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Research Article

Assessment of the Effects of Different Nitrogen Fertilizers on Growth and Yield of Wheat (*Triticum Aestivum L.*) In El Multaga Area - Northern State of Sudan

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Abstract

A field experiment was executed during two consecutive winter seasons of the years 2020/21 and 2021/22, at the research farm of the National Institute of Desert Studies – University of Gezira, new Hamdab scheme - Northern State of Sudan to assess the effect of Urea (N46%), NPK (20-10-10) and di ammonium phosphate (DAP) (18-46) fertilizers on growth and yield of wheat. The treatments were arranged in a randomized complete block design (RCBD) with three replicates. Consisted control (untreated plots), N (Urea 100 Kg fed^{-1}), NPK (100 Kg fed^{-1}) and di ammonium phosphate (DAP) 100Kg fed^{-1}.

Results indicated that there were no significant (P≤0.05) differences in the numbers of plant per meter square, but there are significant (P≤0.05) differences in plant height (cm), /spike length (Cm), thousand seed weight (g), biological yield, straw yield and harvest index in both seasons and highly significant (P≤0.01) differences in grain yield) ton/ ha) in both seasons compared to the control. The best type of evaluated fertilizer which gave the highest values of growth, yield and yield components of wheat for both seasons in high terrace soil of Northern State of Sudan was N(Urea) followed by NPK and DAP.

Introduction

Wheat *(Triticum aestivum L.)* is the most important food grain crop grown in the world and is a staple food of about one third of the world's population [1]. Wheat *(Triticum aestivumL.)* is mainly grown in the Sudan under irrigation, during winter months; its cultivation has recently expanded into latitudes lower than 15° N [2,3]. Nitrogen and phosphorus are the main important plant food nutrients and most of our soils in North state of Sudan are deficient in these nutrients [4,5]. Role of phosphate fertilizer is much importance to rise per hectare yield of wheat. Dann [6] reported that increasing phosphorus fertilizer application to wheat caused an increased in grain yield, number of tillers per plant, plant height and number of grains per spike. Dry areas require Nitrogen as a means of conservation of moisture for nurturing efficacious crop thought to be one of the greatest necessary [7].

An experiment was conducted in Iraq to study the effects of three different nitrogen fertilizers ammonium sulfate, di ammonium phosphate (DAP) and urea in two wheat species and their interaction on plant height, number of tillers, flag leaf area, shoot dry weight, leaf chlorophylls, number of spikes plant-1, thousand seed weight, grain yield, nitrogen and grain protein content. Nitrogen fertilizers significantly increased all tested parameters of growth, di ammonium phosphate (DAP) followed by ammonium sulfate were a more efficient [8].

The soil of study area lacks macro and micro elements especially nitrogen, so it is expected that fertilizer contains higher percentage of nitrogen will give higher wheat productivity. The aim of this study was to investigate the effect of nitrogen fertilizers including urea, NPK and di ammonium phosphate on wheat growth and yield in El Multaga area of the Northern State of Sudan.

Materials and Methods

Field experiments were carried out during two consecutive winter seasons (2020/21 and 2021/22) at the National Institute of Desert Studies Research Farm, New Hamdab Scheme, Northern State of Sudan (latitude 17°55' N and longitude 31°10' E). The climatic zone of the area is described as desert, which is characterized by high temperature in summer, low temperature in winter and low rainfall [9].

The soil of the study area belongs to El Multaga soil series which is classified as typic, haplocambids, coarse loamy, mixed, superactive, hyperthermic. It is non-saline non-sodic [10]. Generally, the soil chemical fertility is low and deficient in nitrogen, phosphorus and organic carbon. The physical and chemical properties of the soil are shown in table1.

Table 1: Some soil properties of the experimental site.

Soil Properties	Soil Depth (cm)				
	0 - 23	23 - 65	65 - 80	80 - 105	105 - 125
FS (%)	40	23	22	21	24
CS (%)	37	33	43	42	40
Silt (%)	15	25	11	19	8
Clay (%)	8	19	24	18	28
Texture	LS	SL	SL	SL	SCL
pH (paste)	7.5	7.3	8.1	7.8	7.5
ECe	0.35	0.37	0.42	1.1	3.2
ESP	3.0	3.0	4.0	5.0	8.0
$CaCO_3$ (%)	0.8	2.6	10.4	0.2	27.5
O.C (%)	0.052	0.066	0.078	0.061	0.052
C/N ratio	4	4	5	5	5

LS =loamy sand, SL = sandy loam, SCL= sandy clay loam

Treatments and Experimental Design

The treatments were arranged in complete randomized block design (RCBD) with three replicates. The area of each sub- sub plot was 42 m^2 (6 × 7 m). The experimental units were two meter apart from each other. The treatments were control without fertilizer, Urea (46%N), NPK (N20% -P10%- K10%) and di ammonium phosphate DAP (18%N-46% P) with rate of (100Kg ha^{-1}).

Cultural practices

Wheat *(Triticum aestivum L.)* variety Wadi Elneel has been used in this study. Sowing was done manually by digging on 20th of November for both seasons, with seed rate of 120 kg ha^{-1}, at 0.2m inter-row spacing. The crop was harvested on 20th of March in both seasons. Irrigation was applied according to [11] who concluded that, wheat water requirements per season were 635mm.

Data collection

Plant samples were collected randomly from each experimental unit (sub- sub plot) and then growth and yield parameters (Number of plants/m^2, plant height, spike length (Cm), thousand seeds weight (g), biological yield, grain yield (ton ha^{-1}), straw yield (ton ha^{-1}) and harvest index)were determined.

Statistical analysis

Statistical analysis was carried out using a computer software package (MSTAT). Significance of differences among the various characters under study was compared using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Effects of fertilization on wheat growth, yield and yield components

Number of plant per meter square

Figure 1 shows the effect of urea, NPK, and DAP fertilizers on the number of plant per meter square. Results indicated that there were significant (P≤0.05) differences among fertilizers and control in both seasons. The variation may be due to the manual broadcasting effects on germination of wheat seeds rather than effects produced by the type of fertilizer at this early stage of growth.

Plant height (Cm)

Figure 2 illustrated the relation between wheat plant heights versus fertilizers types. Results showed that all fertilizers increased significantly (P≤ 0.05) the plant height especially Urea.

The maximum plant height of 92.0 and 89.0cm was recorded for urea fertilizer for seasons two and one respectively. The minimum plant height 55.0cm was observed at control in season one. Fertilizers type can be arranged according to their effectiveness in plant height as follows: Urea, NPK and DAP. This may be due to the variation in the amount of nitrogen content between different fertilizers. Similar trend was found by [12], who stated that urea affected significantly wheat plant height.

Thousand seeds weight (g)

The result for 1000 seed weight (g) in relationship to fertilizers type is given in figure 3. The results in table 2 showed significant (P≤ 0.05) for the effect of fertilizer type on thousand seeds weight. The maximum 1000 seeds weight (39.0 g) was recorded in season one for urea followed by NPK (37.0 g) and (34g) for DAP in season two. The minimum 1000 seeds weight (30.0 g) was observed at control in season one. This result is in conformity with that of [13] who reported that urea increased significantly thousand seed weight of wheat crop.

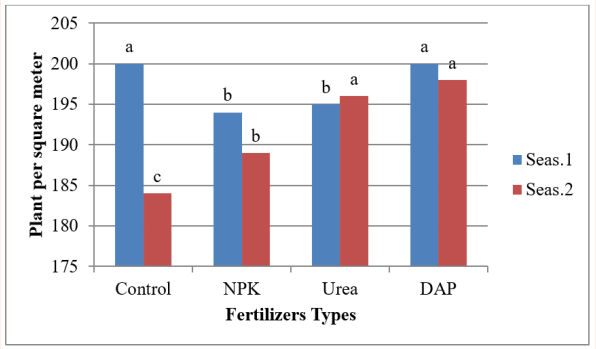

Figure 1: Effect of different Fertilizers on Number of Plant per meter square of Wheat

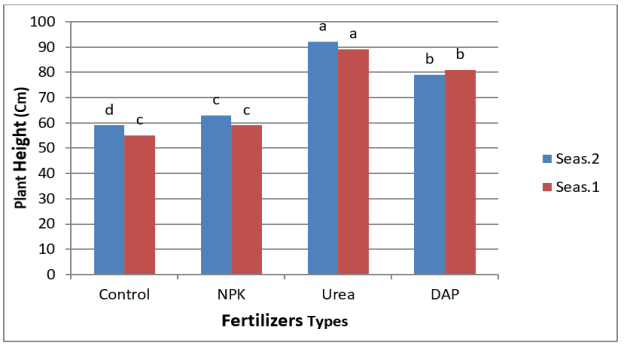

Figure 2: Effect different Fertilizers on Plant Height (Cm) of wheat.

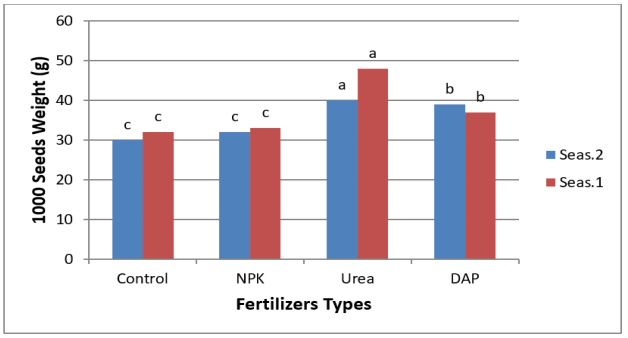

Figure 3: Effect of different Fertilizers on Thousand Seeds Weight of wheat

Spike length (cm)

The result for spike length (cm) in relationship to fertilizers applications on wheat is given in table 2. The results of spike length (cm) showed significant (P≤ 0.05) response for fertilizer types. The maximum spike length 9.8, and 9.1cm were recorded for urea fertilizer in season one and two respectively. The minimum spike length (6.9 cm) was observed at control. This result is online with that of [14] who stated that urea increased significantly wheat spike length.

Biological yield (Ton ha^{-1})

The result for biological yield (Ton ha^{-1}) in relationship to fertilizers applications on wheat was given in table 3.

The results for biological yield showed significant effects (P≤ 0.05) due to fertilizer types. The maximum biological yields of 11.0, 9.9 and 9.4 Ton ha^{-1} were recorded for N (Urea), NPK and DAP in season one respectively. The minimum biological yield of 6.2 Ton ha^{-1} was obtained for the control plots in season two. The same result was obtained by [15] who mentioned that urea improved wheat biological yield significantly.

Grain yield (Ton ha^{-1})

The result for grain yield (Ton ha^{-1}) in response to fertilizers applications on wheat was given in table 3. The results for yield showed highly significant (P≤ 0.01) differences between fertilizer types and control. The results indicated that the maximum grain yield of 4.0, 3.8 and 2.2 Ton ha^{-1} were registered for urea, NPK and DAP in season one respectively. The minimum grain yield 0.81Ton ha^{-1} was obtained for the control plots in season two. The results of the high yield of wheat when using urea were due to high percent of nitrogen (46%) which is greater than that of DAP and NPK fertilizers. The same results were recorded by (16 and 12 who stated that urea improved wheat yield significantly.

Straw yield (Ton ha^{-1})

The average straw yield in both seasons is shown in table 3. Results revealed that there were significant (P≤ 0.05) differences between fertilizer types and control in both seasons. The highest straw yield (7.0 Ton ha^{-1}) was obtained in the second season when adding 100 Kg fed^{-1} of urea. The minimum value of (4.3 Ton ha^{-1}) was obtained for the control plots in season two. This result is in online with that of (17) who stated that nitrogen in form of urea increased yield and yield components of wheat.

Harvest index (%)

Table 3 shows the average harvest index in the both seasons. Results showed that there were significant (P≤ 0.05) differences between the fertilizer types and control in both seasons. The highest value of harvest index (40%) was obtained in the first season (38.0%) when adding 100 Kg fed^{-1} of urea and the lowest in the control of 27.0%. Similar result was recorded by [16].

Table 2: Effects of Nitrogen, NPK and di ammonium phosphate (DAP) fertilization on wheat *(Triticum aestivum L.)* growth during tow winter seasons.

Parameters	No. of plants/m^2		Plant Height (cm)		Spike Length (Cm)	
Treatments	1st Season	2nd Season	1st Season	2nd Season		
Control	184^{c}	200^{a}	55^{c}	59^{d}	7.0^{d}	6.9^{c}
NPK	189^{b}	194^{b}	59^{c}	63^{c}	7.5^{c}	7.3^{b}
N(Urea)	196^{a}	195^{b}	89^{a}	92^{a}	9.8^{a}	9.1^{a}
DAP	198^{a}	200^{a}	81^{b}	79^{b}	8.4^{b}	7.9^{b}
SE±	18.8	6.67	8.34	8.17	2.11	1.98
C.V (%)	15.2	10.2	20.5	18.7	10	11
Sig.	*	*	*	*	*	*

Means within columns followed by the same letter(s) are not significantly different at P<0.05 level according to Duncan's Multiple Range Test.
* and NS indicate significance at P≤0.05 and not significant, respectively.

Table 3: Effects of Nitrogen, NPK and di ammonium phosphate (DAP) fertilization on wheat *(Triticum aestivum L.)* yield and yield components during two seasons

Parameters	1000-Seeds Weight (g)		Biological Yield (Ton ha^{-1})		Grain Yield (Ton ha^{-1})		Straw yield (Ton ha^{-1})		Harvest Index (%)	
Treatments	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season
Control	32^{c}	30^{c}	6.2^{d}	7.6^{c}	0.81^{d}	1.01^{d}	4.9^{c}	4.3^{c}	27^{c}	29^{c}
NPK	34^{c}	32^{c}	7.3^{c}	9.4^{b}	1.3^{c}	2.2^{c}	5.6^{b}	4.8^{b}	32^{b}	30^{c}
N(Urea)	39^{a}	37^{a}	10.0^{a}	11.0^{a}	3.9^{a}	4.0^{a}	6.7^{a}	7.0^{a}	35^{a}	38^{a}
DAP	37^{b}	35^{b}	9.5^{b}	9.9^{b}	3.6^{b}	3.8^{b}	5.9^{b}	4.7^{b}	33^{b}	36^{b}
SE±	1.99	4.8	0.22	0.44	0.465	0.268	3.6	3.1	1.11	1.67
C.V (%)	9.4	10.5	14.1	12.6	17.7	15.6	10.6	9.8	10.2	12.7
Sig.	*	*	*	*	**	**	*	*	*	*

Means within columns followed by the same letter(s) are not significantly different at P<0.05 level according to Duncan's Multiple Range Test.
* and ** indicate significance at P≤0.05, and 0.01, respectively.

Conclusion

On the basis of present finding, it can be concluded that addition of Nitrogen fertilizer in form of urea at a rate of 100 Kg ha^{-1} improved vegetative growth and yield of wheat more than NPK and DAP fertilizers and it is more appropriate to recommend to the farmers of Northern State of Sudan to get maximum benefit from wheat [17,18].

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