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SOME NITROGEN FERTILIZER SOURCES AND SPLITTING EFFECT IN THE PRESENCE AND ABSENCE OF ORGANIC MANURE ON COTTON YIELD AND AVAILABLE SOIL NITROGEN

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ABSTRACT

Two field experiments were conducted at the experimental farm of Sakha Agricultural Research Station during 2007 and 2008 summer seasons to study the effect of splitting some nitrogen fertilizers (ammonium nitrate and urea) in two or three doses with or without organic manure on cotton yield (*Gossypium barabadense*, varity Giza 86), soil available nitrogen and NO_3-N.

The results can be summarized as follows:-

- Cotton yield was scientificantly higher with organic manure by 23% and 22% in the first and second seasons, respectively.
- Ammonium nitrate application with organic manure resulted in higher cotton yield than urea. While the opposite results were obtained in the absence of organic manure.
- The fertilizer splitting into two doses had significant increase in cotton yield regardless the type of N- source.
- The highest cotton yield (10.25 kentar/ fed.) was obtained by application of ammonium nitrate fertilizer in two doses and with organic manure
- Available nitrogen was increased by 53.4% with organic manure application. Significant increase was noticed in soil available nitrogen with application of ammonium nitrate than urea fertilizer. The calculated relative increase was 20.7%. The two doses application of N- fertilizer gave high significant increase of available nitrogen than the three doses application (12.6%).
- With application of ammonium nitrate fertilizer, available nitrogen was increased gradually by going deeper to reach 80 cm, these calculated increases were 27.5, 29.7 and 39.5 % of that at the top layer after 45, 60, and 75 days from sowing. While with application of urea fertilizer, available nitrogen was decreased gradually with deeper layer. The calculated relative decreases at deeper layer (40-80) were 18.3, 21.6 and 21.2% of that at top layer (0- 20 cm) after 45, 60 and 75 days from sowing.
- Amounts of NO_3- N were always higher in the presence than in absence of organic manure. The calculated relative increase was 56.7%.
- Application of ammonium nitrate or urea fertilizer led to nitrate accumulation at deeper soil layer, but application of ammonium nitrate caused a marked high nitrate accumulation compared to urea (63.1%).
- Application of nitrogen fertilizer in two doses was found to increase NO_3-N in the soil profile by 13.3% than that of the three doses.

INTRODUCTION

Cotton is the most important fiber crop in Egypt. Fertilization plays a vital role in its production. This crop in general showed tremendous response to nitrogenous fertilizers in all soil types (Gill *et al.,* 2000). The response to nitrogen fertilization may be explained by lack of available nitrogen in the soil (Halevy and Klater 1970). Crozier (2008) reported that cotton is very sensitive to deficiency of nitrogen. Loss of N from applied N fertilizers has several possible negative agricultural and environmental consequences including decreased crop production and profitability, water contamination and potential impact on global climate change and ozone depletion (Dinnes *et al.,* 2002). Hegde *et al.,* (2007) showed that improvement in nutrient- used efficiency is necessary to reduce the cost of production as well as to prevent environmental pollution. It is necessary to develop fertilizer management practices that can reduce losses and increase the efficiency of fertilizer use (Yusron and Philips, 1997). Maples and frizzell (1985) declared that applying N closer to the stage of peak demand could improve N utilization. Therefore, time of nitrogen application is of prime importance for high crop production. Bryce *et al.,* (1999) reported that in cotton yield no significant response to splitting applied nitrogen rates. The Egyptian soils lies in the arried and semi-arried regions, which cause fast degradation of the added organic residues. Thus, these soils have less organic matter. The addition of organic manure can considerably increase crop yield and exert influence on the physical, chemical and biological properties of soil. The combination of organic and inorganic manures works like slow release fertilizers for providing balanced nutrients to plants (Jayakumart *et al.,* 2007). The objective of the current work is to investigate split applications of mineral nitrogen forms with or without organic manure for improving the utilization of N fertilizer and improve cotton yield and saving environment.

MATERIALS AND METHODS

Two field experiments were established at the experimental farm of Sakha Agric. Res. Station during the two successive seasons of 2007 and 2008. The soil is clayey in texture with pH 7.56. Organic matter content of 1.98% and total soluble salts of 2.5 dS/m in the soil paste extract, this layer contained 22mg available N/ Kg soil, which was extracted by KCl (Keeney and Nelson, 1982), 8.5 mg P/ Kg soil was extracted by 0.5 N $NHCO_3$ adjusted to pH 8.5 (Watanabe and Olsen, 1965) and 316 mg K/ Kg soil was extracted by ammonium acetate (Knudsen *et al.,* 1982).

Using cotton (*Gossypium barabadense*) var. Giza 86, dry cotton seeds at a rate of 30 Kg/ fed were sowing as broadcasts along the ridges and just irrigated. After the complete recovery, cotton plants were thinned to two plants in the hill.

Two forms of nitrogen (urea 46.5% N and ammonium nitrate 33.5% N) were used. The layout of the experiment was split split plot design with four replicates. The main plots were treated with or without organic manure at a rate of 20 m^3/ fed. and well thoroughly mixed with the blew layer before cotton sowing during soil preparation. The sub-plots were treated with the two nitrogen sources at a rate of 62 Kg N/fed., different doses from the two sources of N were used. The sub-sub plots in the next split application into two or three equal doses with second, third, and fourth irrigations were corresponding to 45, 60, and 75 days from planting cotton seeds. Phosphorus fertilizer was added during the blowing of the soil at rate of 22.5 Kg P_2O_5/ fed. in the form of super phosphate. The K fertilizer in form of K_2SO_4 was added at rate of 50 Kg K_2O/ fed. before the second irrigation.

Soil samples were collected from zero to 20, 20 to 40, and 40 to 80 cm after two weeks after the application of any dose of N fertilizer. Available nitrogen (NH_4 and nitrate) were determined according to (Keeney and Nelson, 1982). Cotton yields were weighted and recorded just after harvesting.

RESULTS AND DISCUSSION

Cotton yield

The results in Table (1) showed the effect of organic manure addition, nitrogen source and time of application on cotton yield. The yield was significantly higher with the organic manure addition. These increases were 23% and 22%in the first and second seasons, respectively (Table 4). Such increases could be due to the application of organic manure along with inorganic fertilizers which help to regenerate the degraded soil and ensure sustainability in crop production. In addition, combination of organic and inorganic manures works like slow release fertilizers for providing balanced nutrients to plant (Jayakumart *et al.,* 2007).

Table (1): Mean values of cotton yield (Kentar/ fed) in 2007 and 2008 seasons as affected by different treatments

With organic manure				Without organic manure			
Urea		Ammonium nitrate		Urea		Ammonium nitrate	
Two doses	Three doses	Two doses	Three doses	Two doses	Three doses	Two doses	Three doses
2007							
7.51	7.20	10.25	8.89	7.02	6.54	6.65	5.85
2008							
6.98	6.82	9.64	7.92	6.57	6.09	6.00	5.78

Kentar=157.5 kg

Cotton yield due to application of ammonium nitrate fertilizer was 10.6 and 9.8% higher than that of urea fertilizer (Table 4). Concerning the effect of nitrogen source as a result of organic manure presence, ammonium nitrate application led to producing a higher cotton yield than the produced one which urea was added. While the opposite results were obtained in the absence of organic manure. These results may be attributed to presence of NH_4 and NO_3 ions which enhanced microorganisms with increasing the availability of N, which is normally the most limiting nutrient for optimum plant growth, in the ammonium nitrate, it was higher than urea in the presence of organic manure (Table 2). This was in line with the observation by Abdelfattah and Abdelkader (2004), who reported that nitrification rate depends on the kind of N- fertilizer added, time of application, temperature, pH, and the addition of organic matter. Mohamed and Moawed (2006) found that, NH_4 is partially adsorbed on soil colloids and its uptake rate is usually lower than that of NO_3 under field conditions. For this reason most crops do not respond as quickly to NH_4^+ fertilizer as to NO_3 application, on the other hand Mengel and Kirkby (1982) reported that, the difference between both types of N- fertilizers play only a minor role.

The fertilizer added into two doses had highly significant effect on cotton yield regardless the type of N- source. The obtained data indicated that the cotton yield with application of fertilizer schedule into two doses was increased by 9.36 and 8.84% over that the three doses in the first and second seasons, respectively (Table 4). This can be attributed to the adequate amounts of nitrogen fertilizer added at suitable growth stage in case of two doses. Crozier (2008) concluded that cotton takes up only a small portion of the nitrogen befor flower buds begin to set. About 45 days after emergence, nutrient uptake begins to increase rapidly until it reaches a prolonged peak about two weeks after first bloom (60 days from sowing). On the other hand, Elbordiny *et al.,* (2003) concluded that the fertilizer schedule into three doses had a significant effect on cotton yield.

Soil available nitrogen:

Data in Table (2) show the effect of organic manure addition, nitrogen source, and the application time on soil available nitrogen. Application of organic manure to the soil increased the amount of available nitrogen by about 52, 54, and 54% at 45, 60, and 75 days, respectively (Table 4). The beneficial effect of organic manure could be due to its direct effect on increasing soil microbial and mineralized-N, particularly on nitrifying and nitrogen fixing bacteria. Crozier (2008) suggested that organic manure should be incorporated as soon as possible after application to decrease volatile losses of nitrogen and to minimize the impact of run off on nearby water bodies.

Data in Table (2) show that application of ammonium nitrate fertilizer at two doses and with organic manure resulted in the highest available nitrogen, 193, 230, and 145 mg/kg soil at 45, 60, and 75 days, respectively. While the lowest available nitrogen values obtained from ammonium nitrate fertilizer application were at three doses and without organic manure of 44 and 56 mg/kg at 45 and 60 days, respectively, and at two doses and without organic manure of 48 mg/kg at 75 days. In respect to the effect of nitrogen source, high significant increase was noticed in the available nitrogen with application of ammonium nitrate fertilizer than with urea. The calculated relative increase were 21.23 and 19% (Table 4). Furthermore, the results showed that the behavior of ammonium nitrate fertilizer differs compared to urea fertilizer by going deeper in soil. Available nitrogen was increased gradually by going deeper to reach 80 cm. these calculated relative increases were 27.5, 29.7, and 39.5 % of that at the surface layer with application of ammonium nitrate after 45, 60, and 75 days from sowing (Table 5). While, available nitrogen decreased with application of urea fertilizer gradually by going deeper layer. The calculated relative decreases of available nitrogen at the deeper layer (40-80 cm) were 18.3, 21.6, and 21.2% of that surface layer (0- 20 cm) after 45, 60, and 75 days from sowing, respectively (Table 5). This may be due to slow rate of urea hydrolysis. Beside urea holding on the soil colloids by week forces giving better chance for hydrolysis and nitrification. In contrast, the available soil N with ammonium nitrate was high at surface layer and decreased by going down wards because of ammonium nitrate can undergo faster changes in soil than urea . Similar conclusion was drawn by Elbordiny *et al.,* (2003).

The effect of number of fertilizer applications on the available nitrogen in soil was showed in the same (Table 2). The fertilizer schedule added in two doses had highly significant effect on soil available nitrogen. The obtained data indicated that the available nitrogen values with applying the fertilizers in two doses were increased by 27 and 24% at 45 and 60 days, respectively over that the three doses while the three doses increased available N by 19% at 75 days (Table 4). The obtained results indicated that, regardless the type of fertilizer after 45 or 60 days from sowing, the two doses gave high significant increase than three doses. While, the increases in the available nitrogen were obtained in case of three doses after 75 days from sowing. This can be explained because the amount of nitrogen fertilizer added at each time of two doses (50% of the whole amount) is more than that of three doses (33% of whole amount). In addition, the last dose of fertilizer (one third) was applied after 30 days from addition of the last half of the fertilizer in case of two doses application.

Table (2): Mean values of available soil nitrogen mg/ Kg, (average of the two seasons) at different sampling time as affected by different treatments

Soil depth (cm)	With organic matter				Without organic matter			
	Urea		Ammonium nitrate		Urea		Ammonium nitrate	
	Two doses	Three doses	Two doses	Three doses	Two doses	Three doses	Two doses	Three doses
After 45 days								
0-20	44	33	58	36	29	25	20	10
20-40	39	29	65	49	27	22	23	15
40-80	37	24	70	58	26	20	24	19
Total	**120**	**86**	**193**	**143**	**82**	**67**	**67**	**44**
After 60 days								
0-20	53	40	64	43	33	27	23	17
20-40	42	38	73	54	30	24	25	18
40-80	40	31	93	68	28	21	27	21
Total	**135**	**109**	**230**	**165**	**91**	**72**	**75**	**56**
After 75 days								
0-20	38	43	33	45	23	28	13	19
20-40	34	40	49	59	21	26	17	21
40-80	29	34	63	78	19	22	18	23
Total	**101**	**117**	**145**	**182**	**63**	**76**	**48**	**63**

	After 45 days	**After 60 days**	**After 75 days**
Addition of organic matter (OM)	**	**	**
Nitrogen source (NS)	**	**	**
Number of N doses (ND)	**	**	**
OM vs. NS	**	**	**
OM vs. ND	NS	NS	NS
OM vs. NS vs. ND	NS	NS	NS

* significant at 5% level ** significant at 1% level

Soil nitrate-nitrogen:

Data in Table (3) show the effect of organic manure addition, nitrogen sources and time of fertilizer application on total NO_3-N. Data indicated that the amounts of NO_3-N in the soil were always higher in the presence than in absence of organic manure. The amount of NO_3-N with application of organic manure were increased by 56, 58, and 57% at 45, 60, and 75 days, respectively of that without organic manure (Table 4). After ammonium nitrate and urea fertilizers application, nitrate was accumulated at the soil deeper layer (40-80 cm) than the top one (0- 20cm).

From the data in Table (3), it could be noticed that ammonium nitrate fertilizer application caused a marked high nitrate accumulation by 65, 64, and 61% at 45, 60, and 75 days, respectively as compared to urea fertilizer (Table 4).

The results in Table (5) showed that NO_3-N increased gradually by going deeper in soil to reach 80 cm. These calculated relative increases were 15.9, 21.4, and 19.4% of that at the surface layer with application of urea fertilizer after 45, 60, and 75 days from sowing, respectively. While the corresponding values with application of ammonium nitrate were 40.6, 32.9, and 46.7%.

Table (3): Mean values of soil nitrate –N mg/ Kg (average of two seasons) at different sampling time as affected by different treatments

Soil depth (cm)	With organic matter				Without organic matter			
	Urea		Ammonium nitrate		Urea		Ammonium nitrate	
	Two doses	Three doses	Two doses	Three doses	Two doses	Three doses	Two doses	Three doses
After 45 days								
0-20	10.5	7.3	26.7	23.8	7.8	6.2	12.8	6.6
20-40	11.7	8.12	45.5	35.7	8.4	6.9	15.6	10.9
40-80 (loss)	12.0	8.62	49.7	38.3	9.4	7.8	17.1	12.5
Total	**34.2**	**24.04**	**121.9**	**97.8**	**25.6**	**20.9**	**45.5**	**30.0**
Loss (%)	**35.0**	**35.8**	**40.8**	**39.2**	**36.7**	**37.3**	**37.6**	**41.7**
After 60 days								
0-20	11.2	8.8	40.9	28.4	9.3	7.8	14.7	11.2
20-40	15.6	9.9	51.8	37.1	10.5	8.2	17.8	12.9
40-80	16.8	10.2	65.1	44.2	11.3	8.9	19.2	13.4
Total	**43.6**	**28.9**	**157.8**	**109.7**	**31.1**	**24.9**	**51.7**	**37.5**
After 75 days								
0-20	9.1	10.3	14.9	29.7	7.4	6.4	8.4	12.6
20-40	12.2	11.2	29.4	43.1	8.1	7.8	11.1	15.3
40-80	13.1	11.3	43.5	51.5	8.6	8.2	11.7	16.1
Total	**34.4**	**32.8**	**87.8**	**124.3**	**24.1**	**22.4**	**31.2**	**44.0**

Losses%=leached (40-80 cm) in the first sample (45 days)

	After 45 days	**After 60 days**	**After 75 days**
Addition of organic matter (OM)	**	**	**
Nitrogen source (NS)	**	**	**
Number of N doses (ND)	**	**	**
OM vs. NS	**	**	**
OM vs. ND	NS	NS	NS
OM vs. NS vs. ND	NS	NS	NS

* significant at 5% level   ** significant at 1% level

The high soil nitrate content because of ammonium nitrate application may be explained by the fact that half of its total nitrogen is in the form of ammonium and the other half is in the form of nitrate. These findings are in accordance with the results of Adetunji (1994) who found that 29.5% of nitrogen was lost below the root zone from plots receiving ammonium nitrate fertilizer. In addition, ammonium nitrate is known to be more water soluble form than urea and can consequently leachate under faster loading (Bauder and Montgomery 1980).

Table (4): Relative changes (%) as calculated from mean values for cotton yield (Kentar/ fed), available nitrate and soil nitrate (mg/ Kg soil) (after 45, 60, and 75 days).

Treatments	Mean of yield (2007)	Δ%	Mean of yield (2008)	Δ%	Mean available N mg/kg			Δ%	Mean soil NO_3- N			Δ%
					45	60	75		45	60	75	
With (OM)	8.46	23	7.84	22	136	160	136	52,54,54	70	85	70	56,58,57
Without (OM)	6.52	----	6.11	-----	65	74	63	-------	31	36	30	-------
Ammonium nitrate	7.91	10.6	7.34	9.8	112	132	110	21,23,19	74	89	72	65,64,61
Urea	7.07	----	6.62	-----	89	102	89	-------	26	32	28	--------
Two doses	7.86	9.36	7.30	8.84	116	133	89	27,24,--	57	71	44	25,30,--
Three doses	7.12	-----	6.65	-----	85	101	110	--,--,19	43	50	56	--,--,21

Relative change yield %7=

$$\frac{\sum yield\ with(OM)\ \ -\sum without(OM)}{\sum yield\ with(OM)} X\ 100$$

Relative changes (two doses) %=

$$\frac{\sum two\ doses\ \ -\sum three doses}{\sum two\ doses} X\ 100$$

Relative changes of ammonium %=

$$\frac{\sum ammonium\ \ -\sum urea}{\sum ammonium} X\ 100$$

The process of urea transformation in the soil include a hydrolytic step brought a bout by enzyme urease which may take sometime in soil beside the fact that NH_4-N and not NO_3-N can be fixed on clay particles (Anghinoni and Barber, 1988). Moreover, urea contributes little to NO_3- N as mentioned by Balba *et al.,* (1969). Application of nitrogen fertilizer in two doses was found to increase NO_3- N by 25 and 30% at 45 and 60 days respectively over this with three doses while the three doses were increased by 21% at 75 days (Table 4).

Nitrogen in the nitrate form is very mobile and highly soluble in water. Rainfall moving through the root zone may wash nitrate down ward (Espinoza et *al*). In this respect, Stewart (1998) concluded that the cotton has a deep root that is capable of extracting mobile nutrients like nitrate nitrogen (NO_3-N) from greater depth than many other plants. In addition, cotton will store it in leaves during periods of adequacy for later use in the boll filling period.

Nevertheless, after 45 days from sowing, cotton root did not reach 40 cm so we can consider the layer (40- 80 cm) nitrate content as a loss content. Results in Table (3) showed that the most loss was (41.7 %) when ammonium nitrate fertilizer was applied at three doses and without organic manure addition, while the lowest loss was (35%) when urea fertilizer was applied at two doses and with organic manure.

Table (5): Relative changes (∆%) as calculated from mean values for soil available nitrogen and soil nitrate- N by going deeper from (0- 20) to (40- 80) cm after 45, 60, and 75 days from planting

Total	Soil depth(m)	45 days	∆%	60 days	∆%	75 days	∆%
Available nitrogen	**Urea**						
	0-20	32.8	18.3	38.3	21.6	33.0	21.2
	40- 80	26.8		30.0		26.0	
	Ammonium nitrate						
	0-20	31.0	27.5	36.8	29.7	27.5	39.5
	40- 80	43.0		52.3		45.2	
Soil nitrate	**Urea**						
	0-20	8.0	15.9	9.3	21.4	8.3	19.4
	40- 80	9.5		11.8		10.3	
	Ammonium nitrate						
	0-20	17.5	40.6	23.6	32.9	16.4	46.7
	40- 80	29.4		35.5		30.7	

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تأثير بعض مصادر السماد الأزوتي وعدد دفعات إضافته في وجود وغياب السماد العضوي على محصول القطن ونيتروجين التربة الميسر

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أجريت تجربتان حقليتان في مزرعة محطة البحوث الزراعية بسخا- كفر الشيخ خلال الموسمان الزراعيان ٢٠٠٧ و٢٠٠٨ في قطع منشقة مرتين بأربعة مكررات لدراسة تأثير السماد العضوي والأسمدة النيتروجينية وتجزئ إضافتها على دفعتين أو ثلاث دفعات مع ماء الري على كل من محصول القطن الزهر (صنف جيزة ٨٦) والنيتروجين المسير بالتربة، الصورة النيتراتية منه.
وأوضحت النتائج ما يلي:-

- كانت زيادة محصول القطن الزهر٢٣ و٢٢٪ في السنة الأولى والثانية بسبب إضافة السماد العضوي.
- أعطى سماد نترات الأمونيوم أعلى محصول قطن زهر في وجود السماد العضوي؛ بينما كان أعلى محصول قطن زهر عند استخدام اليوريا في غياب السماد العضوي.
- تقسيم السماد النيتروجيني على دفعتين أدى إلى زيادة محصول القطن الزهر عنه عند إضافته على ثلاث دفعات وكان أعلى محصول قطن زهر٢٥,١٠ قنطار / فدان عند التسميد بسماد نترات الأمونيوم على دفعتين في وجود السماد العضوي.
- ازداد النيتروجين الميسر في التربة مع وجود السماد العضوي لـ٤,٥٣٪ عن غيابه. كما أدى استخدام سماد نترات الأمونيوم إلي زيادته أكثر من سماد اليوريا بـ٧,٢٠٪ و ايضا إزداد النتيروجين الميسر عند إضافة السماد النتيروجيني على دفعتين بـ٦,١٢٪ عنه عند إضافته على ثلاث دفعات.
- كان أعلى تركيز نيتروجين ميسر٩٣جزء في المليون عند استخدم نترات الأمونيوم على دفعتين في وجود المادة العضوية.
- عند التسميد بنترات الأمونيوم يزداد تركيز النيتروجين الميسر في التربة تدريجياً من الطبقة السطحية (٠-٢٠ سم) إلى عمق (٤٠ –٨٠ سم) وكانت هذه الزيادة ٢٧,٥و ٢٩,٧ و ٣٩,٥% بعد الزراعة بـ ٤٥و ٦٠و ٧٥ يوماً على التوالي. على النقيض من ذلك، مع استخدام سماد اليوريا يتناقص تركيز النيتروجين الميسر في التربة تدريجاً من الطبقة السطحية (٠- ٢٠ سم) إلى عمق (٤٠- ٨٠ سم) وكانت نسبة النقص ١٨,٣و ٢١,٦و ٢١,١ % بعد ٤٥ و ٦٠ و ٧٥ يوماً من الزراعة على التوالي.
- ازدادت الصورة النتراتية من الانيتروجين الميسر بسبب وجود السماد العضوي وكانت هذه الزيادة ٥٦,٩ و ٥٧,٣ و ٥٦,٤ % بعد ٤٥ و ٦٠ و٧٥ يوماً.
- بعد إضافة سماد نترات الأمونيوم أو اليوريا يزداد تراكم النترات عند عمق (٤٠- ٨٠ سم) وتكون هذه الزيادة أكثر باستخدام نترات الأمونيوم عن اليوريا (بمقدار ٦٣,١٪) وايضاً باضافة السماد على دفعتين عنها على ثلاث دفعات (بمقدار ١٣,٣٪).

ولهذا أوصت الدراسة بأنه يجب استخدام سماد نترات الأمونيوم على دفعتين مع مياة الرى فى وجود السماد العضوي عند زراعة نبات القطن في أرض طينية ولكن في غياب السماد العضوي يستخدم سماد اليوريا ويضاف على دفعتين.