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EFFECT OF NITROGEN SOURCES, LEVELS AND DEFOLIATION ON YIELD AND QUALITY OF TARO

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ABSTRACT

The present study was conducted at Barrage Horticultural Research Station, Kalubia Governorate. Two field experiments were carried out during seasons of 2004 and 2005 to study the effect of nitrogen sources , nitrogen levels and defoliation on growth and corm yield, as well as some chemical constituents, of the local cv. Balady of taro plant. Three nitrogen sources. i.e. ammonium sulphate , ammonium nitrate and urea with three nitrogen levels (40,80 and 160 Kg N/Fed.) and defoliation (leaving 4,5,6 leaves/plant) , as well as the control (not leaves removing) were used. Results showed that the application of nitrogen in the form of ammonium sulphate increased plant height, fresh weight/plant, total yield/plot, corm length and corm diameter. The results also indicated that plant height, leaf area, chlorophyll content, fresh weight/ plant, total yield/plot, corm length, and corm diameter increased with increasing nitrogen application up to 80 Kg N/Fed. Morever, defoliation of the (6 leaves and the control) gave the highest values in all characters expect the chlorophyll leaf content, diameter corm and dry matter percentage. Starch percentage of corms increased with increasing nitrogen level up to 80 Kg N/Fed., in the form of urea in addition to the control, while, nitrogen and protein percentage of corms increased with increasing nitrogen level up to 160 Kg N/Fed. in the form of ammonium nitrate and the control one.
Keywords: Taro, Nitrogen, Defoliation and Starch.

INTRODUCTION

Taro plants are the third food taken by more than 400 million people in tropics (Agbor-Egbe and Rickard 1990).

Today there is a trend of producing nitrogen fertilizer with high nitrogen levels, by eleminating some industrial processes in order to reduce the cost of nitrogen unit. A great number of nitrogen fertilizer sources such as calcium nitrate, ammonium nitrate, ammonium sulphate and urea are used in Egypt. The major inorganic forms of N absorbed by plants are No_3^- and NH_4^+ , both forms of N can present naturally in the soil solution. NH_4 is released from decay of organic matter where as NH_3^+ is released from nitrification of NH_4^+ (Haynes,1986).

Dry matter and leaf area of taro plants increased up to 2m NH_4NO_3 and then decreased at the highest N level (Osorio *et al.* 2003). The yield of vegetable crops reduced with using N-fertilizer in forms of ammonium sulphate or urea. (Hageman, 1984).

The requirement of N continues throughout plant development to maintain growth; as N is a constituent of both structural and non-structural components of plant cells. Plants can take up N as either nitrate or ammonium ions. The form of N supplied to plants has a significant influence on the absorption of other ions. Although, both nitrate and ammonium ions may serve as source of

N for plant growth, numerous reports mentioned that plant growth is more rapid when nitrate is the N source than ammonium one. (Chailou *et al*. 1986). Urea has become the most important N carrier in many parts of the world and its reaction when added to the soil is unique in many ways in order to improve the uptake efficiency of added urea-N in upland rainfed dasheen (Gouveia *et al*, 1995). Several investigators studied the effect of nitrogen level on the vegetative growth and the yield components. Hossain and Rashid (1982) found that yields of taro were 11.08, 13.63 and 16.22 ton/ha when given 0, 40 or 80 Kg N/ha ,these yields were not significantly different,but at the rate of 160 or320 kg N/ha, yields were significantly higher by 29.2 and 77.06 ton/ha,respectively, also , plant height., leaf area and number of carmles/hill responded to only the highest N rate. Bhuyan and Quasem (1983) indicated that the plant height, average weight of cormels and corm yields were highest with 80 Kg N/ha.

Sen and Roychoudhury (1988) found that max. yield was obtained by applying 120 Kg N compared with 40, 80 Kg N. On the other hand , Mohankumar et al. (1990) revealed that the highest corms yield was obtained by 80 Kg N/ha compared with 40 Kg , while the highest N rate gave no further benefit.

Mehla *et al*. (1997) reported that corm yields increased significantly with increasing in fertilizer level up to 100 Kg N + 50 Kg P_2O_5/ha . Scheffer *et al*. (1999) found that nitrogen application up to 150 Kg N/ha increased yields with a slight reduction at a higher rate.

In taro plant , leaf harvest of taro had no effect on corm yield but corm size and cormel size suckers were affected by leaf harvesting (Safo-Kantanka *et al.* 1987). Defoliation stimulated the rate of leaf growth , however, continued harvesting of lamiae, reduced leaf length indices after 7 weeks or later, depending on severity of treatment, where half of each lamina was removed or leaving 3 laminae/plant, the percentage of dry matter and corms yield were reduced significantly and the plants were so small . Leaving 3 laminae/plant also significantly reduced corm yield. It was suggested that at least 4 leaves/plant should be maintained to avoid significant reduction in growth and losses in corm yield (Cable *et al* 1988). Lu-Hsiuying *et al.* (1994) reported that the areas of 3rd and 4th leaves were more closely correlated with the total leaf area than the area of other leaves especially between 106 and 190 days after transplanting.

Gouveia (2002) found that application of N (0,150,300 and 600 Kg N/ha) improved vegetative growth which was characterized by an increase in plant height and a shorter leaf emergence interval resulting in a more than doubling of the leaf area index compared to the control.

The aim of this investigation is to study the influence of various nitrogen sources , nitrogen levels and defoliation on growth, corms yield and some chemical contents of taro plant.

MATERIALS AND METHODS

Two field experiments were carried out at the experimental farm of Barrage Horticultural Research Station. Kalubia Governorate, during the two successive seasons of 2004 and 2005 to study the effect of nitrogen sources, nitrgen levels and defoliation, on growth, yield and quality of taro plant . Seed pieces of taro corm were planted on February 13th and 22nd in the two growing seasons, respectively.

Seeds were cutted from the mother corms of taro (local cv. Balady). Plots were arranged in a split-split plot design with three replications. Three sources of nitrogen i,e, ammonium nitrate (33.5N%), ammonium sulphate (20.5%N) and urea (46.5% N) consisted the main plots, Three levels of nitrogen (40, 80 and 160Kg N/Fed.) were devoted to the sub-plots while defoliation leaving(4, 5 & 6 leaves) and control (no leaves removing)[were assigned randomly to sub-sub-plots. Removeing of leaves was carried out after 180 dayes from planting date . Each experimental unit was 3 rows of 5m long and 1m width raw ,while the spacing was 50cm. The experimental unit area was 15m^2 . Phosphorus (150 Kg/Fed. calcium super phosphate 15.5% P_2O_5) and potassium (200 Kg/Fed potassium sulphate 48% K_2O) were added at equal doses to all experimental plots. All cultural practices (irrigation, weeding ridging and pest control) were applied according to the recommendations of Ministry of Agriculture.

Data recorded:

I. Growth characters:

The following growth characters were recorded on three plants taken randomly at 210 days after planting from each sub sub plot: plant height (cm), leaf area/plant (m^2) by using the leaf area meter (L - 1.310) and chlorophyll content of leaf by using chlonophyll meter (SPAD-501).

II. Yield and yield components:

Average corm length(cm), diameter of corm (cm), dry matter(%), total yield/plant and total yield (Kg/plot).

III. Chemical analysis:

Starch and protein contents were determined in corms at harvest time (270 days after planting). Samples of corms were dried at 70 ^oC till constant weight then were used for the chemical determinations and were calculated on dry weight basis. Starch content was determined according to Somogyi (1952), and protein content was determined as nitrogen content according to Koch and Mc-Meckin (1924) and converted to its equivalent protein content by multiplying with 6.25 as described by Pregl (1945).

Statislical analysis:

Data were statislically analyzed by using a General Liner Model procedure of SAS Institute (1989). Fishers protected least significant (LSD) at $P \leq 0.05$ was employed to separate the treatment means.

RUSULTS AND DISCUSSION

1- Vegetative growth characters:-

1) Plant height:

Data presented in table (1) show that nitrogen fertilizer in the form of ammonium sulphate significantly increased plant height by 15.56-26.85% and 15.15-33.51% as compared with ammonium nitrate and urea in the two seasons, respectively.

It is also evident from table (1) that plant height increased under nitrogen level of 80 Kg N/Fed by 10.19-18.11% and 8.19-9.91% as compared with 40 and 160 Kg N/Fed during 2004 and 2005 seasons, respectively. Similar results were obtained by Mohankumar and Sandanandan (1989).Table (1) also show that the defoliation of 6 leaves increased plant height as compared with other treatments including the control one, but differences were only significant during the second growing season. The interaction between nitrogen sources and levels affected significantly plant height, during the two seasons of 2004 and 2005. Ammonium sulphate produced the longest stem as compared to ammonium nitrate and urea by using 80 Kg N/Fed. As for the effect between nitrogen sources and defoliation on plant height, data in (table 1) also indicated that the tallest taro plants were obtained with ammonium sulphate and defoliating 4 and 6 leaves, as well as the control in the first season, while in the second one, it was only obtained by defoliating 6 leaves/plant. However, the interaction between nitrogen sources, levels and defoliation was only significant in the second season, indicating that ammonium sulphate at the rate of 80 Kg N/Fed. produced the tallest plants by defoliating 6 leaves.

2) Leaf area/plant :

Data presented in table (2) clearly show that leaf area / plant tended to increase by increasing nitrogen level in the form of urea as compared with ammonium sulphate and ammonium nitrate. The differences were only significant in the first season. It is also evident from table (2) that leaf area/plant tends to increase significantly under nitrogen level of 80 Kg N/Fed by 28.69 and 10.27% as compared with 40 and 160 Kg N/Fed, respectively in the first season. Paradales *et al*.,(1982) report that nitrogen fertilizer was more important than P and K for plant growth and increased leaf area / plant.

Data in the same table also indicate that the defoliation of 6 leaves resulted in increasing leaf area/plant than the control by 12.52 and 8.86% during the two growing seasons, respectively.

Concerning with the interaction effect of nitrogen sources and levels, results in table (2) show that the leaf area/plant was higher when plants were fertilized with urea at level of 160 Kg N/Fed in both seasons. The interaction between defoliation and nitrogen sources indicated that leaf area/plant increased by applying ammonium sulphate or urea combined with defoliating 6 leaves in the first season only. Application of 80 Kg N/Fed of ammonium sulphate increased leaf area/plant when joined with defoliating 6 leaves in 2004,while in 2005 leaf area/plant responded positively to the application of 160 Kg N/Fed of urea and combined with defoliating 6 leaves. Nitrogen plays an important role in building stable soil organic matter as well as to produce optimum plant growth (Wallace, 1994).

3) Chlorophyll content :

Table (3) clearly indicated that chlorophyll content increased significantly with urea by 6.74, 2.92 and 4.93, 6.98% as compared with ammonium sulphate and ammonium nitrate during the two growing seasons, respectively.

Applying 80 Kg N/Fed increased chlorophyll content by 1.59 and 2.82% than applying 40, or 160 Kg N/Fed, respectively. The differences were not significant during the first season.

These results hold true since nitrogen mediated in cell division, elongation, protein and carbohydrates synthesis (FAO, 1984) , as well as in simulating the merstimic activety which turned and lead to more building of new tissues and organs. Data presented in table (3) also clearly showed that the highest chlorophyll content was with control treatment in both years of studies.

The application of 160 Kg/Fed of urea fertilizer increased chlorophyll leaf/content in both seasons of 2004 and 2005.

Concerning the interaction between nitrogen levels and defoliation, it could be noticed from the same table that applying nitrogen at levels of 40 or 80 Kg N/Fed produced the highest chlorophyll content in the two seasons. The control treatment gave the same result.

The interaction effect of nitrogen sources and defoliation indicated that chlorophyll content increased significantly when ammonium nitrate and urea were combined with the control treatment in the first season, while in the second one urea fertilizer with the control were only significant.

4) Fresh weight of corms /plant:

As shown in table (4) the fresh weight of corms/plant at harvest time increased significantly with applying both ammonium sulphate and ammonium nitrate in 2004, while in 2005 ammonium sulphate fertilizer only resulted in higher corms fresh weight /plant significantly than the other two nitrogen fertilizer sources.

Data in table (4) also indicate that fresh weight of corms/plant increased significantly with increasing nitrogen fertilizer level up to 80 Kg N/Fed by 24.39-12.19% as compared the two other levels in the second season.

A wide range of variation was reported by many authers, i.e, Bhuyan and Quasem (1983), Barroso *et al.* (1986), Sen and Roychoudhury (1988), Ruiz *et al.* (1989), and Mohankumar *et al*. (1990).

Table (4) also revealed that the defoliation of 6 leaves/plant as well as the control, produced the highest yield of corms in both seasons as compared with other treatments. On the contrary, Safo-Kantanka *et al* (1987) reported that leaf harvesting had no effect on corms taro yield.

Concerning the interaction effect of nitrogen sources and levels, data presented in the same table indicated that the highest values of corms taro yield were obtained with applying nitrogen fertilizer in the form of ammonium sulphate and ammonium nitrate at levels of 80, and 160 Kg N/Fed in the first season , while in the second one applying 80 Kg N/Fed in the form of ammonium sulphate produced the largest corm fresh weight/plant.

Moreover, application of 80 Kg/Fed of ammonium sulphate increased fresh weight of corms/plant when joined with defoliation of 6 leaves/plant, as well as the control in both seasons of 2004 and 2005 as presented also in (table 4).

The interaction effect of nitrogen sources, levels and defoliation were also significant during the two seasons. Applying 80 Kg/Fed of ammonium sulphate combined with defoliation of 6 leaves/plant, as well as the control, resulted in increasing fresh weight of corms/plant as shown in table (4). In 2005, applying 160 Kg N/Fed as ammonium sulphate and without leaves remove had an opposite effect on fresh weight of corms/plant.

These results could be attributed not only to the effect of NH_4 cation but also to SO_4 anions, since the two ions could participate in lowering soil PH and hence increasing the ability of the plant in absorbing most of the important nutrients in soil which in turn, increased plant growth (Smiley, 1974).

Total yield/plot :

Table (5) show the effect of nitrogen sources on total yield/plot. Generally, fertilizing by ammonium sulphate increased total yield by 1.31, 25.97 and 10.43, 43.24% compared with ammonium nitrate and urea in both seasons, respectively. However, difference between the two nitrogen sources ammonium sulphate and ammonium nitrate did not reach to the significant level in the first season. Concerning the effect of nitrogen levels, data presented in table (5) also indicated that the total yield/plot increased significantly with applying 80 Kg N/Fed. by 39.29, 13.14 and 24.93, 11.59% as compared with 40 and 160 Kg N/Fed during the two seasons, respectively. A wide range of variation was reported by many authers,i.e., Ramaswamy *et al*. (1982), Hossain and Rashid (1982), Mohankumar *et al*. (1990), Silva *et al.* (1990) Ramnanan *et al.* (1995), Scheffer *et al*. (1999) and Hartemink *et al.* (2000). Regarding the effect of defoliation, data in table (5) also showed that differences between defoliating 6 leaves and the control were not significant in both seasons compared with the other two treatments. These results were in harmony with those obtained by Cable *et al.* (1988) and Gouveia (2002).

The interaction between nitrogen sources and levels affected total yield/plot during the two seasons of 2004, and 2005. Applying 80 Kg N/Fed in the form of ammonium suphate produced the highest yield as compored with other treatments. These results are in agreement with Gouveia (2002). Concerning the interaction between nitrogen sources and defoliation, data presented in table(5) indicated that defoliating of 6 leaves and the control responded significantly with ammonium sulphate in both 2004 and 2005. The same trend was observed by ammonium nitrate and the control in the first season.

The interaction between nitrogen sources, levels and defoliation, indicated that the highest values were obtained with applying of ammonium sulphate at rate of 80 Kg /Fed. with 6 leaves and control in the both seasons.

Average of corm length :

Data presented in table (6) showed that applying nitrogen fertilizer in the form of ammonium sulphate significantly increased average of corm length by 5.11, 10.40 and 12.70, 16.88% as compared with the other two sources of nitrogen in the two seasons, respectively.

Data presented in table (6) also show clearly that the average of corm length increased significantly and consistently with increasing nitrogen level up to a rate of 80 Kg N/Fed. during the second season, whereas the differences were not significant in the first one.

Regarding the effect of defoliation, table (6) revealed that defoliating 6 leaves as well as the control treatment, surpassed significantly the 4 and the 5 leaves with regard to the corm length in the first season, whereas in the second one the control treatment surpassed the 6 leaves.

The interactive effects of nitrogen sources and nitrogen levels were significant during the two growing seasons, as presented also in table (6).

Applying ammonium sulphate at the level of 80 Kg N/Fed gave the highest significant values compared with the other treatments. However, the promoting effect of defoliation 6 leaves on the corm length average was depending on nitrogen fertilizer application at rate of 80 Kg N/Fed.

Average of corm length was generally stimulated when joined with defoliation of 6 leaves and applied ammonium sulphate at rate of 80 Kg N/Fed in both seasons of 2004 and 2005.

Average of corm diameter :

Data presented in table (7) revealed that using ammonium sulphate fertilizer gave the highest average diameter of corm in both seasons. Results indicated that the average of corm diameter significantly increased with increasing nitrogen levels up to 80 Kg N/Fed in both growing season.

Table (7) also revealed that the control treatment produced the biggest corm diameter as compared to the defoliation treatments in both years of study. The interaction between nitrogen sources and levels was significant during 2004 and 2005, indicating that nitrogen level of 80 Kg N/Fed in the form of ammonium sulphate gave the highest significant average of corm diameter. Data in the same table indicated that the differences between ammonium sulphate and ammonium nitrate were not significant in 2005.

Concerning with the interaction between nitrogen sources and defoliation. Results in table (8) indicated that corm diameter increased significantly by using ammonium sulphate with the control treatment during the first season,while in the second season, applying ammonium sulphate with the 6 leaves and ammonium nitrate with the control treatment showed the highest average of corm diameter.

Dry matter of corms:-

Data presented in table (8) indicate that the dry matter (%) of corms at harvest time increased significantly with using ammonium sulphate by 3.27, 15.63 and 5.72, 11.98% as compared with ammonium nitrate and urea during the two growing seasons, respectively. At harvest time, dry matter (%) increased significantly with increasing nitrogen fertilizer up to 160 Kg N/Fed in the first season, and up to 80 Kg N/Fed in the second one.

Table (8) also clearly indicate that the defoliation of 6 leaves/plant produced the greatest dry matter (%) during 2004 and 2005 seasons, respectively.

Concerning the interaction effect of nitrogen sources and levels, results in the same table also show that dry matter was higher when plants were fertilized with 80 Kg N/Fed of ammonium sulphate in both seasons. The interaction between defoliation and nitrogen sources indicated that dry matter (%) increased when defoliation of 6 leaves was combined with applying ammonium sulphate. The maximum dry matter (%) of the taro corms was obtained by applying 80 Kg N/Fed of ammonium sulphate combined with defoliation of 6 leaves in both years.

Chemical constituents in corms:-

1- Starch :

The effect of nitrogen sources, nitrogen levels and defoliation on (%) of starch in corms on dry weight basis are shown in table (9).

Starch percentage in corms increased by using urea with 27.59, 12.35 and 25.23, 19.35% as compared with ammonium sulphate and ammonium nitrate in both seasons, respectively. Similarly starch (%) of corms increased with increasing nitrogen level up to 80 Kg N/Fed during the two growing seasons. Concerning with the defoliation, data in table(9) also indicated that the control treatment significantly enhanced corm starch (%) by 1.88, 11.70, 15.81, and 2.73, 7.78, 10.26% as compared with the other treatments in both seasons, respectively.

The interaction effect between nitrogen sources and levels on starch (%) indicate that using urea fertilizer at the rate of 80 Kg N/Fed increased significantly starch (%) of corms. Regarding the interaction between nitrogen sources and defoliation, it could be noticed in table (9) that corms starch (%)increased by using urea in 2004, as well as the control treatment, while in 2005 it increased by defoliating of 6 leaves and the control one. Concerning the interaction effects of the three factors under investigation, results in the same table show that starch % with a combination of 80 Kg N/Fed urea fertilizer and defoliating of 6 levels/plant, as well as the control treatment, produced the highest values as compared with the other treatments.

2- Nitrogen :

As shown in Table (10), nitrogen concentration significantly increased with applying ammonium nitrate compared with ammonium sulphate and urea by 25, 31.25 and 5.80, 18.84 % in both seasons, respectively.

Concerning nitrogen level, it was evident that 160 Kg N/Fed significantly increased corm nitrogen(%) by 8.33, 16.67 and 8.82, 11.76% as compared with 80 and 40 Kg N/Fed respectively, in both seasons.

Regarding the defoliation effect, it was observed also in the same table that control treatment and the 6 leaves one surpassed the other two defoliation treatments in nitrogen (%) in corms, but the differences were not significant with 6 leaves treatment during the first growing season.

The interaction between nitrogen sources and levels were significant during the two season indicating that fertilizing with 160 Kg N/Fed of ammonium nitrate or ammonium sulphate produced higher nitrogen (%) than urea fertilizer. Data in table (10) illustrated that the nitrogen content in corms reached its maximum value with applying 160 Kg of ammonium nitrate and defoliating of 6 leaves / plant, as well the control treatment.

In general, it is evident that nitrogen content in corms tended to increase by increasing nitrogen level up to 160 Kg N/Fed of ammonium nitrate without leaves removing .

3- Protein :

Table (11) clearly indicated that, ammonium nitrate produced greater protein (%) in corms which reached 5.02 and 4.34% on (dry weight basis) during 2004 and 2005 seasons, respectively. Regarding nitrogen levels; application of 160 Kg N/Fed resulted in higher protein (%) 4.57 and 4.23% than the other two levels during the two studied seasons, respectively. Concerning with the interaction effect between nitrogen sources and levels, results in the same table showed also that protein content was greater by applying ammonium nitrate at rate of 160 Kg/Fed. The same opinion was reported by Mandal *et al.* (1982).

Application of ammonium nitrate at rate of 160 Kg/Fed increased protein content in corms when it was joined with defoliating of 6 leaves / plant and the control treatment in 2004 and 2005.

Data presented in table (11) clearly showed that nitrogen in the form of ammonium nitrate at rate of 160 Kg N/Fed without leaves removing significantly affected the protein content in corm during the two growing seasons.

CONCLUSION

It could be concluded that application of ammonium sulphate at the rate of 80 Kg N/Fed with defoliation of 6 leaves / plant was the best treatment for improving the vegetative growth of taro plant and producing the highest corm yield, while starch percentage of corms increased with increasing N level up to 80 Kg N/Fed in the form of urea.

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تأثير مصادر ومستوى النيتروجين والتوريق على المحصول والجودة للقلقاس

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أجريت هذه الدراسة بمحطة بحوث البساتين بالقناطر الخيرية فى موسمى الزراعة الصيفى ٢٠٠٤، ٢٠٠٥لصنف القلقاس المحلى (البلدى) لدراسةتأثير مصادر و معدلات من التسميد النتروجينى مع التوريق على النمو الخضرى والمحصول والمحتوى الكيماوى للكورمات .وقد أستخدمت ثلاثة مصادر نتروجينية هى (سلفات النشادر ونترات الأمونيوم واليوريا) وبثلاثة معدلات هى (٤٠, ٨٠, ١٦٠ وحدة نتروجين للفدان) مع التوريق (٤, ٥, ٦ ورقات) و بدون توريق.
أوضحت النتائج أن أضافة النتروجين فى صورة سلفات النشادر أدى لزيادة أرتفاع النبات والوزن الطازج للنبات والمحصول الكلى للقطعة التجريبية وقطر وطول الكورمة.
بينت الدراسة أن أرتفاع النبات والمساحة الورقية ومحتوى الكلوروفيل والوزن الطازج للنبات ومحصول القطعة التجريبية وطول وقطر الكورمة يزداد مع زيادة معدل النتروجين حتى٨٠ كجم نتروجين للفدان . وبالنسبة للتوريق فإن ٦ ورقات وكذلك الكنترول (بدون ازالة للأوراق) قد أعطى أفضل القيم فى معظم الصفات المدروسة فيما عدا محتوى الورقة من الكلوروفيل وقطر الكورمه والنسبة % للمادة الجافة. أيضا أوضحت الدراسة ان محتوى الكورمات من النشا قد تزايد بزيادة معدل النتروجين حتى٨٠ وحده للفدان فى صورة يوريا مع كنترول التوريق (بدون ازالة للأوراق)، بينما محتوى الكورمات من النتروجين والبروتين قد زاد بزيادة معدل النتروجين حتى ١٦٠ وحدة نتروجين للفدان فى صورة سلفات أمونيوم مع كنترول التوريق (بدون ازالة للأوراق).

Table (1): Interactive effect of nitrogen sources, nitrogen levels and defoliation on plant/height (cm) during 2004 and 2005 seasons.

Nitrogen level / Nitrogen sources	Nitrogen level																			
	40 (Kg N/Fed.)					80 (Kg N/Fed.)					160 (Kg N/Fed.)					Average				
	Defoliation					Defoliation					Defoliation					Defoliation				
	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean
											2004									
Ammonium sulphate	208.9	210.5	233.6	217.9	**217.7**	228.6	234.7	246.0	222.6	**233.0**	205.2	192.2	157.3	203.8	**189.6**	214.2	212.5	212.3	214.7	**213.4**
Ammonium nitrate	181.7	186.7	192.6	178.7	**184.9**	183.6	189.3	196.0	200.4	**192.3**	164.2	170.0	161.6	154.8	**162.6**	176.5	182.0	183.4	177.9	**180.0**
Urea	121.4	126.4	155.6	164.6	**142.0**	174.4	178.7	181.7	189.0	**181.0**	145.0	153.5	159.3	123.6	**145.3**	146.9	152.9	165.5	159.1	**156.1**
Mean	**170.7**	**174.5**	**193.9**	**187.1**	**181.5**	**195.5**	**200.9**	**207.9**	**204.0**	**202.1**	**171.5**	**171.9**	**159.4**	**160.7**	**165.9**	**179.2**	**182.4**	**187.1**	**183.9**	
											2005									
Ammonium sulphate	206.7	209.7	217.7	197.3	**207.8**	220.5	227.3	235.0	214.3	**224.3**	197.8	194.0	208.8	189.4	**197.5**	208.3	210.4	220.5	200.3	**209.9**
Ammonium nitrate	171.0	175.7	181.4	180.6	**177.2**	175.7	186.7	185.2	196.2	**185.9**	176.4	177.8	169.5	161.1	**171.2**	174.4	180.1	178.7	179.3	**178.1**
Urea	124.7	130.0	134.7	127.6	**129.3**	144.8	145.8	152.1	155.7	**149.9**	134.3	138.3	141.2	130.1	**136.0**	134.6	138.0	143.0	137.8	**138.4**
Mean	**167.5**	**171.8**	**177.9**	**168.5**	**171.4**	**180.3**	**186.6**	**191.1**	**188.7**	**186.7**	**169.5**	**170.0**	**173.2**	**160.2**	**168.2**	**172.4**	**176.2**	**180.7**	**172.8**	

		Sources (S)	Levels (L)	Defoliation (D)	S x L	S x D	L x D	S x L x D
L.S.D. 5%	**2004**	9.68	4.41	7.64	5.39	9.34	9.33	16.18
	2005	3.93	1.88	3.26	2.01	3.50	3.48	6.03

Table (2): Interactive effect of nitrogen sources, nitrogen levels and defoliation on leaf area/plant (m^2) at 210 days during 2004 and 2005 seasons.

Nitrogen level / Nitrogen sources	40 (Kg N/Fed.)					80 (Kg N/Fed.)					160 (Kg N/Fed.)					Average				
	Defoliation					Defoliation					Defoliation					Defoliation				
	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean
2004																				
Ammonium sulphate	7.22	10.75	18.13	13.72	**12.45**	9.22	13.63	19.47	14.02	**14.08**	7.69	14.19	15.54	14.14	**12.89**	8.04	12.86	17.17	13.96	**13.14**
Ammonium nitrate	7.05	10.39	12.95	14.84	**11.31**	5.61	16.79	14.38	15.19	**12.99**	8.40	12.19	17.03	13.20	**12.71**	7.02	13.13	14.79	14.41	**12.34**
Urea	6.31	10.21	16.70	11.84	**11.26**	6.22	16.84	18.09	15.76	**14.23**	9.27	14.10	17.96	18.66	**15.00**	7.27	13.72	17.58	15.42	**13.50**
Mean	**6.86**	**10.45**	**15.92**	**13.47**	**11.68**	**7.02**	**15.75**	**17.13**	**14.99**	**13.77**	**8.45**	**13.49**	**16.84**	**15.34**	**13.53**	**7.44**	**13.23**	**16.69**	**14.60**	
2005																				
Ammonium sulphate	5.31	8.80	12.07	11.75	**9.48**	6.28	12.78	15.98	11.56	**11.65**	7.10	14.40	15.83	13.30	**12.66**	6.23	11.99	14.63	12.20	**11.26**
Ammonium nitrate	4.89	9.26	11.79	14.19	**10.03**	4.03	16.12	11.99	13.00	**11.29**	7.13	10.02	15.50	12.57	**11.31**	5.35	11.80	13.09	13.25	**10.87**
Urea	5.00	6.62	14.49	12.04	**9.54**	4.25	14.67	16.99	13.73	**12.41**	5.39	12.74	17.38	18.20	**13.56**	5.06	11.34	12.28	14.66	**11.84**
Mean	**5.07**	**8.23**	**12.78**	**12.66**	**9.68**	**4.85**	**14.53**	**14.99**	**12.76**	**11.78**	**6.72**	**12.39**	**16.24**	**14.69**	**12.51**	**5.55**	**11.71**	**14.67**	**13.37**	

		Sources (S)	Levels (L)	Defoliation (D)	S x L	S x D	L x D	S x L x D
L.S.D. 5%	**2004**	0.33	0.21	0.37	0.24	0.41	0.42	0.72
	2005	0.65	0.17	0.30	0.28	0.48	0.50	0.83

Table (3): Interactive effect of nitrogen sources, nitrogen levels and defoliation on Chlorophyll leaf content at 210 days after planting during 2004 and 2005 seasons.

Nitrogen level / Nitrogen sources	Nitrogen level																			
	40 (Kg N/Fed.)					80 (Kg N/Fed.)					160 (Kg N/Fed.)					Average				
	Defoliation					Defoliation					Defoliation					Defoliation				
	4	5	6	Control	Mean	4	5	6	Control	Mean	4	5	6	Control	Mean	4	5	6	Control	Mean
	Leaves/plant					Leaves/plant					Leaves/plant					Leaves/plant				
2004																				
Ammonium sulphate	156.9	211.0	241.8	295.4	**226.3**	147.2	214.3	258.0	298.9	**229.6**	148.7	196.2	235.8	235.8	**204.1**	150.9	207.2	245.2	276.7	**220.0**
Ammonium nitrate	161.9	208.7	257.0	293.1	**230.1**	147.2	188.5	254.0	308.5	**224.6**	156.4	246.9	252.4	273.9	**232.4**	155.2	214.7	254.5	291.8	**229.0**
Urea	165.3	214.5	243.9	299.0	**230.7**	169.1	209.5	268.5	284.8	**233.0**	161.8	224.0	299.6	291.1	**244.1**	165.4	216.0	270.7	291.6	**235.9**
Mean	**161.4**	**211.4**	**247.6**	**295.8**	**229.0**	**154.5**	**204.1**	**260.1**	**297.2**	**229.0**	**155.6**	**222.4**	**262.6**	**267.0**	**226.9**	**157.2**	**212.6**	**256.8**	**286.7**	
2005																				
Ammonium sulphate	162.8	213.7	273.3	314.9	**241.2**	171.3	229.0	276.9	297.2	**243.6**	141.6	215.7	230.9	251.4	**209.9**	158.5	219.5	260.4	287.8	**231.5**
Ammonium nitrate	154.8	230.2	242.9	272.8	**225.2**	138.3	219.0	255.3	287.9	**225.2**	146.9	245.0	252.1	272.3	**229.1**	146.7	231.4	250.1	277.7	**226.5**
Urea	174.6	216.1	256.0	291.7	**234.6**	180.8	224.7	276.2	291.2	**243.2**	161.8	238.8	291.8	318.5	**252.7**	172.4	226.6	274.7	300.5	**243.5**
Mean	**164.1**	**220.0**	**257.4**	**293.1**	**233.6**	**163.5**	**224.3**	**269.5**	**292.1**	**237.3**	**150.1**	**233.2**	**258.3**	**280.7**	**230.6**	**159.2**	**225.8**	**261.7**	**288.7**	

		Sources (S)	Levels (L)	Defoliation (D)	S x L	S x D	L x D	S x L x D
L.S.D. 5%	**2004**	6.52	5.12	8.88	7.48	4.32	7.50	12.96
	2005	6.30	1.57	2.72	2.53	4.37	4.38	7.58

Table (4):Interactive effect of nitrogen sources, nitrogen levels and defoliation on fresh weight of corms/plant in (Kg) at harvest time during 2004 and 2005 seasons.

Nitrogen level / Nitrogen sources	Nitrogen level																			
	40 (Kg N/Fed.)					80 (Kg N/Fed.)					160 (Kg N/Fed.)					Average				
	Defoliation					Defoliation					Defoliation					Defoliation				
	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Contro	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Contro	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Contro	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean
2004																				
Ammonium sulphate	0.60	0.78	1.43	1.60	**1.10**	1.63	2.05	2.50	2.42	**2.15**	1.32	1.50	1.83	2.00	**1.66**	1.18	1.44	1.92	2.01	**1.64**
Ammonium nitrate	0.60	1.03	1.40	1.42	**1.11**	1.43	1.75	2.03	2.25	**1.87**	1.33	1.58	1.75	1.93	**1.65**	1.12	1.46	1.73	1.87	**1.54**
Urea	0.67	0.95	1.25	1.40	**1.07**	1.00	1.22	1.73	1.42	**1.34**	0.78	1.07	1.35	1.17	**1.09**	0.82	1.08	1.44	1.33	**1.17**
Mean	**0.62**	**0.92**	**1.36**	**1.47**	**1.094**	**1.36**	**1.67**	**2.09**	**2.03**	**1.79**	**1.14**	**1.38**	**1.64**	**1.70**	**1.47**	**1.04**	**1.33**	**1.70**	**1.73**	
2005																				
Ammonium sulphate	0.72	1.33	1.75	1.85	**1.41**	1.12	2.08	2.52	2.47	**2.05**	0.83	1.92	2.27	2.37	**1.85**	0.89	1.78	2.18	2.23	**1.77**
Ammonium nitrate	0.63	1.25	1.90	1.88	**1.42**	0.87	1.87	2.15	2.10	**1.75**	0.82	1.38	2.10	1.85	**1.54**	0.77	1.50	2.05	1.94	**1.57**
Urea	0.33	0.78	1.20	1.25	**0.89**	0.80	0.98	1.27	1.43	**1.12**	0.68	0.85	1.07	1.12	**0.92**	0.61	0.87	1.18	1.27	**0.98**
Mean	**0.56**	**1.12**	**1.62**	**1.66**	**1.24**	**0.93**	**1.64**	**1.98**	**2.00**	**1.64**	**0.78**	**1.38**	**1.81**	**1.78**	**1.44**	**0.76**	**1.38**	**1.80**	**1.81**	

L.S.D. 5%	Sources (S)	Levels (L)	Defoliation (D)	S x L	S x D	L x D	S x L x D
2004	0.16	0.37	0.65	0.052	0.091	0.089	0.155
2005	0.03	0.05	0.08	0.050	0.080	0.090	0. 160

Table (5): Interactive effect of nitrogen sources, nitrogen levels and defoliation on total yield/plot in (Kg) at harvest time during 2004 and 2005 seasons.

Nitrogen sources \ Nitrogen level	40 (Kg N/Fed.)					80 (Kg N/Fed.)					160 (Kg N/Fed.)					Average				
	Defoliation					Defoliation					Defoliation					Defoliation				
	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Contro	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Contro	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Contro	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	ontrol	Mean
2004																				
Ammonium sulphate	12.06	15.72	28.57	31.88	**22.06**	32.72	40.12	49.91	48.61	**42.84**	26.38	30.00	36.85	39.99	**33.30**	23.72	28.61	38.44	40.16	**2.73**
Ammonium nitrate	12.02	20.74	27.98	28.33	**22.26**	28.72	35.00	40.60	45.08	**37.35**	43.51	31.76	35.12	38.79	**37.30**	28.08	29.17	34.56	37.40	**2.30**
Urea	13.33	19.06	25.12	27.00	**21.35**	20.10	24.36	35.23	32.21	**27.98**	16.15	23.12	28.55	25.67	**23.37**	16.53	22.18	29.63	28.59	**4.23**
Mean	**12.47**	**18.50**	**27.22**	**29.37**	**21.89**	**27.18**	**33.16**	**41.91**	**41.97**	**36.06**	**28.68**	**28.29**	**33.51**	**34.82**	**31.32**	**22.78**	**26.65**	**34.21**	**35.38**	
2005																				
Ammonium sulphate	14.10	25.83	34.45	35.80	**27.55**	22.33	40.67	49.50	48.11	**40.15**	16.77	37.87	45.71	47.25	**36.90**	17.73	34.79	43.22	43.72	**4.87**
Ammonium nitrate	12.69	23.93	37.75	37.78	**28.04**	17.20	37.50	42.86	41.93	**34.87**	16.38	27.66	42.00	37.12	**30.79**	15.42	29.70	40.87	38.94	**1.23**
Urea	6.79	15.67	23.77	25.04	**17.82**	15.52	19.60	25.33	30.66	**22.78**	13.69	17.17	21.32	22.93	**18.78**	12.00	17.48	23.47	26.21	**9.79**
Mean	**11.19**	**21.81**	**31.99**	**32.87**	**24.47**	**18.35**	**32.59**	**39.23**	**40.23**	**32.60**	**15.61**	**27.57**	**36.34**	**35.77**	**28.82**	**15.05**	**27.32**	**35.86**	**36.29**	

L.S.D. 5%		Sources (S)	Levels (L)	Defoliation (D)	S x L	S x D	L x D	S x L x D
	2004	4.67	2.28	2.88	3.96	4.98	4.98	8.63
	2005	1.05	0.98	1.70	1.02	1.76	1.76	3.05

Table (6) : Interactive effect of nitrogen sources, nitrogen levels and defoliation on corm length (cm) at harvest time during 2004 and 2005 seasons.

Nitrogen level / Nitrogen sources	Nitrogen level																
	40 (Kg N/Fed.)					80 (Kg N/Fed.)					160 (Kg N/Fed.)						
	Defoliation					Defoliation					Defoliation						
	4	5	6	Control	Mean	4	5	6	Control	Mean	4	5	6	Control	Mean	4	
	Leaves/plant					Leaves/plant					Leaves/plant					Leave	
	2004																
Ammonium sulphate	11.90	14.57	14.73	14.83	**14.01**	13.77	14.70	16.83	15.97	**15.32**	13.47	14.77	16.73	15.93	**15.23**	13.04	14
Ammonium nitrate	11.90	14.53	14.53	15.27	**14.06**	13.93	14.43	14.60	14.67	**14.41**	11.40	14.37	14.43	14.97	**13.79**	12.41	14
Urea	10.23	12.57	13.90	14.33	**12.76**	11.60	12.13	14.77	15.03	**13.38**	12.87	13.50	14.07	14.27	**13.68**	11.57	12
Mean	**11.34**	**13.89**	**14.39**	**14.81**	**13.61**	**13.10**	**13.76**	**15.40**	**15.22**	**14.37**	**12.58**	**14.12**	**15.08**	**15.06**	**14.23**	**12.34**	**13**
	2005																
Ammonium sulphate	11.47	13.30	14.27	16.97	**14.00**	14.30	17.53	21.37	19.30	**18.13**	13.10	15.60	15.63	16.30	**15.16**	12.96	15
Ammonium nitrate	11.17	13.70	14.33	15.17	**13.59**	9.63	14.97	16.57	15.97	**14.28**	12.60	13.27	13.83	13.90	**13.41**	11.13	13
Urea	9.90	10.93	11.57	14.77	**11.79**	11.57	14.03	15.50	15.73	**14.12**	8.83	12.30	15.43	16.60	**13.29**	10.10	14
Mean	**10.84**	**12.64**	**13.39**	**15.63**	**13.13**	**11.83**	**15.51**	**17.81**	**17.00**	**15.54**	**11.51**	**13.72**	**14.98**	**15.60**	**13.95**	**11.40**	**13**

L.S.D. 5% **Sources (S)** **Levels (L)** **Defoliation (D)** **S x L** **S x D** **L x**

2004	0.33	0.23	0.39	0.17	0.30	0.3
2005	0.64	0.31	0.54	0.23	0.39	0.4

Table (7): Interactive effect of nitrogen sources, nitrogen levels and defoliation on diameter of corm (cm) at harvest time during 2004 and 2005 seasons.

Nitrogen level / Nitrogen sources	Nitrogen level																
	40 (Kg N/Fed.)					80 (Kg N/Fed.)					160 (Kg N/Fed.)						
	Defoliation					Defoliation					Defoliation						
	4	5	6			4	5	6			4	5	6			4	
	Leaves/plant			Control	Mean	Leaves/plant			Control	Mean	Leaves/plant			Control	Mean	Leave	
									2004								
Ammonium sulphate	8.90	10.80	11.43	13.43	**10.89**	11.83	12.17	12.87	13.63	**12.63**	11.03	11.53	12.63	13.00	**12.05**	10.59	11
Ammonium nitrate	9.33	10.43	11.60	11.77	**10.78**	11.20	11.67	12.70	12.47	**12.01**	9.90	11.37	10.33	12.20	**10.95**	10.14	11
Urea	8.43	10.37	10.80	12.10	**10.43**	8.53	10.87	11.40	12.00	**10.70**	11.03	12.20	12.37	12.60	**12.05**	9.33	11
Mean	**8.89**	**10.53**	**11.28**	**12.10**	**10.70**	**10.52**	**11.57**	**12.32**	**12.70**	**11.78**	**10.66**	**11.70**	**11.78**	**12.60**	**11.68**	**10.02**	**11**
									2005								
Ammonium sulphate	9.43	9.90	11.07	11.17	**10.39**	10.33	10.80	12.33	11.33	**11.20**	9.60	10.27	11.07	11.33	**10.57**	9.79	10
Ammonium nitrate	8.60	9.17	10.07	11.00	**9.71**	9.57	10.83	11.97	12.27	**11.16**	8.67	9.37	10.43	11.40	**9.97**	8.94	9.
Urea	7.53	8.37	8.70	10.63	**8.81**	8.37	9.90	10.47	10.43	**9.79**	8.87	10.63	11.17	11.43	**10.52**	8.26	9.
Mean	**8.52**	**9.14**	**9.94**	**10.93**	**9.64**	**9.42**	**10.51**	**11.59**	**11.34**	**10.72**	**9.04**	**10.09**	**10.89**	**11.39**	**10.35**	**9.00**	**9.**

		Sources (S)	Levels (L)	Defoliation (D)	S x L	S x D	L x
L.S.D. 5%	2004	0.22	0.08	0.14	0.11	0.18	0.1
	2005	0.11	0.09	0.16	0.15	0.26	0.2

Table (8): Interactive effect of nitrogen sources, nitrogen levels and defoliation on D.M(%) of corms at harvest time during 2004 and 2005 seasons.

Nitrogen level / Nitrogen sources	Nitrogen level																
	40 (Kg N/Fed.)					80 (Kg N/Fed.)					160 (Kg N/Fed.)						
	Defoliation					Defoliation					Defoliation						
	4	5	6	Control	Mean	4	5	6	Control	Mean	4	5	6	Control	Mean	4	
	Leaves/plant					Leaves/plant					Leaves/plant					Leave	
	2004																
Ammonium sulphate	24.19	25.81	27.57	24.10	**25.42**	24.96	27.16	28.92	25.95	**26.74**	23.65	24.71	25.83	25.02	**24.80**	24.27	25
Ammonium nitrate	20.53	23.97	24.38	23.43	**23.08**	22.17	25.38	27.90	26.49	**25.49**	23.49	26.81	27.21	25.66	**25.91**	22.22	25
Urea	16.42	17.45	18.98	22.97	**18.95**	22.07	23.71	22.03	17.48	**21.32**	23.04	26.40	26.74	22.55	**24.68**	20.51	22
Mean	**20.38**	**22.41**	**23.64**	**23.50**	**22.48**	**23.07**	**25.41**	**26.28**	**23.31**	**24.52**	**23.55**	**25.97**	**26.59**	**24.41**	**25.13**	**22.33**	**24**
	2005																
Ammonium sulphate	24.88	27.15	28.87	25.36	**26.56**	26.69	28.50	30.86	29.23	**28.82**	25.36	27.67	28.54	26.34	**26.98**	25.64	27
Ammonium nitrate	23.31	22.55	25.69	25.16	**24.18**	24.59	25.76	27.50	26.13	**25.99**	26.93	27.41	27.99	27.69	**27.50**	24.94	25
Urea	21.04	21.08	23.29	23.35	**22.19**	22.95	25.67	27.66	27.83	**26.03**	22.54	26.67	27.18	20.73	**24.28**	22.18	24
Mean	**23.07**	**23.59**	**25.95**	**24.63**	**24.31**	**24.74**	**26.65**	**28.67**	**27.73**	**26.95**	**24.94**	**27.25**	**27.90**	**24.92**	**26.25**	**24.25**	**25**

		Sources (S)	Levels (L)	Defoliation (D)	S x L	S x D	L x
L.S.D. 5%	2004	0.29	0.28	0.48	0.24	0.42	0.4
	2005	0.31	0.27	0.47	0.29	0.51	0.5

Table (9): Interactive effect of nitrogen sources, nitrogen levels and defoliation on Starch (%) of corms at harvest time during 2004 and 2005 seasons.

Nitrogen level / Nitrogen sources	Nitrogen level																
	40 (Kg N/Fed.)					80 (Kg N/Fed.)					160 (Kg N/Fed.)						
	Defoliation					Defoliation					Defoliation						
	4	5	6	Control	Mean	4	5	6	Control	Mean	4	5	6	Control	Mean	4	
	Leaves/plant					Leaves/plant					Leaves/plant						Leave
	2004																
Ammonium sulphate	40.16	44.23	44.12	52.49	**45.25**	44.05	47.25	47.93	53.07	**48.08**	36.12	35.41	36.09	36.74	**36.09**	40.11	42
Ammonium nitrate	32.71	34.38	35.71	36.20	**34.75**	33.91	33.67	36.35	41.01	**36.24**	30.67	34.86	37.65	40.55	**35.93**	32.43	34
Urea	44.54	49.44	49.18	50.72	**48.47**	48.71	46.94	57.79	56.93	**52.59**	42.84	44.79	46.36	52.45	**46.61**	45.36	47
Mean	**39.13**	**42.68**	**43.00**	**46.47**	**42.82**	**42.22**	**42.62**	**47.36**	**50.34**	**45.64**	**36.54**	**38.35**	**40.03**	**43.25**	**39.54**	**39.30**	**41**
	2005																
Ammonium sulphate	38.39	41.12	42.19	45.73	**41.86**	42.26	44.89	48.89	50.60	**46.66**	34.27	36.41	37.49	40.09	**37.06**	38.31	40
Ammonium nitrate	41.77	35.49	36.69	37.58	**37.88**	35.69	37.86	40.26	42.03	**38.96**	35.97	37.41	39.30	38.48	**37.79**	37.81	36
Urea	45.15	48.80	50.14	50.44	**48.63**	50.03	49.48	54.77	55.32	**52.40**	48.96	51.32	53.99	54.82	**52.27**	48.05	49
Mean	**41.77**	**41.81**	**43.01**	**44.58**	**42.79**	**42.66**	**44.08**	**47.98**	**49.32**	**46.01**	**39.73**	**41.71**	**43.59**	**44.46**	**42.38**	**41.39**	**42**

		Sources (S)	Levels (L)	Defoliation (D)	S x L	S x D	L x
L.S.D. 5%	2004	0.32	0.28	0.28	0.48	0.49	0.5
	2005	0.74	0.48	0.60	0.84	1.04	1.0

Table (10): Interactive effect of nitrogen sources, nitrogen levels and defoliation on nitrogen (%) in corms at harvest time during 2004 and 2005 seasons.

Nitrogen level / Nitrogen sources	Nitrogen level																
	40 (Kg N/Fed.)					80 (Kg N/Fed.)					160 (Kg N/Fed.)						
	Defoliation					Defoliation					Defoliation						
	4	5	6	Control	Mean	4	5	6	Control	Mean	4	5	6	Control	Mean	4	
	Leaves/plant					Leaves/plant					Leaves/plant					Leave	
									2004								
Ammonium sulphate	0.53	0.58	0.61	0.63	**0.58**	0.59	0.62	0.64	0.70	**0.64**	0.67	0.69	0.68	0.73	**0.69**	0.59	0
Ammonium nitrate	0.70	0.69	0.74	0.77	**0.73**	0.72	0.72	0.82	0.84	**0.78**	0.84	0.87	0.90	0.98	**0.89**	0.75	0
Urea	0.46	0.47	0.51	0.54	**0.49**	0.54	0.57	0.57	0.59	**0.57**	0.56	0.57	0.62	0.63	**0.59**	0.52	0
Mean	**0.56**	**0.58**	**0.62**	**0.65**	**0.60**	**0.62**	**0.64**	**0.68**	**0.71**	**0.66**	**0.67**	**0.71**	**0.73**	**0.78**	**0.72**	**0.62**	**0**
									2005								
Ammonium sulphate	0.59	0.59	0.59	0.61	**0.59**	0.63	0.58	0.67	0.69	**0.64**	0.69	0.70	0.70	0.71	**0.70**	0.64	0.
Ammonium nitrate	0.68	0.66	0.68	0.69	**0.68**	0.69	0.63	0.69	0.69	**0.68**	0.71	0.73	0.72	0.76	**0.73**	0.69	0.
Urea	0.52	0.53	0.53	0.54	**0.52**	0.54	0.55	0.55	0.55	**0.55**	0.57	0.59	0.61	0.59	**0.59**	0.54	0.
Mean	**0.59**	**0.59**	**0.60**	**0.61**	**0.60**	**0.62**	**0.58**	**0.63**	**0.64**	**0.62**	**0.66**	**0.68**	**0.68**	**0.69**	**0.68**	**0.63**	**0.**

L.S.D. 5%		**Sources (S)**	**Levels (L)**	**Defoliation (D)**	**S x L**	**S x D**	**L x**
	2004	0.01	0.01	0.01	0.02	0.02	0.0

2005	0.01	0.01	0.01	0.02	0.03	0.0

Table (11): Interactive effect of nitrogen sources, nitrogen levels and defoliation on protein (%) in corms at harvest time during 2004 and 2005 seasons.

Nitrogen level / Nitrogen sources	40 (Kg N/Fed.)					80 (Kg N/Fed.)					160 (Kg N/Fed.)					Average				
	Defoliation					Defoliation					Defoliation					Defoliation				
	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean	4 Leaves/plant	5 Leaves/plant	6 Leaves/plant	Control	Mean
2004																				
Ammonium sulphate	3.19	3.62	3.81	3.94	**3.63**	3.70	3.88	4.11	4.39	**4.02**	4.16	4.28	4.38	4.55	**4.34**	3.69	3.93	4.09	4.29	**3.99**
Ammonium nitrate	4.39	4.34	4.63	4.79	**4.54**	4.48	4.52	4.14	5.28	**4.86**	5.22	5.44	5.83	6.17	**5.66**	4.70	4.77	5.19	5.41	**5.02**
Urea	2.86	3.00	3.23	3.36	**3.11**	3.38	3.58	3.58	3.71	**3.56**	3.55	3.56	3.87	3.91	**3.72**	3.25	3.36	3.56	3.66	**3.46**
Mean	**3.48**	**3.63**	**3.89**	**4.03**	**3.76**	**3.84**	**3.99**	**4.27**	**4.46**	**4.14**	**4.31**	**4.43**	**4.80**	**4.87**	**4.57**	**3.88**	**4.02**	**4.28**	**4.45**	
2005																				
Ammonium sulphate	3.69	3.74	3.74	3.78	**3.73**	3.98	4.01	4.18	4.29	**4.12**	4.36	4.41	4.40	4.46	**4.41**	4.01	4.05	4.11	4.18	**4.09**
Ammonium nitrate	4.26	4.14	4.21	4.30	**4.22**	4.29	3.93	4.34	4.34	**4.23**	4.43	4.56	4.52	4.78	**4.57**	4.33	4.21	4.36	4.47	**4.34**
Urea	3.22	3.33	3.34	3.31	**3.30**	3.39	3.42	3.41	3.47	**3.42**	3.58	3.72	3.79	3.68	**3.69**	3.39	3.49	3.52	3.49	**3.47**
Mean	**3.72**	**3.74**	**3.76**	**3.79**	**3.76**	**3.88**	**3.79**	**3.98**	**4.03**	**3.92**	**4.13**	**4.23**	**4.23**	**4.31**	**4.23**	**3.91**	**3.92**	**3.99**	**4.05**	

		Sources (S)	Levels (L)	Defoliation (D)	S x L	S x D	L x
L.S.D. 5%	**2004**	0.08	0.06	0.06	0.30	0.96	0.9
	2005	0.04	0.07	0.07	0.13	0.11	0.1

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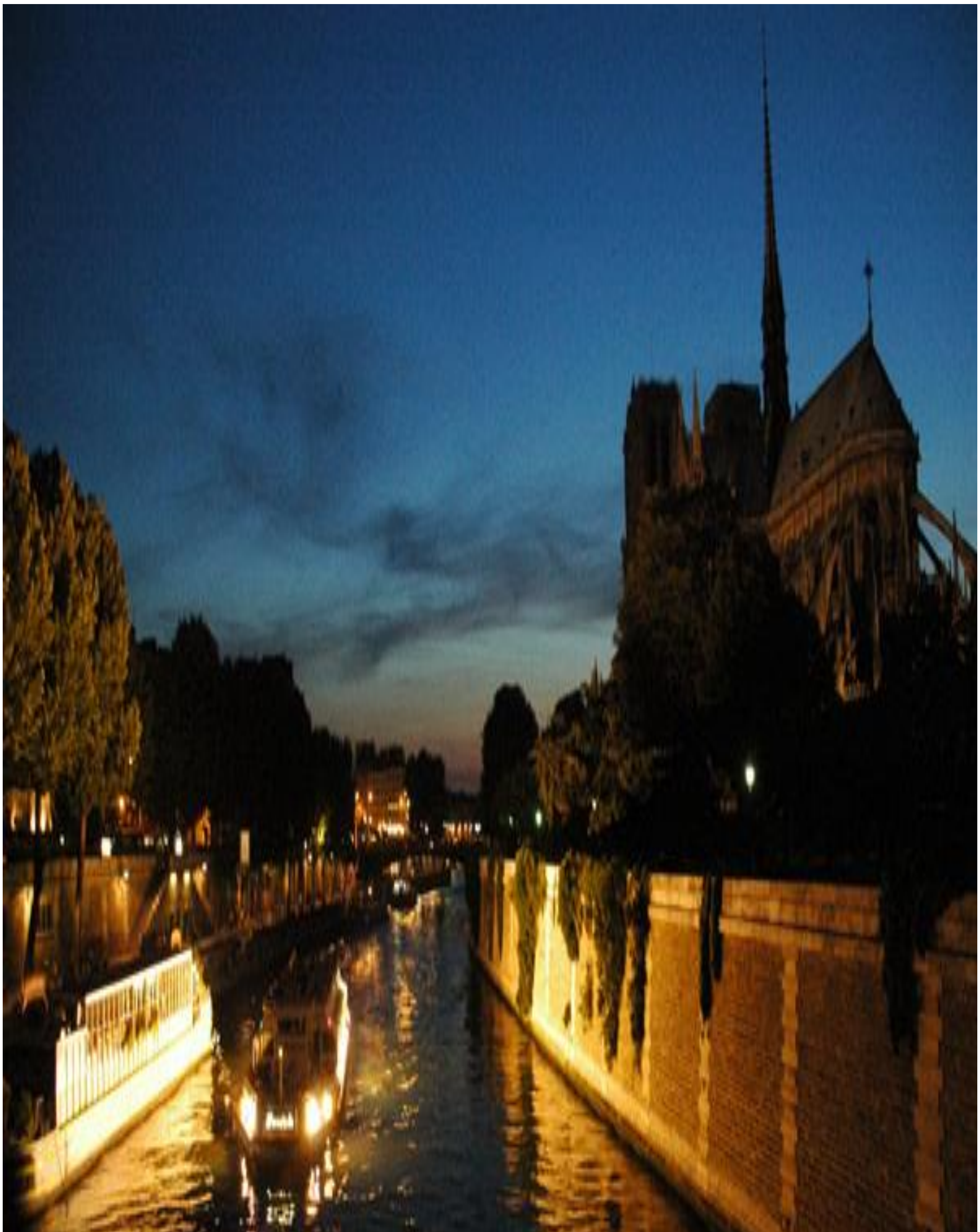
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