

EFFECT OF ORGANIC AND INORGANIC FERTILIZATION ON GROWTH, YIELD AND QUALITY OF TWO GARLIC CULTIVARS

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Abstract: This study was conducted during the two successive seasons of 2003/2004 and 2004/2005 at El-Kouther Experimental Farm, Sohag, Egypt on two garlic cultivars i.e., Balady and Sids40. This investigation aims to study the effect of organic and inorganic fertilizer on growth, bulb characters, quality bulb, yield and its components and chemical analysis for two garlic cultivars. Seven treatments of fertilizer were used in this study i.e., cattle manure, poultry manure, (cattle manure50%+poultry manure 50%), (50%NPK+ 50%cattle manure), (50%NPK+ 50%poultry manure), (50%NPK+ 25%cattle manure+25%poultry manure) and 100%NPK. The results indicated that

Balady cv. Gave the best results for plant height, fresh weight leaves/plant, number of leaves/bulb and weight loss. While, Sids40 cv. Gave the best results for number of leave/plant, bulb diameter and weight, fresh and totally yield, average clove weight. Moreover, there are no significant differences between garlic cultivars for phosphorus and potassium content. Also, the best fertilizer treatment was (50%NPK+ 25%cattle manure+25% poultry manure) for most studied characters. The Sids40 cultivar receiving 50%NPK+ 25%cattle manure+25%poultry manure gave the best results for most studied characters.

Key words: Garlic, organic and inorganic fertilizer, Cattle manure, Poultry manure, NPK

Introduction

Garlic (*Allium stivum* L.) is a perennial herb of the Alliaceae family. It is one of the most commercially important bulb crops in Egypt and is cultivated for both local consumption and exportation. The bulb in fresh or in processed form has been used as food, condiment, and for medicinal purposes. Garlic is a relatively good source of calcium, phosphorus, and potassium. Its leaves are sources of protein and of Vitamins A and C. Also, Garlic contains antibiotic substances that inhibit the growth of certain bacteria and fungi. (Parkinson and Clarke, 1964 and Cavallito et al., 1944).

The importance of using organic fertilizer and decrease using chemical fertilizer in plant production is one of the important ways in health protection. There are many advantages to use the organic fertilizer in plant production such as the addition of organic material improves soil structure. It also vastly improves the water-holding capacities of sandy soils, a distinct advantage in arid climates such as ours. Commercial fertilizer, especially nitrogen, is easily washed below the level of the plant's root system through the leaching of rain or irrigation. As well, overly heavy applications of commercial fertilizers can build up toxic concentrations of salts in the soil, thus creating chemical imbalances. If organic materials are readily available and cheap, the expense of the

commercial fertilizer should also be considered. All organic manure improve the availability of several elements in the soil through their active groups which have the ability to retain the elements in a complex or chalet forms and consequently improve the plant growth and yield both quantitatively and qualitatively (Soliman et al., 1991; Shafeek and El-Habbasha, 2000). Osman et al., 1991 found in garlic that Balady cultivar surpassed Chinese cultivar in plant height, average leaves fresh weight, bulbing ratio, fresh and cured yield, average bulb weight and number of cloves per bulb, while Chinese cultivar gave higher values than Balady cultivar in dry matter percentage of leaves, dry matter percentage of bulb and average weight of cloves.

There are significant differences between garlic cultivars (Balady and Chinese) in chemical composition, storage ability and the weight loss percentage during curing. Balady cultivar exhibited the highest loss as compared to Chinese cultivar. (Fatthalla, et al., 1992; El-Mansi et al., 1999; Gad El-Hak and Abd El-Mageed 2000).

Holanda et al., (1982) found that the highest yields of organic were obtained with half the recommended levels of lime and fertilizers (NPK) plus poultry manure, poultry manure was the only alone supplied adequate levels of nutrients to the crops.

Koltunov (1984) Showed that the application of farm yard manures at 40t/ha+NPK gave the best yield of bulbs in garlic suitable for long-term storage. Khalaf and Taha (1988) indicated that the organic manure application significantly increased the weight of plants, number of leaves bulb and neck diameter and percent of dry matter of bulbs. Also organic manure improved yield, bulbs quality and increased potassium content in bulbs. Applied farm yard manure at 20t/ha compared with 100Kg N, 60Kg P and 100Kg K on onion plants gave the highest values of plant height, bulb weight, bulb diameter and yield onion (Jana and Jahangir, 1990). Mallanagouda et al., (1995) indicated that the highest yield of garlic was obtained from plots receiving the recommended rate of NPK+ farm yard manure. Zhang et al., (1998) they found the combination of organic fertilizers and NPK fertilizers increased the yield by 78.4-118.4%. Mohamed et al., (2000) applications of organic manures and NPK treatments showed a significant increase in growth parameters, total yield, fresh and dry weight of bulb and bulb diameter. Chemical composition determined as N,P and K content in onion bulbs increased significantly due to treatments as

compared with the control Farrag and Husssein (2000) indicated that, the organic fertilizers significantly increased vegetative growth characters, bulbs yield, quality and also increased the potassium content in plant. The highest values of number of leaves/plant, fresh weight of leaves/plant and dry matter percentage of leaves and bulb fresh weight were obtained by application of 30 ton/fed. of poultry manure. Also, the effect of cattle manure on bulbs yield and quality was moderate. Fatma et al., (2002) found that the highest levels of nitrogen fertilizer (120N unit/fed.) gave the best growth characters. While, using organic manure fertilizer with the highest levels of nitrogen (120N unit/fed.) gave the best bulb yield of onion plant. Ahmed (2004) found that application of filter mud and chicken manure at the rate 5.0 ton/fed. led to significant increases in plant length, number of leaves/plant, plant and bulb fresh weight and total bulb onion yield/fed.

The aim of this study is to investigate the effect of organic and inorganic fertilizers on growth, yield and bulb quality in two garlic cultivars i.e., Balady and Sids40.

Materials and Methods

Two garlic (*Allium Sativum* L.) cultivars were used in this investigation i.e., Balady and Sids40 (a clone selected from the Chinese cultivar) to study the effect of organic and inorganic fertilization on Garlic. The experiment was conducted in Experimental Farm, Sohag University during successive seasons of 2003/2004 and 2004/2005 in a loamy clay soil. The organic materials Cattle manure and Poultry manure were applied by spread and thoroughly mixing with the surface soil layer (0-20 cm). While the inorganic fertilizer was

(NPK) at rate of 120N, 60 P₂ O₅ and 48 K₂O Kg/fed. Ammonium nitrate (33.5%) was added on three equal portions at 30, 60 and 105 days after planting date. Super-phosphate (15.5% P₂ O₅) was added on three equal parts during the soil preparation, 30 and 60 days after planting date. While, potassium sulfate (48% K₂O) was added on two equal parts at 60 and 105 days after planting date. Rate and amount of fertilizers were used in the treatments are shown in Table1.

Table (1): The rate and amount of fertilizer treatments

Treatments	Rate of fertilizers (Kg/fed.)					Amount of fertilizers				
	Cattle	Poultry	N	P	K	Cattle Ton/fed.	Poultry Ton/fed.	N Kg/fed.	P Kg/fed.	K Kg/fed.
1	120	-	-	-	-	16	-	-	-	-
2	-	120	-	-	-	-	5.33	-	-	-
3	60	60	-	-	-	8	2.67	-	-	-
4	60	-	60	30	24	8	-	201	193.6	50
5	-	60	60	30	24	-	2.67	201	193.6	50
6	30	30	60	30	24	4	1.34	201	193.6	50
7	-	-	120	60	48	-	-	402	387.2	100

A split-plot design with three replicates was used in this investigation. The garlic cultivars were placed in the main plots while, fertilizer treatments were in sub-

plots. The plot area was 10.5m² (1/400fed.) consisted of 5 ridges, 60cm wide and 3.5m long. The fertilizer treatments were added at rate 120N Kg/fed. as follow

- 1-Cattle manure
 - 2- Poultry manure
 - 3-Cattle + Poultry manure
 - 4-50% NPK + 50% Cattle manure.
 - 5-50% NPK + 50% Poultry manure.
 - 6-50% NPK + 25% Cattle manure
 - +25% Poultry manure
 - 7- 100% NPK (as control).
- The chemical analysis of organic manures used in this study is shown in Table 2.

Table (2): Chemical analysis of the used organic manure

Organic manure	Organic matter	PH	Ec (ds/m)	N%	P%	K%
Cattle manure	38.40	7.28	4.43	0.75	0.58	0.65
Poultry manure	43.8	7.15	4.29	2.25	1.23	0.72

Within each cultivar, garlic cloves were selected uniformly in shape and size. The cloves were planted on the 12th and 4th of October in the first and second seasons respectively. The cloves were planted on both sides of each ridge at 10 cm apart. The harvest date was in 10 April and 24 April in the first season for Balady and Sids40 cultivars respectively. In the second season the date of harvest was 14 April and 28 April for Balady and Sids40 cultivars respectively. Normal cultural practices of soil preparation and irrigation were followed. Data were recorded on ten plants from each replicate. The following characters were determined

A-Vegetative growth measurements

- 1-plant height (cm)
- 2- Number of leaves/plant (All visible

leaves were counted, the dry leaves were excluded)

- 3-Fresh weight of leaves/plant (g)

B- Yield characters

- 1-Fresh total yield (ton/fed.)
- 2-Cured yield (ton/fed.), garlic plants were cured for two weeks and weighted.
- 3- Average clove weight (g)
- 4-Weight loss%

C-Bulb quality

After curing, 10plants from each plot were taken randomly to determine the following characters.

- a- Physical characters
 - 1- Average cured bulb diameter (cm).
 - 2- Average cured bulb weight (g).

3- Average number of cloves/bulb.

b- Chemical analysis of cloves

Nitrogen, phosphorus and potassium percentage in the dry matter of cured cloves were determined according to methods described by (Kock and Mc Meekin, 1924) for nitrogen, (Murphy and Riley 1962) for phosphorus and (Brown and Lilleland, 1946) for potassium.

The obtained data were statistically analyzed by using the analysis of variance methods according to Snedecor and Cochran (1982).

Results and Discussion

A) Vegetative growth measurements

1.1 Plant character

The effect of organic and chemical fertilizer on the vegetative characters of garlic plant in both seasons 2003/2004 and 2004/2005 is presented in Table 3. The obtained results show that plants of the Balady cultivar were significantly taller than those of the Sids40 cultivar. Also, treatment 6 (50%NPK+ 25% cattle manure+25% poultry manure) gave the highest values for plant height and was significantly higher than other treatments except for treatment 4 in both seasons. The interaction between cultivars and treatment of fertilizer indicated that, the combination between treatment 6 and Balady cultivar gave the highest values and significant differences among other combinations except treatment 4 (50%NPK+50% cattle manure) with

Balady cultivar in both seasons.

Data on number of leaves/plant are presented in Table 3. The results indicated that Sids40 cultivar was significantly higher than Balady cultivar in both planting seasons in this trait. Treatment 4 gave the highest values for this character in first season while treatment 6 was the better in the second season but there is no significant differences were found between the two treatments in both seasons. The interactions in Table 3 showed that both of treatments 4 and 6 when used for fertilizer the Sids40 cultivar gave the highest values for number of leaves/plant in both planting seasons.

Data in Table 3 show that there are significant differences between the two garlic cultivars in fresh weight of leaves/plant (g) with the Balady cv. gave the highest values. Treatments 4 and 6 gave significantly the highest values than other treatments in both seasons 2003/2004 and 2004/2005. The interactions between both treatments 4 and 6 with Balady cv. were significantly higher than other combinations in this study trait.

These results agreed with those obtained by Soliman et al., 1991; Osman et al.,1991; Shafeek and El-Habbasha,2000 ; Farrag and Hussein, 2000 and Mohamed et al., 2000.

1.2 Bulb characters

Data in Table 4 indicated that there are highly significant differences between the two cultivars regarding

bulb diameter in both seasons. Sids40 cv. gave the highest value of bulb diameter (4.38 and 4.71 cm in season 2003/2004 and 2004/2005, respectively). Both treatments 6 and 4 gave the highest values (4.74 and 4.59 cm, respectively) and they significantly differences than other treatment in first season 2003/2004. While, only treatment 6 was significantly higher than other treatments in season. The interactions between fertilizer and garlic cultivars in this trait indicated that plants of Sids40 cultivar when received 50% NPK + 25% Cattle manure +25% poultry manure gave the highest value and was significantly higher than other treatments except when we used the treatment 4 in first season 2003/2004.

The results in Table 4 show that Sids40 cv. was significantly higher differences than Balady cv. in both seasons. Also, Treatment 6 (50%NPK+ 25% cattle manure+25% poultry manure) gave the highest values for bulb weight (g). Fertilizer Sids40 cultivar with treatment 6 was the better for this trait in both seasons.

Data of number of cloves/bulb are presented in Table 4. Balady cv. records the highest values for this trait in both seasons. The highest values of number of leaves/bulb were obtained from treatment 6 in both seasons. Balady cultivar when received 100% NPK gave the highest values.

The results are in harmony with many of investigations which indicate

the organic manure plus chemical fertilizer improve the bulb characters (Khalaf and Taha ,1988 ; Jana and Jahangir,1990 and Mohamed et al., 2000).

B-Yield characters

Data of total fresh yield in Table 5 showed that Sids40 cultivar gave higher value of fresh yield than Balady cultivar. There is significant differences between the two garlic cultivars in both seasons 2003/2004 and 2004/2005. Both treatments 6 and 4 were not significantly different and gave the highest values in both seasons. The interaction between Sids40 cultivar and both treatments 4,5 and 6 gave the highest values and were significantly higher than other interactions in both seasons.

Data in Table 5 indicate that Sids40 cultivar was significantly higher than the Balady cv. in cured total yield character in both seasons (6.06 and 6.22 ton, respectively). Higher cured total yield was obtained by applied treatment 6 (50% NPK+ 25% cattle manure+ 25% poultry manure) to garlic plants and was significantly higher than other treatments in this experiment excepted treatment 4 in second season. The interactions between (Balady and Sids40) cultivars and treatment 6 gave the highest values for this trait.

These results are in agreement with those obtained by Mallanagouda et al., (1995); Zhang et al., (1998); Farrag and Hussein (2000); Fatma *et al.*, (2002) and Ahmed (2004).

The average of clove weight for two garlic cultivars fertilizer with organic and inorganic fertilization is presented in Table 6. Sids40 cultivar was significantly higher than Balady cultivar in this trait. There is no significant difference between treatments 6 and 4 in both seasons. These treatments gave the highest values for this trait. The interaction (Sids40 + treatment 6) was significantly higher than other interactions. Similar results were obtained by Jana and Jahangir,1990; and Mohamed et al., (2000).

The percentages of weight loss for two garlic cultivars are presented in Table 5. The results indicated that, Balady cultivar lost loss weight higher than Sids40 cultivar in both seasons. Treatment7 (100%NPK) lead to increased loss weight than other treatments in both seasons. The interaction between Balady cultivar and treatment 7 (100 %NPK) caused higher losses in weight than other interactions in seasons 2003/2004 and 2004/2005. These results are in accordance with those obtained by El-Mansi et al., 1999; Gad El-Hak and Abd El-Mageed 2000).

c- Chemical analysis

Percentages of nitrogen in garlic plant cloves are presented in Table 6. The nitrogen content in cloves of Sids40 cultivar was greater than nitrogen content in cloves of the Balady cultivar in both seasons (2.49 and 2.57). Treatments 6 and 4 gave the highest values. Cloves of Sids40 plants when received 50% NPK + 25% cattle manure +25% poultry manure gave the higher content of nitrogen than other treatments.

Data in Table 6 indicated that there is no significant difference between the two garlic cultivars in respect of percentage of phosphorus content in the cloves. The same trend in this trait was similar with percentage of nitrogen for both fertilizer treatments and their interactions. There is no significant differences between the to garlic cultivars for percentage of potassium (Table 6). Treatments 6 and 7 gave the highest values in both seasons. Also, the interaction between Sids40 cultivar and treatment 7 was the best interaction in this trait. Similar results were obtained by Khalaf and Taha (1988); Farrag and Husssein (2000) and Mohamed et al., (2000).

Table (3): Effect of organic and inorganic fertilizers on plant growth characters in two garlic cultivars in seasons 2003/20004 and 2004/2005.

Treat.	Plant height (cm)			Number of leaves/plant			Fresh weight of leaves/plant (g)		
	2003/2004 Season								
	Balady	Sids40	Mean	Balady	Sids40	Mean	Balady	Sids40	Mean
1	72.6	64.0	68.3	8.7	10.4	9.6	37.8	34.5	36.2
2	71.2	60.6	65.9	8.6	10.3	9.5	36.3	34.6	35.5
3	76.3	65.2	70.8	9.5	10.4	10.1	38.5	36.2	37.4
4	80.5	66.5	73.5	10.2	12.0	11.1	43.2	39.9	41.6
5	78.3	65.9	72.1	9.8	11.0	10.4	41.2	37.5	39.4
6	83.2	67.4	75.3	10.1	11.6	10.9	42.6	38.5	40.6
7	77.3	65.7	71.5	9.2	10.2	9.7	39.5	36.2	37.9
Mean	77.1	65.0		9.4	10.8		39.8	36.8	
LSD at 0.05	A(cultivars)		4.1	A 0.7			A 2.1		
	B(treatments)		2.6	B 0.9			B 3.4		
	AB		4.3	AB 1.2			AB 5.7		
2004/2005 Season									
Treat.	Balady	Sids40	Mean	Balady	Sids40	Mean	Balady	Sids40	Mean
1	78.5	65.5	72.0	9.9	10.5	10.2	39.2	35.2	37.2
2	78.0	63.5	70.8	10.1	11.7	10.9	37.3	35.3	36.3
3	84.5	67.3	75.9	10.2	12.1	11.2	39.2	36.7	38.0
4	89.2	70.1	79.6	11.2	12.6	11.9	45.3	40.1	42.7
5	86.3	68.5	77.4	11.5	12.3	11.9	43.5	38.2	40.9
6	90.5	73.5	82.0	11.5	13.7	12.6	45.7	42.2	44.0
7	85.7	68.3	77.0	10.6	11.2	10.9	40.2	40.1	40.2
Mean	84.7	68.1		10.7	12.0		41.5	38.3	
LSD at 0.05	A(cultivars)		3.6	A 0.9			A 3.1		
	B(treatments)		2.8	B 1.2			B 4.2		
	AB		4.9	AB 1.4			AB 4.9		

Table (4): Effect of organic and inorganic fertilizers on bulb characters in two garlic cultivars in seasons 2003/20004 and 2004/2005.

Treat.	Bulb diameter (cm)			Bulb weight (g)			Number of cloves /bulb		
	2003/2004 Season								
	Balady	Sids40	Mean	Balady	Sids40	Mean	Balady	Sids40	Mean
1	3.70	3.94	3.82	31.0	35.2	33.1	32.4	12.3	22.4
2	3.60	3.96	3.78	30.2	34.6	32.4	32.6	12.5	22.6
3	4.01	4.25	4.13	33.3	36.2	34.8	33.7	13.1	23.4
4	4.42	4.76	4.59	35.9	38.2	37.1	34.2	13.4	23.8
5	4.24	4.47	4.36	34.2	37.3	35.8	33.7	13.2	23.5
6	4.52	4.96	4.74	39.3	40.1	39.7	35.2	14.0	42.2
7	4.21	4.32	4.27	33.6	35.2	34.4	35.7	14.2	25.0
Mean	4.10	4.38		33.9	36.7		33.9	13.2	
LSD at 0.05	A(cultivars) 0.23		A 2.3			A 1.7			
	B(treatments) 0.17		B 2.7			B 2.3			
	AB 0.39		AB 2.8			AB 3.6			
2004/2005 Season									
Treat.	Balady	Sids40	Mean	Balady	Sids40	Mean	Balady	Sids40	Mean
1	4.01	4.39	4.20	36.2	45.3	40.8	36.2	13.2	24.7
2	4.12	4.29	4.21	35.2	45.0	40.1	36.1	13.4	24.8
3	4.23	4.58	4.41	38.5	48.2	43.4	37.2	13.6	25.4
4	4.71	4.96	4.83	41.2	49.6	45.4	38.5	14.2	26.4
5	4.55	4.79	4.67	40.9	50.2	45.6	37.5	14.7	26.1
6	4.81	5.29	5.05	48.3	55.9	52.1	38.0	15.2	27.1
7	4.22	4.68	4.45	39.2	48.5	43.9	38.7	15.0	26.9
Mean	4.38	4.71		39.9	49.0		37.6	14.2	
LSD at 0.05	A(cultivars) 0.28		A 3.7			A 1.8			
	B(treatments) 0.21		B 2.9			B 2.1			
	AB 0.32		AB 2.5			AB 3.9			

Table (6): Effect of organic and in-organic fertilizer on chemical analysis characters in two garlic cultivars in seasons 2003/20004 and 2004/2005.

Treat.	Nitrogen %			Phosphorus %			Potassium %		
2003/2004 Season									
	Balady	Sids40	Mean	Balady	Sids40	Mean	Balady	Sids40	Mean
1	2.21	2.29	2.25	0.31	0.33	0.32	1.42	1.45	1.44
2	2.19	2.28	2.24	0.33	0.34	0.34	1.40	1.42	1.41
3	2.14	2.45	2.43	0.34	0.36	0.35	1.47	1.49	1.48
4	2.52	2.63	2.58	0.35	0.36	0.36	1.51	1.55	1.53
5	2.43	2.53	2.48	0.34	0.36	0.35	1.56	1.59	1.58
6	2.52	2.73	2.63	0.36	0.37	0.37	1.62	1.63	1.63
7	2.42	2.49	2.46	0.32	0.34	0.33	1.63	1.72	1.68
Mean	2.39	2.49		0.34	0.35		1.52	1.55	
LSD at 0.05	A (cultivars) 0.07			A NS			A NS		
	B(treatments) 0.15			B 0.03			B 0.17		
	AB 0.23			AB 0.04			AB 0.18		
2004/2005 Season									
Treat.	Balady	Sids40	Mean	Balady	Sids40	Mean	Balady	Sids40	Mean
1	2.32	2.39	2.36	0.33	0.32	0.33	1.46	1.48	1.47
2	2.31	2.40	2.36	0.35	0.33	0.34	1.48	1.50	1.49
3	2.46	2.51	2.49	0.35	0.37	0.36	1.51	1.53	1.52
4	2.56	2.67	2.62	0.37	0.38	0.38	1.60	1.68	1.64
5	2.52	2.60	2.56	0.35	0.37	0.36	1.55	1.67	1.61
6	2.64	2.89	2.77	0.39	0.41	0.40	1.71	1.73	1.72
7	2.41	2.53	2.47	0.35	0.35	0.35	1.69	1.81	1.75
Mean	2.46	2.57		0.36	0.36		1.57	1.63	
LSD at 0.05	A (cultivars) 0.09			A NS			A NS		
	B(treatments) 0.17			B 0.05			B 0.18		
	AB 0.14			AB 0.07			AB 2.3		

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Badawy A.S., et al., (2007).