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EFFECT OF FERTILIZATION AND GA_3 APPLICATION ON GARLIC (*Allium sativum* L.) GROWTH, YIELD AND ITS COMPONENTS

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ABSTRACT

Two field experiments were conducted at the private farm in El-Mataryia region, Dakahlia Governorate during 2004/2005 and 2005/2006 seasons to study the effect of Gibberellic acid (GA_3), chemical and organic fertilization on vegetative growth, yield and its components, of garlic crop. The split plot design with three replications was used. The main obtained results could be summarized as follows:

GA_3 application at 10 ppm caused significant increases on plant height, number of leaves/plant, plant leaf area, fresh weight of plant, dry weight of plant, total chlorophyll, neck diameter, bulb diameter, total yield of garlic (t/fed), bulb diameter, bulb weight, number of cloves/bulb and clove weight in both seasons as well as bulbing ratio in the second season only. All studied characters of this study were significantly increased by using 100 % chemical fertilizers (CF) and 50 % CF + 50 % FYM treatments in both seasons. Also, there were not significant differences between using 100 % CF and 50 % CF + 50 % FYM treatments in both seasons. The interaction between GA_3 application and fertilization treatments had a significant effect on total yield of garlic, bulb diameter in both seasons. The highest values of these characters were resulted from using 100 % CF with GA_3 application and 50 % CF + 50 % FYM treatments with application of GA_3 without significant differences between them in both seasons.

INTRODUCTION

Garlic (*Allium sativum* L.) is one of the oldest and popular vegetable crops in Egypt. It is cultivated for local consumption as well as for exportation. It is commonly used as a spice and for many medical purposes.

Plant growth regulators proved to be a very helpful tool to regulate physiological processes in plants. Gibberellic acid (GA3) is one of such growth regulators. In this respect; El-Gazar *et al.* (1988) indicated that GA_3 at the rate of 20 ppm caused an increase in total yield, average weight of bulb, average weight of cloves and average diameter of bulb on garlic. Barman *et al.* (1996) found that the highest number of cloves/bulb was obtained from the GA_3 treatment at the rate of 50 ppm. Ramniwas and Singh (1998) found that GA_3 application at the rate of 25 ppm at 45 days after sowing had insignificant effect on growth and yield of garlic. Mondino and Rossi (2000) found that double decker- garlic and pseudobulbs were observed with spraying of GA_3 and dormancy period was shorter. Arguello *et al.* (2001) reported that low levels of GA_3 were found at the end of dormancy and the sprouting channel was formed of garlic. Fabricinus and Rossi (2004) found that GA_3 treatment resulted in high branching incidence of the white garlic type. Rahman *et al.* (2006) found that GA_3 had a significant effects on sprouting of cloves, number of leaves per plant and plant height of garlic.

Concerning to the effect of chemical fertilization with NPK on garlic, many investigators indicated that addition Optimum rate of NPK led to control its growth and productivity. In this concern; Mallanagouda *et al.* (1995) reported that the highest bulb yield of garlic was obtained from plots that treated with the recommended rate of N P K (150 kg N + 75 kg P_2O_5 + 100 K_2O/ha). Ashok *et al.* (1996) indicated that combination rates of N (0, 50, 100 and 150 kg/ha) with P_2O_5 (0, 40 and 80 kg/ha) caused a significant increases in plant height, dry weight/plant and bulb yield. The highest values of these characters resulted from adding 150 kg N/ha with 80 kg P_2O_5/ha. Fayed (1998) showed that application 24 kg P_2O_5/fed had a significant increase in dry weight and number of leaves/plant of garlic plants as compared with those of plants in the unfertilized plots. El-Moursi (1999) indicated that plant height, number of leaves, leaf area and total yield significantly increased with increasing of N levels up to 150 kg/fed. Gad El-Hak and Abd El-Mageed (2000) reported that garlic plants that received 150 kg N/fed as $(NH_4)_2SO_4$ significantly increased in plant height, fresh and dry weight/plant and bulb yield as compared with the control treatment (0 kg N/fed).

Recently, the world go on using organic manure such as Farmyard (FYM) without using chemical fertilizers or at least decrease using of its. Whereas, Farmyard (FYM) application could be led to reduce the applied amounts of chemical fertilizers (NPK) that needed for plant growth. There are many researchers recorded such conclusion among them; Gupta *et al.* (1999) found that application FYM at the rate of 288 kg/ha along with ammonium sulphate at the rate of 565 kg/ha were effective in increasing the growth and yield characters of onion. Singh and Singh (2001) showed that the highest yield of radish was obtained with FYM and oil seed cake + rock phosphate combined with endosulfan. Hassan *et al.* (2001) found that local marketable and exportable of garlic yield significantly increased with increasing chicken manure rates up to 6 t/fed. Alkaff *et al.* (2002) reported that the highest increments in bulb weight, diameter and height of onion were recorded with the mineral fertilizer. Meanwhile, the highest increase in total bulb yield/fed was obtained due to application FYM. Abo El-Magd *et al.* (2003) found that total yields of onion were obtained by chicken manure, whereas the lower values were resulted from mineral fertilization. El-Bassyouni *et al.* (2005) showed that plant height, number of leaves/plant, bulbing ratio and total and exportable yield of onions recorded higher values with mineral fertilizer compared with FYM alone.

Therefore, the aim of this study was to determine the effect of Gibberellic acid (GA_3), chemical and organic fertilization as on vegetative growth, yield and its components of garlic crop under the environmental conditions of Dakahlia Governorate.

MATERIALS AND METHODS

Two field experiments were conducted at the private farm in El-Mataryia region, Dakahlia Governorate during seasons of 2004/2005 and 2005/2006 to study the effect of GA_3 chemical and organic fertilization on vegetative growth, yield and its components of garlic crop.

The experiments were carried out in split plot design with three replications. The main plots were arranged with the following soaking garlic cloves in Gibberellic acid (GA_3) treatments:

1- Without GA_3 *i.e.* soaking garlic cloves in water for 12 hours.

2-With GA_3 *i.e.* soaking garlic cloves in 10 ppm GA_3 solution for 12 h.

The sub plots were assigned to combinations of chemical fertilizers levels and farmyard manure (FYM) as follows:

F_1 – 100 % of chemical fertilizers + 0 % of FYM.
F_2 – 75 % of chemical fertilizers + 25 % of FYM.
F_3 – 50 % of chemical fertilizers + 50 % of FYM.
F_4 – 25 % of chemical fertilizers + 75 % of FYM.
F_5 – 0 % of chemical fertilizers + 100 % of FYM.

The recommended chemical fertilizers (N, P and K) rates were 120 kg N + 75 kg P_2O_5 + 72 kg K_2O/fed, respectively. All doses of chemical fertilizers N, P and K were applied as ammonium sulphate (20.5 % N), calcium superphosphate (15.5 % P_2O_5) and potassium sulphate (48.52 % K_2O), respectively, 50 % at 6 weeks after planting and another 50 % at 12 weeks after planting.

Farmyard manure (FYM) was added to the experimental units corresponding to chosen experimental design (split plot design) before planting in the interior of ridges and then turned over via hack. Before that, samples of FYM were taken to estimate its chemical analysis The experiments were carried out in a clay soil with medium fertility. Each experimental unit contains 5 rows, 3.5 m long and 0.6 m width occupying an area of 10.5 m2. The preceding summer crop was rice (*Oryza sativa* L.) in both seasons.

The planting was carried out during the first week of September in both seasons. The garlic cloves were sown on both sides of the ridges at 10 cm apart. The common agricultural practices for growing garlic according to the recommendations of Ministry of Agriculture were followed, except the factors under study. The harvest was done after 180 days from planting in the both seasons of this study.

STUDIED CHARACTERS:

A- Vegetative growth characters:

At 120 days after planting a random sample of five plants was taken from the inner rows of each sub plot to estimate plant vegetative growth characters as follows:

1- Plant height (cm): It was measured in cm starting from tip of the longest leaf blade to the base of bulb.

2- Number of leaves/plant: All visible leaves of chosen plants were counted (dry and undifferentiated leaves were excluded)

3- Leaf area/plant (cm^2): The leaves of chosen plants were cleaned from the dust and 10 disks (1.66 cm diameter) from the leaves of each plant were taken, dried and weighted up to 0.1 mg. Plant leaf area was calculated according to the method described by Koller (1972) using the following formula:

$$\text{Leaf area (cm}^2\text{)/plant} = \frac{\text{Disk area} \times 10 \text{ disk} \times \text{dry weight of leaves}}{\text{Dry weight if 10 disks}}$$

4- Fresh and dry weight of plant: Leaves and neck of each plant were weighted and dried until constant weight at 70º C.

5- Total chlorophyll: It was measured by Minolta chlorophyll meter produced by Minolta Camera Co. LTD.

6- Bulbing ratio: It was measured as reported by Mann (1952) using the following formula.

$$\text{Bulbing ratio} = \frac{\text{Neck diameter (cm)}}{\text{Bulb diameter (cm)}}$$

B- YIELD AND ITS COMPONENTS:

At harvest time, marketable yield (all plants) in the all rows of each sub plot was cured. After 15 days from harvesting, its weighted in kg and converted to record as total yield (t/fed). A random sample (10 bulbs) was taken from each sub plot to determine the following traits:

1- Average bulb weight (g).
2- Average bulb diameter (cm).
3- Cloves number per bulb.
4- Cloves weight per bulb (g).
5- Average clove weight (g).

Statistical Analysis

All data of this study were statistically analyzed according to the technique of variance (ANOVA) for the split plot design. The treatment means were compared using the Least Significant Differences as published by Gomez and Gomez (1984), using "MSTAT-C " Computer software package.

RESULTS AND DISCUSSION

1- Vegetative growth characteristics:

GA_3 application caused significant increases on plant height, number of leaves/plant, plant leaf area, fresh weight of plant, dry weight of plant, total chlorophyll, neck diameter and bulb diameter in both seasons as well as bulbing ratio in the second season only as shown in Tables 1, 2 and 3. These results may be due to applying GA_3 led to endogenous gibberellins level in plant tissues which in turn stimulated both cell division and cell elongation. Similar results were reported by El-Gazar *et al.* (1988) ; Fabricinus and Rossi (2004) and Rahman *et al.* (2006).

Plant height, number of leaves/plant, plant leaf area, fresh weight of plant, dry weight of plant, total chlorophyll, plant neck diameter and bulb diameter were significantly increased by using 100 % chemical fertilizers (C.F.) and 50 % C.F. + 50 % FYM treatments in both seasons. Also, there were not significant differences between using 100 % C.F. and 50 % C.F. + 50 % FYM treatments in both seasons of this study. The enhancing effect of 50 % C.F. + 50 % FYM on vegetative growth of garlic plants may be attributed to organic manures are valuable as a source of many fertilizers and essential macro and micronutrients to plants and serves as a good natural soil texture conditioner being rich in organic matter and increase availability and uptake of NPK which positively reflected on plant cell elongation and

division as well as stimulate photosynthesis and metabolic processes. The obtained results are in accordance with those of Gupta *et al.* (1999) and El-Bassyouni *et al.* (2005)

Table 1: Plant height (cm), number leaves/plant and plant leaf area (cm^2) after 120 days from planting as affected by GA_3 application and fertilization treatments during 2004/2005 and 2005/2006 seasons.

Character / Treatments	Plant height (cm)		Number leaves/plant		Plant leaf area (cm^2)	
	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
A: GA_3 application effect:						
Without GA_3	104.14	104.08	8.45	8.74	83.91	85.35
With GA_3	107.56	109.84	9.23	9.43	87.40	89.74
LSD at 5 %	0.53	2.18	0.14	0.07	0.05	0.03
B: Fertilization treatments effect:						
1- 100 % C.F.	111.79	113.05	8.94	9.21	87.63	90.04
2- 75 % C.F.+ 25 % FYM	107.04	108.88	8.85	9.09	85.47	87.36
3- 50 % C.F.+ 50 % FYM	109.30	110.37	8.92	9.19	87.40	89.69
4- 25 % C.F.+ 75 % FYM	101.14	102.50	8.76	8.99	84.08	85.50
5- 100 % FYM	99.99	100.00	8.72	8.96	83.70	85.12
LSD 5 %	2.60	3.12	0.08	0.12	1.64	1.57

C.F. = Chemical fertilizer. FYM = Farmyard manure.
100 % C.F. = Recommended NPK rate (120 kg N + 75 kg P_2O_5 + 72 kg K_2O/fed).
100 % FYM = Content 120 kg N/fed (1^{st} season = 11183.6 kg/fed about 40 m^3/fed ; 2^{nd} season = 10067.1 kg/fed about 38 m^3/fed).

Table 2: Fresh and dry weight of plant without bulb (g) and total chlorophyll as affected by GA_3 application and fertilization treatments during 2004/2005 and 2005/2006 seasons.

Character / Treatments	Fresh weight of plant (g)		Dry weight of plant (g)		Total chlorophyll	
	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
A: GA_3 application effect:						
Without GA_3	73.61	74.49	11.52	12.55	73.81	74.29
With GA_3	76.39	77.04	12.94	14.45	75.01	75.61
LSD at 5 %	0.27	0.74	0.21	0.08	0.29	0.25
B: Fertilization treatments effect:						
1- 100 % C.F.	76.77	77.47	13.71	15.12	75.53	76.42
2- 75 % C.F.+ 25 % FYM	74.97	75.99	11.94	13.58	74.65	75.09
3- 50 % C.F.+ 50 % FYM	76.67	76.83	13.51	14.86	75.47	76.32
4- 25 % C.F.+ 75 % FYM	73.48	74.60	11.14	12.15	73.29	73.84
5- 100 % FYM	73.09	73.92	10.86	11.79	73.11	73.08
LSD 5 %	1.75	1.36	1.22	1.31	1.01	0.60

2- Yield and its components:

As shown in Tables 4 and 5, GA_3 application caused significant increases in total yield of garlic (t/fed), bulb diameter, bulb weight and number of cloves/bulb as well as clove weight in both seasons. These results may be due to applying GA_3 as a plant growth substances having an act-gibberellane skeleton and stimulating cell division and cell elongation as well as other regulatory functions. The obtained results are in harmony with those reported by El-Gazar *et al.* (1988).

Table 3: Neck diameter (cm), Bulb diameter (cm) and Bulbing ratio (Neck/bulb diameter) as affected by GA_3 application and fertilization treatments during 2004/2005 and 2005/2006 seasons.

Character / Treatments	Neck diameter (cm)		Bulb diameter (cm)		Bulbing ratio	
	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
A: GA_3 application effect:						
Without GA_3	1.55	1.64	3.17	3.27	0.490	0.503
With GA_3	1.64	1.73	3.54	3.64	0.464	0.479
LSD at 5 %	0.10	0.02	0.10	0.10	N.S.	0.01
B: Fertilization treatments effect:						
1- 100 % C.F.	1.70	1.80	3.67	3.77	0.465	0.480
2- 75 % C.F.+ 25 % FYM	1.59	1.69	3.41	3.51	0.467	0.483
3- 50 % C.F.+ 50 % FYM	1.69	1.78	3.64	3.73	0.466	0.478
4- 25 % C.F.+ 75 % FYM	1.50	1.60	3.07	3.17	0.492	0.507
5- 100 % FYM	1.48	1.56	3.00	3.10	0.496	0.506
LSD 5 %	0.10	0.12	0.12	0.12	N.S.	N.S.

Total yield of garlic, bulb diameter, bulb weight, number of cloves/bulb and clove weight were significantly increased by using 100 % C.F. and 50 % C.F. + 50 % FYM treatments in both seasons. In addition, there were not significant differences between using 100 % C.F. and 50 % C.F. + 50 % FYM treatments in both seasons of this study. These results may be due to the increases in plant growth characteristics plant height, number of leaves/plant and plant leaf area fresh and dry weight and total chlorophyll which increase photosynthesis rate and turn increased the total yield and its components. The obtained results are in harmony with those reported by Ashok *et al.* (1996), El-Moursi (1999) and Gad El-Hak and Abd El-Mageed (2000).

The interaction between GA_3 application and fertilization treatments had a significant effect on total yield of garlic and bulb diameter in both seasons (Table 6). The highest values of these characters were resulted from using 100 % C.F. with GA_3 application and 50 % C.F. + 50 % FYM treatments with application of GA_3 without significant differences between them in both seasons of this research.

Table 4: Total yield (t/fed) and bulb diameter (cm) as affected by GA3 application and fertilization treatments during 2004/2005 and 2005/2006 seasons.

Treatments	Total yield (t/fed)		Bulb diameter (cm)	
	2004/2005	2005/2006	2004/2005	2005/2006
A: GA_3 application effect:				
Without GA_3	7.340	7.403	5.73	5.82
With GA_3	7.709	8.085	5.95	5.98
LSD at 5 %	0.10	0.06	0.18	0.05
B: Fertilization treatments effect:				
1- 100 % C.F.	8.038	8.265	6.39	6.51
2- 75 % C.F. + 25 % FYM	7.547	7.829	5.91	5.94
3- 50 % C.F. + 50 % FYM	7.914	8.127	6.14	6.27
4- 25 % C.F. + 75 % FYM	7.113	7.290	5.47	5.42
5- 100 % FYM	7.012	7.210	5.28	5.37
LSD 5 %	0.131	0.161	0.19	0.13

Table 5: Bulb weight (g), number of cloves/bulb and clove weight (g) as affected by GA_3 application and fertilization treatments during 2004/2005 and 2005/2006 seasons.

Character / Treatments	Bulb weight (g)		Number of cloves/bulb		Clove weight (g)	
	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
A: GA_3 application effect:						
Without GA_3	65.13	66.65	40.15	42.10	1.63	1.60
With GA_3	67.37	69.20	42.43	44.21	1.61	1.57
LSD at 5 %	1.07	0.60	0.65	1.02	0.01	0.01
B: Fertilization treatments effect:						
1- 100 % C.F.	71.94	74.06	48.83	50.64	1.47	1.46
2- 75 % C.F.+ 25 % FYM	67.46	69.13	43.39	43.90	1.55	1.57
3- 50 % C.F.+ 50 % FYM	70.64	72.15	46.48	48.92	1.52	1.47
4- 25 % C.F.+ 75 % FYM	61.62	62.64	35.38	36.85	1.74	1.70
5- 100 % FYM	59.59	61.66	32.38	35.46	1.83	1.74
LSD 5 %	2.52	2.01	2.38	2.15	0.13	0.13

Table 6: Total yield (t/fed) and bulb diameter (cm) as affected by the interaction between GA3 application and fertilization treatments during 2004/2005 and 2005/2006 seasons.

Character / Treatments		Total yield (t/fed)		Bulb diameter (cm)	
		2004/2005	2004/2005	2004/2005	2004/2005
Without GA_3	1- 100 % C.F.	7.850	7.963	6.23	6.36
	2- 75 % C.F.+ 25 % FYM	7.527	7.532	5.87	5.89
	3- 50 % C.F.+ 50 % FYM	7.700	7.774	6.02	6.17
	4- 25 % C.F.+ 75 % FYM	6.862	6.898	5.33	5.37
	5- 100 % FYM	6.763	6.850	5.21	5.34
With GA_3	1- 100 % C.F.	8.227	8.568	6.56	6.67
	2- 75 % C.F + 25 % FYM	7.567	8.125	5.96	5.99
	3- 50 % C.F + 50 % FYM	8.127	8.481	6.27	6.38
	4- 25 % C.F + 75 % FYM	7.364	7.681	5.62	5.48
	5- 100 % FYM	7.262	7.571	5.36	5.41
	LSD at 5 %	0.186	0.23	0.27	0.20

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تأثير الجبرلين ومعاملات التسميد على النمو والمحصول ومكوناته فى الثوم

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***** طالب دراسات عليا بقسم الخضر والزينة ، كلية الزراعة – جامعة المنصورة.**

أجريت تجربتان حقليتان بمزرعة خاصة بمركز المطرية - محافظة الدقهلية خلال موسمى ٢٠٠٤/٢٠٠٥ و٢٠٠٥/٢٠٠٦م. لدراسة تأثير التسميد الكيماوى والعضوى وإضافة حمض الجبرلين وذلك على صفات النمو الخضرى والمحصول ومكوناته لأبصال الثوم. نفذت التجارب فى تصميم القطع المنشقة مرة واحدة فى ثلاث مكررات. ويمكن تلخيص أهم النتائج المتحصل عليها من هذه الدراسة فيما يلى:

أظهر نقع فصوص الثوم فى الجبرلين بتركيز ١٠ جزء فى المليون إلى زيادة معنوية فى نسبة الإنبات وطول النبات وعدد الأوراق للنبات والمساحة الورقية والوزن الطازج والجاف للنبات والكلوروفيل الكلى وقطر العنق والمحصول الكلى للثوم وقطر الأبصال ووزن البصلة وعدد الفصوص بكل بصلة وكذلك وزن الفص فى كلا موسمى الزراعة علاوة على الزيادة المعنوية فى معدل التبصيل فى الموسم الثانى فقط.

تأثرت جميع الصفات تحت الدراسة معنوياً بالتسميد بـ ١٠٠ % كيماوى و٥٠ % كيماوى + ٥٠ % عضوى دون وجود فرق معنوى بين تلك المعاملتين فى كلا موسمى الزراعة. ومن جهة أخرى كانت أقل القيم لتلك الصفات نتيجة المعاملة ١٠٠ % تسميد عضوى فى كلا موسمى الدراسة.

كان للتفاعل بين إضافة الجبرلين ومعاملات التسميد تأثيراً معنوياً على المحصول الكلى للثوم وقطر الأبصال وكانت أعلى القيم لتلك الصفات مع إضافة الجبرلين والتسميد ١٠٠ % كيماوى و إضافة الجبرلين مع التسميد ٥٠ % كيماوى + ٥٠ % عضوى على التوالى دون وجود فرق معنوى بين تلك المعاملتين.