RESPONSE OF GROWTH AND YIELD OF WHEAT TO NPK FERTILIZER

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Abstract: A field experiment was conducted to investigate the combined effect of NPK (Nitrogen, Phosphorus and Potash) on the growth and yield of wheat cultivars Sahar-2006. The objective of study was to determine optimum rate of NPK for wheat variety. The thrice replicated treatments F_0: 0-0-0 (NPK), F_1: 75-50-25(NPK), F_2: 100-75-50 (NPK), F_3: 125-100-75 (NPK), F_4: 150-125-100 (NPK), F_5: 175-150-125 (NPK) and F_6: 200-150-125 (NPK) Kg ha^{-1} were tested in Randomized Complete Block Design (RCBD). The results revealed that maximum growth parameters responded significantly to NPK fertilizers. It is concluded that highest grain yield of 5168 Kg ha^{-1} was recorded with the application of 175-150-125 NPK Kg ha^{-1}. The increase in yield was 51.58% higher as compared to control (2502 Kg ha^{-1}), where no fertilizer was used.

Keywords: NPK; Response; Sahar-2006; Growth; Yield; ARS

INTRODUCTION

Wheat is most significant cereal food crop in the world. It is effectively cultivated in Pakistan on more than 9 million hectares with a production of 24 million tons. The average yield of wheat (*Tritium aestivum* L.) in Pakistan (2660 Kg ha^{-1}) is low as compared to world average (3010 kg ha^{-1}) or even to its adjoining countries like India (2910 Kg ha^{-1}) and China (4710 Kg ha^{-1}) [1].

The wheat prerequisite is gradually increasing every year due to population pressure but its yield per hectare is low. There are various reasons for low down yield in Pakistan. The yield gap in the country needs to be filled by increasing yield per unit area. To overcome the gap between realized and potential yield, collective use of suitable types of fertilizer is of key importance as proper combination of fertilizer can increase the yield by 50% [2].

The combined use of NPK fertilizers plays an important role in wheat production. Application of NPK in balanced share at proper time has great impact on wheat yield. Plant species, even varieties with in species vary in their behavior to obtain and utilize NPK for grain production [3,4]

Increase in cropping intensity and introduction of high yielding varieties have caused substantial deplete of N and crop storage positive response to added N in the soil [5]. Nitrogen plays a vital role in growth processes as it is an integral part of chlorophyll, protein and nucleic acid [6,7]. It is viewed as the central element because of its role in substance synthesis [8]. It constitutes 1.5 to 5 percent of the dry weight of higher plant [9].

Phosphorous insufficiency is common in most of the soils of Pakistan and application of phosphatic fertilizer is considered crucial for crop production [10]. Phosphorus stimulates flourishing and seed formation. Its deficiency is directly related with 1000 grains weight [11].

Potassium (K^+) is of unusual significance because of its live role in biochemical functions of the plant like activating various enzymes, improvement of protein, carbohydrates and fat concentration, developing tolerance against drought and resistance to frost, lodging, pests and disease attack [6]. The increase in intensity of cropping and production of high yielding fertilizer responsive cultivars has resulted in a considerable deplete of soil K reserves and eventually limits efficiency of other nutrients.

It is thus necessary to devise a fertilizer technology facilitating use of NPK in apt combination for enhancing wheat yield [7,12]. The present study was therefore, designed to determinate the quantitative response of wheat to NPK application under "Thal" (arid) irrigated conditions.

MATERIAL AND METHODS

The experiment was conducted at Agronomic Research Station, Karor District Layyah during the year, 2007-09, where the region receives mean annual rainfall of less than 25 mm. Minimum/maximum temperature and rainfall observations during the study period is depicted in Table 4. The soil analysis showed that experimental field is sandy loam in texture with pH of 8.5, organic matter 0.41%, 6.25 ppm phosphorus and 175 ppm Potash.

The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. The net plot size of was 4.00 m × 9.00 m. Six fertilizer levels with one control plot (no fertilizer) were included as factors under study. The treatments comprised of; F_0: 0-0-0 (NPK), F_1: 75-50-25(NPK), F_2: 100-75-50 (NPK), F_3: 125-100-75 (NPK), F_4: 150-125-100 (NPK), F_5: 175-150-125 (NPK) and F_6: 200-150-125 (NPK) Kg ha^{-1}. The wheat crop (Sahar-2006) was sown on a well prepared seed bed in second week of November in all seasons under investigation. All the phosphorus and potash was applied at the time of seed bed preparation along with ¼ dose of Nitrogen. The remaining equal splits of Nitrogen were top dressed with first three irrigations. The source of Nitrogen, phosphorous and potash was urea (46%N), Single Super Phosphate (P_2O_5 18%) and Sulphate of potash (K_2O 0%), respectively. The crop was sown with a single row hand drill maintaining line to line

Table 1. Effect of NPK fertilizer on number of tillers & number of spike per m^2

The means in columns bearing same letters do not differ significantly ($p<0.05$)

Treatments	Number of tillers (m^{-2})				Number of spike (m^{-2})			
	2006-07	2007-08	2008-09	Average	2006-07	2007-08	2008-09	Average Values
F_0	214.79	220.44	398.77	278.00 e	204.66	209.34	378.00	264.00e
F_1	225.05	358.50	361.45	315.00d	210.06	341.94	342.00	298.00de
F_2	280.10	413.00	482.90	392.00c	271.36	361.78	391.85	341.66cd
F_3	299.94	437.00	517.06	418.00ec	279.21	385.52	420.36	361.70bc
F_4	302.13	462.54	561.33	442.00ab	305.37	398.32	462.30	388.66ab
F_5	340.50	478.50	582.00	467.00a	341.60	421.10	476.29	413.00a
F_6	308.58	481.30	587.12	459.00ab	294.41	302.90	359.69	319.00d

Table 2. Effect of NPK fertilizer on grains spike^{-1} and 1000 grains weight (g)

Treatments	Grains spike^{-1}				1000 grains weight (g)			
	2006-07	2007-08	2008-09	Average	2006-07	2007-08	2008-09	Average Values
F_0	21.64	22.20	40.16	28.00d	20.97	21.00	31.41	22.60b
F_1	26.49	29.09	34.42	30.00c	29.36	32.25	38.16	33.26ab
F_2	28.58	31.50	34.90	31.66b	38.39	37.03	41.28	38.90a
F_3	32.49	33.23	37.27	34.33b	39.14	40.02	44.89	41.35a
F_4	32.68	33.98	41.34	36.00b	40.19	41.15	45.12	44.31a
F_5	38.70	40.72	49.58	43.00a	41.84	44.03	46.62	46.50a
F_6	28.31	29.12	34.58	30.67c	40.64	41.82	44.65	44.04a

The means in columns bearing same letters do not differ significantly ($p<0.05$)

Table 3. Effect of NPK fertilizer on Plant Height (cm) and Yield (Kg ha^{-1})

Treatments	Plant Height(cm)				Yield (Kg ha^{-1})			
	2006-07	2007-08	2008-09	Average	2006-07	2007-08	2008-09	Average Values
F_0	64	74	90	70d	1933	1984	3589	2502f
F_1	74	81	96	84c	3250	3571	4225	3682e
F_2	80	83	99	85c	4250	4100	4571	4307d
F_3	85	86	102	92b	4333	4431	4970	4578c
F_4	88	89	107	94ab	4450	4497	5771	4906b
F_5	91	93	111	95ab	4650	4894	5960	5168a
F_6	95	96	113	98a	4500	4630	5498	4876b

The means in columns bearing same letters do not differ significantly ($p<0.05$)

distance of 22.5 cm. The crop was kept free of weeds by manual hoeing and hand weeding to avoid possible competition between weed-crop. All other cultural practices were kept normal and identical for all treatments.

Observations on desired parameters were recorded using standard procedures. The data collected were subjected to statistical analysis on computer MSTAT-C software, where as the means were compared through LSD test at p0.05 [13].

Results and Discussion

Plant Height (cm)

Data pertaining to the final plant height as affected by different NPK levels are given in Table 3. The analysis of variance revealed that different levels of NPK differ significantly from each other. Maximum plant height (98cm) was attained when NPK was applied at the rate of 200-150-125 Kg ha^{-1} against minimum plant height was observed from treatment where no fertilizer was applied. The plant height increased linearly with each successive increase in NPK which was attributed to the gradual increase in plant height. These results are in agreement with Ayub *et al*., (2002)[14]; Maqsood *et al*., (2001)[15].

Number of Tillers m^{-2}

Data on number of tillers m^{-2} is presented in Table 1 indicated that different levels of NPK were found to be highly significant. Highest number of tillers m^{-2} (467) was obtained where 175-150-125 NPK Kg ha^{-1} was applied. These results are statistically at par to fertilizer levels of 150-125-100 and 200-150-125 NPK (Kg ha^{-1}) by producing 459 and 442 tillers m^{-2}. Minimum number of tillers m^{-2} (278) was attained from control where neither N nor P and K were applied. The different

levels means indicated that there was progressive increase in number of tillers but this trend did not continue beyond T_6 (175-150-125 NPK Kg ha^{-1}). The number of tillers m^{-2} started decreasing where maximum dose of NPK (200-150-125 Kg ha^{-1}) was applied. These results are in line with [15] who found significant differences of NPK on number of tillers.

Number of grains Spike^{-1}

Data on number of spikes m^{-2} given in table 1 revealed that the number of spikes differ significantly from each other. Fertilizer dose of 175-150-125 Kg ha^{-1} NPK produced maximum number of spikes m^{-2} (413). It was statistically similar (388) with fertilizer level of 150-125-100 NPK Kg ha^{-1}. The trend from mean values showed that number of spikes m^{-2} decreased with further increase in NPK fertilizer level. Minimum number of spikes m^{-2} was obtained from control (264).

Number of grains Spike^{-1}

The data regarding number of grains per spike is presented in Table 2. It indicated that fertilizer level 175-150-125 NPK Kg ha^{-1} produced significantly higher number of grains per spike (43) as compare to other fertilizer levels. The mean values of different fertilizer levels against number of grains per spike differ significantly. Fertilizer level of 100-75-50, 125-100-75 and 150-125-100 NPK Kg ha-1 remained statistically at par with other treatments producing 31.66, 34.33 and 36.00 number of grains per spike, respectively. The lowest number of grains per spike (28) was recorded from control where no fertilizer was applied. These results are in line with Alam, et al., (2007)[16] and Ayub (2001)[17].

1000 grains weight (g)

1000 grains weight (g) is an important yield contributing parameter for cereal crops. The data regarding 1000 grains weight is depicted in Table 2 indicated significant effect of fertilizer levels on grains weight. Fertilizer level 175-150-125 NPK Kg ha^{-1} gave higher grain weight than all other treatments but statistically stood at par with fertilizer levels of 75-50-125, 100-75-50, 125-100-75, 150-125-100 and 200-150-125 NPK Kg ha^{-1} by producing 33.26 g, 38.90 g, 41.35 g, 44.31 g and 44.04 g, respectively. The minimum grains weight (22.60g) was obtained when no fertilizer was applied. These results are quite similar with [18] who found significant effect of NPK fertilizer levels on grain weight of cereals.

Grain Yield (Kg ha^{-1})

The data regarding grain yield is presented in Table 3. It is clear from the data that there was highly significant difference among treatments. The highest wheat grain yield (5168 Kg ha^{-1}) was obtained where 175-150-125 Kg ha^{-1} NPK was applied. The lowest grain yield (2502 Kg ha^{-1}) was obtained from control (with out NPK fertilizer). The increase in yield trend from Table 3 showed increase in NPK resulted in increase of yield. However, there was decrease in certain level (175-150-125 Kg ha^{-1}) might be due to nitrogen interaction with P and K. These results are in accordance with Sharma et al., (1998)[18]; Maqsood et al., (2001)[15]; Sharar et al., (2003)[19] and Asghar et al., (2010)[20] who concluded that grain yield of maize and cereal crops increased with application of NPK fertilizer.

CONCLUSION

It is concluded that different fertilizer levels affected significantly on the wheat variety Sahar, 2006 and responded well. By the increase of N beyond the certain level (T_6) resulted in increase plant height but yield trend became low. Application of NPK in combination increased wheat yield. It was also observed that N and P ratio must be 1:1 to get maximum yield for wheat. The use of NPK fertilizer in combination increased wheat yield when N is applied in four splits.

REFERENCES

1.Anonymous. United States Department of Agriculture, *Foreign Agriculture Services.* USA. (2009-10)

2.Zia, M.S., M.A. Gill, M.Aslam and M.F. Hussain. Fertilizer use efficiency in Pakistan. *Progressive farming*, 11:35-8 (1991).

3.Gill, M.A. and Rahmat Ullah Saleem, M. Growth response of twelve wheat cultivars and their phosphorus utilization from rock phosphate. *Journal of Agronomy*, 173:204-209. (1994)

4.Nisar, A., Saleem, M.T Wyford, I.T. Phosphorus research in Pakistan- a review. In: Proceeding symposium "On the role of phosphorus in crop production" NFDC. Islamabad. P.P-59-92. (1992)

5.Ali, H., S.A Randhawa and M. Yousaf, Quantitative and qualitative traits of sunflower (*Helianthus annus* L.) as influenced by planting dates and Nitrogen application. *International* Journal *of Agriculture Biology*, 6:410-2 (2004).

6.Marschner, H. Mineral nutrition of higher plants, PP:148-73. *Academic press inc.*, San Diego. USA. (1995)

7.Jabbar. A., T. Aziz, I. H. Bhatti, Z. A. Virk, M. M. Khan and Wasl-u-Din. Effect of potassium application on yield and protein contents of late sown wheat (*Triticum aestivum* L.) under field conditions. *Soil & Environment.* 28(2): 193-196. (2009)

8.Mahboob A., Shakil, A.R., M. Tahir, and Ehsanullah. Interactive effect of Nitrogen and phosphorus on agronomic traits of Maize (Zea mays L.). *International Journal of Agriculture and Biology*. 1560-8530 /99/01-4-334-336.

9.Nova, R. and R.S. Loomis. Nitrogen and plant production. *Plant and Soil* 58: 177-204 (1981)

10.Memon, K.S. Soil and Fertilizer phosphorus, In Soil Science (Bashir and Bantel eds.). *National Book Foundation* Islamabad, PP-291-316 (1996)

11.Iqbal, M. and H. Q. I. Chauhan. Relationship between different growth and yield parameters in Maize under varying levels of phosphorous. *Journal of Biological Sciences* 3(10): 921-925 (2003)

12.NFDC. Fertilizer use in Pakistan. National Fertilizer Development Centre, Islamabad, Pakistan (2003)

13.Steel, R. G. D., J. H. Torrie and D. A. Dickey. Principles and Procedures of Statistics. A Biometrical Approach, 3rd Ed. McGraw Hill Book Co., New York, 172-177 (1997).

14.Ayub, M., M. A. Nadeem, M. S. Sharar and M. Mahmod. Response of maize (Zea mays L.) to different leveks of nitrogen and potassium fertilizer. *Asian Journal of Plant Sciences*. 4(1):352-354. (2002)

15.Maqsood M., A.M. Abid, A. Iqbal, M. I. Hussain. Effect of variable rate of nitrogen and phosphorus on growth and yield of maize (golden). Online *Journal of Biological Sciences*. 1:19-20 (2001)

16.Alam, M. Z., S. A. Haider and N. K. Paul. Yield and yield components of Barley (Hordium vulgare L.) cultivars in relation to nitrogen fertilizer. *Journal of Applied Sciences Research*. 3(10): 1022-1026. (2007)

17.Narayana, V. S., P. V. Parsad, V. R. K. Murthy and K. J. Boote. Influence of integrated use of farm yard manure and inorganic fertilizer on yield and yield components of irrigated low rice. Journal of Plant Nutrition. 25(10): 2081-2090 (2002)

18.Sharma, M. P. and J. P. Gupta. Effect of organic materials on grain yield and soil properties in maize-wheat cropping systems. *Indian Journal of Agriculture Sciences*. 68: 715-717 (1998).

19.Sharar, M. S., M. Ayub, M. A. Nadeem and N. Ahmad. Effect of different rates of nitrogen and phosphorus on growth and grain yield of maize (2003).

20.Asghar, A., A. Ali, W. H. Syed, M. Asif, T. Khaliq and A. A. Abid. Growth and yield of maize cultivars affected by NPK application in different proportion. *Pakistan Journal of Sciences*. 62(4): 211-216 (2010)

Table 4. Metrological data during the study period at Agronomic Research Station Karor District Layyah

Year/Month	November			December			January			February			March			April			Average		
	Min.	Max.	Rainfall (mm)	Min.	Max.	Rainfall (mm)	Min.	Max.	Rainfall (mm)	Min.	Max.	Rainfall (mm)	Min.	Max.	Rainfall (mm)	Min.	Max.	Rainfall (mm)	Min.	Max.	Rainfall (mm)
2006-07	10	33	08	04	27	21	01	25	00	08	30	104	08	35	70	13	42	00	7.33	32	33.83
2007-08	09	34	00	02	26	00	01	22	00	02	22	32	11	36	10	24	44	29	8.17	30.67	11.83
2008-09	07	35	00	06	23	39	05	20	02	07	24	09	12	29	29	18	35	12	9.17	27.67	15.17
Average	8.67	34.00	2.67	4.00	25.33	20.00	2.33	22.33	0.67	5.67	25.33	48.33	10.33	33.33	36.33	18.33	40.33	13.67			

Minimum (Min.) and Maximum (Max.) values are used for Temperature (C°).