56	11.50	11.95	12.78	11.69
	2000 - 2001	9.25	10.44	11.86	12.48	11.01	9.58	10.51	11.59	11.90	10.89
15 - Nov.	1999 - 2000	13.22	15.47	16.76	17.80	15.81	11.84	13.55	14.47	15.26	13.78
	2000 - 2001	10.07	12.21	12.95	14.09	12.33	10.98	11.82	13.05	13.42	12.32
01 - Dec.	1999 - 2000	10.35	11.93	13.32	13.89	12.37	9.77	10.64	11.90	12.11	11.10
	2000 - 2001	8.57	10.37	10.21	11.53	10.17	8.85	9.79	10.92	11.80	10.34

L.S.D. at 0.05

	Planting dates	Spacings	Micronutrients	Dat. X spa.	Dat.XMic	Spa. X mic.	Dat.Xspa.X mic.
1999 -2000	1.183	0.817	0.895	N.S.	N.S.	N.S.	N.S
2000 - 2001	0.445	N.S.	0.820	N.S.	N.S.	N.S.	N.S

Effect of planting date, spacings and foliar on mictronutrients concentration in leaves (ppm) during (1999 – 2000) and (2000 – 2001) seasons.

The results of micronutrients concentration (ppm) in leaves of geranium plants as affected by planting dates, spacings and foliar applications of some mictronutrients are given in Tables (6,7 and 8). The persent results indicated that:

Iron:

- Fe – concentration in leaves was increased on 15 – November sampling date in the two seasons.
- Planting at 40 cm., gave the highest values of Fe – concentration.
- All micronutrient treatments increased Fe – concentration in leaves compared to the untreated plants. The greatest value was observed with Fe treatment. Other foliar treatments also increased Fe – concentration but less than Fe treatment.

Manganese:

- The planting date of 15 – November produced the highest Mn – concentration in leaves,
- The increase in plant spacing (40 cm.) enhanced Mn – concentration of geranium plants.
- Foliar application of micronutrients increased Mn – concentration in leaves than the untreated plants. The maximum increase was observed with Mn treatment, the respective order of increase was Mn > Fe > Cu.

Table (5): Effect of planting dates, spacings and micronutrients fertilization on oil yield (L.) / fed.during (1999 - 2000) and (2000 - 2001) seasons in Geranium.

Seasons	1999 - 2000													
Planting dates	Spacings		Micronutrients					Spacings		Micronutrients				
	20	40	Un-treated	Cu	Mn	Fe	Mean	20	40	Un-treated	Cu	Mn	Fe	Mean
01 - Nov.	13.49	11.69	11.09	12.61	12.76	13.90	12.59	11.01	10.89	9.41	10.47	11.72	12.19	10.95
15 - Nov.	15.81	13.78	12.53	14.51	15.62	16.53	14.79	12.33	12.32	10.52	12.01	13.00	13.76	12.32
01 – Dec.	12.37	11.10	10.06	11.28	12.61	13.00	11.74	10.17	10.34	8.71	10.08	10.56	11.66	10.25
Mean	13.89	12.19	11.23	12.80	13.66	14.48		11.17	11.18	9.55	10.85	11.76	12.54	

Seasons	1999-2000					2000-2001				
Spacings	Untreated	Cu	Mn	Fe	Mean	Untreated	Cu	Mn	Fe	Mean
20	11.73	13.71	14.55	15.57	13.89	9.29	11.01	11.67	12.70	11.17
40	10.72	11.89	12.77	13.38	12.19	9.80	10.70	11.85	12.37	11.18
Mean	11.23	12.80	13.66	14.48		9.55	10.85	11.76	12.54	

Table (6): Effect of planting dates, spacings and micronutrients fertilization on iron concentration in leaves (ppm), during (1999 - 2000) and (2000- 2001) seasons in Geranium.

Planting dates		20 cm					40 cm				
		Untreated	Cu	Mn	Fe	Mean	Untreated	Cu	Mn	Fe	Mean
	1999 - 2000	432.00	436.80	461.28	533.00	465.77	435.60	442.00	463.40	546.00	471.75
01 - Nov.	2000 - 2001	391.40	396.00	432.21	462.00	420.40	393.95	400.50	440.00	464.33	424.70
	1999 - 2000	434.00	438.00	462.00	538.00	468.00	434.48	444.50	464.00	542.00	471.25
15 - Nov.	2000 - 2001	393.00	398.00	430.00	464.50	421.38	394.50	400.58	438.00	470.50	425.90
	1999 - 2000	433.50	435.45	461.40	532.80	465.79	436.00	436.90	462.50	547.00	470.60
01 - Dec.	2000 - 2001	389.80	395.30	435.00	463.50	420.90	393.00	401.00	437.50	468.00	424.88

Table (7): Effect of planting dates, spacings and micronutrients fertilization on manganese concentration in leaves (ppm), during (1999 - 2000) and (2000- 2001) seasons in Geranium.

Planting dates		20 cm					40 cm				
		Untreated	Cu	Mn	Fe	Mean	Untreated	Cu	Mn	Fe	Mean
	1999 - 2000	50.00	55.00	69.50	67.50	60.50	52.50	55.00	70.00	68.00	61.38
01 - Nov.	2000 - 2001	44.75	51.33	62.00	60.00	54.52	46.00	52.80	68.00	62.50	57.33
	1999 - 2000	52.00	60.50	69.50	65.00	61.75	53.00	61.00	72.25	66.25	63.13
15 - Nov.	2000 - 2001	45.50	52.14	63.00	60.50	55.29	46.30	52.50	71.00	61.00	57.70
	1999 - 2000	51.50	59.00	70.00	61.50	60.50	52.25	60.00	72.00	63.00	61.81
01 - Dec.	2000 - 2001	44.30	51.55	65.00	60.00	55.21	45.80	52.53	68.50	62.00	57.21

Table (8): Effect of planting dates, spacings and micronutrients fertilization on copper concentration in leaves (ppm), during (1999 - 2000) and (2000- 2001) seasons in Geranium..

Planting dates		20 cm					40 cm				
		Untreated	Cu	Mn	Fe	Mean	Untreated	Cu	Mn	Fe	Mean
01 - Nov.	1999 - 2000	7.69	8.93	8.00	7.83	8.11	8.00	9.24	8.60	8.50	8.59
	2000 - 2001	6.88	7.86	7.23	7.11	7.27	7.08	7.90	7.55	7.43	7.49
15 - Nov.	1999 - 2000	7.56	8.76	8.30	8.05	8.17	8.06	9.53	8.65	8.53	8.69
	2000 - 2001	6.63	7.60	7.12	7.36	7.18	6.69	7.80	7.32	7.50	7.33
01 - Dec.	1999 - 2000	7.30	9.00	8.43	8.20	8.23	7.85	9.36	8.74	8.35	8.58
	2000 - 2001	6.80	7.76	7.46	7.40	7.36	7.00	7.92	7.52	7.60	7.51

Copper :

- The planting date of 15 – Nov., and 1 – Dec., produced the highest copper concentration in leaves in the first and second seasons, respectively.
- The highest values of Cu – concentration were found in plants spaced at 40 cm., whereas the least values were produced from plants spaced at 20 cm. Cu – concentration was increased with Cu application. Other micronutrient treatments also increased Cu – concentration more than the untreated treatment.

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تأثير الرش ببعض العناصر الصغرى و مواعيد ومسافات الزراعة على التركيب الكيميائي و الإنتاج لنبات العتر.

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يهدف هذا البحث إلى دراسة تأثير العوامل المناخية والتسميد بالعناصر الصغرى (الحديد والمنجنيز والنحاس) على التركيب الكيميائي والمحصولي لنبات العتر . وقد استخدم في هذه الدراسة مواعيد الزراعة ومسافات الزراعة كمتغيرات للمناخ المحلي لهذه النباتات.

أجريت الدراسة بمنطقة دمو – محافظة الفيوم – مصر خلال موسمين متتاليين (١٩٩٩ –٢٠٠٠) ، (٢٠٠٠ – ٢٠٠١)

استخدم نظام القطع المنشقة مرتين في تصميم التجربة – حيث كانت مواعيد الزراعة هي القطع الرئيسية والمسافات بين النباتات هي القطع الفرعية.، بينما كان الرش بالعناصر الصغرى مرتين لكل موسم هي القطع تحت الفرعية ومواعيد الزراعة ١ نوفمبر ، ١٥ نوفمبر ، ١ ديسمبر

ومسافات الزراعة مسافة ٢٠ سم و٤٠ سم بين النباتات .

والعناصر الصغرى كبريتات النحاس . منجنيز (صورة مخلبية). حديد (صورة مخلبية).

أما معاملات العناصر الصغرى أضيفت مرتين رشا خلال الموسم .

استخدم سماد الامونيا الغازية (٨٢ % ن) بمعدل ٧٠ كجم / فدان . وأضيفت دفعة واحدة قبل الزراعة حقنا في التربة وسماد سوبر فوسفات الكالسيوم (١٥ % فو٢١) وأضيفت قبل الزراعة بمعدل ٣٠ كجم / فدان وسماد كبريتات البوتاسيوم (٤٨ % بو٢) وأضيفت بعد شهر من الزراعة بمعدل ٤٨ كجم / فدان .

وجمعت النتائج وحللت إحصائيا ويمكن تلخيص النتائج فيما يلي : –

سجلت البيانات أعلى وزن طازج للمحصول (بالطن / فدان) عندما كانت النباتات منزرعة على مسافات ضيقة (٢٠ سم) بين النباتات .

- تشير نتائج التحليل الإحصائي أن مواعيد الزراعة ومسافة الزراعة بين النباتات قد أثرت تأثير معنوي على الوزن الطازج لمحصول الفدان في كلا الموسمين .
- وسجلت أقل وزن طازج لمحصول الفدان عند زراعة النباتات في ميعاد ١٥ نوفمبر وعلي مسافة زراعة ٢٠ سم بين النبات والأخر ، يليه الزراعة المبكرة في نوفمبر في كلا الموسمين ، نقص محصول الفدان عند الزراعة المتأخرة في أول ديسمبر .
- كذلك سجلت البيانات أعلى وزن طازج للمحصول (بالطن / فدان) عندما كانت النباتات منزرعة على مسافات ضيقة (٢٠ سم) بين النباتات....
- زاد متوسط الوزن الطازج للمحصول زيادة معنوية عند استعمال الرش بجميع العناصر الصغرى وكان الزيادة في محصول الفدان تبعا لترتيب التالي الحديد > المنجنيز > النحاس > الكنترول .

٣. محصول الزيت / فدان :

- اختلافي مواعيد الزراعة قد أثرت تأثيرا معنويا على محصول الزيت للفدان في كلا الموسمين . والزراعة في ميعاد ١٥ نوفمبر سجلت أعلى القيم بالمقارنة بمواعيد الزراعة الأخرى .
- تأثر محصول الزيت للفدان تأثيرا معنويا بمسافات الزراعة في الموسم الأول بينما لم يكن هناك تأثير معنوي في الموسم الثاني . وسجل أعلى محصول زيت بالنسبة للفدان من الزراعة على مسافة (٢٠ سم) بين النباتات خصوصا في الموسم الأول . جميع معاملات العناصر الصغرى أعطت أعلي محصول زيت للفدان عن الكنترول ، والمعاملة بالحديد أعطت أعلى محصول زيت بالنسبة للفدان في كلا الموسمين .