

RESPONSE OF GARLIC PRODUCTIVITY AND STORABILITY TO APPLICATION TIMES OF PHOSPHORUS AND CERTAIN MICRO-NUTRIENTS

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ABSTRACT

In two field trials during the winter seasons (2000/2001 and 2001/2002), garlic plants were grown at the Hort. Res. Farm of El- Broom, Dakahlia Governorate, to evaluate the effects of application times of P-fertilizer, either a single or in combinations with some micro-nutrients on plant growth, yield and its components as well as chemical constituents and bulb storability during five months of storage period. Phosphorus was applied as a soil dressing at 90 kg P_2O_5 /fed in four different times, i.e. 100 % before planting (BP), 75% (BP) + 25% at 30 days after planting (AP), 50 % (BP) + 50 % in 2 equal doses 30 and 60 days (AP) and 25% (BP) + 75% in 3 equal doses 30, 60 and 90 days (AP). Micro-nutrients were used in mixture, 100 ppm each of Fe, Zn and Cu sprayed on plants once or twice 30 and 60 days (AP), at the level of 400 liters / fed.

Results showed that application of P in splits was generally more beneficial than the single dressing. The applied-P as 25% (BP) + 75% (AP) exerted significant increases on plant height, leaf area/plant and dry weight/plant as well as total yield, bulb weight and diameter, clove weight and P concentrations in plant foliage and cloves. Moreover, storability of bulbs was markedly improved as a result of reducing the total weight loss percentage during the storage period. Most of the studied parameters of the plants sprayed with micro-nutrients were more better than those of the untreated. Application of micro-nutrients at 30 and 60 days after planting was more useful than the application once. The positive interactions between application times of P-fertilizer and micro-nutrients were often observed. The best results were generally obtained by applied-P in doses 25% (BP) + 75% (AP) with foliar spray of micro-nutrients at 30 and 60 days (AP). Therefore, this treatment could be recommended for raising productivity and improving bulb quality of garlic under such conditions of this study.

INTRODUCTION

Garlic (*Allium sativum* L.) is one of the most commercially important bulb crops in Egypt which is cultivated for both local consumption and export. It is used as spice or condiment or for many medicinal purposes. Therefore, increasing productivity and improving bulb quality of garlic are essential aims for both growers and consumers. Yet, the increase in yields is usually dependent on many factors that influence the plant growth throughout the growth period (Mann, 1952). Optimize the use of P-fertilizers and micro-nutrients by plants is among the major factors affecting garlic productivity especially nowadays after that Egyptian soils become deficient in one or more of trace-elements needed by garlic plants due to the building of the High Dam. Moreover, most Egyptian soils are alkaline in reaction where soil pH surpasses 7 value consequences of the high calcium levels in soils. Under such conditions, in spite of the huge additions of P-fertilizers to

cultivated soils, the available P-level for plants is usually low, since it rapidly converts to unavailable form and this becomes inaccessible by plants (Mahmoud and Abd El-Hafez, 1982). Thus, application of P-fertilizers or some micro-nutrients in a single treatment may make some problems. On the contrary, split dressing at regular intervals during the growth period of garlic plants increased bulb yield and its components (Osman *et al.*, 1991, Wang *et al.*, 1992, Ashok *et al.*, 1996, Verma *et al.* 1996, Wankhade *et al.*, 1996 and Sadaria, *et al.*, 1997). In addition, Mahmoud (2001) reported that the highest yield quantity and bulb quality of garlic were obtained by application of 150 kg P₂O₅/fed, 50% was applied at planting and 50% one month later.

With regard to micro-nutrients, several investigators indicated that soaking cloves or spraying garlic plants with mixtures of Fe, Zn, Mn, and Cu enhanced plant growth, stimulated dry matter accumulation and increased bulb yield and quality (Eid *et al.*, 1991, Ibrahim *et al.*, 1991, Saravanan and Nambisan, 1994, Phor *et al.*, 1995 and Abdel-Hamied, 1997).

Thus, this study was planned to determine the effects of application times of P-fertilizer and some micro-nutrients (Fe + Zn + Cu), in addition to their interactions on garlic productivity and storability under the conditions of Dakahlia District.

MATERIALS AND METHODS

Two field experiments were conducted at the Horticultural Research Farm of El-Bramoon, Dakahlia Governorate, during the two successive winter seasons (2000/2001 and 2001/2002), to study the effect of application times of phosphorus and certain micro-nutrients, in addition to their interactions on productivity and storability of garlic (Sids-40). The experimental field soil was clay loam in texture with pH 7.8, available N 21.1 ppm, P 13.5 ppm, K 320 ppm, Fe 0.19 ppm, Zn 0.29 ppm and Cu 4.6 ppm (standard method of Jackson, 1967 was used for soil analysis). Each experiment included 12 treatments which were 4 times of P-application and 3 treatments of micro-nutrients. Phosphorus was applied as calcium superphosphate (15.5% P₂O₅) at the rate of 90 kg P₂O₅/fed as follows:-

- 1- 100 % before planting (BP).
- 2- 75 % (BP) + 25 % at 30 days after planting (AP).
- 3- 50 % (BP) + 50 % in 2 equal doses 30 and 60 days (AP).
- 4- 25 % (BP) + 75 % in 3 equal doses 30, 60 and 90 days (AP).

Chelated micro-nutrients of iron, zinc and copper were used (100 ppm Fe + 100 ppm Zn + 100 ppm Cu). Plants were sprayed once or twice with mixture 40 gm each of element added to 400 liters water / fed 30 and 60 days after planting. The control treatment was sprayed with tap water.

The experimental design was a split-plot with 4 replicates. The main plots were devoted to times of P-application, while micro-nutrient treatments were randomly distributed in the sub-plots. The sub-plot area was 15 m² (5 rows, each 60 cm width and 5 m long). Garlic cloves were soaked in running water for 24 h prior to sowing and planted at 10 cm apart on the two sides of each row in the first week of October, for both seasons of the study. At soil

preparation (pre-ridging), 15 m³ farmyard manure and 72 kg K₂O/fed were applied. All plants in plots were fertilized with 120 kg N/fed which added in three equal doses 30, 60 and 90 days after planting. The other agricultural practices were carried out as commonly followed in the district. The harvesting time was in the first week of April, for both seasons.

Data recorded:-

1- Vegetative growth:

Representative samples (Each of 10 plants) were taken from each sub-plot after 120 days from planting for measuring plant height, number of leaves/plant, leaf area/plant, plant dry weight and bulbing ratio as mentioned by Mann (1952).

2- Yield and its components:

At harvest time, all plants of each treatment were harvested and the total yield/fed was calculated after curing for 3 days. Also, a random sample (10bulbs) was taken from each treatment to determine bulb weight, bulb diameter, number of cloves/bulb and clove weight.

3- Chemical constituents:

Random samples from plant foliage and cloves of each treatment were dried, ground and wet digested to determine nitrogen (N), phosphorus (P), potassium (K), iron (Fe), Zinc (Zn) and copper (Cu) according to the methods described by Pregl (1945) for N, John (1970) for P, Brown and Lilleland (1946) for K and Chapman and Pratt (1961) for micro-nutrients (Fe, Zn and Cu).

4- Storability:

After curing, random samples (each 10 kg) were taken from each treatment, stored at the normal room conditions (Table 1). Total weight loss percentage was recorded monthly during five months of storage period. All obtained data were subjected to statistical analysis according to Snedecor and Cochran (1968).

Table (1): Average (maxi. + min.) of air temperature and relative humidity in store room during 2001 and 2002 seasons.

Months	2001		2002	
	Temp. C°	Humidity %	Temp. C°	Humidity %
April	14.6	59	15.3	61
May	16.3	63	16.9	63
June	19.1	65	20.1	67
July	21.3	69	22.5	68
August	22.9	70	22.7	71

RESULTS AND DISCUSSION

1-Vegetative growth:

Data presented in Table (2) show the effect of application fertilizer, micro-nutrients and their interactions on growth asr plants.

Concerning the effect of P-application times, it is clear from such data in Table (2) that plant height and leaf area/plant in both seasons as well as dry weight/plant in the second season only were significantly increased with applied-P in splits 25 % before planting + 75 % after planting followed by 50 % PB + 50 % AP as compared with the single dressing (100 % PB). However, application times of P-fertilizer had no significant increase on number of leaves/plant in both seasons and dry weight in the first season. Also, no significant decrease was obtained in bulbing ratio. These results may be due to the fact that applied-P in doses at regular intervals during growth periods is accessible by plants and it is less subject to loss from the soil. Conversely, application of P-fertilizer in a single treatment pre-sowing is untimely. The obtained results concerted with those of Osman *et al.* (1991).

Regarding the effect of micro-nutrients, the same data in Table (2) reveal that foliar application of micro-nutrients (Fe + Zn + Cu) exerted significant increases on all studied parameters of vegetative growth, except number of leaves/plant and bulbing ratio in both seasons of the study as compared with the check treatment. In this connection, plants sprayed with micro-nutrients 30 and 60 days after planting were generally stocky and healthy in appearance than plants sprayed once at 30 days after planting. These results could be attributed to the great role of such micro-nutrients in controlling various enzymes activities and photosynthetic pigments formation, consequently affecting plant growth. The obtained results are in harmony with those reported by Ibrahim *et al.* (1991), Phor *et al.* (1995), and Abdel-Hamied (1997).

As for the interaction effects, it is obvious from the same data in Table (2) that at all treatments of P-fertilizer were generally more effective in the presence than in the absence of micro-nutrients. In this regard, plants received P-fertilizer in doses (25 % before + 75 % after planting) and sprayed with micro-nutrients 30 and 60 days after planting gave the highest values of plant growth in both seasons. Similar results were reported by Yamanishi and Castellane (1987).

2- Yield and its components:

Data illustrated in Table (3) show the effect of application times of P-fertilizer, micro-nutrients and their interactions on yield and its components of garlic. Such data indicate that applied-P in splits was generally beneficial than the single dressing. Moreover, application of P-fertilizer in doses 25 % before planting + 75 % after planting significantly increased total yield, bulb weight and diameter as well as clove weight than with applied-P in a single dose (100 % before planting) in both seasons. The increase in total yield was about 5.61 % and 5.30 % in the first and second seasons, respectively. However, number of cloves/bulb was not significantly affected by times of P-application in both seasons. The positive effect of applied-P in splits at different times may be imputed to the fact that availability of P-nutrition throughout the growth period of garlic plants is known to control its growth and productivity (Panchal *et al.*, 1992). The obtained results are in accordance with those of Verma *et al.* (1996) and Mahmoud (2001).

Table (2): Vegetative growth characteristics of garlic plants as affected by application times of phosphorus, some micro-nutrients and their interactions during 2000/2001 (S1) and 2001/2002 (S2) seasons.

Characters	Plant height (cm)		No. of leaves/plant		Plant leaf area (cm ²)		plant dry weight (gm)		Bulbing ratio		
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	
Treatments											
P ₂ O ₅ appli. (BP and AP):											
100 % BP	71.24	70.98	10.97	11.43	531	527	27.05	24.29	0.51	0.49	
75 % BP + 25 % AP	73.49	73.98	11.50	11.96	544	537	27.42	25.67	0.48	0.46	
50 % BP + 50 % AP	74.42	75.10	11.74	12.74	545	548	28.31	27.43	0.44	0.45	
25 % BP + 75 % AP	77.27	78.37	12.08	12.80	559	552	28.94	28.74	0.41	0.42	
L.S.D. at 5%	01.13	1.06	N.S	N.S	3.12	4.11	N.S	0.06	N.S	N.S	
Micronutrients appli. (AP):											
Control	72.23	72.93	11.15	11.84	534	530	26.92	25.85	0.48	0.47	
Once, 30 days	73.84	74.62	11.62	12.34	544	541	27.92	26.57	0.45	0.45	
Twice, 30 and 60 days	76.24	76.27	11.95	12.50	555	552	28.94	27.17	0.44	0.44	
L.S.D. at 5%	00.36	00.41	N.S	N.S	1.69	1.19	00.03	00.02	N.S	N.S	
Interactions :											
P ₂ O ₅	Micro.										
100 % BP	Control	70.19	70.63	10.31	10.57	524	517	26.13	23.79	0.53	0.51
	Once	71.43	71.01	11.29	11.83	532	529	26.91	23.91	0.51	0.49
	Twice	72.09	71.29	11.31	11.89	536	535	28.11	25.16	0.48	0.47
75 % BP	Control	72.41	71.87	11.25	11.61	538	527	26.39	25.12	0.50	0.47
	Once	73.61	73.91	11.36	11.96	545	539	27.29	25.69	0.47	0.46
25 % AP	Twice	74.46	76.17	11.90	12.30	550	546	28.57	26.21	0.46	0.44
	Control	72.31	73.51	11.41	12.57	535	539	27.19	26.86	0.45	0.47
50 % BP +	Once	75.21	74.89	11.61	12.79	542	547	28.61	27.51	0.43	0.45
	Twice	75.73	76.91	12.19	12.86	557	559	29.12	27.91	0.43	0.43
25 % BP +	Control	74.01	75.71	11.63	12.63	541	539	27.96	27.62	0.43	0.45
	Once	75.11	78.66	12.21	12.80	557	551	28.89	29.19	0.41	0.40
75 % AP	Twice	82.70	80.73	12.39	12.97	578	567	29.97	29.41	0.39	0.41
	L.S.D. at 5%	01.10	1.16	N.S	N.S	N.S	N.S	0.06	0.04	N.S	N.S

BP and AP = before and after planting.

As for the effect of micro-nutrients, data in Table (3) indicate that total yield and its components, with exception of the number of cloves/bulb were better with spraying the plants with mixture of micro-nutrients (Fe + Zn + Cu) comparing with the untreated plants. Moreover, application of micro-nutrients at 30 and 60 days after planting was more useful than the application once. Total yield was increased by about 8.26 % and 6.95 % (with two sprays over the control treatment) in the first and second seasons, respectively. These increases might be ascribed to the favourable role of the used micro-nutrients in pigments formation, photosynthesis activation and carbohydrates assimilation diverted to the bulbs which represent the economic part of plant (Hilman and Asandhi, 1987). Similar results were reported by Guadi *et al.* (1988) and Eid *et al.* (1991).

Table (3): Yield and its components of garlic as affected by application times of phosphorus, some micro-nutrients and their interactions during 2000/2001 (S1) and 2001/2002 (S2) seasons.

Characters	Total yield (ton/fed)		Bulb weight (gm)		Bulb diameter (cm)		No. of cloves/bulb		Clove weight (gm)		
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	
P₂O₅ appli. (BP and AP):											
100 % BP	7.40	7.50	107	120	5.24	5.37	27.56	28.89	3.53	3.64	
75 % BP + 25 % AP	7.53	7.55	119	130	5.32	5.53	29.96	27.98	3.73	3.83	
50 % BP + 50 % AP	7.69	7.68	129	137	5.46	5.63	29.55	29.95	4.01	3.34	
25 % BP + 75 % AP	7.84	7.92	140	143	5.64	5.87	28.24	28.21	4.23	4.51	
L.S.D. at 5%	0.36	0.33	3.11	4.06	0.16	0.21	N.S	N.S	0.20	0.15	
Micronutrients appli. (AP):											
Control	7.22	7.36	112	122	5.29	5.45	27.95	29.76	3.57	3.95	
Once, 30 days	7.75	7.72	126	134	5.41	5.61	29.54	29.68	3.97	4.08	
Twice, 30 and 60 days	7.87	7.91	133	141	5.54	5.73	28.99	26.83	4.08	4.21	
L.S.D. at 5%	0.16	0.11	1.53	2.17	0.03	0.02	N.S	N.S	0.13	0.11	
Interactions :											
P ₂ O ₅	Micro.										
100 % BP	Control	7.03	7.19	96	111	5.13	5.26	25.36	32.11	3.41	3.59
	Once	7.51	7.63	109	121	5.29	5.39	30.17	29.21	3.56	3.63
	Twice	7.66	7.69	115	129	5.31	5.45	27.15	25.35	3.61	3.71
75 % BP +	Control	7.19	7.28	108	119	5.20	5.31	29.11	27.27	3.53	3.69
	Once	7.69	7.59	121	131	5.31	5.59	29.36	30.21	3.79	3.83
25 % AP	Twice	7.71	7.77	128	139	5.46	5.68	31.41	26.46	3.86	3.96
	Control	7.27	7.41	117	126	5.36	5.51	26.21	33.51	3.60	4.17
50 % BP +	Once	7.83	7.75	133	139	5.43	5.60	33.29	28.13	4.13	4.36
	Twice	7.96	7.89	137	146	5.59	5.78	29.15	28.21	4.31	4.49
50 % AP	Control	7.39	7.56	126	133	5.49	5.73	31.12	26.15	3.73	4.36
	Once	7.96	7.91	142	145	5.63	5.86	25.33	31.19	4.39	4.51
75 % AP	Twice	8.16	8.29	151	150	5.79	6.02	28.26	27.29	4.56	4.67
	L.S.D. at 5%	0.34	0.29	3.09	3.69	N.S	N.S	N.S	N.S	0.19	0.14

BP and AP = before and after planting.

Regarding the interaction effects, it is clear from data in Table (3) that bulb diameter and number of cloves/bulb were not significantly influenced in both seasons there were significant interactions between application times of P-fertilizer and micro-nutrients (Fe + Zn + Cu) on total yield, bulb weight and clove weight in both seasons. In general, plants fed by P-fertilizer in splits 25 % PB + 75 % AP and sprayed with micro-nutrients at 30 and 60 days after planting produced the highest values. These results coincide with those of Yamanishi and Castellane (1987).

3- Chemical constituents:

Data in Table (4) show the effect of application times of P-fertilizer, micro-nutrients and their interactions on element concentrations of N, P, K, Fe, Zn and Cu in plant foliage and cloves of garlic. From such data, it is evident that application times of P-fertilizer did not reflect significant variations on all element concentrations in both plant foliage or cloves. Yet, P-content was

significantly increased with the applied-P in doses 25 % PB + 75 % AP followed by 50 % PB + 50 % AP as compared with a single dose (100 % PB). It is thought that applied-P in doses during the plant growth period increasing available-P in root zone of established plants and hence enhance root sorption and P-uptake (Asandhi, 1989). These results are in agreement with those of Wang *et al.* (1992) and Sadaria *et al.* (1997).

Concerning the effect of micro-nutrients data in Table (4) show that all concentrations of elements, except N and K in both plant foliage and cloves were significantly increased due to spraying the plants with mixture of micro-nutrients (Fe + Zn + Cu) comparing with the untreated plants. Such increments were positively connected with the application times. These results agree with those reported by Abed *et al.* (1988) and Saravanan and Nambisan (1994).

Table (4): Chemical constituents in plant-foliage and cloves of garlic as affected by application times of phosphorus, some micro-nutrients and their interactions (average two seasons).

Characters	Macro-elements (%)						Micro-elements (ppm)						
	Leaves			Cloves			Leaves			Cloves			
	N	P	K	N	P	K	Fe	Zn	Mn	Fe	Zn	Mn	
P₂O₅ appli. (BP and AP):													
100 % BP	2.86	0.81	1.28	1.79	0.62	1.17	182	233	75	167	123	45	
75 % BP + 25 % AP	2.77	0.86	1.25	1.71	0.64	1.23	180	225	74	171	127	53	
50 % BP + 50 % AP	2.89	0.86	1.27	1.62	0.67	1.22	187	219	76	165	128	51	
25 % BP + 75 % AP	2.91	0.91	1.27	1.71	0.70	1.26	192	226	75	179	126	46	
L.S.D. at 5%	N.S	0.03	N.S	N.S	0.02	N.S	N.S	N.S	N.S	N.S	N.S	N.S	
Micronutrients appli. (AP):													
Control	2.76	0.78	1.27	1.67	0.59	1.19	162	189	66	158	115	36	
Once, 30 days	2.76	0.87	1.26	1.73	0.67	1.21	187	236	73	166	127	49	
Twice, 30 and 60 days	3.04	0.94	1.27	1.73	0.71	1.25	206	251	86	188	137	61	
L.S.D. at 5%	N.S	0.02	N.S	N.S	0.01	N.S	1.65	2.63	1.79	2.27	1.13	1.96	
Interactions :													
P ₂ O ₅	Micro.												
100 % BP	Control	2.72	0.74	1.34	1.79	0.56	1.16	163	196	69	153	113	38
	Once	2.79	0.81	1.27	1.83	0.61	1.15	186	240	71	150	126	41
	Twice	3.08	0.89	1.24	1.76	0.69	1.19	197	263	86	198	129	56
75 % BP + 25 % AP	Control	2.77	0.72	1.26	1.63	0.60	1.25	159	188	58	161	117	41
	Once	2.70	0.89	1.27	1.71	0.68	1.17	193	239	69	173	129	56
	Twice	2.83	0.96	1.23	1.80	0.65	1.26	189	247	96	179	136	63
50 % BP + 50 % AP	Control	3.01	0.78	1.19	1.59	0.59	1.19	167	191	65	150	111	35
	Once	2.76	0.86	1.27	1.62	0.69	1.22	179	226	75	163	131	51
	Twice	2.91	0.95	1.36	1.66	0.72	1.25	216	239	89	182	143	69
25 % BP + 75 % AP	Control	2.56	0.87	1.30	1.69	0.61	1.18	161	181	71	167	120	32
	Once	2.81	0.91	1.24	1.75	0.70	1.31	192	241	79	178	121	49
	Twice	3.36	0.96	1.27	1.69	0.79	1.29	222	256	74	193	139	57
L.S.D. at 5%	N.S	0.03	N.S	N.S	N.S	N.S	2.81	N.S	N.S	N.S	N.S	N.S	

BP and AP = before and after planting.

As for the interaction effects, it is obvious from data in Table (4) that the interaction between application times of P-fertilizer and micro-nutrients (Fe + Zn + Cu) had no significant effects on all concentrations of studied elements, with exception of the P and Fe in plant foliage which were significantly affected. Applied-P in splits 25 % before + 75 % after planting with foliar application of micro-nutrients achieved the highest concentrations. Similar results were obtained by Wankhade et al (1996)

4- Storability:

Data in Table (5) show the effect of application times of P-fertilizer, micro-nutrients and their interactions on storability of garlic bulbs. Such data reveal that the total weight loss percentage of bulbs was not significantly affected during the first two months of storage period in both seasons. However, it increased by increasing the storage period and reached its maximum values at the fifth month. It is notable that, at the end of five months the most interesting observation was the enhancing of storability by applied-P in splits than a single dressing. The lowest total weight loss percentage was obtained by P supply in doses 25 % before planting + 75 % after planting. These results may be due to increase dry matter in plants (Table 1) and P-element in cloves (Table 4). Similar results were reported by Osman et al. (1991) and Mahmoud (2001).

Regarding the effect of micro-nutrients, data in table (5) indicate that bulb storability of plants sprayed with micro-nutrients (Fe + Zn + Cu) was better than that of the untreated plants. Moreover, application of micro-nutrients at 30 and 60 days after planting was more beneficial than the application once. These results are in harmony with those of Abdel-Hamied (1997).

Concerning the interaction effects, it is clear from data in Table (5) that the positive interactions between application times of P-fertilizer and micro-nutrients (Fe + Zn + Cu) were often observed on storability of bulbs. Application of P-fertilizer in doses (25 % before + 75 % after planting) with foliar spray of micro-nutrients at 30 and 60 days after planting gave the lowest total weight loss percentage during storage period. These results agree with those of Abed et al. (1988) and Ashok et al. (1996).

From the results of this study, it could be concluded that, application of P-fertilizer in splits 25 % before planting + 75 % at 30, 60 and 90 days after planting with spraying the plants with mixture of micro-nutrients (Fe + Zn + Cu) at 30 and 60 days after planting are the recommended treatments for increasing productivity and improving bulb quality of garlic under such conditions of this study.

Table (5): Total weight loss percentage in garlic bulbs during the storage period as affected by application times of phosphorus, some micro-nutrients and their interactions during 2000/2001 (S1) and 2001/2002 (S2) seasons.

Characters	At 30 days		At 60 days		At 90 days		At 120 days		At 150 days		
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	
Treatments											
P₂O₅ appli. (BP and AP):											
100 % BP	30.60	29.68	47.97	46.73	56.95	54.75	60.97	59.39	63.25	61.44	
75 % BP + 25 % AP	28.88	30.83	46.14	46.10	54.37	52.61	57.92	56.83	60.61	58.55	
50 % BP + 50 % AP	29.99	27.80	47.58	43.81	54.60	50.03	58.54	53.61	60.34	56.02	
25 % BP + 75 % AP	27.27	26.92	43.02	42.54	50.04	48.37	53.82	51.65	55.55	52.93	
L.S.D. at 5%	N.S	N.S	N.S	N.S	3.21	1.66	2.10	1.96	3.15	2.06	
Micronutrients appli. (AP):											
Control	31.49	30.62	49.78	47.54	58.40	55.05	63.01	59.27	65.38	61.11	
Once, 30 days	28.18	28.72	45.14	44.58	53.48	51.46	56.86	55.46	59.28	57.07	
Twice, 30 and 60 days	27.88	27.08	43.61	42.26	50.09	47.80	53.56	51.38	55.14	52.77	
L.S.D. at 5%	0.26	0.54	1.17	1.28	1.39	0.63	1.30	1.08	1.13	1.01	
Interactions :											
P ₂ O ₅	Micro.										
100 % BP	Control	33.56	29.60	50.78	47.85	60.01	55.67	64.52	60.79	67.17	62.75
	Once	27.73	31.25	47.33	47.76	56.40	57.27	60.63	61.96	62.89	64.29
	Twice	30.51	28.19	45.81	44.58	54.43	51.30	57.75	55.42	59.68	57.29
75 % BP + 25 % AP	Control	30.91	32.66	50.12	48.62	58.07	57.23	63.23	61.84	65.64	63.97
	Once	29.13	30.71	45.64	46.24	55.17	52.03	56.46	55.95	60.41	57.58
	Twice	26.61	29.13	42.67	43.45	49.88	48.57	54.06	52.70	55.78	54.11
50 % BP + 50 % AP	Control	31.52	30.59	51.64	48.36	61.33	55.75	66.02	59.26	67.91	60.89
	Once	30.25	27.11	45.76	42.36	52.01	48.42	55.92	52.59	58.03	53.98
	Twice	28.19	25.69	45.35	40.72	50.46	45.91	53.88	48.98	55.09	50.19
25 % BP + 75 % AP	Control	29.97	29.65	46.60	45.34	54.20	51.55	58.26	55.18	60.80	56.83
	Once	25.62	25.81	41.83	41.97	50.34	48.13	54.45	51.34	55.81	52.45
	Twice	26.21	25.30	40.62	40.31	45.58	45.43	48.74	48.44	50.03	49.51
L.S.D. at 5%		0.49	0.61	N.S	N.S	3.05	N.S	2.13	1.66	2.27	2.11

BP and AP = before and after planting.

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استجابة إنتاجية وقابلية تخزين الثوم لمواعيد إضافة سماد الفوسفور وبعض العناصر الصغرى

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لقد تمت تجربة حقلية على محصول الثوم (سلالة سدر-٤١) في مزرعة بحوث البساتين بالرامون - محافظة الفيوم خلال موسم الزراعة ٢٠٠٠/٢٠٠١ و ٢٠٠١/٢٠٠٢ م لتقييم تأثير مواعيد استعمال سماد الفوسفور كل منها منفردا أو مع الرش الورقي بحلوط بعض العناصر الصغرى على نمو النباتات والمحصول الكلي ومكوناته وكذلك المحتويات الكيميائية في أوراق النباتات والفصوص وقابلية التخزين خلال فترة حضانة شهر. وقد اصيف سماد الفوسفور (شميد ارضي) في صورة سوبر فوسفات الكالسيوم بمعدل ٩٠ كغم فـ٠/هـ/دان كالتالي:

- ١- قبل الزراعة.
 - ٢- قبل الزراعة + ٢٥، بعد ٣٠ يوم من الزراعة.
 - ٣- قبل الزراعة + ٥٠، في حرتين متساويتين بعد ٣٠ و ٦٠ يوم من الزراعة.
 - ٤- قبل الزراعة + ٧٥، في ثلاث جرعات متساوية بعد ٣٠، ٦٠ و ٩٠ يوم من الزراعة.
- بينما استختمت العناصر الصغرى (الحديد + الزنك + النحاس) بمعدل ١٠٠ حزه/مليون من كل عنصر في مخلوط رش عطسي النباتات مرة واحدة بعد ٣٠ يوم من الزراعة أو مرتين بعد ٣٠ و ٦٠ يوم من الزراعة وذلك بالإضافة إلى معاملة الكنترول (رشت بماء الصنوبر) وذلك بمعدل ٤٠٠ لتر/دان. وقد وزعت المعاملات في قطع منتشرة مرة واحدة في أربعة مكررات ويمكن تلخيص النتائج المتحصل عليها فيما يلي:
- استعمال سماد الفوسفور في جرعات كل مصفحة عامة أكثر فائدة من الاستعمال مرة واحدة قبل الزراعة. وقد أتت اضافة الفوسفور ٢٥% قبل الزراعة + ٥٥% بعد الزراعة إلى حدوث زيادات معنوية في ارتفاع النبات والمساحة الورقية والتورن انخفاض للمنتج والمحصول الكلي ومكوناته (وزن وقطر المصنعة - وزن الفص)، كما أتت إلى زيادة تركيز الفوسفور في كل من أوراق النباتات والفصوص وحسنت بوضوح قابلية التخزين وذلك نتيجة انخفاض نسبة النقص الكلي في وزن الاتصال خلال فترة التخزين. أدى رش النباتات بحلوط العناصر الصغرى (الحديد - الزنك - النحاس) إلى حدوث زيادات ملموسة في معظم الصفات المختبرة مقارنة مع معاملة الكنترول. وقد لوحظ أن الرش بالعناصر الصغرى مرتين بعد ٣٠ و ٦٠ يوم من الزراعة كان كسفر بعضا وفاضلية من الرش مرة واحدة.
- التفاعلات الموجبة بين مواعيد استعمال سماد الفوسفور والعناصر الصغرى لوحظت في حالات كثيرة وقد كانت افضل النتائج المتحصل عليها باستخدام الفوسفور المضاف في جرعات ٢٥% قبل الزراعة + ٧٥% بعد الزراعة مسع رش النباتات بالعناصر الصغرى مرتين بعد ٣٠ و ٦٠ يوم من الزراعة. لذلك يمكن التوصية باستخدام هذه المعاملة لرفع إنتاجية وحيدة اتصال الثوم تحت الظروف المشابهة لطرف هذا البحث.