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Effects of nitrogen forms on yield of sorghum (*Andropogen sorghum*) and their residual effect on a following wheat crop on a sandy soil.

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Abstract

Two field experiments were carried out on a sandy soil at Ismailia Agric. Res. Station, Ismailia governorate Egypt in a split plot design. The first experiment was during summer 2016 on sorghum (*Andropogen sorghum, v.* Dorado). The main plots contained treatments of fertilizer nitrogen forms, i.e. Ammonium Nitrate 33%N, Urea 46 %N Urea Formaldehyde 40%N and Neem Coated Urea 40%N on sorghum. Four rates of *i.e.* 190,238and286 Kg N /ha(80, 100 and 120 kg N/fed) were arranged in the sub main plots. The second field experiment was carried out during the following winter, season of 2016- 2017 growing wheat (Tricticum aestivum), on the same plots of the first experiment, to study the residual effect. Results obtained the increases the rate of caused a significant increase in grains and straw yields of sorghum, as well as grain yield of the following wheat. The highest mean values of soil total-N as well as and available-N occurred after wheat harvest in soil given the 238 kg/ha in rate as urea formaldehyde or Neem coated urea.

Key words: Ammonium Nitrate, Urea Formaldehyde, sorghum, wheat, Neem coated urea.

Introduction

Sandy soils represent the largest areas in Egypt, which can contribute in Egyptian expansion in agriculture. through reclamation of these soils. These soils have problems in plant nutrient. Therefore, one of the most important problems in sandy soils is the shortage in most essential nutrients especially nitrogen. N- fertilizers have marked and direct effects on yield of cereal crops. **Readman *et al.*(2002)** reported a high response of wheat grown on a sandy soil to N- fertilizers. Positive response of maize on sandy soils to N was observed by **Shengmao *et al.*(2004).** N-uptake by maize was reported to positively respond to N-fertilization.(**El-Gindy *et al.* 2000).** However, nitrogen added to sandy soil may be easily leached down through sandy soils due to their coarse texture. This is one of the reasons of N loss of added N- fertilizer. The form of NO_3-N more easily lost by rapid leaching through the soil. **Shengmao *et al.* (2004)** reported an accumulation of NO_3-N in most subsoil layers and consequently less increase in crop yields grown on sandy soils.

Efforts have been devoted to solving this problem,. In this concern, slow release nitrogen fertilizers can be used, the slow release fertilizers include many forms such urea Formaldehyde (40% N). and coated urea which were with compared ammonium nitrate, ammonium sulphate and fertilizer applied to wheat grown on a sandy soil **(Zeidan 2001) (Taalab and Badr 2007)** compared calcium nitrate and ammonium sulphate applied to sorghum.

Material and Methods

A field experiment was carried out on a sandy soil at Ismailia Agricultural Research Station farm, Ismailia Governorate, Egypt. Sorghum followed by wheat as tested crops were used to respond to N fertilization. Physical and chemical properties of these two soils under investigation are shown in Table (1). fertilizers were added to sorghum plant at rates of 190,238and286 Kg/ha (such rates represent 80, 100 or 120% of the rate recommended for the crop in Ismailia. These rates were added in three equal doses after 3, 5 and 7 weeks respectively after planting. The plot area was 3 x 4 m^2 = 12m^2 .Wheat did not receive any N fertilization in order to evaluate the residual effect of these sources of N fertilizers.

Experimental work:

All forming processes were carried out before planting. Superphosphate (15.5% p_2o_5|) was applied at rate of 100 kg / fed during tillage soil. Potassium sulfate was applied rate 75kg k_2o / fed on two equal 30 and 55 day after planting.

Sorghum was planted on the 5 th of June 2016. Three plant samples from each plot were taken after 120 days of sowing at maturity stage. Wheat (triticum aestivum) variety Sakha 93 was sown is november 2016 on to study the residual effect of N application .At harvesting stage 20 may 2017. Surface soil samples from each plot were collected to determine total N and available.

Methods of analyses:

- **Soil analysis**
- The mechanical analysis was determined according to **Piper (1950).**
- Calcium carbonate was determined using the calcimeter as described by **Piper (1950).**
- Electrical conductivity (EC) was measured in soil paste extract using the method described by **Page**

et al. (1982).

- Soluble cations: Ca^{++} and Mg^{++} were determined by titration using the versinate method, while Na+ and K+ were determined using flame photometer.
- Soluble anions: CO3--, HCO3- and Cl- were determined titrimetrically according to **Page et al. (1982).**
- pH value was determined in 1:2.5 soil-water suspension using a glass-electrode pH-meter.
- Organic matter content was determined according to the Walkley and Black (Jackson **1973).**
- Available nitrogen was determined, as described by **Page et al. (1982).**

Plant analyses

The wet digestion method using conc. H_2So_4 and H_2O_2 was used as follows: 0.5g oven - dry plant material was added in 50 ml volumetric flask and digest with 10 ml H2SO4 conc. on a hot plate at approximately 270 °C small quantities of H2O2 was added repeatedly until the digest remains clear. Nitrogen, was determined as described by **Chapman and Pratt (1961).**

Table 1. Soil physical and chemical properties of the soils under investigation.

Chemical analysis	**Value**	Available N P K(mg/kg soil)	**Value**
pH (1 :2.5 suspension)	7.85	N	34
EC dS/m in soil paste extract	2.80	P	5
Ca CO_3 %	2.75	K	85
CEC (of paste extract)	4.50	**Soluble ions (meq/L)**	
Organic matter %	0.27		
Organic carbon %	0.15	Na^+	13.44
		K^+	1
Particle size distribution		Ca^{++}	8
Clay %	2	Mg^{++}	5.56
Silt %	4	CO_3^{--}	0.00
Fine sand %	25	HCO_3^-	1.7
Course sand %	69	Cl^-	22.3
Textural class	Sand	SO_4^{--}	4

* Extractants are : KCl (N), Na-bicarbonate (P), NH_4-acetate (K)

Different forms of N fertilizers were compared the forms were

A. Ammonium nitrate (33% N)

B. Urea (46% N)

C. urea formaldehyde (40% N) is a slow release N form.

D. Neem coated urea (40% N) is a slow release N form where urea was coated with the thick oil produced from neem plants.

Results and Discussion

Plant heights as affected by the application of different N-forms and rates.

Data of Table 2 show that, sorghum plant heights in both vegetative and blooming stages were not significantly increased using different N-forms, while in maturity stage there were significant differences, where the ammonium nitrate gave the highest increase in plant heights Addition of any level for all N-forms tended to a significant increase in the plant height, values for 238 kg or 286 kg N/ha gave higher heights than 190 kg N/ha and the non-traded. These data agree with **Bahr *et al.* (2006) and El-Yazied *et al.* (2007).**

Wheat, as a tested crop for residual effect also responded to N-forms and rates in cases of vegetative and maturity plant. There were significant differences among different N- forms. Urea formaldehyde gave the highest values of plant height compared with the other forms.. Plant height increased with using 190 kg N/ha level more than other rates, and values for the 238kg and 286kg N/ha were statistically the same. These result agree with **Liao *et al.* (2006).**

Crop yield.

Data in table 3 Show that sorghum grain and Straw yields as affected by application of nitrogen rates under different forms were significantly. Increasing the rate of all nitrogen forms caused a significant increase in sorghum yield (grains and Straw). The use of either ammonium nitrate or urea formaldehyde was more effective on grains yield attained with them were higher than with either urea or neem-coated urea. These results are similar to those reported by **El-Etre et al. (2001), Zeidan et al. (2001) and El-Hussieny (2002)** They reported that grain yield responded to N fertilization by any of urea forms in the range of 190.4 to 238 kg N/ha . These results are also in agreement with those obtained by **Bharda et al.(2006), Bahr et al. (2006), El-Yazied et al. (2007), El-Hendawy and Hokam (2007) Abouziena et al. (2007) and Asibuo et al. (2008)** Increasing of N rate up to 286 kg N/ha caused light increase over that of

238 kg N/ha for grain yield. **Asibuo et al. (2008)** showed that the increase of sorghum Straw yield was significant by using ammonium nitrate and urea formaldehyde fertilizers.

With regard to the residual effect of rates on wheat, yield responded to N rates and forms. The obtained data agree with those of **Brennan and Bolland (2009),** who showed a significant increase in the grain yield obtained with urea formaldehyde and lower yield by neem coated urea. These results agree with Cahill **et al. (2007).** The N application to sorghum was significant still effective at any of rates superiority. On other hand case of wheat straw yield for all N-forms were statistically of the same effect. The N- rates were recorded the same effect on grain yield.

Table 2. Plant height (cm) for Sorghum and wheat plants (at harvest) affected by different N-rates using different N- forms.

Crop		form of N (F)	Rate of N (kg/ha.) (R)			Mean of plant height (cm)
			190	238	286	
Sorghum	Maturit	(A)	71.50	75.75	80.00	71.50
		(B)	65.50	64.25	67.50	64.00
		(C)	67.75	74.25	73.25	68.50
		(D)	64.75	68.75	73.50	66.44
		Mean	**67.38**	**70.75**	**73.56**	
Wheat	Maturit	(A)	50.25	49.00	49.50	47.69
		(B)	47.50	48.75	45.25	45.88
		(C)	55.75	50.25	48.75	49.19
		(D)	47.00	51.50	48.75	47.31
		Mean	**50.13**	**49.88**	**48.06**	
L.S.D. at 0.05 level		Sorghum	**F= 5.65**	**R= 5.65**	**F*R = n.s**	
		Wheat	**F= 2.78**	**R= 2.98**	**F*R= n.s**	

Notes: A. Ammonium nitrate (33% N) B. Urea (46% N)
C. Urea formaldehyde (40% N) D. Neem coated urea (40% N)

Table 3. Straw and grains yields of sorghum and wheat crop (tons/ha.) as affected by application of different N-rates using different N-forms.

Crop		form of N	Rate of N (kg/ha)			Mean
			190	238	286	
Sorghum	Grains	(A)	3.21	5.81	6.59	**5.20**
		(B)	1.93	4.24	6.09	**4.09**
		(C)	2.55	5.45	6.93	**4.98**
		(D)	1.71	3.69	2.52	**2.64**
		Mean	**2.35**	**4.80**	**5.53**	
	Straw	(A)	3.52	3.89	4.4	3.24
		(B)	2.73	3.43	4.32	2.91
		(C)	3.73	4.05	5.43	3.59
		(D)	2.29	3.66	2.91	2.51
		Mean	**3.07**	**3.76**	**4.27**	
Wheat	Grains	(A)	1.90	1.81	2.62	**2.11**
		(B)	1.71	2.12	2.48	**2.10**
		(C)	1.93	2.62	3.07	**2.54**
		(D)	1.24	1.81	1.83	**1.63**
		Mean	**1.70**	**2.09**	**2.5**	
	Straw	(A)	3.78	3.12	4.28	**3.73**
		(B)	3.07	3.52	3.31	**3.3**
		(C)	3.43	4.09	3.86	**3.79**
		(D)	2.50	3.86	3.86	**3.41**
		Mean	**3.20**	**3.65**	**3.83**	

L.S.D. at 0.05 level : Forms (F) Rates (R)
Sorghum Grain F =0.47 R = 0.33 F*R= n.s **Stover** F =0.70 R = 0.75 F*R= n.s
Wheat Grain F = 0.25 R = 0.19 F*R=n.s. **Straw** F = n.s R = 0.21 F*R=n.s.

A. Ammonium nitrate (33% N) B. Urea (46% N)
C. Urea formaldehyde (40% N) D. Neem coated urea (40% N

Nitrogen uptake mg / plant.

Data of nitrogen uptake by sorghum and wheat plants, respectively at in Table 4, Ammonium nitrate gave the highest grain yiled followed by urea formaldehyde while neem- coated urea gave the lowest for sorghum. Straw yield of sorghum were highest by urea- formaldehyde; followed by ammonium nitrate and, neem- coated urea gave the lowest. Concurring wheat yield of grains as well as straw, urea- formaldehyde gave the highest followed by ammonium nitrate while neem- coated urea gave the lowest . Such patterns with all N rates. Increased rates of N was associated with increased yields, and this occurred with all forms of N. N uptake in all cases. These results gave with those of El-Gindy **et al. (2000) and Abd-El-Monem et al. (1995)**.

Table 4 Nitrogen uptake (mg/plant) by sorghum and wheat plants as affected by application of different N rates using different N-forms

Crop type		N-form	N-Rate (kg/ha). (R)			Mean
			190	238	286	
Sorghum	Grains	(A)	89.73	110.77	130.88	**110.47**
		(B)	119.43	141.30	71.14	**110.62**
		(C)	204.42	138.06	135.09	**159.19**
		(D)	71.71	79.25	90.87	**80.61**
		Mean	**121.32**	**117.35**	**107**	
	Stover	(A)	71.11	86.35	107.08	**88.18**
		(B)	86.89	89.44	71.14	**82.49**
		(C)	137.97	131.45	135.11	**134.84**
		(D)	61.67	71.76	90.87	**74.77**
		Mean	**89.41**	**94.75**	**101.03**	
Wheat	Grains	(A)	37.37	32.58	41.67	**37.21**
		(B)	32.49	30.39	43.82	**35.57**
		(C)	30.87	39.48	53.81	**41.39**
		(D)	19.75	23.23	16.54	**19.84**
		Mean	**30.12**	**31.42**	**38.96**	
	Straw	(A)	18.09	27.56	23.85	**23.17**
		(B)	22.28	30.18	16.90	**23.12**
		(C)	22.13	28.04	14.38	**21.52**
		(D)	24.32	37.37	55.74	**39.14**
		Mean	**21.71**	**30.79**	**27.72**	

L.S.D. at 0.05 level :
Sorghum Grain F =n.s. R =2.26 F*R=n.s. Stover F = 9.494 R =7.677 F*R= n.s
Wheat Grain F = 2.93 R = 3.48 F*R = 5.86 Straw F =1.92 R =1.91 F*R=3.82

N– forms:-

A. Ammonium nitrate (33% N) *B. Urea (46% N)*
C. Urea formaldehyde (40% N) *D. Neem coated urea (40% N*

N- uptake

Table 5 represent total N uptake by Urea formaldehyde gave highest uptake than urea and neem coated urea, in sorghum. **Bahr et al. (2006)** and **El-Yazied et al. (2007),** showed that urea- formaldehyde gave high N uptake in wheat the crop of residual effect was not statistically affected with different N-forms. All rates were significantly effective in increasing N-uptake in wheat The rates were of ascending affect according to their applications. The 286 kg N/ha was superior to the 190 kg N/ha. As for N recovery of sorghum and wheat, urea formaldehyde caused higher uptake than urea and neem coated urea. The rates used in applications were of similar effect. Ammonium nitrate was the only form which increased proportionally by increasing the application rates. Urea formaldehyde showed the highest efficienc followed with urea, ammonium nitrate and neem coated urea. **Readman et al. (2002) & Singh et al. (1995)** obtained trends similar to the present study.

Table 5. N uptake (kg/ha.) by sorghum and wheat crops as affected by N rates using different N-forms.

Crop	N-forms (F)	N-Rates (kg/ha) (R)			Mean
		190	238	286	
Sorghum	(A)	160.84	197.11	237.95	**198.63**
	(B)	206.32	230.74	142.28	**193.11**
	(C)	342.39	269.51	270.20	**294.03**
	(D)	133.38	151.01	181.74	**155.38**
	Mean	**210.73**	**212.09**	**208.04**	
Wheat	(A)	55.45	60.14	65.52	**60.37**
	(B)	54.76	60.57	60.71	**58.68**
	(C)	53.00	67.52	68.19	**62.90**
	(D)	44.08	60.59	72.28	**58.98**
	Mean	**21.78**	**26.14**	**28.01**	
Total (sorghum+ Wheat)	(A)	216.29	257.25	303.47	**259**
	(B)	261.09	291.31	202.99	**251.80**
	(C)	395.39	337.03	338.39	**356.94**
	(D)	177.45	211.61	254.02	**214.36**
	Mean	**262.56**	**274.3**	**274.72**	
L.S.D. at 0.05 level : **Sorghum (F) =15.16 (R) =13.00 F*R= n.s. Wheat (F) =n.s (R) = 2.16 F*R = n.s Whole (F) =16.48 (R) =13.14 F*R=n.s.**					

N-Forms

A. Ammonium nitrate (33% N) *B. Urea (46% N)*
C. Urea formaldehyde (40% N) *D. Neem coated urea (40% N)*

Nitrogen status in soil:

Available N as affected by nitrogen forms at different rates were determined after 4 months of application to study the nitrogen status in soil. The data are presented in Table 6. Available N in soil was lowest 190kg N/ha (58.68mg/kg soil) by urea- formaldehyde at lowest rate and highest (98.37 mg/ kg) by same form at highest rate(286 kgN/ha). The used of N- form and different rate were significant increase for available N in soil.

Table 6. Available nitrogen in soil (mg/kg soil) as affected by different N rates with using different N-forms.

N-Form (F)	N- Rate (kg/ha) (R)			Mean
	190	238	286	
	Available N			
(A)	69.02	81.71	85.68	**78.80**
(B)	68.23	74.57	76.16	**72.99**
(C)	58.68	95.2	98.37	**84.08**
(D)	72.99	83.3	84.89	**80.39**
Mean	**67.23**	**83.70**	**86.28**	
L.S.D. at 0.05 level :			(F) = 4.15 R= 4.15 F*R= 9.29	

N – Forms:

A. Ammonium nitrate (33% N) B. Urea (46% N)
C. Urea formaldehyde (40% N) D. Neem coated urea (40% N)

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تاثيرات صور النيتروجين المختلفة والتاثير المتبقي لها على محصول الذرة الرفيعة والقمح فى الارض الرملية.

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تهدف هذه الدراسة إلى تحديد أنسب صورة من صور التسميد الأزوتى والتى يمكن إضافتها إلى الأراضى المستصلحة حديثا ، مثل الأراضى الرملية حيث تختلف صور النيتروجين فى معدل انطلاقها وتحررها، وبالتالى يختلف معدل استجابة النبات بطريقة مباشرة او غير مباشرة نتيجة لإضافة صور النيتروجين.

لتحقيق هذا الهدف أجريت تجربة فى ارض رملية بمحطة بحوث الإسماعيلية فى تصميم احصائى قطع منشقة. المعاملات الرئيسية كانت لعدة صور من النيتروجين ، وهى نترات الامونيوم (N%33)، يوريا (N %46) ، يوريا فورمالدهيد (N %40) ، يوريا مغلفة بزيت النيم (N%40) ، تم إضافة هذه الصور من النيتروجين بمعدلات 190 ,238 ,286 كجم/هكتار وذلك إلى محصول الذرة الرفيعة فقط كمحصول صيفى (لعام 2016) ، ومحصول قمح زرع لدراسة الأثر المتبقى كمحصول شتوى (لعام 2017/2016)، تم اخذ عدة قياسات فى مراحة النضج بالنسبة لمحصولى الذره والقمح ، مثل قياس ارتفاع النباتات ووزن الحبوب والحطب (القش) ، كذلك تم تقدير كل من النيتروجين ، الفوسفور ، البوتاسيوم الممتص بواسطة نباتات الذرة الرفيعة والقمح ، وكذلك محتوى التربة من هذه العناصر فى نهاية التجربة ، وكانت أهم النتائج المتحصل عليها كالتالى :

- طول النبات لكل من حطب الذرة الرفيعة وقش القمح زاد بزيادة معنويا بزيادة معدلات اضافة النيتروجين ، كما أعطت اليوريا فورمالدهيد فى حالة الذرة الرفيعة والقمح أعلى القيم.
- زاد محصول الحبوب للذرة الرفيعة زيادة مقبولة بزيادة معدل إضافة النيتروجين ، استجاب محصول الحبوب للقمح إلى التأثيرات المتبقية لهذه الإضافات حتى 286كجم نيتروجين/هكتار، وكانت افضل النتائج مع اضافة اليوريا فورمالدهيد عند اعلى معدل.
- حطب الذرة الرفيعة وقش القمح قد سلكا نفس سلوك محصول الحبوب.
- أثرت اليوريا فورمالدهيد معنوياً على محصول الحبوب لكلا من الذرة الرفيعة والقمح .
- الوزن الجاف لحبوب الذرة الرفيعة تأثر معنوياً بإضافة 238 كجم نيتروجين/هكتار، وذلك بالمقارنة بالمعدلات الأخرى ، أما بالنسبة الوزن الجاف لمحصول الحبوب للقمح فقد زاد بزيادة معدلات الإضافة حتى 286 كجم/هكتار .
- زاد النيتروجين الممتص معنوياً باستخدام اليوريا فورمالدهيد مقارنة بباقى صور النيتروجين الأخرى فى حالة الحطب للذرة الرفيعة والحبوب لمحصول القمح كتأثير متبقى.
- زاد محتوى النيتروجين فى القش معنويا بزيادة معدلات الإضافة.
- زاد معنويا المحتوى الكلى للنيتروجين فى كل من الذرة والقمح مع إضافة اليوريا فورمالدهيد، وذلك مقارنة باستخدام اليوريا ، اليوريا المغلفة بزيت النيم.
- زاد النيتروجين الميسر فى التربة مع استخدام صور النيتروجين المختلفة مقارنة بالكنترول ، حيث أدت معاملة النيتروجين المغلف بزيت النيم إلى زيادة محتوى النيتروجين بالتربة أعلى من الصور الأخرى.