

Response of Onion Productivity and Storability to Some Sources, Rates and Times of Application of Nitrogen Fertilizers

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ABSTRACT

Two field experiments were carried out during the two seasons of 2008/2009 and 2009/2010 at Sakha Agricultural Research Station to study the effect of N-fertilizer sources i.e., ammonium nitrate (33.5% N) and Enciabein (40% N) as a slow release N fertilizer. Six nitrogen treatments including three rates (60, 90 and 120 kg/fed.) and two times of application were used. These amounts were divided in to two equal doses applied at 30 and 60 days after transplanting (DAT), or applied in three equal doses, at transplanting, 30 and 60 DAT, on plant growth, yield and quality, as well as storability of onion plants (*Allium cepa* L. cv. Giza 20).

The main results could be summarized as follows:

- Ammonium nitrate treatments were detected as the best source of nitrogen for vegetative growth characters (plant height, bulb diameter and fresh and dry weight of whole plant) at 90 and 120 DAT, bulbs yield (marketable, culls and total bulbs yield/fed.) as well as bulb quality (average bulb weight, bulb diameter, TSS and dry matter percentage) except storability of onion bulbs was decreased.
- The highest values concerning the previous characters and total loss of bulbs weight during storage periods were obtained in plants which received 120 kg N/fed. at two equal doses (at 30 and 60 DAT). On the other hand, TSS and dry matter percentage recorded maximum mean values by adding 90 kg N/fed. at two or three equal doses in both seasons.
- Mean while, highly significant differences concerning the interaction effects between nitrogen fertilizer sources and different nitrogen treatments were noticed. Adding 120 kg N/fed. as ammonium nitrate at two equal doses in 30 and 60 DAT gave the vigour plant growth, marketable yield and total bulbs yield with the best quality and caused a reduction in the storability of onion bulbs in 1st and 2nd seasons.

Keywords: onion, *Allium cepa* L., N-sources, slow release N, mineral fertilizer

INTRODUCTION

Onion (*Allium cepa* L.) is widely cultivated in multifarious countries and considered one of the major field crops grown in Egypt. Moreover, beside its importance for local consumption, it has great potentiality as an export commodity to some European and Arabian markets. It is one of the important sources for hard currency, due to the early exportation of the crop for foreign markets as well as its higher quality compared to other exported onions.

Application of high rates of N to onion crop is a common practice by Egyptian onion growers. Supply onion crop with an optimum nitrogen level proved to be very essential for plant growth, production of high yield and its components (Rizk *et al.*, 2002; Islam *et al.*, 2007; Yaso and Abd El-Razzak, 2007; Shaheen *et al.*, 2010 and Abd El-Samad *et al.*, 2011). In addition, nitrogen nutrition can influence onion bulb development, flavor and bulb quality (Nasreen *et al.*, 2007; Biesada and Kolota, 2009 and Shaheen *et al.*, 2010).

Use of slow release nitrogenous fertilizers (SRNF) is one of the important alternatives to rationalize the use of soluble nitrogenous fertilizers, beside, to protect the soil, water and atmosphere from nitrogenous residues pollution. Moreover, other studies reported that the use of SRNF reduced

N leaching from soils, decreased nitrate (NO₃) level in ground and surface water as well as reduced N-losses by evaporation (Allen, 1984; Abbady *et al.*, 1997; Lichtenberg and Shapiro, 1997 and El-Mallah *et al.*, 1998).

Mostafa and Ahmad (1992) showed that the application of nitrogen fertilizer in two equal doses at three and six weeks after transplanting resulted in maximum growth of onion plants. Recently, Al-Moshileh (2002), concluded that the application of 200 Kg N/ha at 15 and 30 days after transplanting, gave the highest onion yield.

Hence, the objective of this investigation aims to evaluate the performance of Enciabein fertilizer as a SRNF, compared to soluble one (ammonium nitrate) and the optimum rate and time of application and its effectiveness on growth, yield, quality and storability of onion plants.

MATERIALS AND METHODS

Two field experiments were carried out during 2008/2009 and 2009/2010 seasons at the Experimental Farm of Sakha Agricultural Research Station, Kafr El-Sheikh governorate, Egypt, to investigate effects of the two sources of nitrogen fertilizer at three rates and times of application on onion plant growth, productivity and storability. The mechanical and chemical analysis of the experimental soil is presented in Table (1).

Table 1: Mechanical and chemical analysis of field experiment in the two growing seasons of 2008/2009 and 2009/2010.

Variables	Season	
	2008/2009	2009/2010
Mechanical analysis:		
Sand%	17.88	16.43
Silt%	31.98	32.64
Clay %	50.14	50.93
Textural class	Clay loam	Clay loam
Chemical analysis		
pH	8.30	8.10
EC (mmhos/cm)	3.45	3.30
organic matter	1.85	1.95
Available N ppm	17.25	18.30
Available P ppm	6.83	6.18
Available K ppm	295.36	269.35

The experimental lay out was split plot in randomized complete block design with four replications. The studied treatments were as follows:

Main plots (nitrogen fertilizer sources):

1. Ammonium nitrate 33.5% N (as conventional mineral nitrogen).
2. Enciabein 40% N (a commercial trade name of slow release N-fertilizer).

Subplots (nitrogen treatments):

- N₁ 60 kg N/fed. in two equal doses at 30 and 60 days after transplanting (DAT).
 N₂ 60 kg N/fed. in three equal doses, at the time of transplanting (AT), 30 and 60 DAT.
 N₃ 90 kg N/fed. in two equal doses at 30 and 60 DAT.
 N₄ 90 kg N/fed. in three equal doses, AT, 30 and 60 DAT.
 N₅ 120 kg N/fed. in two equal doses at 30 and 60 DAT.
 N₆ 120 kg N/fed. in three equal doses, AT, 30 and 60 DAT.

Seedlings of onion crop cv. Giza 20 (60 days old) were transplanted on the first ten days of December in the two seasons. The experimental plot size was 10.5 m² (1/400 fed.). Each plot consisted of 6 ridges (3.5 m long and 3 m width). Seedlings were planted in both sides of the ridge and spaced at 7-10 cm. The recommended doses of phosphorus as calcium super phosphate (15.5% P₂O₅) and potassium as potassium sulphate (48 % K₂O) were applied at the rate of 45 kg P₂O₅/fed. and 50 kg K₂O/fed., respectively during the soil preparation. Other cultural practices for growing onion were applied as recommended for onion production.

Recorded data:**A. Vegetative growth characters:**

Random sample of 10 plants was taken from every experimental plot at 90 and 120 DAT, to determine the vegetative growth characters, i.e. plant height (cm), bulb diameter (cm) and fresh and

dry weight of whole plant (g) according to the methods described in A.O.A.C. (1975).

B. Bulb yield and its components:

At harvest (50% tops down), onion plants were harvested and left in the field to cure for two weeks, then tops and roots were removed and the following data were recorded. Total bulbs yield (t/fed.), marketable bulbs yield (t/fed.) and culls yield (t/fed.), which contained small bulbs <3.5 cm in diameter and double bulbs.

C. Bulb quality:

In a representative sample of each plot, average bulb weight (g), bulb diameter (cm), total soluble solids % (TSS), according to A.O.A.C. (1975) and dry matter (DM%), were determined in fresh bulbs at harvest time.

D. Storability:

Measures of the percentage of bulb weight loss after six months at 60 days intervals according to following equation of Wills *et al.* (1982), were calculated as:

$$\text{Weight loss \%} = \frac{\text{Initial weight} - \text{weight after storage}}{\text{Initial weight}} \times 100$$

Statistical analysis:

All data collected were subjected to statistical analysis as described by Snedecor and Cochran (1980). The mean values of treatments were compared according to Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION**A. Vegetative growth characters:**

The obtained data (Tables 2 and 3) showed of the effect of the two sources of nitrogen fertilizer for plant height (cm), bulb diameter and fresh and dry weight of the whole plant after 90 and 120 DAT in both growing seasons, showed that the maximum values in this respect were achieved by using ammonium nitrate compared to Enciabein. The promoting effect of ammonium nitrate on vegetative growth characters of onion plant might be due to the fact that ammonium nitrate released nutrients in

available form, suitable rates and proper time of the growing period of the crops. The obtained results agreed with those of Tumbare and Pawar (2003) and Geries (2007). Also Shahin (2005) who reported that urea gave the highest growth characters and yield of paspalum turf compared with slow release N (Enciabein). While Ahmed *et al.* (2007), mentioned that sorghum grown in soil amended with slow release N fertilizer (Enciabein) gave significantly more vegetative growth at all growing stages than sorghum grown in soil amended with ammonium sulphate and urea.

Tables 2 and 3 showed the effect of N-treatments (rates and time of application) for all studied characters. The listed results indicated that there were gradual and progressive significant increases on vegetative growth characters of onion plants with increasing N-fertilizer up to the highest used level; 120 kg N/fed. at two equal doses followed by three equal doses (AT, 30 and 60 DAT) without significant difference with 90 kg N/fed. at two equal doses (30 and 60 DAT). The results are in the same line with those obtained by Abd El-Fattah and Sorial (1998), Barakat *et al.* (2004), El-Beheidi

et al. (2004), Mohamed and Hemida (2004), Islam *et al.* (2007), Shaheen *et al.* (2010) and Abd El-Samad *et al.* (2011).

As for the interaction between the two factors under this study, there were significant effects on vegetative growth characters at all sampling dates in the two seasons, except bulb diameter at 90 DAT in the first season as well as plant dry weight at 120 and 90 DAT in 1st and 2nd seasons, respectively. Whereas, the maximum values were recorded by the highest tested level; i.e., 120 Kg N/fed. of ammonium nitrate at two portions in both seasons followed by 90 kg N/fed. at two portions or 120 kg N/fed. at three portions as ammonium nitrate in most cases. Similar results were obtained by Hasanin (2007) with his studies who found that the vegetative growth characters of cantaloupe plants gave the highest values by using ammonium sulphate at the rate of 120 kg N/fed. compared to Enciabein and ammonium nitrate in terms of vegetative growth gave the same results. The same results were also obtained by many authors on onion plants (Mostafa and Ahmed, 1992 and Al-Moshileh, 2002).

Table 2: Effect of different N-sources, rates, application dates and their interaction on some vegetative growth characters of onion at 90 and 120 DAT in 2008/2009 season.

Treatment	Plant height (cm)		Bulb diameter (cm)		Plant fresh weight (g)		Plant dry weight (g)	
	Days after transplanting (DAT)							
	90	120	90	120	90	120	90	120
N-Fertilizer source(S):								
Nitrate	64.80 a	67.24 a	3.21 a	5.27 a	98.35 a	160.62 a	6.61 a	17.63
Enciabein	62.14 b	65.48 b	2.94 b	4.66 b	92.71 b	150.13 b	5.83 b	16.51
F-test	**	**	*	*	**	**	**	NS
N-treatment (N):								
N ₁	60.59 cd	63.99 c	2.85 cd	4.58 cd	90.28 cd	121.43 e	5.78 cd	16.32 bc
N ₂	58.71 d	63.34 c	2.77 d	4.41 d	88.55 d	123.00 e	5.44 d	15.48 c
N ₃	64.71 b	67.65 ab	3.23 ab	5.12 b	97.53 b	166.79 c	6.42 b	17.51 ab
N ₄	63.99 bc	65.96 b	3.03 bc	4.87 bc	93.79 bc	161.25 d	6.17 bc	17.09 b
N ₅	68.29 a	69.31 a	3.41 a	5.67 a	105.73 a	187.25 a	7.14 a	18.55 a
N ₆	64.54 b	67.92 ab	3.17 b	5.16 b	97.31 b	172.53 b	6.33 b	17.47 ab
F-test	**	**	**	**	**	**	**	*
Interaction (S x N):								
S ₁ N ₁	63.15 bcd	65.23 cde	3.01	5.02 cd	94.05 cde	129.90 e	6.25 cd	16.61
S ₁ N ₂	56.70 e	62.88 e	2.84	4.49 ef	88.28 fg	122.50 f	5.48 e	15.99
S ₁ N ₃	66.45 b	70.05 ab	3.49	5.58 b	103.23 b	184.58 b	7.14 b	18.34
S ₁ N ₄	64.88 bc	65.45 cde	3.08	5.11 bcd	94.83 cd	153.50 d	6.41 c	17.33
S ₁ N ₅	72.73 a	72.06 a	3.69	6.26 a	113.58 a	202.25 a	8.08 a	19.94
S ₁ N ₆	64.93 bc	67.75 bc	3.18	5.19 bc	96.15 cd	171.00 c	6.29 cd	17.55
S ₂ N ₁	58.03 de	62.75 e	2.69	4.14 f	86.50 g	112.95 g	5.32 e	16.02
S ₂ N ₂	60.73 cde	63.80 de	2.70	4.34 ef	88.83 efg	123.50 f	5.41 e	14.97
S ₂ N ₃	62.98 bcd	65.25 cde	2.97	4.66 de	91.83 d-g	149.00 d	5.71 de	16.68
S ₂ N ₄	63.10 bcd	66.46 cd	2.98	4.63 de	92.75 c-f	169.00 c	5.94 cde	16.85
S ₂ N ₅	63.85 bc	66.55 cd	3.13	5.09 cd	97.88 bc	172.25 c	6.21 cd	17.15
S ₂ N ₆	64.15 bc	68.09 bc	3.16	5.13 bcd	98.46 bc	174.05 c	6.37 c	17.40
F-test	*	**	NS	**	**	**	**	NS

*, ** and NS indicate P<0.05, P<0.01 and not significant, respectively.

Means in the same column for each factor designed by the same letter are not significantly different at 5% level according to Duncan's multiple range test.

Whereas, (N₁ & N₂), (N₃ & N₄) and (N₅ & N₆) = 60, 90 and 120 kg N/fed. in two, or three equal doses, respectively.

Table 3: Effect of different N-sources, rates, application dates and their interaction on some vegetative growth characters of onion at 90 and 120 DAT in 2009/2010 season.

Treatment	Plant height (cm)		Bulb diameter (cm)		Plant fresh weight (g)		Plant dry weight (g)	
	Days after transplanting (DAT)							
	90	120	90	120	90	120	90	120
N-Fertilizer source(S):								
Nitrate	72.33 a	84.05 a	3.75 a	5.16 a	104.95 a	183.43 a	7.68 a	18.55 a
Enciabein	68.56 b	74.95 b	3.04 b	4.53 b	93.11 b	174.33 b	7.18 b	17.20 b
F-test	*	**	*	**	**	*	**	**
N-treatment (N):								
N ₁	66.81 c	76.64 c	2.96 c	3.85 d	89.03 d	155.16 d	6.99 b	16.48 d
N ₂	67.63 c	74.05 d	2.63 d	3.92 d	83.00 e	153.60 d	6.92 b	16.47 d
N ₃	71.88 b	80.53 b	3.61 b	5.21 b	105.94 b	187.71 c	7.61 ab	18.52 b
N ₄	71.25 b	79.83 b	3.67 b	4.80 c	99.68 c	183.49 c	7.36 b	17.91 c
N ₅	73.45 a	84.08 a	4.07 a	5.80 a	110.39 a	199.90 a	8.15 a	19.33 a
N ₆	71.64 b	81.90 b	3.44 b	5.48 b	106.13 b	193.44 b	7.54 ab	18.53 b
F-test	**	**	**	**	**	**	*	**
Interaction (S x N):								
S ₁ N ₁	70.75 b	85.13 b	3.31 c	4.18 gh	96.65 c	162.80 g	7.41	17.35 e
S ₁ N ₂	70.25 b	78.25 cd	2.49 e	4.02 h	83.90 d	150.88 hi	6.99	16.58 f
S ₁ N ₃	74.50 a	84.85 b	4.26 b	5.99 b	117.19 a	199.44 b	7.97	19.59 b
S ₁ N ₄	71.75 b	82.80 b	4.13 b	4.62 ef	104.30 b	185.55 de	7.42	18.12 d
S ₁ N ₅	75.15 a	89.25 a	4.90 a	6.54 a	121.94 a	208.79 a	8.79	20.72 a
S ₁ N ₆	71.55 b	84.05 b	3.44 c	5.62 bc	105.70 b	193.15 bc	7.51	18.90 c
S ₂ N ₁	62.88 c	68.15 e	2.60 e	3.51 i	81.40 d	147.51 i	6.58	15.60 g
S ₂ N ₂	65.00 c	69.85 e	2.76 de	3.83 hi	82.10 d	156.33 gh	6.85	16.36 f
S ₂ N ₃	69.26 b	76.20 d	2.97 cde	4.43 fg	94.70 c	175.99 f	7.24	17.44 e
S ₂ N ₄	70.75 b	76.85 cd	3.22 cd	4.98 de	95.05 c	181.43 ef	7.30	17.71 de
S ₂ N ₅	71.75 b	78.90 cd	3.25 cd	5.06 d	98.85 c	191.01 cd	7.51	17.94 de
S ₂ N ₆	71.73 b	79.75 c	3.44 c	5.34 cd	106.55 b	193.74 bc	7.58	18.15 d
F-test	**	**	**	**	**	**	NS	**

*, ** and NS indicate P<0.05, P<0.01 and not significant, respectively.

Means in the same column for each factor designed by the same letter are not significantly different at 5% level according to Duncan's multiple range test.

Whereas, (N₁ & N₂), (N₃ & N₄) and (N₅ & N₆) = 60, 90 and 120 kg N/fed. in two, or three equal doses, respectively.

B. Bulb onion yield and its components:

Table 4 revealed that the application of ammonium nitrate resulted the highest values of marketable bulbs yield (12.44 and 13.47 t/fed.), culls bulbs yield (2.50 and 2.23 t/fed.) and total bulbs yield (14.94 and 15.70 t/fed.) in 1st and 2nd experiments, respectively. The results are in harmony with those obtained by Nazir *et al.* (1985), Mohmoud *et al.* (1993) and Osman (2004). On the other hand, Ragasits and Bereez (1996) and Zhang *et al.* (1998) revealed that slow release urea increased wheat yield by 18.3-27.8% and rice yield by 27.5-50.4% as compared with common urea.

With respect to the effect of rates and times of nitrogen fertilizer application, data in Table (4) showed that application of nitrogen at the highest level (120 kg/fed.), in two equal doses at 30 and 60 DAT significantly increased marketable bulbs yield (12.91 and 13.75 t/fed.), culls yield (2.94 and 2.67 t/fed.) and total bulb yield (12.91 and 13.75 t/fed.), culls yield (2.94 and 2.67 t/fed.) and total bulbs yield (15.86 and 16.43 t/fed.) in both seasons, respectively. Similar results were obtained by Islam *et al.* (2007), Yaso and Abd El-Razzak (2007),

Shaheen *et al.* (2010) and Abd El-Samad *et al.* (2011). In addition, Asandhi (1989) reported that the best method of fertilizer application was at 15, 30 and 75 DAT.

Data in Table 4 show that the interaction between sources of nitrogen fertilizers and nitrogen treatments significantly affected bulb onion yields and its components. Statistical analysis revealed that the highest value of marketable, culls and total bulbs yield/fed. of onion were produced by applying 120 Kg N/fed., as ammonium nitrate along with two equal doses at 30 and 60 DAT followed by 90 Kg N/fed. as ammonium nitrate at 30 and 60 DAT or 120 Kg N/fed. as ammonium nitrate at three equal doses (40 kg/fed., AT + 40 kg /fed. at 30 DAT + 40 kg N/fed. at 60 DAT). Whereas, the treatment of 60 Kg N/fed., as Enciabein at two or three equal doses gave the lowest values of onion yield and its components. This could be due to the low requirement for nitrogen at the early stages of crop growth, as compared to later stages of the crop growing period. However, the results indicated that, the application of nitrogen at later stages of crop growth was more beneficial to achieve higher

Table 4: Total bulbs yield and its components, as affected by different N-sources, rates, application dates and their interaction in 2008/2009 and 2009/2010 seasons

Treatment	Marketable bulbs yield (t/fed.)		Culls bulbs yield (t/fed.)		Total bulbs yield (t/fed.)	
	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
N-Fertilizer source(S):						
Nitrate	12.44 a	13.47 a	2.50 a	2.23 a	14.94 a	15.70 a
Enciabein	10.35 b	11.47 b	2.13 b	1.63 b	12.47 b	13.11 b
F. test	**	**	*	**	**	**
N-treatment (N):						
N ₁	9.69 d	10.76 c	1.83 c	1.26 c	11.52 d	12.02 c
N ₂	9.97 d	10.98 c	1.87 c	1.13 c	11.84 d	12.11 c
N ₃	12.07 b	12.98 b	2.73 c	2.16 ab	14.81 b	15.14 b
N ₄	11.66 c	12.82 b	2.20 bc	1.97 b	13.86 c	14.78 b
N ₅	12.91 a	13.75 a	2.94 a	2.67 a	15.86 a	16.43 a
N ₆	12.06 b	13.55 a	2.29 b	2.39 ab	14.35 bc	15.94 a
F-test	**	**	**	**	**	**
Interaction (S x N):						
S ₁ N ₁	11.15 def	11.65 e	2.11 bc	1.88	13.26 ef	13.53 c
S ₁ N ₂	10.79 ef	11.47 e	1.92 bc	1.41	12.70 f	12.87 c
S ₁ N ₃	13.53 b	14.47 b	3.24 a	2.76	16.77 b	17.23 a
S ₁ N ₄	12.15 c	13.76 c	2.06 bc	2.01	14.22 cd	15.76 b
S ₁ N ₅	14.47 a	15.10 a	3.52 a	2.77	17.99 a	17.85 a
S ₁ N ₆	12.58 c	14.39 b	2.13 bc	2.56	14.71 c	16.94 a
S ₂ N ₁	8.23 h	9.87 g	1.55 c	0.64	9.78 h	10.51 d
S ₂ N ₂	9.16 g	10.49 f	1.82 bc	0.86	10.98 g	11.35 d
S ₂ N ₃	10.62 f	11.49 e	2.22 b	1.56	12.84 f	13.05 c
S ₂ N ₄	11.16 def	11.88 e	2.35 b	1.93	13.51 def	13.81 c
S ₂ N ₅	11.36 de	12.42 d	2.37 b	2.58	13.73 de	15.00 b
S ₂ N ₆	11.54 d	12.70 d	2.46 b	2.23	13.99 cde	14.93 b
F. test	**	**	**	NS	**	**

*, ** and NS indicate P<0.05, P<0.01 and not significant, respectively.

Means in the same column for each factor designed by the same letter are not significantly different at 5% level according to Duncan's multiple range test.

Whereas, (N₁ & N₂), (N₃ & N₄) and (N₅ & N₆) = 60, 90 and 120 kg N/fed. in two, or three equal doses, respectively.

marketable yield, total yield and average bulb weight Biesiada and Kolota (2009). Also, Hasanin (2007) stated that, the total yield of cantaloupe significantly increased by ammonium sulphate application at the rate of 120 Kg N/fed. of Enciabein.

C. Bulb quality:

Data recorded in Table 5 show clearly that, the highest values of average bulb weight, bulb diameter, TSS and dry matter percentage in bulbs were obtained by ammonium nitrate, as compared to Enciabein in the two experimental seasons.

Concerning average bulb weight, bulb diameter, total soluble solids and dry matter percentage as affected by rates and time of nitrogen application are shown in Table 5. Results indicated that, adding the nitrogen fertilizer at the rate of 120 kg N/fed. in two equal doses after transplanting, gave the maximum records compared to the other treatments. On the other hand, the highest value of TSS and dry matter percentage were obtained when plants

received nitrogen at the rate of 90 kg/fed., either with addition of two or three equal portions in both seasons. The same trend was found by Nasreen *et al.* (2007) and Shaheen *et al.* (2010).

With respect to the interaction between nitrogen sources, rates and application dates under this study, the data in the same table indicated that onion plants received either 90 kg or 120 kg N/fed. as ammonium nitrate at two equal doses (30 and 60 DAT), had the highest mean values for average bulb weight, bulb diameter, TSS and DM%, followed by those received the same rates at three equal doses (at the time of transplanting, 30 and 60 DAT) in both seasons. However, 60 kg N/fed., as Enciabein at two equal doses (30 and 60 DAT), gave the lowest values. Increasing average bulb weight, bulb diameter, TSS and DM% with increase in nitrogen level up to 90 kg N/fed. were reported by Rizk (1997) and Biesiada and Kolota (2009).

Table 5: Bulb quality of onion plants as influenced by different N-fertilizer sources, rates, application dates and their interaction in 2008/2009 and 2009/2010 seasons.

Treatment	Average bulb weight (g)		Bulb diameter (cm)		TSS %		Dry matter %	
	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
N-Fertilizer source(S):								
Nitrate	92.72 a	100.95 a	6.72 a	7.55 a	13.07 a	12.58 a	15.25 a	16.98 a
Enciabein	89.30 b	93.20 b	6.02 b	6.96 b	12.11 b	12.09 b	14.14 b	15.06 b
F. test	*	**	*	**	**	**	**	**
N-treatment (N):								
N ₁	77.92 d	86.19 d	5.86 d	6.88 d	11.91 c	11.78 e	13.97 d	15.66bc
N ₂	76.99 d	85.02 d	5.74 d	6.72 d	11.97 c	12.09 d	14.13 d	15.45 c
N ₃	97.41 b	100.20 c	6.63 b	7.24 c	13.16 a	12.72 a	15.44 a	16.53 a
N ₄	94.41 c	99.29 c	6.27 c	7.38 bc	13.10 a	12.56ab	15.22 ab	16.57 a
N ₅	101.69 a	107.16 a	7.10 a	7.76 a	12.75 b	12.37 c	14.57 c	15.88 b
N ₆	97.63 b	104.59 b	6.61 b	7.56 b	12.65 b	12.48 bc	14.84 bc	16.03 b
F-test	**	**	**	**	**	**	**	**
Interaction (S x N):								
S ₁ N ₁	81.73 e	93.78 f	6.44 bc	7.53 bc	12.73 d	12.21 de	14.35 d	16.89 ab
S ₁ N ₂	75.72 fg	87.75 g	5.66 de	6.80 d	12.59 de	12.16 de	14.48 d	16.48 bc
S ₁ N ₃	102.49 b	105.53 b	7.33 a	7.71 b	13.52 a	12.93 a	15.98 a	17.29 a
S ₁ N ₄	94.06 cd	100.81 d	6.48 bc	7.45 bc	13.35 ab	12.88 a	15.54 ab	17.08 a
S ₁ N ₅	107.04 a	112.59 a	7.72 a	8.19 a	13.31 abc	12.71 ab	15.96 a	17.19 a
S ₁ N ₆	95.26 cd	105.24 b	6.67 b	7.65 b	12.90 bcd	12.59 bc	15.19 bc	16.95 ab
S ₂ N ₁	74.10 g	78.61 i	5.28 e	6.23 e	11.10 f	11.36 f	13.59 de	14.43 f
S ₂ N ₂	78.26 f	82.28 h	5.82 d	6.64 d	11.34 f	12.02 e	13.78 d	14.43 f
S ₂ N ₃	92.34 d	94.88 f	5.93 d	6.76 d	12.80 d	12.52 bc	14.91 cd	15.77 d
S ₂ N ₄	94.77 cd	97.77 e	6.07 cd	7.31 c	12.84 cd	12.23 de	14.89 cd	16.06 cd
S ₂ N ₅	96.34 c	101.74 cd	6.47 bc	7.33 c	12.20 e	12.02 e	13.18 f	14.57 f
S ₂ N ₆	99.99 b	103.95 bc	6.55 bc	7.47 bc	12.40 de	12.36 cd	14.48 d	15.11 e
F. test	**	**	**	**	**	**	**	**

*, ** and NS indicate P<0.05, P<0.01 and not significant, respectively.

Means in the same column for each factor designed by the same letter are not significantly different at 5% level according to Duncan's multiple range test.

Whereas, (N₁ & N₂), (N₃ & N₄) and (N₅ & N₆) = 60, 90 and 120 kg N/fed. in two, or three equal doses, respectively.

D. Storability of onion bulbs

Data presented in Table 6 revealed that there was a constant significant loss in bulbs weight percentage with applying ammonium nitrate as N-source, compared to Enciabein during storage periods in both seasons. Such differences did not reach the 5% level of significant after 120 days in the second season. These results may be attributed to the positive relation between TSS in bulb and sprouting percentage of bulbs during the storage period. These results confirm the findings of Hegazy (1998), who stated that, urea decreased storability of bulbs compared to ammonium nitrate. Abbady *et al.* (2003), found the urea-form performance as a slow release nitrogen fertilizer improved storability compared to those of urea ones.

Also, significant difference among nitrogen treatments were recorded in the weight loss percent of bulbs during storage period in the two seasons, (Table 6). The lowest values of weight loss during the different months of storage were recorded from

applying 60 kg N/fed. in two equal portions (30 kg N at 30 DAT and 30 kg N/fed. at 60 DAT) or in three equal portions (20 kg N AT + 20 kg N at 30 DAT + 20 kg at 60 DAT). It means that, the lowest and highest percent losses were recorded by adding the lowest and highest nitrogen level, respectively. The effect of high level of nitrogen on keeping quality of onion bulbs was reported by many researcher such as Brewster (1994) who cleared that excessive N application contributes to increased storage losses, and Batal *et al.* (1994) who revealed that high levels of nitrogen fertilization promote sprouting and decay of onions. The same trend was found by Tumbare and Pawar (2003) and Marey (2009) who reported that extensive application especially of nitrogen fertilizers causes adverse effect on storability of onion bulbs.

The interaction within different nitrogen sources, rates and application dates had significance effect on bulbs weight loss during the storage period in both seasons, except at 120 days storage period in

Table 6: Effect of different sources of nitrogen fertilizers, rates, times of application and their interaction on bulbs weight loss% at three storage periods, during 2008/2009 and 2009/2010 seasons.

Treatment	2008/2009			2009/2010		
	Storage period (days)					
	60	120	180	60	120	180
N-Fertilizer source(S):						
Nitrate	9.63 a	9.84 a	10.10 a	11.31 a	6.68	13.92 a
Enciabein	7.86 b	8.94 b	7.77 b	9.33 b	6.65	11.87 b
F. test	**	**	**	**	NS	**
N-treatment (N):						
N ₁	8.17 e	8.70 d	7.86 e	9.78 d	6.44 b	11.74 e
N ₂	8.27 e	9.05 c	8.17 d	10.17 c	6.45 b	11.93 e
N ₃	8.53 d	9.47 b	9.15 c	10.39 bc	6.69 ab	13.22 c
N ₄	8.89 c	9.46 b	8.99 c	10.31 bc	6.65 ab	12.88 d
N ₅	9.46 a	9.91 a	10.07 a	10.55 ab	6.86 a	13.93 a
N ₆	9.14 b	9.74 a	9.37 b	10.72 a	6.89 a	13.67 b
F-test	**	**	**	**	*	**
Interaction (S x N):						
S ₁ N ₁	9.24 c	9.73 b	9.13 d	11.19 ab	6.53	13.38 d
S ₁ N ₂	9.08 c	9.13 c	8.85 e	11.13 b	6.51	12.86 e
S ₁ N ₃	9.65 b	9.88 b	10.64 b	11.50 a	6.78	14.40 b
S ₁ N ₄	9.57 b	9.86 b	9.93 c	11.24 ab	6.60	13.74 c
S ₁ N ₅	10.59 a	10.55 a	11.96 a	11.54 a	6.87	15.00 a
S ₁ N ₆	9.64 b	9.86 b	10.08 c	11.28 ab	6.78	14.16 b
S ₂ N ₁	7.11 g	7.66 d	6.59 h	8.37 e	6.35	10.11 h
S ₂ N ₂	7.46 f	8.97 c	7.49 g	9.22 d	6.40	10.99 g
S ₂ N ₃	7.41 f	9.06 c	7.65 g	9.29 d	6.59	12.03 f
S ₂ N ₄	8.22 e	9.07 c	8.04 f	9.38 d	6.70	12.03 f
S ₂ N ₅	8.32 e	9.27 c	8.19 f	9.56 d	6.85	12.86 e
S ₂ N ₆	8.64 d	9.62 b	8.67 e	10.16 c	7.00	13.19 d
F. test	**	**	**	**	NS	**

*, ** and NS indicate P<0.05, P<0.01 and not significant, respectively.

Means in the same column for each factor designed by the same letter are not significantly different at 5% level according to Duncan's multiple range test.

Whereas, (N₁ & N₂), (N₃ & N₄) and (N₅ & N₆) = 60, 90 and 120 kg N/fed. in two, or three equal doses, respectively.

the second season. Generally, use of 120 kg N/fed., as ammonium nitrate at two equal doses (30 and 60 DAT), gave the highest value of the weight loss percent of onion bulbs during the storage periods. On the contrary, the lowest weight loss was obtained with 60 kg N/fed., as Enciabein at two equal doses (30 and 60 DAT).

It means that the storability of onion bulbs under the conditions of this study suggest that different N-sources, rates and application dates act dependently on each other.

From the previous results, it was concluded that the combination of nitrogen fertilization as ammonium nitrate at rate ranged from 90 to 120 kg N/fed. together with split nitrogen application, 30 and 60 days after transplanting, gave the best results of onion plant growth parameters, yield, quality and storability of onion bulbs under the conditions of this investigation.

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الملخص العربى

استجابة إنتاجية البصل والقدرة التخزينية لبعض مصادر ومعدلات ومواعيد إضافة التسميد النيتروجينى

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أجريت تجربتان خلال موسمى ٢٠٠٨/٢٠٠٩م، ٢٠٠٩/٢٠١٠م بالمزرعة البحثية بمحطة البحوث الزراعية بسخا- محافظة كفرالشيخ وذلك لدراسة تأثير مصادر السماد الأزوتى(نترات الأمونيوم، الانسيابين) بثلاث معدلات(٦٠، ٩٠، ١٢٠ كجم/فدان) على دفتين بعد ٣٠، ٦٠ يوم من الشتل أو ثلاث دفعات عند الزراعة، بعد ٣٠، ٦٠ يوم من الشتل على صفات النمو الخضرى، محصول وجودة الأبصال والقدرة التخزينية للأبصال صنف جيزه ٢٠.

ويمكن تلخيص أهم النتائج فى النقاط الأتية:

- ١- أوضحت النتائج أن استخدام نترات الأمونيوم كان أفضل مصدر للسماد النيتروجينى على صفات النمو الخضرى ومنها ارتفاع النبات- عدد الأوراق/نبات- قطر البصلة والوزن الطازج والجاف للنبات عند ٩٠، ١٢٠ يوم من الشتل، وكذلك متوسط وزن البصلة ومحصول النقضة والقابل للتسويق والمحصول الكلى وجودة الأبصال مثل قطر البصلة والنسبة المئوية للمواد الصلبة الذائبة والمادة الجافة بالأبصال بينما نقصت القدرة التخزينية للأبصال.
- ٢- أدى إضافة السماد النيتروجينى بمعدل ١٢٠ كجم أزوت/فدان على دفتين متساويتين بعد ٣٠ و ٦٠ يوم من الشتل أعلى القيم للصفات السابقة بينما زادت كل من المواد الصلبة الذائبة والنسبة المئوية للمادة الجافة بالأبصال مع إضافة ٩٠ كجم أزوت/فدان على دفتين أو ثلاث دفعات متساوية فى كلا الموسمين.
- ٣- كما وجد أن التفاعل بين معدلات ومواعيد إضافة بعض مصادر السماد النيتروجينى كان عالى المعنوية حيث أعطت المعاملة ١٢٠ كجم أزوت/فدان على دفتين متساويتين عند ٣٠ و ٦٠ يوم من الشتل فى صورة نترات الأمونيوم أعلى القيم من صفات النمو الخضرى والمحصول التسويقي والمحصول الكلى وكذلك جودة الأبصال فى كل من الموسمين.