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RESPONSE OF WHEAT TO N-FERTILIZER UNDER THE CROPPING SYSTEMS OF NEWLY RECLAIMED DESERT LAND AND OLD IRRIGATED LAND IN EGYPT

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(Note: Certain figures are not included)

Abstract

Extending agriculture to desert land is one of the major components of the national agricultural strategy to increase agricultural production in Egypt. As most of the newly reclaimed soils are sandy and calcareous, with poor organic matter and macro- and micronutrient content, application of fertilizers is important for crop production in these soils. Fertilizer management practices for the cropping systems in the newly reclaimed desert land are different from those in the old irrigated land of the Nile Valley. In this study a field trial was conducted in two locations, representing the sandy soil of the newly reclaimed land and the clay irrigated land of the Nile Valley, to compare nitrogen and water use efficiency of two wheat varieties as affected by N rate and irrigation regime. Nitrogen fertilizer was applied at four rates as ammonium sulfate applied in two split applications in the clay soil, and in five split applications for the sandy soil. Two irrigation treatments were used. Surface irrigation was used for the clay soil, and sprinkler irrigation was practiced in the sandy soil. Biological yield of wheat as well as N- recovery varied according to soil texture, rate of fertilizer and wheat variety. Average nitrogen recovery was 45% and 25% for wheat grown in the clay and sandy soils respectively. Values of N recovered by Sakha 69 are higher than that of Sids 6 in both sites. However, values of N recovery by both cultivars are always higher in case of the clay soil than the sandy soil. Water consumptive use values WUE (m^3/ha) for the two wheat cultivars is affected by irrigation treatments and locations. Data indicated that average CU values for both cultivars at the sandy soil were about 23% higher than the values at the clay soil. Also Sids 6 consume more water than Sakha 69. As water use efficiency is estimated, it was found that it is higher for Sakha 69 (1.11) than that of Sids 6 (0.77). Average WUE value at the clay soil (1.26) was higher than that at the sandy soil (0.62). Results suggests that Sakha 69 wheat is more efficient in using nitrogen and water.

Introduction

Egypt occupies a total area of about one million square kilometers, or 238 million feddans (one feddan = 0.42 hectare) of which only a small portion (about 3.5%) is agriculturally productive, while desert occupies 96% of Egypt's territory. The old irrigated land with an area of 5.4 million feddans laying within the Nile Valley and Delta. It represents the most fertile soils in Egypt, which is alluvial, level, deep, dark brown and medium to heavy in texture. According to USDA soil taxonomy, the order Vertisiol dominates the major part of the old land. Agriculture in Egypt is almost entirely dependent on irrigation; the country has no effective rain except in a narrow band along the northern coastal areas (about 150 mm/yr). Egypt has only one main source of water, the River Nile. Intensive land reclamation projects in Egypt started early in the fifties and continued until now to develop and utilize new lands and to intensify and diversify agricultural and livestock production to meet the growing national demand for food. Most of the newly reclaimed soils are sandy and calcareous (about 84% is sandy). The newly reclaimed areas depend on irrigation water either from canals coming from the Nile or underground water. Usually modern irrigation systems (sprinkler and drip) are used.

Wheat is the staple food crop in Egypt where the national consumption reaches about 10 million

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tons, while the production reached 5.7 million ton in 1996. Contribution of the newly reclaimed land for the wheat production increased from 112 thousand tons in 1990 to more than half million tons in 1996. The potential of increasing area and productivity is high, wheat became appealing to farmers as the price increases after agricultural market liberalization policies were initiated.

Producing the massive quantities of food materials needed in Egypt, would have been impossible today without using fertilizers. Results of a soil fertility survey study carried out by the Soils and Water Research Institute (ARC 1994), where 5670 soil samples representing eleven governorate were collected, indicated that the tested samples contain an adequate concentration of potassium, 36% were poor in phosphorus and 75% were poor in nitrogen. Total fertilizer consumption in Egypt was increased about 69%, while the increase in nitrogen fertilizer consumption was 77% in 1994 as compared with 1980 (IFDC 1993). The intensive agricultural farming system, where the crop rotation consists of 2 or 3 crops per year, adding new cultivated areas, and the gradual increase in the recommended fertilizer rate for various crops are the main reasons for the high consumption of fertilizers in Egypt (Hamissa and El Mouwelhi 1989). Several studies show that, efficient use of the applied N fertilizers by the various crops in Egypt is poor.

The objectives of these field trials were to 1) Compare productivity of the newly introduced cultivar (Sids 6) and the tradition one (Sakha 69) under the newly reclaimed sandy soil and the old irrigated land of the Nile Valley, 2) Assess the response of the two wheat cultivars to N fertilizer rates and irrigation regimes, 3) Determine the actual water consumptive use and water use efficiency for the wheat cultivars, 4) Estimate the nitrogen use efficiency for the added fertilizer for each cultivar under both soil conditions.

Material and Methods

1- Giza site: The site represents the old irrigated clay soil. Chemical and physical properties of the soil are presented in Table 1. The experiment plot was planted in 1995/1996 growing season on 17 November 1995. A split-split plot design was used where two irrigation treatments represented the main plots, two wheat cultivars represented the sub-plot and four N-fertilizer levels represented the sub sub-plots with three replicates. The experimental unit used in the trial was 20 m^2. The two irrigation treatments were I1 (required level, irrigating to replenish the difference in water content at field capacity and water content before the next irrigation) and I2 (75% of the amount of irrigation water applied in I1). Two wheat cultivars namely Sakha 69 (traditional cultivar) and Sids 6 (newly released long-spike cultivar) were compared. The N-fertilizer levels were 0, 70, 140 and 210 kg N/ha. Phosphorus fertilizer was applied at one rate of 150 kg P_2O_5 /ha, while nitrogen fertilizer was applied as ammonium sulfate in two splits. The first (1/3 N-rate) was applied after 21 days from planting, while the second (2/3 N-rate) was applied at the growing stage of Z-31. Grain and straw yields from each plot were recorded to determine the effect of the tested variables on wheat yield, water consumptive use and water use efficiency. Surface irrigation system was used and the amount of water consumption was determined by collecting soil samples at sowing, before and after each irrigation and at harvest time. The depth of water applied at each irrigation was calculated according to the formula suggested by Israelson and Hansen (1962). The data were subjected to the proper analysis using the CoHort (1986) statistical package. Average values from the three replicates of each treatment were interpreted using the analysis of variance (ANOVA). Also, the Student-Newman-Keuls Test was used for comparisons between means.

Table 1: Chemical and physical properties of the soil at Giza.

Organic Matter	pH	CEC meq/100g soil	EC dS/m	Clay	Silt	Sand
				------------- % ----------------		
1.80	8.4	50	0.7	53	31	16

2-Ismailia site: The site represents the newly reclaimed sandy soils. Chemical and physical properties of the soil are presented in Table 2. The experiment was planted in 1995/1996 growing season on 23 November 1995. The same experimental design, tested variables and statistical analysis techniques were used as in Giza site. The experimental unit was 42 m^2. N fertilizer levels used in this site were 70, 140, 210 and 280 kg N/ha applied in five splits. Sprinkler irrigation system was used for applying the irrigation water. The irrigation treatments were performed by varying the distances between sprinklers and between laterals such that the number of sprinklers for the I2 treatment were three fourth those of the I1 irrigation treatment. The depth of applied water for each irrigation was determined by collecting gravimetric soil samples.

Table 2: Chemical and physical properties of the soil at Ismailia.

Organic Matter	pH	CEC meq/100g soil	$CaCO_3$	Clay	Silt	Sand
			----------------- % --------------------			
0.25	8.1	11	2.0	9	4	87

Results and Discussions:

I -Wheat response to fertilizer and N recovery:

Data presented in Table 3 show that, as an average for all N treatments, grain and straw yield of Sakha 69 is significantly higher than Sids 6 (36.6% and 47.9% higher in grain and straw yield respectively). The newly released cultivar Sids 6 has long spikes, however its yield is lower than Sakha 69 this du to its lower tillering. Data of table 3 also reveled that, application of N fertilizer resulted in significant increase in grain and straw yield of the both cultivars tested. However, percentage of increase for the cultivar Sakha 69 was higher than that of cultivar Sids 6. While percentage of grain yield increase for Sakha 69 was 33, 41 and 78 for the application of 70, 140, and 210 kg N/ ha, those percentages were 19, 34, and 50 for Sids 6.

Compared to the average yield at Giza, grain and straw yield at Ismailia under the sandy soil conditions (Table 4) is lower. Grain yield obtained from the control plot where N= 0 kg N/ha at Giza (3.676 Mg/ha) is higher than yield obtained from the first rate applied at Ismailia where N= 70 kg N/ha (2.306 Mg/ha), reflecting the poor chemical and physical properties of that sandy soil (Table 2). Similar to its performance in the clay soil, yield of Sakha 69 is significantly higher (33.5% and 25.5% in grain and straw yield respectively) than Sids 6. Mitkess et al. (1992) reported that Sakha 69 responded significantly to N fertilizer under different environmental conditions

Table 3: Average grain yield of two wheat cultivars (Mg/ha) as affected by irrigation treatments and nitrogen rates at Giza:

Cultivar	N-Level	Grain Yield (ton/ha)	Straw Yield (ton/ha)
Sakha 69	N000	3.676	7.598
	N070	4.876	11.382
	N140	5.181	13.174
	N210	6.555	14.860
	Average	**5.072**	**11.753**
Sids 6	N000	2.953	6.304
	N070	3.505	7.282
	N140	3.950	8.286
	N210	4.436	9.926
	Average	**3.711**	**7.949**
LSD (0.05) values for:			
diff. N-level & same cultivar		0.3715	0.7405
same N-level & diff. cultivar		0.5343	1.2041
		ANOVA effect	
	N	***(0.263)	***(0.524)
	Cultivar ©	**(0.558)	**(1.200)
	I	NS	NS
	N X I	NS	NS
	N X C	***	***
	C X I	NS	NS
	N X C X I	NS	NS

Values between practices represent the LSD at 0.05 significant levels for the averages.
, * Significant at the 0.1, 0.01 and 0.001 probability levels, respectively.

Table 4: Average grain yield of two wheat cultivars (Mg/ha) as affected by irrigation treatments and nitrogen rates at Ismailia

Cultivar	N-Level	Grain Yield (ton/ha)	Straw Yield (ton/ha)
Sakha 69	N070	2.306	3.880
	N140	3.313	4.937
	N210	3.484	6.016
	N280	3.635	5.865
	Average	**3.184**	**5.174**
Sids 6	N070	1.751	3.328
	N140	2.431	3.986
	N210	2.587	4.287
	N280	2.773	4.893
	Average	**2.385**	**4.123**
LSD (0.05) values for:			
diff. N-level & same cultivar		0.5314	0.7965
same N-level & diff. cultivar		0.5228	0.8592
	N	ANOVA effect	
	Cultivar ©	***(0.376)	***(0.563)
	I	**(0.339)	*(0.674)
	N X I	NS	NS
	N X C	NS	NS
	C X I	NS	NS
	N X C X I	NS	NS
		NS	NS

Values between practices represent the LSD at 0.05 significant levels for the averages.
*, **, *** Significant at the 0.1, 0.01 and 0.001 probability levels, respectively.

Data presented in Figure 1 illustrate that the values of N recovered by Sakha 69 are higher than that of Sids 6, indicating higher N use efficiency by Sakha 69 in both sites. However, values of N recovery by both cultivars are always higher in case of the clay soil than the sandy soil. In different study conducted in heavy clay soil of the Nile Valley, Abdel Monem (1996) found that percentage of N recovery by the wheat cultivar Sakha 69 as estimated by ^{15}N method averaged 46%. High percentage of the unrecovered N by plant is lost in sandy soil as estimated to be as high as 49% (Soliman et al 1993).

II- Water Consumptive Use (CU) and Water Use Efficiency (WUE):

Water consumptive use values (m^3/ha) for the two wheat cultivars as affected by irrigation treatments and locations are presented in Figure 2. Data indicated that average CU values for both cultivars at Ismailia (sandy soil) were about 23% higher than the values at Giza (clay soil). The average water consumptive use values for Sids 6 were 7% and 4% higher than the average CU values for Sakha 69 at Giza and Ismailia sites, respectively. Average CU values for I2 irrigation treatment were about 2 cm less than those of I1. Serry et al. (1980) reported that average CU values for wheat were 38.3, 47.5 and 52.3 cm for Lower, Middle and Upper Egypt, respectively. While the CU values for wheat crop grown in the newly land under sprinkler irrigation system ranged between 52.4 and 57.1 cm (Ministry of Agriculture, 1989).

Figure 3 illustrate the effect of wheat cultivars and irrigation treatments at the experimental sites on water use efficiency. The results showed that average WUE (kg grain/m^3 water consumed) value for Sakha 69 wheat cultivar (1.11) was higher than that of Sids 6 wheat cultivar (0.77). Average WUE value at Giza site (1.26) was higher than that at Ismailia site (0.62). Results indicated also that average water consumptive use value for the I2 irrigation treatment was 0.97 while for I1 irrigation treatment the average value was 0.91. These results suggests that for more efficient water use we can grow Sakha 69 wheat cultivar using 75% of the required amount of water per irrigation. Several studies indicated that increasing soil moisture deficit resulted in increasing WUE values (Metwaly et al., 1984; Abdel Maksoud et al., 1988 and Yousef and Eid, 1994). In the old irrigated, average WUE values ranged between 0.9 (Ibrahim et al., 1987) to 1.46 (El Refaie et al., 1988) while the average value in the sandy soil was 0.56 (Ministry of Agriculture, 1989).

Conclusion:

Selection of varieties according to its better efficient use of fertilizer and water, became an economic and environmental need, for rational use of the limited natural resources. Cultivating the sandy soil of the desert in Egypt is important, however considering the limited water resource and low fertility of the soil has to be taken into consideration while managing this new land. In this respect, according to the results obtained from this field trail, Sakha 69 wheat cultivar uses the applied N fertilizer and the irrigation water more efficiently in both the clay and sandy soil than Sids 6.

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