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Evaluation of Wheat Growth Under Different Fertilizer Type, Application and doses at Northern State of Sudan

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Abstract

Wheat is one of the most important strategic crops in terms of food security. The objective of the experiment was to measure growth parameters of wheat under different fertilizer regimes. The experiment was conducted at the Demonstration Farm of the Faculty of Agricultural Sciences, University of Dongola, Northern State, Sudan, during the successive growing seasons of 2008/2009 and 2009/2010. The experimental method applied was a split-split plot trial with four replications. The main plot composed of two methods of fertilizer application (broadcasting and localized placement) in randomized complete block design. Subplots consisted of four doses (0, 43, 86 and 129 kg/ha) of each of the two types of compound fertilizers {(Urea (46% N) + Triple super phosphate (46% P_2O_5)) and Nitrophoska (18:18:5)}. Growth parameters investigated included plant height, number of tillers per meter square, leaf area index, days to 50% heading and days to 95% maturity. In this study the general trend was that the increase in fertilizer dose significantly increased plant height, number of tillers per meter square, leaf area index, but there were no significant differences in days to heading and days to maturity which were not affected. Generally the results show that there were no significant differences in growth parameters between the fertilizer types and between the application methods.

Keywords: fertilizer type, fertilizer application, growth parameters, vegetative growth, wheat

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Introduction

Wheat is one of the most important strategic crops in terms of food security. In Sudan, wheat is grown under irrigation during the dry and comparatively cool and short growing season, which extended from November to February [1]. The crop suffers from a number of abiotic and biotic stresses, the most important of which are heat stresses, low soil fertility, water logging, pest and diseases, irregular irrigation, delayed harvest and fertilizer distribution [2]. Experiments in fertilization started since 1925 while commercial use began 1950, where ammonium sulphate was used as a source of N. Urea as a source of nitrogen dominated since the 1960s. In the 1980s the use of triple super phosphate was introduced as a source of phosphate. This was followed late (mid 90s) by the use of complex or compound fertilizers, solid or in liquid form [3]. High terraces of the Northen State are new areas for wheat expansion and are virgin soils. The main objective of this experiment was to study the effect of fertilizer dose, type and application method on the vegetative growth of wheat.

Materials and Methods

The experiment was conducted during the successive seasons of 2008/2009 and 2009/2010 at the Farm of the Faculty of Agricultural Sciences, University of Dongola, Northern State, Sudan, located within latitude 19°11' N, and longitude 30°29' E and altitude 227m. The Northern State occupies the distant Northern part of the republic of Sudan and lies between latitudes 16°- 22° N and longitudes 20°- 32° E. The state was cited within the desert region of the Sudan. The soil of the experimental site (classified as high terrace) was alkaline soil with high content of CaCo3. The soil texture characterized as sandy loam with 72% Sand, 11% Silt and 17% Clay. The experimental area was tilled adequately to prepare a suitable seedbed with improved physical conditions. The implements used included a chisel plough (Cross plow) to break and loosen the soil and a leveler (scraper) to level the experimental area for the easy movement and uniform distribution of irrigation water. The Field was then divided into four blocks (Replications) each contained 16 equal plots of 3m*2m size. Planting was done at first of December 2008 and 2009 for both winter seasons, respectively, in rows 20 cm apart at the seed rate of 90 Kg /h or 48.6 gm/plot of 11 rows (3m long). Experimental method is a split-split plot trial with four replications. The main plot was composed of two methods of fertilizer application in randomized complete block design (RCBD).

Subplots consisted of two types of compound fertilizers each consisted of four doses of each fertilizer. The experiment includes the following treatments:

A. Application methods of fertilizer (M):

1- Broadcasting (M1)
2- Localized placement (M2)

B. Fertilizer type (T):

1- (Urea (46% N) + Triple super phosphate (46% P2O5)) (T1)
2- Nitrophoska (18:18:5) (T2)

C. Fertilizer dose (D):

The fertilizer doses for the two compounds used contain the same amount of nitrogen and P_20_5 as described:

1- 0 N and P_2O_5 kg/ha (D0)
2- 43 N and P_2O_5 kg/ha (D1)
3- 86 N and P_2O_5 kg/ha (D2)
4- 129 N and P_2O_5 kg/ha (D3)

The seed of wheat cultivar Wadi El Neil (Giza 160) was obtained from Arab Sudanese Seed Company (ASSCO). Weed control was done by hand weeding ten days after sowing and then as needed throughout the growing season. Irrigations were applied at 7 to 10 days intervals according to temperature range and need of the soil. An insecticide (Morisban 4) was used twice in both seasons to protect the experimental crop from aphids and termites attacks. Growth parameters of wheat which were investigated in this study include:

1. Plant Height (cm):

The plant height was averaged from ten randomly selected plants from the middle rows in each plot, measured in centimeters (cm) from the soil surface to the tip of the spike.

2. Leaf Area Index (LAI):

From ten randomly selected plants from the middle rows in each plot, the area of individual green leaves (LA) was determined by measuring their length (L) and maximum width (W) and multiplying their products by 0.75. LA = (L.W) .0.75 To determine the green leaf area, the flag leaf from the plant was used. The mean leaf area per plant was obtained and the number of plants within an area of one meter square was determined.

$$LAI = \frac{LA * \text{Number of leaves per plant} * \text{Number of plants/m2}}{\text{Ground area (m2)}}$$

3. Number of Tillers:

Average number of tillers per meter square from the middle rows in each plot was recorded.

4. Days to Heading:

The heading date was recorded as the number of days from planting until 50% of the heads were completely exposed.

5. Days to Maturity:

The maturity date was reported as the number of days from planting until the crop attained 95% maturity. The data collected from the different treatment were subjected to analysis of variance (ANOVA) appropriate for randomized complete block design. Duncan's Multiple Range Test (DMRT) was applied for the separation of treatment means. All statistical analyses were performed using M-STAT-C program computer package.

Results and Discussion

Generally most of the growth attributes in this study had been significantly affected by fertilizer dose (Table 1). In this study the general trend was that the increase in fertilizer dose significantly increased the plant height, the highest plant was obtained by the application of 129 kg/ha.

The difference in plant height due to fertilizer dose was clearer when fertilized and unfertilized plots were compared (Table 2). This could be attributed to elongation of internodes stimulated by nitrogen and phosphorus elements. According to Bolland et al. [4], early plant growth is particularly dependent on phosphorus because it needs rapid cell division. Wolf andKippe [5] reported that adequate nitrogen supply, produces will leaf and stem development.

Table 2 shows that the application of 129 kg/ha increased the number of tillers over the control by 53 and 54% in both season respectively. The trend was that number of tillers increased with fertilizer level (Table 2). This result is supported by many workers, Abdel Rahman [6] found that number of tillers increased with phosphorous application and Sharma et al.[7]; and Singh [8] reported that increasing nitrogen levels significantly increase the effective tillers. Analysis of variance shows clear highly significant differences in leaf area index between the fertilizer doses in both seasons. The application of 129 kg/ha increased the leaf area index over the control by 124% and 187% in both season, respectively (Table 2). The same result was reported by Giorgio et al. [9] who reported that leaf area index was increased by higher nitrogen rate. Lockhart and Wiaeman[10] stated that the increase in flag leaf area due to phosphorus expected since phosphorus stimulates cell division and multiplication.

From the statistical analysis (Table 2), it was clear that there was no significant difference in days to heading between the fertilizer doses in both seasons, except the application of 43 kg/ha in the second season which decreased number of days from sowing to heading stage by 2% under control (Table 2) and this result may be attributed to the influence of other factors than treatments such as environmental conditions or aphids and termites damage. From Tables 2 and 3 it is clear that there was no significant difference in days to maturity between the fertilizers doses and application methods in both seasons (Table 2). There was no significant difference in all growth attributes between the fertilizers types in both seasons (Table 3), the same result was obtained by Snacer [11].

But the results showed highly significant differences in the second season where we find the application of (Triple super phosphate + Urea) affected 10% greater number of tillers per meter square over the application of Nitrophoska.

This result may be attributed to other factors than treatments such as environmental conditions. In both seasons the effects of application methods in vegetative growth parameters were not significant (Table 4). These results might be due to the control in fertilizers distribution under experimental conditions. These results were supported by Ibrahim et al. [12] who reported that there were no significant differences between the different methods of phosphorus application.

Table 1: F- Value of the measured variables for the different fertilizer type (T), application (M) and doses (D) during (2008/2009 and 2009/ 2010) seasons

Treatment	Plant height		No.of tillers/m^2		Leaf area index		Days to headir		Days to maturity	
	Seasons									
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
M	1.03 n.s	0.06 n.s	0.06 n.s	0.22 n.s	0.89 n.s	1.02 n.s	0.37 n.s	0.81 n.s	0.91 n.s	0.74 n.s
T	0.35 n.s	0.44 n.s	0.33 n.s	15.42 n.s	0.21 n.s	3.18 n.s	0.05 n.s	0.15 n.s	0.31 n.s	0.47 n.s
D	25.17**	93.61**	13.30**	43.30*	14.48**	29.95**	2.70 n.s	3.49**	0.54 n.s	2.54 n.s

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

n.s = not significant.

Table 2: Effect of fertilizer dose on vegetative growth parameters of wheat along with their significance ranking in (2008/2009 and 2009/ 2010) seasons

Treatments	Plant height		No. of tillers/m2		Leaf area index		Days to heading		Days to maturity	
	Seasons									
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
D0	75.35c	56.33d	262.66c	205.81d	1.08c	0.46d	68.44a	69.44a	113.50a	101.06a
D1	81.32b	74.30c	291.25bc	250.08c	1.30bc	0.74c	67.00a	68.00b	112.81a	100.00a
D2	84.78b	81.03b	315.78b	282.38b	1.67b	1.09b	68.31a	69.00a	113.25a	100.50a
D3	89.81a	85.69a	402.50a	316.82a	2.42a	1.32a	68.31a	69.25a	113.06a	100.88a
SE±	1.211	1.332	16.545	7.186	0.154	0.06982	0.413	0.3425	0.395	0.2941
CV%	5.58	7.17	20.81	10.90	38.16	30.83	2.43	1.99	1.39	1.17

Note: Means within column followed by the same letter(s) were not significantly different according to Duncan's Multiple Range test at 5% level.

Table 3: Effect of fertilizer type on vegetative growth parameters of wheat along with their significance ranking in (2008/09 and 2009/10) seasons

Treatments	Plant height		No. of tillers/m2		Leaf area index		Days to heading		Days to maturity	
	Seasons									
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
T1	82.33a	74.69a	310.88a	276.75a	1.56a	0.94a	68.06a	68.88a	113.34a	100.72a
T2	83.29a	73.98a	325.22a	250.78b	1.67a	0.87a	67.97a	68.97a	112.97a	100.50a
SE±	1.155	0.7689	17.6262	4.6757	0.1667	0.0297	0.2984	0.1688	0.476	0.2264
CV%	5.58	7.17	20.81	10.90	38.16	30.83	2.43	1.99	1.39	1.17

Note: Means within column followed by the same letter(s) were not significantly different according to Duncan's Multiple Range test at 5% level.

Table 4: Effect of fertilizer method on vegetative growth parameters of wheat along with their significance ranking in (2008/09 and 2009/10) seasons

Treatments	Plant height		No. of tillers/m2		Leaf area index		Days to heading		Days to maturity	
	Seasons									
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
M1	83.58a	74.66a	315.72a	266.98a	1.73a	0.97a	68.31a	69.41a	113.81a	100.88a
M2	82.04a	74.01a	320.38a	260.56a	1.51a	0.84a	67.72a	68.44a	112.50a	100.34a
SE±	1.0743	1.8655	13.0192	9.592	0.1623	0.0895	0.6907	0.759	0.9746	0.4381
V%	5.58	7.17	20.81	10.90	38.16	30.83	2.43	1.99	1.39	1.17

Note: Means within column followed by the same letter(s) were not significantly different according to Duncan's Multiple Range test at 5% level.

References

Ageeb OAA. Agronomic aspect of wheat production in Sudan. In (Wheat in Heat-Stressed Environments: Irrigated, Dry Areas and Rice Wheat Farming Systems) (ed./ D. A. Saunders and G. P. Hettel), 1993; pp 154-162.

Salih AEM, Abdalla OA, Sidahmed M, Faki H, Ismail MA. Wheat production in the Gezira scheme, Wad Medani, Sudan, 1993.

Dahab OA, Abdala AG, Ageeb OA. Current Research in Fertilizer use in Irrigated Agriculture in Sudan. 13th AFA Int'l Annual Fertilizers Forum and Exhibition 6-8 February 2007 Intercontinental Hotel- Sharm El-Sheikh, Egypt, 2007.

Bolland MDA, Bowden JW, Brennan RF, Cartroll JW, Mason MG, Porter WP. Wheat nutrition. In: The Wheat Book: a technical manual for wheat producers compiled by Michael Perry and Brain Hillman, 1991; pp 55-76.

Wolfe TK, Kippes MS. Production of Field Crops. McGrow-Hill Book Company Inc, 1959.

Abdel Rahman FMA. The effect of phosphorus and time of nitrogen application on growth and yield of wheat (Triticum aestivum L.). M.Sc. Thesis. U of K, Sudan, 1997.

Sharma KC, Misra RD, Wright BC, Krantz BA. Response of some dwarf and tall wheats to nitrogen. Indian J Agron, 1970; 15(2): 131-135.

Singh BN. Yield and water use efficiency of bread wheat under varying levels of irrigation and N in humid subtropical Hills of Meghalaya. Indian J Agric Sci, 1987.

Giorgio DDE, Rizzo V, Rinaldi M. Growth analysis of durum applied to different fertilizer doses. In Proceedings of Second Congress of the European Society for Agronomy, Warwick University, 1992; pp 23-28.

Lockhart JAR, Wiseman AJL. Introduction to crop husbandry. Pregman press, 1988; P. 54.

Sencar SGO. Effect of phosphorus fertilizers and application methods on the yield of wheat grown under dry land condition. Trop J Agric Forest Turkey, 1999; 23: 393-399.

Ibrahim HS, Babiker EA, Mohamed GE, Omer MM, Gorashi AM, Salih AA, Satti E, Mohamed MI. Response of wheat to different rates of NP combinations and the method of P application in the Sudan. Pages 60-70 in Nile Valley Regional Program. Bread wheat report – Sudan, Annual coordination meeting Cairo, Egypt, 16 – 23 September 1991.