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EVALUATION OF NITROGEN APPLICATION METHODS TO WHEAT PLANTS GROWN ON SIWA OASIS, EGYPT

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ABSTRACT

The study was carried out in Sewa Oasis, Egypt, in Tegthierty area whose soil is loamy sand in texture. Two field experiments were carried out depicting the application of three N levels in three methods namely soil, foliar, or combinations of both methods. The application of N via soil or foliage separately was on the purpose of exposing the effects of such routes in a clear cut as being not affected by the other levels or routes. These treatments were assessed in two successive seasons. Wheat variety Sakha 93 was the test plant. The aim of this study was to approach the goal yield of wheat by using the least possible N level via either soil, foliar, or both. It was found that all N fertilization levels and methods proved to be significantly better than the control treatment regarding wheat grain, straw, and biomass yields, growth parameters, and NPK uptake in both plant parts, as well in both seasons of study. The best combination treatment was found to be the integrated soil and foliar application of fertilizer N at the highest rate.

Keywords: Integrated between soil and foliar N fertilizer, loamy sand soil in Sewa Oasis, maximum yield, wheat

INTRODUCTION

It is well recognized that balance fertilizer has an effective role in increasing the yield of many crops including wheat. For growing healthy plants, there is a need to provide balance nutrition to the plants for which an integrated management is an essential part. Farmers either apply no nitrogen or apply nitrogen fertilizer exorbitantly that could cause imbalance in the nutrient supply. The trend in fertilizer use is mostly driven by the need of developing countries to keep food supply up with population growth. It has been projected that by the year 2025, world population will be more than 8 billion people, with more than 90% of this additional growth concentrated in developing countries. Foliar fertilization is a widely used practice to correct nutritional deficiencies in plants caused by improper supply of nutrient to roots (Ling & Silberbush, 2002). Woolfolk *et al*., (2002) and Afifi *et al.* (2011) reported that a significant linear increase in total N of grain wheat was observed for post flowering foliar applications. Similarly, Akhtar *et al*., (2002) observed that spike N content was higher in the N fertilized plants. Number of grains was positively associated with spike N and P content as well as spike dry matter at heading. Number of grains per unit of spike dry matter at heading in N fertilized micro crops tended to be higher than in N stressed ones. Foliar applied N tended to increase seed yield of soybean, cotton and rap-seed-mustard (Oko *et al*., 2003; Siddique *et al*., 2008; El-Abady *et al*., 2009).

Foliar feeding is an effective method for correcting soil deficiencies and overcoming soil's inability to transfer enough nutrients to the plant. Einstein (2004) found that tests showed that up to 90 percent of a foliar fed nutrient solution could be detected in the smallest roots of a plant within 60 minutes of application. Foliar feeding could prove 8 to10 times more effective than soil feeding. Jamal *et al*. (2006) reported that wheat grain yield increased when NPK were applied as foliar and soil applications. Soil feeding of NPK fertilizer resulted in better wheat yield than foliar feeding.

Maitlo *et al*. (2006) concluded that foliar fertilization with N through 2-2.5% of urea in foliar solution improved growth, yield, nutrient uptake and quality of wheat. Jamal and Chaudhary (2007) concluded that soil and foliar application of fertilizers together increased wheat growth and yield. Also, Khan *et al*. (2009) reported that wheat grain yield increased by 32% when 4% of urea in foliar solution was applied.

Regarding the integrated between soil and foliar of N application, Jehan *et al.* (2010) indicated that maximum grain yield was produced by treatments fertilized with highest dose of foliar N (150 kg ha^{-1} ($2/3^{rd}$ soil + $1/3^{rd}$ foliar).The objective of this work is to evaluate the soil and foliar routes with N under the conditions of loamy sand soil at Siwa Oasis to achieve the highest possible wheat grain and straw yields.

MATERIALS AND METHODS

Field experiments in three completely randomized replications for each treatment were carried out in two successive years on a loamy sand soil at Tegthierty area, Sewa Oasis (located at 30º 36' 14" N and 30º 16' 43" E). Physical and chemical analyses of the studied soils are presented in Table1. Analyses were accomplished according to Page, *et al*, (1982) and Klute, (1986). The experimental plot area was $225m^2$ at studied location. Grains of wheat variety Sakha 93 were cultivated in two seasons. Three experiments were carry out; the first was soil N fertilizer, while the second was foliar N fertilizer and the third was integration between soil and foliar N fertilizer.

With regard to the soil N fertilizer trial, the soil applied portion of N fertilizer applied rates were N1= 80, N2= 100, and N3=120 kg N/fed as urea. In the foliar N fertilizer trial, three foliar fertilizer treatments rates were Fol1= 1%, Fol2= 2% and Fol3= 3% of urea (46%N). In the third trial, nine combinations of soil and foliar applications were made (i.e. N1Fol1, N1Fol2, N1Fol3, N2Fol1, N2Fol2, N2Fol3, N3Fol1, N3Fol2 and N3Fol3. In addition, there was a non-fertilized treatment (control) in experiments. A basal doses of phosphorus and potassium (i.e. 13kgP and 42kgK/fed) were added as calcium super phosphate for P and potassium sulfate for K to all treatments. Calcium super phosphate and potassium sulfate fertilizers were incorporated with the studied soil during seedbed preparation. Each soil N treatment was split into four equal doses and applied after 20, 40, 60, and 80 days from sowing for the 1^{st}, 2^{nd}, 3^{rd} and 4^{th} dose, respectively. Also, foliar N treatments were applied four times at the same periods of N soil application.

Table (1): Chemical and physical soil properties of the studied soils.

Depth cm	pH	E.C dS/m	OM	$CaCO_3$	Sand	Silt	Clay	C.E.C meq/100g soil	Texture
			%						
0-30	7.78	1.68	1.06	8.73	82.3	9.2	8.5	8.99	Loamy Sand
30-60	7.81	1.52	0.78	6.53	81.6	9.8	8.6	9.41	Loamy Sand

Available nutrients in soil (ppm)							
	N	P	K	Fe	Mn	Zn	Cu
0-30	43.9	4.56	84	8.25	5.15	0.74	0.26
30-60	31.6	3.95	96	9.76	5.37	0.87	0.34

Plant samples were collected at harvest stage. At the end of each experiment, the biomas, grain and straw yields were recorded in both seasons. Grain and straw content of N, P and K were analyzed according to Cottenie *et al* (1982). The obtained data were statistically analyzed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of N fertilizer treatments on wheat production:

Fertilizer application methods for enhancing and/or obtaining maximum crop production necessitate a careful monitoring of crop need for nutrient elements especially during its life time.

Data in Table2 & Fig.1 state that wheat a yield increased with increasing the total added N fertilizers as foliar, in studied soil in the two seasons and the best N fertilizer treatment was Fol_3 at foliar and integration of field trials. This treatment scored 1.11 and 2.63 tonfed^{-1} grains to foliar and integration of field trials respectively. In the integration N application trial, wheat yield increased up to the soil N_2 after which it decreased with the best treatment being Fol_3N_2. This treatment scored 5.77 and 2.63 tonfed^{-1} of wheat straw and grains, respectively. The foliar application of N may completed for a requirement of wheat at N_2 application which compensate for a little N available in loamy sand soil. At the soil N application trial, the yield parameters of wheat were taking the same trend of integration field trial. The straw yield was increased with increase N rates in all field trials. It may be due to the fact that nitrogen is an essential element for growth and development and thus promotes growth and yield parameters. Similar results are also reported by Ling & Silberbush (2002), Woolfolk *et al*., (2002), Bly & Woodard (2003), Oko *et al*., (2003), Siddiqui *et al*., (2008) and Otteson *et al*., (2007 & 2008)

Table (2). Effect of N fertilizer treatments on wheat yields in the two seasons

Treatments		Yield (tonfed^{-1})		
		Bio.	Straw	Grain
Control		1.94	1.37	0.57
Soil	N_1	3.83	2.67	1.16
	N_2	4.25	2.89	1.36
	N_3	4.26	2.94	1.32
Foliar	Fol_1	2.65	1.81	0.84
	Fol_2	3.10	2.10	1.00
	Fol_3	3.78	2.67	1.11
Integration	Fol_1N_1	6.26	4.36	1.9
	$Fol_1 N_2$	6.63	4.47	2.16
	$Fol_1 N_3$	6.56	4.52	2.04
	Fol_2N_1	7.06	4.82	2.24
	$Fol_2 N_2$	7.90	5.42	2.48
	$Fol_2 N_3$	7.92	5.59	2.33
	Fol_3N_1	8.10	5.64	2.46
	Fol_3N_2	8.45	5.82	2.63
	Fol_3N_3	8.42	5.87	2.55
$LSD_{0.05}$ Soil		0.08	0.05	0.04
$LSD_{0.05}$ Foliar		0.04	0.02	0.02
$LSD_{0.05}$ Integration		0.12	0.07	0.05

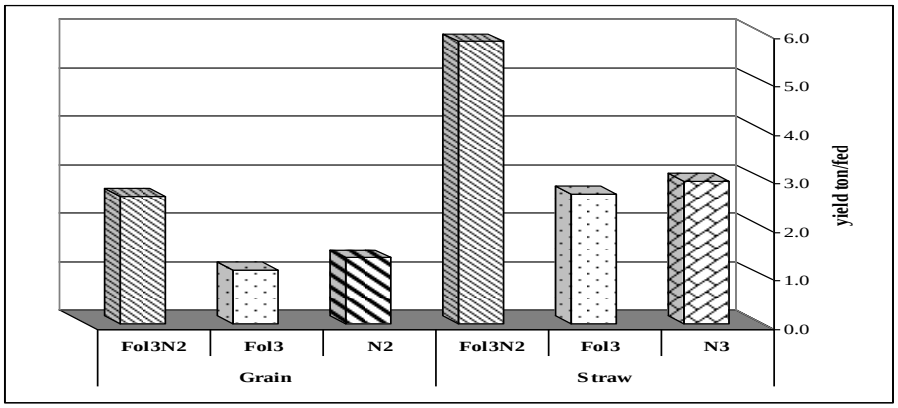

Fig. 1: The highest values of grain and straw yield in the different N application methods.

All fertilizer treatments were significantly better than the control. In addition, high plant response to fertilization portrays the clear finger prints of integration of soil and foliar feeding. The above results agreed with those obtained by Bertic *et al*.(2006), Jamal *et al*. (2006), Silwana, *et al*. (2007) and Khan *et al*. (2009).

Fig.1 shows the comparison between the rates of different application methods which achieved the highest values of grain and straw of wheat yield It can be concluded that the highest straw and grain yields were given by the Fol3N2 level.

Effect of N fertilizer treatments on NPK uptake by wheat:

Concerning the effect of N fertilizers applied via both soil and aerial parts on the uptake of N, P, and K nutrients by wheat straw and grains (Table3), NPK uptake increased with all foliar N applications at all field trials during the two studied seasons.

Table (3): Effect of treatments on uptake (Kg/fed) of NPK by wheat through two seasons.

Treatments		N		P		K	
		Straw	Grains	Straw	Grains	Straw	Grains
		Uptake (Kg/fed)					
Control		2.9	1.8	0.4	0.3	4.7	1.3
Soil	N_1	8.5	7.1	2.9	2.5	12.3	4.1
	N_2	11.0	9.9	3.8	3.0	14.2	4.9
	N_3	12.3	11.4	3.8	3.2	15.3	5.2
Foliar	Fol_1	4.3	3.9	0.9	1.1	6.5	2.1
	Fol_2	6.5	5.8	1.3	1.4	8.0	2.7
	Fol_3	9.1	7.1	1.9	1.7	10.7	3.2
Integration	Fol_1N_1	16.1	14.8	5.2	4.2	23.1	7.2
	$Fol_1 N_2$	21.4	20.5	6.7	5.0	24.6	8.6
	$Fol_1 N_3$	23.5	18.7	6.8	4.9	26.2	8.6
	Fol_2N_1	20.7	19.7	6.8	5.6	28.5	9.6
	$Fol_2 N_2$	27.7	26.0	8.7	6.5	34.2	11.2
	$Fol_2 N_3$	31.3	24.3	8.9	6.3	36.3	10.7
	Fol_3N_1	32.1	23.6	8.5	6.9	37.2	11.8
	Fol_3N_2	37.8	30.5	10.5	7.6	39.6	13.2
	Fol_3N_3	39.9	29.3	10.0	7.1	39.3	12.5
$LSD_{0.05}$ Soil		0.9	1.3	0.3	0.4	5.6	2.3
$LSD_{0.05}$ Foliar		0.4	0.6	0.2	0.2	2.5	1.0
$LSD_{0.05}$ Integration		1.2	1.8	0.5	0.5	7.9	3.3

On the other hand, the field trials were sort to highest NPK uptake by wheat as flowing the foliar N fertilizer field trial, the soil N fertilizer field trial and integration field trial. The NPK uptake responded to the foliar application incrementally up to the second level of soil applied N, while with the highest level of soil applied N the uptake fell down in grain. But in straw, N uptake increased with increase in rate in all field trials. So, the best N fertilizer treatment in the integration field trial was Fol_3N_2. This may be referred to equilibrium case between nutrients at Fol_3N_2 treatment when it comparison with Fol_3N_3 treatment, or it is sufficient for providing enough N, K and P to wheat plants. The above results agreed with those obtained by **Bly &** Woodard (2003), Bertic *et al.*(2006), Kegang (2005), Jamal & Chaudhary (2007), Subedi *et al*., (2007) and Khan *et al*. (2009).

Fig.2 shows the comparison between the rates of different application methods which achieved the highest values of NPK uptake in both grain and straw of wheat. It can be concluded that the highest N uptake in straw was given by the Fol3N3 level but in grain it was given by the Fol3N2 level. On the other hand, the highest P or K uptake was given by the Fol3N2 level either in straw or in grain.

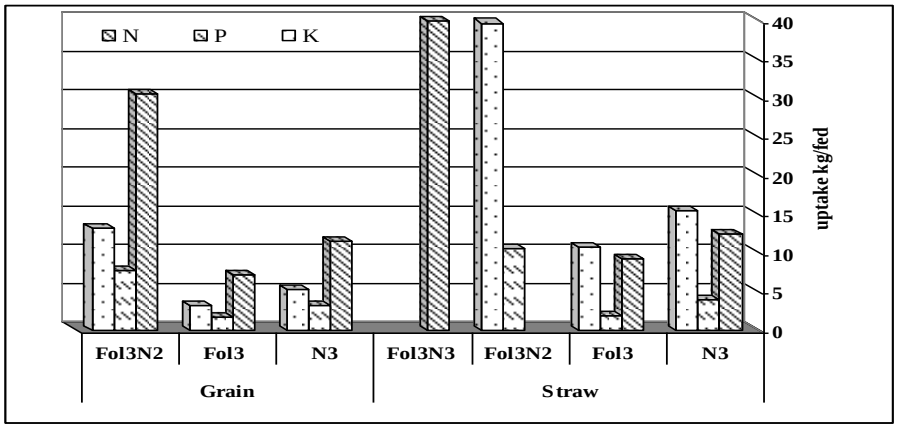

Fig. 2: The highest values of NPK uptake in both grain and straw of wheat in the different N application methods.

CONCLUSION

It can be concluded that at loamy sand soil, the most effective treatment was (Fol_3N_2), in integration field trial which depicted the soil application of 100 Kg N/fed, 30 kg P_2O_5/fed, and 50kg K_2O/fed + spraying the plants with the cumulative amounts of 0.3% N/fed for wheat plant. This treatment scored 5.77 and 2.63 tonfed^{-1} of wheat straw and grains, respectively. At the soil N application trial, the yield parameters of wheat were taking the same trend of integration field trial. The three field trials were sort to up highest yields of wheat and NPK uptake by wheat as flowing the foliar N fertilizer field trial, the soil N fertilizer field trial and integration field trial. The straw yield was in increased with increase N rates in all field trials. The foliar N application may compensate for a little decrease of N application in low fertility status soils, i.e. loamy sand soil to sufficient level for wheat requirement of N nutrient.

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تقييم طرق إضافة النيتروجين لنبات القمح النامى فى واحة سيوة بمصر

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أقيمت هذة الدراسة فى موسمين متتالين بواحة سيوة بمصر فى منطقة تجزرتى وهى أرض رملية طمييية بهدف تقييم طرق إضافة النيتروجين لنبات القمح النامى فى واحة سيوة بمصر حيث أجريت ثلاثة تجارب لإضافة التسميد النتروجين الأولى ورقياً والثانية ارضياً أما الثالثة فهى عبارة عن التكامل بين التسميد الأرضى والورقى. والقمح صنف سخا 93 كان هو النبات المختبر. والهدف من الدراسة هو الوصول الى اقصى انتاجية من القمح باستخدام أقل قدر ممكن من الأسمدة النتروجين الأرضية والورقية المضافة.

وقد أوضحت النتائج أن تجارب التسميد النتروجينى الثلاثة تترتب تصاعدياً من حيث زيادة الإنتاجية المحصولية والممتص من المغذيات كالأتى تجربة التسميد الورقى ثم تجربة التسميد الأرضى ثم تجربة التكامل بين التسميد الأرضى والورقى للنتروجين. ان التسميد الورقى أعطى تفوقاً فى زيادة القياسات المحصولية وتركيزات العناصر الغذائية الكبرى والممتص منها بواسطة القمح خلا ل الموسمين، بينما فى التسميد الأرضى للنتروجين توقفت الإستجابة عند المستوى الثانى للنتروجين المضاف ارضياً. التكامل بين التسميد الارضى والورقى اخذ نفس سلوك التسميد الارضى للنتروجين مع كل معاملات النتروجين المضافة ورقياً. فى تجربة التسميد الأرضى المعاملة المثلى كانت المستوى الثانى من إضافة النتروجين , كانت المعاملة السمادية الأكثر تأثيراً (N_2) والتى حققت 2.89 طن /فدان للقش و 1.36 طن /فدان لحبوب القمح ، بينما فى تجربة التسميد الورقى للنتروجين كانت 2.10 طن /فدان للقش و 1.0 طن /فدان للحبوب. على الجانب الآخر فى تجربة التكامل كانت المعاملة السمادية المثلى للقمح (Fol_3N_2) التى حققت 5.82 طن /فدان للقش و 2.63 طن /فدان لحبوب القمح.

قام بتحكيم البحث

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