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EFFECT OF PLANTING DATES AND NITROGEN SOURCES ON DRY WEIGHT, YIELD AND NITROGEN USE EFFICIENCY OF GARLIC PLANTS GROWN UNDER SOUTH SINAI GOVERNORATE CONDITIONS

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ABSTRACT: A field experiment was carried out during the two successive winter seasons of 2014/2015 and 2015/2016 at a private farm in El-Tour region, South Sinai Governorate, Egypt, to study the effect of planting dates, nitrogen sources and their interactions on dry weight, yield and its components and nitrogen use efficiency (NUE) of garlic (Balady cultivar) grown in sandy soil conditions using drip irrigation system. The obtained results could be summarized as follows: The interaction between planting dates on 15th Oct. or 1st Nov. and fertilizing plants with 100% of the recommended rate (RR) of N as poultry manure (PM) or and 50% RR of N as ammonium sulphate (AS)+50% RR of N as PM gave the highest values of each of dry weight of bulbs, leaves, and total dry weight/plant at 135 days after planting (DAP), N and P uptake by bulbs and leaves and total uptake of them by plant, yield of grades 1,2, exportable, marketable, total yield, average bulb weight and the highest values of nitrogen use efficiency (NUE). Whereas, the interaction between planting on 15th Oct. and fertilizing plants with 50% RR of N as AS + 50% RR of N as PM gave the highest values of K uptake by bulbs and leaves as well as K total uptake by plant.

Kew words: Garlic, planting dates, nitrogen sources, yield, nitrogen use efficiency.

INTRODUCTION

Garlic (*Allium sativum* L.), a member of the Alliaceae family, is one of the most aromatic herbaceous annual spices (**Kurian, 1995**). It is the second most widely spice crop of the cultivated Allium crops, next to onion in the world (**Purseglove, 1975**) with a characteristic pungent smell. In Egypt, the total cultivated area of garlic, was about 29688 fad., during 2016 season which produced 280216 tons with average of 9.438 tons/faddan (**FAO, 2016**).

Planting dates plays an important role on the growth and yield of garlic. Garlic is known to be thermo and photo-sensitive crop (**Jones and Mann, 1963**) and its vegetative growth and bulb formation are greatly influenced by growing environment, such as cool weather and grows well in a well-drained soils (**Rahim and Fordham, 1988**).

There were significant differences between planting dates of garlic (15th Sept, 1st Oct., 15th Oct. and 1st Nov.) in this regard (**Abdalla *et al*., 2011; Gunda, 2013; Vidya *et al.,* 2013; Hassan *et al*., 2016** on garlic) concerning plant dry weight **(Ahmed, 2002; El-Zohiri and Farag, 2014** on garlic) as for plant chemical composition, (**Mohanty, 2001** on onion, **Muhammad *et al.,* 2001; Bhuiya *et al.,* 2003; Rahim *et al.,* 2003; Vidya *et al.*, 2013; Youssef and Tony, 2014; Choudhary, 2015; Hassan *et al*., 2016** on garlic) regarding yield and its components.

Excessive amounts of mineral nitrogen are applied to vegetables in order to achieve a higher yield. However, nitrogen fertilizer alone generate several deleterious effects to the environment and human health and also should be replenished in every cultivation season. Since, the synthetic N fertilizer is rapidly lost by either evaporation or by leaching in drainage

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water causing dangerous environmental pollution (**Aisha *et al*., 2007**). Moreover, continuous usage of nitrogen fertilizer affects soil structure. Hence, organic manures can serve as alternative to mineral fertilizers, improving soil structure and microbial biomass (**Dauda *et al*., 2008**).

Fertilizing garlic plant with the mixture of mineral and organic nitrogen increased dry weight of plant, plant chemical composition and yield and its components **(Farrag and Hussein, 2000** on onion, **Ali *et al.*, 2001; El-Shabasi *et al*., 2003; Hassan, 2005; Badawy *et al.*, 2007; Suthar, 2009; El-Hifny, 2010; Bardisi *et al*., 2011** on garlic).

Therefore, the aims of this work are to study the most suitable planting date and evaluate the possibility of partial substitution of the expensive nitrogen chemical fertilizer by organic nitrogen to obtain high growth and best productivity of garlic under South Sinai Governorate condition.

MATERIALS AND METHODS

A field experiment was carried out during the two successive winter seasons of 2014/2015 and 2015/2016 at a private farm in El-Tour region, South Sinai Governorate, Egypt, to study the effect of planting dates, nitrogen sources and their interactions on dry weight, plant chemical composition, NUE and yield and its components of Balady garlic cultivar under sandy soil condition using drip irrigation system.

The used soil properties were: sandy soil in texture for the two experimental seasons, while it had 0.04 and 0.06% organic matter, 8.19 and 8.16 pH, 2.08 and 1.99 mmhos/cm EC, 4.07 and 3.98 ppm available N, 3.17 and 3.36 available P and 10.24 and 9.91available K in the 1st and 2nd seasons, respectively.

This experiment included 20 treatments, which were the combination between four planting dates (15th Sept., 1st Oct., 15th Oct. and 1st Nov.) and five nitrogen treatments (100% RR of N as AS 20.6% N, 100% RR as compost, 100% RR as PM), 50% RR as AS + 50% RR as compost and 50% RR as AS + 50% RR as PM).

Recommended rate (RR) of nitrogen was 120 kg N/fad., 100% recommended rate of N as compost and poultry manure were about 11.11 and 3.39 ton/fad., respectively, whereas 50% recommended rate of N as compost and poultry manure were about 5.55 and 1.69 ton/fad., respectively.

These treatments were arranged in a split plot design with three replicates. The planting dates were devoted in the main plots, while nitrogen sources were devoted in the sub plots.

The experimental area was 10.8 m^2 it contained three drippier lines with 6 meter length and 60 cm between lines. Garlic cloves were selected for uniformity in shape and size and sown at distance of 10 cm apart in the two sides of the dripper line.

The analyses of compost and poultry manure (PM) fertilizers (average of two seasons were 1.08 and 3.53% total N, 0.62 and 1.18% total P, 0.84 and 1.72 5 total K, 379 and 160 ppm Fe, 210 and 168 ppm Mn, 32.4 and 33 ppm Cu as well as 129.5 and 174 ppm Zn for compost and PM, respectively.

The PM was obtained from a private Farm at El-Tour, South Sinai Governorate.

The amounts of compost, PM and one third of both ammonium sulfate, potassium sulfate and 100% P_2O_5 as calcium superphosphate were added during soil preparation in the center of row and covered by sand. The rest of amounts of N and K fertilizers were added through irrigation water (fertigation) by 7 days intervals beginning one month after planting

The normal agricultural practices were carried out as commonly followed in district.

Data Recorded

Dry weight

A random sample of ten plants were taken from each plot at 135 days after planting (DAP) in both seasons of study for measuring the dry weight characters of garlic plants: The different parts of garlic plant; *i.e.*, bulb and leaves were oven dried at 70ºC till constant weight and then the following data were recorded

Dry weight of bulb, dry weight of leaves/ plant, and total dry weight (bulb +leaves) /plant.

Nitrogen, phosphorus and potassium uptake (mg/plant) were calculated by element (%) in bulb or leaves x dry weight bulb or leaves x 10.

Yield and its components

At proper maturity stage of bulbs, bulbs of each plot were harvested and graded into four categories according to **Ministry of Economic, Egypt (1963)** as follow:

Grade 1: Bulbs with diameter above 5.5 cm, grade 2: Bulbs with diameter between 4.5-5.5 cm, grade 3: Bulbs with diameter between 3.5-4.4 cm, and grade 4: Bulbs with diameter less than 3.5 cm.

Each grade was weighed separately in the same day and the following data were recorded

Exportable yield (grade 1+ grade 2) ton /fad., marketable yield (grade 1+ grade 2+ grade 3) ton/fad., and total yield (grade 1+ grade 2 + grade 3 + grade 4) ton/fad.

$$\text{Average bulb fresh weight} = \frac{\text{Yield of bulbs /plot}}{\text{Total number of bulbs/plot}}$$

Nitrogen use efficiency (NUE)

It was determined by dividing the bulb yield/ fad., by the nitrogen quantity/fad., and expressed as kg bulb/kg N according to **Clark (1982)**.

Statistical Analysis

Statistical analysis was conducted for all collected data. The analysis of variance was calculated according to **Snedecor and Cochran (1980)**, means separation were done according to LSD at 0.05 level.

RESULTS AND DISCUSSION

Dry Weight

Effect of planting dates

Results in Table 1 show the effect of planting dates on the dry weight of different parts of garlic plants at 135 days after planting (DAP) in both seasons. Planting dates reflect a significant effect on the dry weight of bulb, leaves, and total dry weight/ plant.

Planting dates on 15th Oct. or 1st Nov. increased dry weight of bulb, leaves and total dry weight/plant without any significant difference between them. The increase in total dry weight/ plant were about 41.38 and 25.25% for planting on 15th Oct. and 41.11 and 25.93% for planting on 1st Nov. over the planting on 15th Sept. in the 1st and 2nd seasons, respectively.

Planting dates plays an important role on the growth of garlic. Garlic is known to be thermo and photo-sensitive crop (**Jones and Mann, 1963**) and its vegetative growth and bulb formation are greatly influenced by growing environment (**Rahim and Fordham, 1988**).

These results agree with those reported by **Abdalla *et al*. (2011), Gunda (2013), Vidya *et al.* (2013) and Hassan *et al*. (2016)** on garlic.

Effect of nitrogen sources

Nitrogen sources had significant effect on the dry weight of bulb, leaves, and total dry weight/ plant at 135 DAP in both seasons (Table 2).

Fertilizing garlic plants with 100% recommended (RR) of N as poultry manure (PM) or with 50% RR of N as AS + 50% RR of N as PM, increased dry weight of bulb, leaves, and total dry weight/plant (g) without any significant differences compared to 100% RR of N as compost in the 2nd season.

The increase in total dry weight/plant were about 14.16 and 13.17% for 100% RR of N as PM and 16.74 and 14.37% for 50% RR of N as ammonium sulphate (AS) + 50% RR of N as PM over 100% RR of N as AS in the 1st and 2nd seasons, respectively.

Application of organic and mineral nitrogen fertilizers together may increase the exchangeable water soluble of NPK, and the uptake of these elements (**Cooke, 1972**), consequently increasing cell division and cell enlargement. As a result, this might be reflected on the growth of garlic.

Obtained results are in a good line with those reported by **Farrag and Hussein (2000)** on onion, **Ali *et al.* (2001) and El-Mansi *et al.* (2004a)** on garlic, **Mahmoud (2006)** on onion and **Bardisi *et al*. (2011)** on garlic.

Effect of the interaction between planting dates and nitrogen sources

Results in Table 3 show that the interaction between planting dates and nitrogen sources had significant effect on the dry weight of bulb, leaves, and total dry weight/ plant at 135 DAP in both seasons.

Table 1. Effect of planting dates on dry weight of different garlic plant organs at 135 days after planting during 2014/2015 and 2015/2016 seasons under South Sinai Governorate conditions

Treatment / Character	Dry weight of bulb (g)	Dry weight of leaves (g)	Total dry weight g/plant (bulb + leaves)	Relative increases in total dry weight (%)
Planting date		**2014/2015 season**		
15th Sept.	4.00	7.02	11.02	-
1st Oct.	5.05	8.75	13.80	25.23
15th Oct.	5.60	9.98	15.58	41.38
1st Nov.	5.74	9.81	15.55	41.11
LSD at 0.05 level	0.15	0.45	0.78	---
		2015/2016 season		
15th Sept.	4.90	8.33	13.23	-
1st Oct.	5.97	8.99	14.96	13.08
15th Oct.	6.46	10.11	16.57	25.25
1st Nov.	6.62	10.04	16.66	25.93
LSD at 0.05 level	0.38	1.07	1.35	---

Table 2. Effect of nitrogen sources on dry weight of different garlic plant organs at 135 days after planting during 2014/2015 and 2015/2016 seasons under South Sinai Governorate conditions

Treatment / Character	Dry weight of bulb (g)	Dry weight of leaves (g)	Total dry weight g/plant (bulb+leaves)	Relative increases in total dry weight (%)
Nitrogen source			**2014/2015 season**	
100% RR of N as AS	4.69	8.09	12.78	-
100% RR of N as compost	5.20	8.94	14.14	10.64
100% RR of N as PM	5.34	9.25	14.59	14.16
50% RR of N as AS+ 50% RR of N as compost	4.85	8.65	13.50	5.63
50% RR of N as AS+ 50% RR of N as PM	5.41	9.51	14.92	16.74
LSD at 0.05 level	0.19	0.38	0.99	---
			2015/2016 season	
100% RR of N as AS	5.53	8.67	14.20	-
100% RR of N as compost	6.09	9.53	15.62	10.0
100% RR of N as PM	6.24	9.83	16.07	13.17
50% RR of N as AS+ 50% RR of N as compost	5.76	8.89	14.65	3.17
50% RR of N as AS+ 50% RR of N as PM	6.32	9.92	16.24	14.37
LSD at 0.05 level	0.27	0.73	0.78	

RR: recommended rate (120 kg N/fad.), AS: ammonium sulphate, PM: poultry manure
100% RR of N (11.11 and 3.39 ton/fad.) compost and PM, respectively), 50% RR of N (5.55 and 1.69 ton/fad., compost and PM, respectively).

Table 3. Effect of the interaction between planting dates and nitrogen sources on the dry weight of different garlic plant organs at 135 days after planting during 2014/2015 and 2015/2016 season under south Sinai Governorate conditions

Treatment	Character	Dry weight of bulb (g)		Dry weight of leaves (g)		Total dry weight g/plant (bulb+leaves)		Relative increases in total dry weight (%)	
Planting date	Nitrogen source	2014/ 2015 season	2015/ 2016 season	2014/ 2015 season	2015/ 2016 season	2014/ 2015 season	2015/ 2016 season	2014/ 2015 season	2015/ 2016 season
15th Sept.	100% RR of N as AS	3.63	4.53	6.05	7.63	9.68	12.16	0.00	0.00
	100% RR of N as compost	4.06	4.95	6.89	8.48	10.95	13.43	13.12	10.44
	100% RR of N as PM	4.23	5.13	7.21	8.79	11.44	13.92	18.18	14.47
	50% RR of N as AS+ 50% RR of N as compost	3.83	4.73	7.05	7.95	10.88	12.68	12.40	04.28
	50% RR of N as AS+ 50% RR of N as PM	4.25	5.15	7.90	8.80	12.15	13.95	25.52	14.72
1st Oct.	100% RR of N as AS	4.73	5.62	8.08	8.33	12.81	13.95	32.33	14.72
	100% RR of N as compost	5.23	6.12	8.87	9.11	14.10	15.23	45.66	25.25
	100 RR of N as PM	5.23	6.17	9.21	9.44	14.44	15.61	49.17	28.37
	50% RR of N as AS+ 50% RR of N as compost	4.77	5.73	8.40	8.64	13.17	14.37	36.05	18.17
	50% RR of N as AS+ 50% RR of N as PM	5.27	6.22	9.17	9.41	14.44	15.63	49.17	28.54
15th Oct.	100% RR of N as AS	5.22	5.93	9.15	9.41	14.37	15.34	48.45	26.15
	100% RR of N as compost	5.60	6.49	10.07	10.34	15.67	16.83	61.88	38.40
	100% RR of N as PM	5.81	6.71	10.35	10.62	16.16	17.33	66.94	42.52
	50% RR of N as AS+ 50% RR of N as compost	5.43	6.33	9.69	9.29	15.12	15.62	56.20	28.45
	50% RR of N as AS+ 50% RR of N as PM	5.93	6.83	10.63	10.89	16.56	17.72	71.07	45.72
1st Nov.	100% RR of N as AS	5.16	6.03	9.07	9.31	14.23	15.34	47.00	26.15
	100% RR of N as compost	5.92	6.81	9.93	10.17	15.85	16.98	63.74	39.64
	100% RR of N as PM	6.07	6.94	10.23	10.47	16.30	17.41	68.39	43.17
	50% RR of N as AS+ 50% RR of N as compost	5.36	6.25	9.47	9.69	14.83	15.94	53.20	31.09
	50% RR of N as AS+ 50% RR of N as PM	6.18	7.06	10.33	10.57	16.51	17.63	70.56	44.98
LSD at 0.05 level		0.38	0.54	0.76	1.46	1.97	1.58	---	--

RR: recommended rate (120 kg N/fad), AS: ammonium sulphate, PM: poultry manure
100% RR of N (11.11 and 3.39 ton/fad.) compost and PM, respectively), 50% RR of N (5.55 and 1.69 ton/fad., compost and PM, respectively).

The interaction between planting on 15th Oct. or 1st Nov. and fertilizing plants with 100% RR of N as PM or and 50% RR of N as AS + 50% RR of N as PM gave the highest values of each of dry weight of bulb, leaves, and total dry weight/plant at 135 DAP in both seasons with no significant differences with some interaction treatments.

The increase in total dry weight/plant were about 66.94 and 42.52% for the interaction between planting on 15th Oct. and 100% RR of N as as PM, 71.07 and 45.72% for the interaction between planting on 15th Oct. and 50% RR of N as AS + 50% RR of N as PM, 39.44 and 43.17% for the interaction between planting on 1st Nov. and 100% RR of N as PM and 70.56 and 44.98% for the interaction between planting on 1st Nov. and 50% RR of N as AS+50% RR of N as PM over the interaction between planting on 15th Sept. and 100% RR of N as AS in the 1st and 2nd seasons, respectively.

N, P and K Uptake and Total Uptake

Effect of planting dates

Results in Table 4 show that planting dates on 15th Oct. gave the highest values for each of N, P and K uptake by bulb and leaves, N, P and K total uptake by plant with no significant differences with planting on 1st Nov. in most cases at 135 DAP in the 2nd season. On the other hand planting on 15th Sept. have the lowest values in this respect.

The stmulative effect on N, P and K uptake by bulb and leaves may be due to that these treatments increased total dry weight/plant (Table 1).

These results are in agreement with those reported by **Ahmed (2002)** and **El-Zohiri and Farag (2014)** on garlic.

Effect of nitrogen sources

Nitrogen sources had significant effect on N, P and K uptake by bulb and leaves and N, P and K total uptake by plant (Table 4).

Fertilizing garlic plants with 50% RR of N as AS + 50% RR of N as PM gave the highest values of each of N, P and K uptake by bulb and leaves and N, P and K total uptake by plant with no significant differences with 100% RR of N as PM with respect to K uptake by bulb, total P and K uptake by plant.

In this regard, **Cooke (1972)** mentioned that when the organic manures decay in the soil, the nutrients may be released slowly which matches uptake by the plants, the processes of the organic fertilizer decay protect the plant nutrients from leaching.

These results agree with those reported by **Ali *et al.* (2001) and El-Mansi *et al*. (2004a)** on garlic. They found that fertilization of garlic plants with organic manure increased N and P uptakes by leaves as well as N, P and K uptakes by bulb.

Effect of the interaction between planting dates and nitrogen sources

The interaction between planting date on 15th Oct. or on 1st Nov. and fertilizing garlic plants with 50% RR of N as AS + 50% RR of N as PM gave the highest values of each of N and P uptake by bulb and leaves and total uptake by plant, whereas the interaction between planting on 15th Oct. and fertilizing plants with 50% RR of N as AS + 50% RR of N as PM gave the highest values of each of P and K uptake by bulb as well as total K total uptake by plant (Table 5).

Yield and its Components

Effect of planting dates

Results in Table 6 show that planting dates reflect a significant effect on yield and its components as well as average bulb weight in both seasons. Planting garlic on 15th Oct. or on 1st Nov. increased yield of grades 1 and 2 and exportable yield, whereas planting on 15th Oct. increased marketable yield and total yield as well as average bulb weight followed by planting on 1st Nov.

As for yield of grades 3 and 4, results showed that planting on 15th Sept. gave the highest values of yield of grades 3 and 4.

The increases in total yield were about 24.48 and 21.29% for planting on 15th Oct. and 16.16 and 14.68% for planting on 1st Nov. over planting on 15th Sept. in the 1st and 2nd seasons, respectively.

The differences between planting dates in yield per faddan (Table 6) as a result of their variation in the total dry weight (Table 1) and total N,P and K uptake by plant (Table 4).

Results are in harmony with those reported by **Mohanty (2001)** on onion, **Muhammad *et al.* (2001), Bhuiya *et al.* (2003), Rahim *et al.* (2003), Vidya *et al.* (2013) , Youssef and Tony (2014), Choudhary (2015) and Hassan *et al.* (2016)** on garlic.

Effect of nitrogen sources

Nitrogen sources had significant effect on yield and its components as well as average bulb weight in both seasons (Table 7).

Fertilizing garlic plants with 100% RR of N as PM or 50% RR of N as AS + 50% RR of N as PM increased yield of grades 1, 2, 3 and 4, exportable , marketable and total yield as well as average bulb weight in both seasons.

The increases in total yield were about 10.78 and 7.83% for 100% RR of N as PM and 13.59

Table 4. Effect of planting dates and nitrogen sources on N, P and K uptake (mg) by bulb, leaves and total uptake by garlic plant at 135 days after planting during 2015/2016 season under South Sinai Governorate conditions

Character / Treatment	N		P		K		Total uptake/plant		
	Bulb	Leaves	Bulb	Leaves	Bulb	Leaves	N	P	K
Planting date									
15th Sept.	117.46	243.34	15.72	30.10	75.31	143.51	360.80	45.83	218.81
1st Oct.	153.00	261.69	20.48	34.63	96.98	162.87	414.68	55.12	259.85
15th Oct.	184.04	343.52	25.69	45.85	122.07	214.29	527.56	71.54	336.36
1st Nov.	183.74	331.51	24.81	42.30	116.91	198.50	515.25	67.12	315.42
LSD at 0.05 level	9.21	14.22	2.17	3.21	4.32	9.15	22.17	5.41	10.41
Nitrogen source									
100% RR of N as AS	135.30	249.67	19.00	33.53	90.14	158.10	384.97	52.54	248.24
100% RR of N as compost	156.60	293.45	21.76	38.68	103.71	181.34	450.04	60.44	285.05
100% RR of N as PM	170.33	313.82	22.83	40.39	109.57	192.98	484.14	63.22	302.55
50% RR of N as AS+ 50% RR of N as compost	155.30	284.61	20.83	36.02	97.97	168.97	439.91	56.85	266.94
50% RR of N as AS+ 50% RR of N as PM	180.29	333.53	23.97	42.50	112.71	197.58	513.81	66.47	310.29
LSD at 0.05 level	7.11	8.07	1.06	1.60	3.40	4.20	20.11	6.09	9.40

RR: recommended rate (120 kg N/fad.), AS: ammonium sulphate, PM: poultry manure
100% RR of N (11.11 and 3.39 ton/fad.) compost and PM, respectively), 50% RR of N (5.55 and 1.69 ton/fad., compost and PM, respectively).

Table 5. Effect of interaction between planting dates and nitrogen sources on N, P and K uptake (mg) by bulb and leaves and their total uptake by plant of garlic plant at 135 days after planting during 2015/2016 season under South Sinai Governorate conditions

Character / Treatment		N		P		K		Total uptake / plant		
		Bulb	Leaves	Bulb	Leaves	Bulb	Leaves	N	P	K
Planting date	**Nitrogen source**									
15th Sept.	**100% RR of N as AS**	102.30	204.57	13.94	25.65	66.54	125.95	306.87	39.59	192.49
	100% RR of N as compost	120.37	241.68	15.55	30.87	75.79	145.01	362.05	46.42	220.79
	100% RR of N as PM	124.07	258.53	16.81	32.45	81.51	156.52	382.59	49.26	238.04
	50% RR of N as AS+ 50% RR of N as compost	113.44	239.99	15.08	28.45	71.37	134.30	353.43	43.53	205.67
	50% RR of N as AS+ 50% RR of N as PM	127.12	271.92	17.24	33.09	81.32	155.76	399.04	50.33	237.08
1st Oct.	**100% RR of N as AS**	133.75	208.17	18.60	30.97	86.55	143.22	341.92	49.58	229.77
	100% RR of N as compost	156.06	253.17	20.63	34.51	98.53	163.92	409.23	55.14	262.45
	100% RR of N as PM	162.36	279.43	20.99	36.06	103.09	176.53	441.78	57.05	279.62
	50% RR of N as AS+ 50% RR of N as compost	144.89	273.03	19.81	33.61	91.63	154.65	417.91	53.42	246.28
	50% RR of N as AS+ 50% RR of N as PM	167.94	294.64	22.39	38.03	105.12	176.03	462.58	60.42	281.15
15th Oct.	**100% RR of N as AS**	142.83	295.58	22.17	40.57	106.09	188.27	438.41	62.74	294.35
	100% RR of N as compost	167.53	352.59	25.52	46.84	122.07	218.17	520.12	72.36	340.25
	100% RR of N as PM	199.86	370.64	27.36	48.64	129.44	229.39	570.50	76.00	358.83
	50% RR of N as AS+ 50% RR of N as compost	193.59	305.53	25.25	41.61	118.94	195.95	499.13	66.85	314.89
	50% RR of N as AS+ 50% RR of N as PM	216.41	393.25	28.13	51.63	133.80	239.65	609.65	79.76	373.46
1st Nov.	**100% RR of N as AS**	162.30	290.37	21.30	36.95	101.36	174.97	452.67	58.25	276.33
	100% RR of N as compost	182.42	326.35	25.32	42.50	118.43	198.25	508.77	67.82	316.69
	100% RR of N as PM	195.01	346.67	26.17	44.41	124.23	209.47	541.68	70.57	333.69
	50% RR of N as AS+ 50% RR of N as compost	169.29	319.88	23.17	40.42	109.94	190.96	489.17	63.60	300.90
	50% RR of N as AS+ 50% RR of N as PM	209.68	374.29	28.10	47.26	130.61	218.87	583.98	75.36	349.48
LSD at 0.05 level		**14.22**	**19.15**	**2.11**	**3.21**	**6.81**	**8.41**	**40.22**	**6.18**	**18.79**

RR: recommended rate (120 kg N/fad.), AS: ammonium sulphate, PM: poultry manure.
100% RR of N (11.11 and 3.39 ton/fad.) compost and PM, respectively), 50% RR of N (5.55 and 1.69 ton/fad., compost and PM, respectively).

Table 6. Effect of planting dates on yield and its components (ton/fad.) of garlic plants during 2014/2015 and 2015/2016 seasons under South Sinai Governorate conditions

Character / Treatment	Grade 1	Grade 2	Grade 3	Grade 4	Exportable yield (ton/fad.)	Marketable yield (ton/fad.)	Total yield (ton/fad.)	Average bulb weight (g)	Relative increases in total (%)
Planting date					**2014/2015 season**				
15th Sept.	1.202	1.600	2.283	1.178	2.802	5.085	6.263	35.77	0.00
1st Oct.	1.647	1.892	2.091	1.063	3.539	5.630	6.693	39.82	6.87
15th Oct.	2.204	2.336	2.062	1.194	4.540	6.602	7.796	47.92	24.48
1st Nov.	2.208	2.193	1.738	1.135	4.401	6.139	7.274	46.04	16.16
LSD at 0.05 level	0.115	0.171	0.090	0.070	0.225	0.422	0.439	2.17	--
Nitrogen source					**2015/2016 season**				
15th Sept.	1.170	1.636	2.375	1.208	2.806	5.181	6.389	37.97	0.00
1st Oct.	1.646	1.930	2.138	1.087	3.576	5.714	6.801	42.09	6.45
15th Oct.	2.152	2.304	2.087	1.206	4.456	6.543	7.749	49.60	21.29
1st Nov.	2.246	2.123	1.775	1.184	4.369	6.144	7.328	47.69	14.68
LSD at 0.05 level	0.174	0.189	0.074	0.089	0.189	0.239	0.411	1.98	--

Table 7. Effect of nitrogen sources on yield and its components (ton/fad.) of garlic plants during 2014/2015 and 2015/2016 seasons under South Sinai Governorate conditions

Treatment / Character	Grade 1	Grade 2	Grade 3	Grade 4	Exportable yield (ton/fad.)	Marketable yield (ton/fad.)	Total yield (ton/fad.)	Average bulb weight (g)	Relative increases in total (%)
Nitrogen source					**2014/2015 season**				
100% RR of N as AS	1.681	1.858	1.940	1.079	3.539	5.479	6.558	38.40	0.00
100% RR of N as compost	1.794	1.997	2.021	1.156	3.791	5.812	6.968	42.46	6.25
100% RR of N as PM	1.880	2.092	2.118	1.175	3.972	6.090	7.265	44.28	10.78
50% RR of N as AS+ 50% RR of N as compost	1.767	1.913	2.000	1.114	3.680	5.680	6.794	41.47	3.58
50% RR of N as AS+ 50% RR of N as PM	1.954	2.167	2.139	1.189	4.121	6.260	7.449	45.34	13.59
LSD at 0.05 level	**0.075**	**0.109**	**0.048**	**0.044**	**0.111**	**0.177**	**0.223**	**1.09**	--
					2015/2016 season				
100% RR of N as AS	1.705	1.894	1.985	1.138	3.599	5.584	6.722	40.62	0.00
100% RR of N as compost	1.810	2.010	2.117	1.174	3.820	5.937	7.111	43.77	5.79
100% RR of N as PM	1.849	2.054	2.148	1.196	3.903	6.051	7.247	46.35	7.83
50% RR of N as AS+ 50% RR of N as compost	1.774	1.957	2.045	1.140	3.731	5.776	6.916	43.60	2.89
50% RR of N as AS+ 50% RR of N as PM	1.879	2.077	2.174	1.210	3.956	6.130	7.340	47.36	9.21
LSD at 0.05 level	**0.092**	**0.075**	**0.086**	**0.048**	**0.113**	**0.170**	**0.209**	**1.59**	--

RR: recommended rate (120 kg N/fad.), AS: ammonium sulphate, PM: poultry manure.
100% RR of N (11.11 and 3.39 ton/fad.) compost and PM, respectively), 50% RR of N (5.55 and 1.69 ton/fad., compost and PM, respectively).

and 9.21 for 50% RR N as AS + 50% RR of N as PM over 100 RR of N as AS in the 1st and 2nd seasons, respectively.

The positive effects of organic nitrogen may be attributed to poultry activated many species of living organisms, which release phytohormones and may stimulate the plant growth and absorption of nutrients (**Arisha *et al.*, 2003**). Such organisms need nitrogen and organic carbon for multiplication which is provided by the poultry manure. This is a plausible that use of organic nitrogen showed a beneficial effect on vegetative growth characters of garlic plants. Moreover, this organic manure improve nutrient availability in the root zone and accordingly reflected in increasing the dry weight, and bulb yield characteristics of garlic.

Similar results were noticed by **Sharma *et al.* (2003**) on onion, **El-Mansi *et al.* (2004b), Hassan (2005)** on garlic, **Mahmoud (2006)** on onion, **Badawy *et al.* (2007)** on garlic, **Mousa and Mohamed (2009**) on onion, **Suthar (2009)** on garlic.

In this regard, **El-Hifny (2010)** on garlic, found that the highest total yield was attained by using of FYM with the high rate (120 kg N/fad.) which increased the yield by 15.9% and 18.5% than the control treatment.

Effect of the interaction between planting dates and nitrogen sources

The interaction between planting dates and nitrogen sources had significant effect on yield and its components as well as average bulb weight in both seasons (Tables 8 and 9). The interaction between planting dates on 15th October and fertilizing garlic plants with 100% RR of N as PM or with 50% RR of N as AS + 50% RR of N as PM gave the highest values of each of yield of grades 1,2 and 4, exportable, marketable and total yield as well as average bulb weight in both seasons, followed by the interaction between planting on 1st Nov. and fertilizing garlic plants with 50% RR of N as AS + 50% RR of N as PM.

The increases in total yield were about 38.34 and 31.78% for the interaction between planting on 15th Oct. and fertilizing with 100% RR of N as PM and 42.07 and 32.83 for the interaction between planting on 15th Oct. and fertilizing with 50% RR N as AS + 50% RR of N as PM over the interaction between planting on 15th Sept. and fertilizing with 100 RR of N as AS in the 1st and 2nd seasons, respectively.

Nitrogen Use Efficiency (NUE)

Effect of planting dates

Results in Table 10 show that, there were significant differences between planting dates regarding NUE in both seasons.

Planting date on 15th Oct. recorded the highest NUE than other planting dates in both seasons. However, Planting date on 15th Oct gave (64.968 and 64.575 kg bulbs /kg nitrogen), followed by planting on 1st Nov. (60.622 and 61.060 kg bulbs/kg nitrogen), while planting on 15th Sept. gave (52.190 and 53.243 kg bulbs/kg nitrogen) in the 1st and 2nd season, respectively.

Effect of nitrogen sources

Obtained results in Table 10 indicate that fertilizing garlic plants with different sources of nitrogen had significant effect on NUE in both seasons.

Fertilizing garlic plants grown in sandy soil with 50% RR of N as AS + 50% RR of N as PM recorded the best results of NUE (62.071 and 61.169 kg bulbs/kg N), followed by fertilizing plants with 100% RR of N as PM (60.544 and 60.390 kg bulbs/kg N), while fertilizing plants with 100% RR of as AS recorded (54.648 and 56.008 kg bulbs/kg nitrogen) in the 1st and 2nd seasons, respectively.

In this regard, **Abdallah (2018)** showed that fertilizing snap bean plants grown in clay soil with 50% RR of N as organic nitrogen +50% RR of N as mineral nitrogen recorded the best results of NUE (69.666 and 70.642 kg green pods/kg N) than 100% RR of N as mineral N (54.417 and 54.883 kg green pods/kg N) in the 1st and 2nd seasons, respectively.

Effect of the interaction between planting dates and nitrogen sources

The same data in Table 10 show that, the interaction between planting dates and nitrogen sources had a significant effect on NUE in both seasons.

Table 8. Effect of interaction between planting dates and nitrogen sources on yield and its components of garlic plants during 2014/2015 season under South Sinai Governorate conditions

Treatment	Character	Grade 1	Grade 2	Grade 3	Grade 4	Exportable yield (ton/fad.)	Marketable yield (ton/fad.)	Total yield (ton/fad.)	Average bulb weight (g)	Relative increases in total (%)
Planting date	Nitrogen source									
15th Sept.	100% RR of N as AS	1.071	1.511	2.181	1.111	2.582	4.763	5.874	31.62	0.00
	100% RR of N as compost	1.162	1.612	2.141	1.189	2.774	4.915	6.104	35.52	3.92
	100% RR of N as PM	1.182	1.656	2.421	1.221	2.838	5.259	6.480	37.19	10.32
	50% RR of N as AS+ 50% RR of N as compost	1.211	1.557	2.249	1.139	2.768	5.017	6.156	35.37	4.80
	50% RR of N as AS+ 50% RR of N as PM	1.386	1.662	2.421	1.231	3.048	5.469	6.700	39.16	14.06
1st Oct.	100% RR of N as AS	1.551	1.784	1.969	1.002	3.335	5.304	6.306	35.56	7.35
	100% RR of N as compost	1.653	1.911	2.112	1.070	3.564	5.676	6.746	39.94	14.85
	100% RR of N as PM	1.692	1.942	2.149	1.089	3.634	5.783	6.872	41.86	16.99
	50% RR of N as AS+ 50% RR of N as compost	1.613	1.853	2.042	1.041	3.466	5.508	6.549	38.73	11.49
	50% RR of N as AS+ 50% RR of N as PM	1.726	1.972	2.181	1.111	3.698	5.879	6.990	43.00	19.00
15th Oct.	100% RR of N as AS	2.011	2.155	1.969	1.131	4.166	6.135	7.266	43.85	23.70
	100% RR of N as compost	2.141	2.355	2.082	1.221	4.496	6.578	7.799	47.88	32.77
	100% RR of N as PM	2.372	2.421	2.111	1.222	4.793	6.904	8.126	49.76	38.34
	50% RR of N as AS+ 50% RR of N as compost	2.081	2.191	2.009	1.164	4.272	6.281	7.445	47.39	26.74
	50% RR of N as AS+ 50% RR of N as PM	2.413	2.559	2.141	1.232	4.972	7.113	8.345	50.72	42.07
1st Nov.	100% RR of N as AS	2.092	1.981	1.641	1.071	4.073	5.714	6.785	42.55	15.51
	100% RR of N as compost	2.221	2.111	1.749	1.142	4.332	6.081	7.223	46.48	22.97
	100% RR of N as PM	2.272	2.350	1.792	1.169	4.622	6.414	7.583	48.3	29.09
	50% RR of N as AS+ 50% RR of N as compost	2.162	2.051	1.698	1.112	4.213	5.911	7.023	44.39	19.56
	50% RR of N as AS+ 50% RR of N as PM	2.291	2.474	1.812	1.182	4.765	6.577	7.759	48.47	32.09
LSD at 0.05 level		0.151	0.218	0.096	.087	0.222	0.354	0.445	2.17	--

RR: recommended rate (120 kg N/fad.), AS: ammonium sulphate, PM: poultry manure.
100% RR of N (11.11 and 3.39 ton/fad.) compost and PM, respectively), 50% RR of N (5.55 and 1.69 ton/fad., compost and PM, respectively).

Table 9. Effect of interaction between planting dates and nitrogen sources on yield and its components of garlic plants during 2015/2016 season under South Sinai Governorate conditions

Treatment	Character	Grade 1	Grade 2	Grade 3	Grade 4	Exportable yield (ton/fad.)	Marketable yield (ton/fad.)	Total yield (ton/fad.)	Average bulb weight (g)	Relative increases in total (%)
Planting date	Nitrogen source									
15th Sept.	100% RR of N as AS	1.102	1.541	2.242	1.14	2.643	4.885	6.025	33.94	0.00
	100% RR of N as compost	1.181	1.651	2.401	1.221	2.832	5.233	6.454	37.73	7.12
	100% RR of N as PM	1.212	1.691	2.452	1.244	2.903	5.355	6.599	39.35	9.53
	50% RR of N as AS+ 50% RR of N as compost	1.141	1.593	2.311	1.177	2.734	5.045	6.222	37.58	3.27
	50% RR of N as AS+ 50% RR of N as PM	1.212	1.704	2.471	1.259	2.916	5.387	6.646	41.27	10.31
1st Oct.	100% RR of N as AS	1.532	1.821	2.026	1.027	3.353	5.379	6.406	37.96	6.32
	100% RR of N as compost	1.633	1.946	2.156	1.095	3.579	5.735	6.830	42.21	13.36
	100% RR of N as PM	1.674	1.982	2.191	1.116	3.656	5.847	6.963	44.08	15.57
	50% RR of N as AS+ 50% RR of N as compost	1.641	1.891	2.092	1.064	3.532	5.624	6.688	41.03	11.00
	50% RR of N as AS+ 50% RR of N as PM	1.752	2.011	2.224	1.133	3.763	5.987	7.120	45.18	18.17
15th Oct.	100% RR of N as AS	2.054	2.191	1.985	1.147	4.245	6.230	7.377	45.63	22.44
	100% RR of N as compost	2.165	2.323	2.121	1.218	4.488	6.609	7.827	49.54	29.91
	100% RR of N as PM	2.208	2.362	2.131	1.239	4.570	6.701	7.940	51.46	31.78
	50% RR of N as AS+ 50% RR of N as compost	2.111	2.264	2.042	1.181	4.375	6.417	7.598	49.07	26.11
	50% RR of N as AS+ 50% RR of N as PM	2.22	2.381	2.157	1.245	4.601	6.758	8.003	52.30	32.83
1st Nov.	100% RR of N as AS	2.132	2.021	1.687	1.236	4.153	5.840	7.076	44.93	17.44
	100% RR of N as compost	2.261	2.12	1.788	1.161	4.381	6.169	7.330	45.61	21.66
	100% RR of N as PM	2.302	2.181	1.819	1.183	4.483	6.302	7.485	50.52	24.23
	50% RR of N as AS+ 50% RR of N as compost	2.202	2.081	1.734	1.136	4.283	6.017	7.153	46.72	18.72
	50% RR of N as AS+ 50% RR of N as PM	2.332	2.211	1.845	1.204	4.543	6.388	7.592	50.68	26.01
LSD at 0.05 level		0.185	0.149	0.172	0.096	0.227	0.341	0.417	3.18	----

RR: recommended rate (120 kg N/fad.), AS: ammonium sulphate, PM: poultry manure.
100% RR of N (11.11 and 3.39 ton/fad.) compost and PM, respectively), 50% RR of N (5.55 and 1.69 ton/fad., compost and PM, respectively).

Table 10. Effect of planting dates, nitrogen sources as well as their interaction on nitrogen use efficiency (kg bulb/kg N) of garlic during 2014/2015 and 2015/2016 seasons under South Sinai Governorate conditions

Nitrogen source / Planting date	100% RR of N as AS	100% RR of N as compost	100% RR of N as PM	50% RR of N as AS+ 50% RR of N as compost	50% RR of N as AS+ 50% RR of N as PM	Mean (A)
			2014/2015 season			
15th Sept.	48.950	50.867	54.000	51.300	55.833	52.190
1st Oct.	52.550	56.217	57.267	54.575	58.250	55.772
15th Oct.	60.550	64.992	67.717	62.042	69.542	64.968
1st Nov.	56.542	60.192	63.192	58.525	64.658	60.622
Mean (B)	54.648	58.067	60.544	56.610	62.071	---
LSD at 0.05 level	A= 1.561			B= 1.131	AB= 2.262	
			2015/2016 season			
15th Sept.	50.208	53.783	54.992	51.850	55.383	53.243
1st Oct.	53.383	56.917	58.025	55.733	59.333	56.678
15th Oct.	61.475	65.225	66.167	63.317	66.692	64.575
1st Nov.	58.967	61.083	62.375	59.608	63.267	61.060
Mean	56.008	59.252	60.390	57.627	61.169	---
LSD at 0.05 level	A= 1.201			B= 1.281	AB= 2.562	

RR: recommended rate (120 kg N/fad.), AS: ammonium sulphate, PM: poultry manure.
100% RR of N (11.11 and 3.39 ton/fad.) compost and PM, respectively), 50% RR of N (5.55 and 1.69 ton/fad., compost and PM, respectively).

The interaction between planting date on 15th Oct. and fertilizing plants with 50% RR of N as AS+ 50% RR of N as PM recorded the highest values of NUE (69.542 and 66.692 kg bulb/kg nitrogen) with no significant differences with the same planting date and fertilizing plants with 100% RR of N as PM (67.717 and 66.167 kg bulb/kg nitrogen), while the interaction between planting garlic on 15th Sept. and fertilizing with 100% RR of N as AS recorded the lowest values of NUE (48.950 and 50.208 kg bulb/kg nitrogen) in the 1st and 2nd seasons, respectively.

From foregoing results it could be concluded that, the interaction between planting date on 15th Oct. and fertilizing with 50% RR of N as AS+ 50% RR of N as PM recorded the highest values of NUE in both seasons.

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تأثير مواعيد الزراعة ومصادر النتروجين على الوزن الجاف والمحصول وكفاءة استخدام النيتروجين لنباتات الثوم النامية تحت ظروف محافظة جنوب سيناء

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أجريت تجربة حقلية خلال شتاء موسمي ٢٠١٤/٢٠١٥ ، ٢٠١٥/م ٢٠١٦ بمزرعة خاصة بمنطقة الطور – محافظة جنوب سيناء ، مصر بهدف دراسة تأثير مواعيد الزراعة ، مصادر النتروجين والتفاعل بينهما على الوزن الجاف، المحصول ومكوناته، وكفاءة استخدام النيتروجين للثوم الصنف البلدي النامي تحت ظروف الأرض الرملية وباستخدام نظام الري بالتنقيط وكانت أهم النتائج المتحصل عليها هى: أعطت معاملة التفاعل بين ميعاد الزراعة في ١٥ أكتوبر أو ١ نوفمبر مع التسميد بمعدل ١٠٠% من النتروجين الموصى به فى صورة سماد دواجن ، أو مع التسميد بمعدل ٥٠% من النتروجين الموصى به في صورة سلفات أمونيوم + ٥٠% من النتروجين الموصى به في صورة سماد دواجن للحصول على أعلى القيم لكل من الوزن الجاف للبصلة والأوراق والوزن الجاف الكلى للنبات عند ١٣٥ يوم من الزراعة، الممتص من النيتروجين والفوسفور بالبصلة والأوراق والممتص الكلى منهما بواسطة النبات، محصول الدرجة الأولى والثانية والرابعة، المحصول القابل للتصدير والتسويق والمحصول الكلى ومتوسط وزن البصلة وكفاءة استخدام النيتروجين، بينما أعطت معاملة التفاعل بين ميعاد الزراعة فى ١٥ أكتوبر مع التسميد بمعدل ٥٠% من النتروجين الموصى به فى صورة سلفات أمونيوم + ٥٠% من النتروجين الموصى به فى صورة سماد دواجن للحصول على أعلى القيم للممتص من البوتاسيوم بالبصلة والأوراق والممتص الكلى منه بواسطة النبات.

المحكمـــــون:

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