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PLANT GROWTH, YIELD AND CHEMICAL COMPOSITION OF SOME
GARLIC CULTIVARS AS AFFECTED BY NPK FERTILIZATION

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ABSTRACT

Two field Experiments were carried out at the Experimental Farm of the Faculty of Agriculture at Moshtohor, Zagazig University, to study the response of some garlic cultivars (Chinese, French and Balady) to NPK fertilization. Obtained results revealed that Chinese and Balady cvs. were superior and reflected higher vegetative growth, yield and its components as well as minerals content of total N,P,K and volatile oils percentage of blubs compared with French cv. The third (90 kg N + 45 kg P₂O₅ + 72 kg K₂O) and the fourth (120 kg N + 60 kg P₂O₅ + 96 kg K₂O) fertilization levels reflected the maximum increments in all studied characteristics of growth, yield and quality of garlic cultivar.

So, it is advisable to grow Chinese or Balady cvs. and using the third or the highest level of fertilization, to obtain high yield with good quality of garlic bulbs under similar conditions of this work.

INTRODUCTION

Garlic (Allium sativum, L.) is one of the most important vegetable crops grown in Egypt. Improving garlic yield can be achieved either by planting high yielding ability cultivars or through improving the agricultural treatments especially the application of optimal levels of fertilization or by both. Several trails have been carried out to evaluate some garlic cultivars by each of Maksoud et al., (1984) and Abou-Hamela (1987), who reported that, Chinese cultivar exceeded the local and American cvs. in all growth traits including plant height, number of leaves per plant, bulb diameter and plant dry weight as well as bulb weight and total yield. However, Abou-Hamela (1987) and Maksoud et al., (1987), did not find any significant differences among the tested cultivars, except in case of the percentages

of potassium and total carbohydrates. Where Balady and Chinese cvs. contained the highest percentages of such chemical constituents.

On the other hand, studies which have been carried out by each of Ismail et al., (1979); El-Beheidí et al., (1983 & 1985); Maksoud et al. (1984 & 1987) and Abd El-Fattah et al. (1989), showed that the application of nitrogen, phosphorus and potassium fertilizers either in a single or in a compound form stimulated the growth, enhanced yield and its components as well as chemical constituents of plants.

The aim of this work is to study the effect of different levels of nitrogen, phosphorus and potassium fertilizers on growth, yield and its components as well as chemical constituents of three garlic cultivars, i.e., Chinese, French and Balady under the conditions of Kalubia governorate.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of the Faculty of Agriculture Moshtohor, Zagazig University during the winter seasons of 1989/1990 and 1990/1991. This study was carried out to investigate the response of some garlic cultivars i.e. Chinese, French and Balady to four levels of nitrogen, phosphorus and potassium fertilizers. Each experiment included 12 treatments which were the combinations of three forementioned cultivars combined with 4 levels of nitrogen, phosphorus and potassium fertilizers as follows:

- 1- 30 kg N + 15 kg P₂O₅ + 24 kg K₂O/fad. referred as level (1).
- 2- 60 kg N + 30 kg P₂O₅ + 48 kg K₂O/fad. referred as level (2).
- 3- 90 kg N + 45 kg P₂O₅ + 72 kg K₂O/fad. referred as level (3).
- 4- 120 kg N + 60 kg P₂O₅ + 96 kg K₂O/fad. referred as level (4).

Ammonium sulphate (20.5% N), Calcium superphosphate (15% P₂O₅) and Potassium sulphate (48% K₂O) were used as sources of nitrogen, phosphorus and potassium respectively. Cloves were planted on September 28th and October 5th in 1989 and 1990 respectively at 7 cm apart on both sides of ridges 660 cm wide and 3.5 m long. A split-plot design

with four replicates was adopted, where the cultivars were distributed in the main plots and the fertilization levels in sub-plots. Each sub-plot included 5 ridges. Four ridges were planted and the fifth one was left without planting to act as a border between each sub-plot and the adjacent one. The amounts of fertilizers were subdivided into three equal doses. Addition of such doses started four weeks after planting and then at four weeks by interval. Four weeks later, a representative sample of 10 plants from each experimental plot was taken for measuring vegetative growth parameters and chemical constituents determination. The vegetative growth measurements were recorded as plant height, number of leaves, fresh and dry weight per plant as well as bulb weight, length and diameter. At time of harvest, all plants of each experimental plot were harvested and the total yield per faddan was calculated after curing plants for three days.

Chemical constituents, i.e. total nitrogen, phosphorus and potassium were assayed in dry matter of bulb according to the methods described by Pregl, (1945); Brown & Lilleland (1946) and Murphy & Riely (1962).

Volatile oils percentage were determined in fresh bulb according to the method followed by Farag (1986).

All obtained data were subjected to statistical analysis according to Snedecor and Cochran (1968).

RESULTS AND DISCUSSION

1- Vegetative growth:

Data on vegetative growth parameters, i.e., plant height, number of leaves, fresh and dry weight per plant for the studied garlic cultivars under different levels of nitrogen, phosphorus and potassium fertilizers were presented in Table (1).

Such data revealed that, Chinese cv. recorded the highest values in number of leaves, fresh and dry weight per plant followed by Balady and French cvs. during both seasons of growth. However, Balady cv. ranks first in case of plant height. In this respect, there were significant differences in most studied plant growth characteristics among Chinese, Balady and French cvs. In addition, such differences reached the level of significance in case of plant fresh weight only between Chinese and Balady cvs. during both seasons of growth. Obtained results may be

Table (1): Effect of NPK fertilization level on vegetative growth characteristics of some garlic cultivars.

Season	Fertilizer level	1989/1990				1990/1991			
		Plant height (cm)	No. of leaves/plant	Fresh weight/plant (g)	Dry weight/plant (g)	Plant height (cm)	No. of leaves/plant	Fresh weight/plant (g)	Dry weight/plant (g)
Chinese	1	66.4	9.0	57.2	9.7	71.7	9.4	61.1	11.4
	2	68.7	9.9	66.0	12.7	75.7	10.0	65.0	12.7
	3	71.0	10.4	70.8	12.1	77.3	10.2	76.3	14.0
	4	74.7	10.5	72.4	13.3	79.1	10.7	85.0	17.2
French	1	63.4	8.2	45.9	6.8	66.3	8.7	53.5	8.8
	2	66.3	8.8	49.3	7.6	73.8	9.0	54.8	9.5
	3	71.2	9.0	52.4	8.4	72.5	9.4	57.5	10.2
	4	73.0	9.2	56.2	9.6	76.6	9.7	58.0	11.0
Balady	1	68.0	8.2	50.6	9.2	75.2	9.2	56.3	11.4
	2	69.8	9.0	56.5	10.2	76.9	9.7	62.5	12.2
	3	72.9	9.2	61.2	11.2	77.3	9.9	66.1	13.8
	4	75.2	9.4	65.6	12.7	80.0	9.9	71.7	15.1
L.S.D. at 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	4.9	1.4	
Chinese		70.3	9.9	66.6	11.9	76.0	10.1	71.9	13.8
	French	68.5	8.8	51.0	8.1	72.3	9.2	55.9	9.9
	Balady	71.4	9.0	58.5	10.8	77.4	9.7	64.2	13.1
L.S.D. at 0.05	n.s.	0.3	6.3	1.4	1.2	n.s.	4.3	1.3	
Fertilization level	1	66.1	8.4	51.2	8.6	71.1	9.1	56.9	10.5
	2	68.2	9.2	57.3	10.2	75.5	9.6	60.7	11.4
	3	71.7	9.5	61.4	10.6	75.7	9.8	66.6	12.6
	4	74.3	9.7	64.7	11.9	78.6	10.1	69.1	14.4
L.S.D. at 0.05	3.5	0.2	4.7	0.9	2.7	0.5	3.3	0.8	

attributed to the genetical variance that showed vegetative growth differences among the studied cultivars. Similar results were reported by Maksoud *et al.*, (1984 & 1987); Zaki (1984) and Abou-Hamela (1987) on Chinese, Balady and American garlic cultivars.

Regarding the effect of NPK fertilization, the same data in Table (1) show clearly that there were significant and continuous increments in all studied morphological parameters with increasing fertilization levels during both seasons of growth. In this connection the third (90 kg N + 45 kg P₂O₅ + 72 kg K₂O/fad.) and the fourth (120 kg N + 60 kg P₂O₅ + 96 kg K₂O/fad.) used levels of NPK fertilization reflected the highest increments of all studied growth aspects. Obtained results may be due to the main role of nitrogen, phosphorus and potassium elements in increasing plant growth materials and the net assimilation rate of plant metabolism processes. These results are in agreement with those reported by Ismail *et al.*, (1979); El-Beheidi *et al.*, (1985); Abed *et al.*, (1988); Abd El-Fattah *et al.*, (1989) and Eid *et al.*, (1991) and working on garlic.

Concerning the interactional effect between the studied cultivars and the NPK fertilization levels data in Table (1) revealed that no significant difference could be noticed in most of the vegetative growth parameters. The only exception herein was detected with the fresh and dry weight in the second season only. In this concern Chinese cv. combined with the fourth level of NPK fertilization proved to be the most effective treatment showing the highest values.

2- Yield and its components:

Data on yield and its components for the studied cultivars under the effect of N, P and K fertilization were presented in Table (2). It is obvious from these data that, there were clear differences in bulb weight, length and diameter as well as total yield among the studied cultivars during both growing seasons. Such differences in the forementioned yield components reached the level of significance between Chinese and French as well as between Balady and French cv., but there was no significant difference between Chinese and Balady cvs. during the growing seasons. In this regard, Chinese produced the highest total yield and its components followed by Balady while the French cvs. showed the lowest values in this respect. These results may be attributed to the vegetative growth differences (Table 1) and consequently yield and its components were differed among the studied cultivars. Nassar *et al.*, (1972); Zaki (1984) and Maksoud *et al.*, (1987), reported similar results on evaluation of some garlic cultivars.

Table (2): Effect of NPK fertilization level on yield and its components of some garlic cultivars.

Season	Cultivar	Fertilization level	1989/1990				1990/1991			
			Bulb weight (g)	Bulb diameter (cm)	Bulb length (cm)	Total yield (Ton/Fad)	Bulb weight (g)	Bulb diameter (cm)	Bulb length (cm)	Total yield (Ton/Fad)
Chinese	1		41.6	3.8	2.8	5.773	46.2	4.2	3.2	6.726
	2		48.5	4.1	3.1	6.815	52.9	4.3	3.5	6.815
	3		55.5	4.3	4.3	7.150	56.2	4.4	3.5	8.009
	4		55.8	4.4	3.6	7.313	58.0	4.6	4.2	8.903
French	1		32.3	3.3	2.4	4.641	48.7	3.8	2.6	5.653
	2		34.5	3.4	2.6	4.973	45.4	4.2	2.7	5.794
	3		44.7	3.7	2.8	5.284	46.7	4.2	3.1	6.080
	4		47.3	3.7	3.5	5.677	53.8	4.3	3.7	6.133
Balady	1		40.2	3.8	2.8	5.107	49.1	4.0	3.0	5.957
	2		47.6	3.9	2.9	5.741	50.0	4.1	3.2	6.609
	3		49.4	4.0	3.3	6.667	53.4	4.3	3.4	6.993
	4		54.7	4.3	3.4	6.771	55.0	4.4	4.0	7.578
L.S.D. at 0.05			n.s	n.s	n.s	n.s	n.s	n.s	n.s	0.515
Chinese			50.3	4.2	3.2	6.762	53.3	4.4	3.6	7.613
	French		39.6	3.5	3.7	5.144	48.6	4.1	3.1	5.715
	Balady		47.9	4.0	3.3	6.071	51.8	4.2	3.4	6.784
L.S.D. at 0.05			4.7	0.4	0.3	0.328	2.1	0.2	0.2	0.382
Fertilization level	1		38.0	3.6	2.7	5.174	48.0	4.0	2.9	6.110
	2		41.1	3.8	2.9	5.843	49.4	4.2	3.1	6.406
	3		49.8	4.0	3.2	6.367	52.1	4.3	3.3	7.027
	4		52.6	4.1	3.5	6.587	55.6	4.4	3.9	7.538
L.S.D. at 0.05			3.9	n.s	0.1	0.469	4.1	0.1	0.1	0.056

Concerning the effect of NPK fertilization, the same data in Table (2) indicated that there were statistical differences in all studied yield measurements among the applied fertilizers levels during both seasons of growth. In this respect, the third and fourth levels of fertilization produced the highest total yield and its components compared with the other used levels of fertilization. Such increments in total yield and its components may be due to the increments in vegetative growth measurements as indicated in Table (1). Obtained results agree with those reported by El-Beheidi *et al.*, (1983); Maksoud *et al.*, (1984); Abed *et al.*, (1988); Abd El-Fattah *et al.*, (1989) and Eid *et al.*, (1991).

As for the interactional effect, irrespective of the total yield which was significantly affected during the second season only, no significant differences were obtained in all studied yield parameters among the growth cultivars as a result of the different used fertilizers levels. However, the highest used fertilizer level reflected the maximum increments in all yield parameters in all studied cultivars.

3- Bulb chemical composition:

Data in Table (3) indicate that, no significant differences in percentages of total nitrogen, phosphorus and volatile oils were found among the tested cultivars, which differed only in the percentage of potassium. Balady and Chinese cvs. contained the highest percentage of potassium. Similar results were reported by Abou-Hamela (1987) and Maksoud *et al.*, (1987) on garlic.

The same data in Table (3) indicate that there were significant increments in the percentages of total nitrogen, phosphorus, potassium and volatile oil as a result of increasing the level of fertilization. In this respect, the highest used fertilization level, i.e., 120 kg N + 60 kg P₂O₅ + 96 kg K₂O/fad. proved to be the most effective treatment in increasing all assayed chemical constituents. Obtained results are in conformity with those reported by Abed *et al.*, (1988) and Eid *et al.*, (1991) on garlic.

Regarding the combined effect, no significant differences were noticed in the concentration of the determined chemical constituents of all studied cultivars as a result of using different levels of fertilization. In this respect, the highest values of such chemical constituents were obtained as a result of the highest fertilizers level in case of Balady cv. Generally, it could be concluded that

Table (3): Effect of NPK fertilization level on NPK (mg/100 g dry weight) and volatile oils (%) in garlic bulbs.

Season	1989/1990						1990/1991								
	Fertilizat- ion level	Mineral content			Volatile oils %			Fertilizat- ion level	Mineral content			Volatile oils %			
Cultivars	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Chinese	1	2924	242	2626	0.521	2833	241	2611	0.523						
	2	3273	310	2913	0.607	3271	295	2900	0.580						
	3	3786	375	3313	0.717	3781	366	3320	0.645						
	4	4107	520	4519	0.767	4100	491	4500	0.685						
French	1	2942	235	2605	0.531	2938	235	2615	0.552						
	2	3389	305	2994	0.594	3375	308	2981	0.597						
	3	3870	390	3233	0.718	3865	385	3231	0.671						
	4	4171	521	4492	0.761	4175	527	4475	0.697						
Balady	1	2959	258	2748	0.542	2955	255	2744	0.561						
	2	3364	330	3103	0.601	3361	325	3097	0.599						
	3	3845	403	3466	0.719	3841	397	3461	0.685						
	4	4132	540	4548	0.776	4175	490	4512	0.722						
L.S.D. at 0.05	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Chinese	3522	361	3342	0.653	3496	348	3333	0.608							
French	3545	362	3331	0.651	3588	364	3326	0.629							
Balady	3575	382	3466	0.659	3583	367	3454	0.642							
L.S.D.	n.s	n.s	89	n.s	n.s	79	n.s	n.s							
Fertilizat- ion level	1	2941	245	2659	0.531	2909	244	2657	0.545						
	2	3345	315	3003	0.600	3200	309	2993	0.579						
	3	3833	389	3337	0.718	3829	383	3437	0.667						
	4	4136	527	4519	0.768	4150	503	4496	0.701						
L.S.D. at 0.05	94	16	141	0.029	91	13	135	0.027							

using 90 kg N + 45 kg P₂O₅ + 72 kg K₂O/fad. or 120 kg N + 60 kg P₂O₅ + 96 kg K₂O/fad. were required for obtaining plants with the highest vegetative growth and yield and best nutritive values of either Chinese cv. or Balady cv. under similar conditions of this work.

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تأثير الصنف ومستوى
التسميد الازوتى والفوسفاتى والبوتاسى على نمونات الثوم والمحمول
والمحتوى الكيماوى لابلصال

فتحي أبو النصر أبو سديرة سعيد معوض محمد سعيد ابراهيم عرابى أحمد عرابى

أجريت تجربتان حقليتان بمزرعة أبحاث كلية الزراعة بمشتهر - جامعة الزقازيق خلال الموسم الشتوى لعامى ١٩٩٠/٨٩ ، ١٩٩١/١٩٩٠ وذلك بهدف دراسة تأثير الصنف (المينى - الفرنساوى والبلدى) والتسميد الازوتى والفوسفاتى والبوتاسى على مسورة معادلة سمادية بمستويات مختلفة وذلك على نمو النباتات والمحصول والتركيب الكيماوى لابلصال .

وقد أوضحت النتائج تفوق الصنف المينى وكذلك البلدى فى النمو الخضرى والمحصول ومكوناته وايضا المحتوى المعدنى من النتروجين والفوسفور والبوتاسيوم بالاضافة الى نسبة الزيوت المتطايرة مقارنة بالصنف الفرنساوى وقد أدى استخدام المستوى الثالث (٩٠ كجم ن + ٤٥ كجم فوم أه + ٧٢ كجم بوم ا) والرابع (١٢٠ كجم ن + ٦٠ كجم فوم أه + ٩٦ كجم بوم ا) من التسميد الى الحصول على اعلى زيادة فى صفات النمو الخضرى والمحصول ومكوناته وكذلك المحتوى الكيماوى لابلصال هذه الاصناف المستخدمة .

وبذلك يمكن التوصية بزراعة الصنف المينى أو البلدى واستخدام المستوى الثالث أو الرابع بغرض المحصول على اعلا محصول وافضل جودة لابلصال الثوم وذلك بمنطقة القليوبية أو فى مناطق اخرى مشابه لظروف التجربة .