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IMPACT OF NPK APPLICATIONS ON THE NUMBER OF PRODUCTIVE TILLERS AND COST BENEFIT ANALYSIS OF WHEAT IN HILL–TORRENT IRRIGATED AREA OF D. I. KHAN DIVISION, KHYBER PAKHTOONKHWA

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ABSTRACT

An experimental trial was carried out on two variable textured soils of farmer fields in the hill- torrent irrigated area of Dera Ismail Khan Division (Khyber Pakhtoonkhwa) Pakistan during the years 2006-2007 and 2007-2008 with wheat variety (Daman-98) to observe the result of impact factor of NPK Kg ha^{-1} viz T1 0-0-0, T2 20-0-0, T3 40-20-0, T4 40-20-10, T5 60-30-20, T6 80-40-30 and T7 100-50-40 in terms of number of productive tillers- m^{-2} and cost benefit analysis of fertilizer applications on wheat in Randomized Block Design with three repeats. The results revealed that treatment T6 (NPK @ 80-40-30 kg ha^{-1}) proved most economical NPK dose yielding Rs. 7358.54 ha^{-1} for wheat under hill- torrent irrigated area of D.I.Khan (Pakistan).

Key words: Irrigated area, NPK, productive tillers, length of ear, wheat, cost benefit.

INTRODUCTION

Besides certain local variability, the Dera Ismail Khan area is comprised of four basic divisions viz mountains, a series of steeply sloping alluvial fans, the "Daman" imperceptibly sloping piedmonths, and the "Kacha" the flood plains of the Indus River. The soils of the area are calcareous, deficient in organic matter, nitrogen, phosphorus and adequate to marginal in potassium.

Wheat (*Triticum aestivum* L.) belongs to family Poaceae tribe Hordeae. It is the most important winter crop of Pakistan. Wheat is primarily used as a staple food providing more protein than any other cereal crop. It is consumed in many forms like bread, cakes, biscuits, bakery products, and many confectionery products. Its straw is used as animal feed and also for manufacturing paper. Nitrogen plays a vital role in all living tissues of the plant. No other element has such an effect on promoting vigorous plant growth. Abundant protein tends to increase the size of the leaves, and accordingly, to bring about an increase in carbohydrate synthesis. Nitrogen plays a vital role in increasing the yield of the crop. Application of proper amount of nitrogen is considered key to obtain bumper crop of wheat. Nitrogen comprises 7% of total dry matter of plants and is a constituent of many fundamental cell components such as nucleic acids, amino acids, enzymes, and photosynthetic pigments (Bungard *et al.,* 1999). Ayoub *et al.,* (1994) reported that spilt N application had little effect on yield, but decreased lodging and spike population, while grain weight increased. Nitrogen application at 120 kg/ha for wheat has been recommended by various research workers (Lathwal *et al.,* 1992; Das *et al.,* 1993). Geleto *et al.,* (1995) reported that spike numbers and grain weight were increased with high level of nitrogen. Singh and Uttam (1992) recorded increased grain yield with increase in nitrogen level.

Hill- torrents- irrigated and rainfed areas too face with nutrient deficiency in addition to other problems in Dera Ismail Khan District (Rehman and Khan, 2010). NPK application is an important impact factor throughout the world including Pakistan. Researchers have noticed a significant increasing/positive response of NPK fertilization to wheat crop (Berg and Hamid, 1976). Burio *et al.,* (2004) found a positive association of N application with the production Parameters of wheat. Imtiaz *et al.,* (2003) established that application of N and p205 at 4:3 ratios improves their efficiency of utilization influencing the yield parameter of wheat genotype, SI-91195. Chaudhry *et al.,* (2000) found highest wheat genotype grain and straw yield with NPK @ 120-90-60 Kg ha^{-1} respectively. Bhatti *et al.,* (1985) recorded better yield of two wheat varieties (Khushal and Maxi Pak) with the application of 92 Kg N, 90 Kg P and 67 kg K2O-ha^{-1} under rainfed condition.

MATERIALS AND METHODS

Dera Ismail Khan lies in Pakistan's arid zone (71.07 longitude, 31.57 latitude and 500 m above sea level). This zone is in the extreme south of (NWFP) Pakistan at the bank of the River Indus. Dera Ismail Khan is bounded by Sulaiman Range to the West, the Indus River on the East, Marwat and Bhittani Ranges on the North and Vehowa Nala (Punjab) on the South. The

climate is arid to semi-arid. It is hot and dry in summer with moderate spells of rain during monsoon season. Fertilizers trials were Conducted at two different textured soil of hill-torrent irrigated on two farmer's fields for two years 2006-07 and 2007-08 in Pakistan with Randomized Complete Block Design with seven treatments as:

1. T_1 (NPK @ 0-0-0 kg ha^{-1}),
2. T_2 (NPK @ 20-0-0 kg ha^{-1}),
3. T3 (NPK @ 40-20-0 kg ha^{-1}),
4. T_4 (NPK @ 40-20-10 kg ha^{-1}),
5. T_5 (NPK @ 60-30-20 kg ha^{-1}),
6. T_6 NPK @ 80-40-30 kg ha^{-1}) and
7. T_7 NPK @ (100-50-40) Kg ha^{-1}

Wheat variety i.e Daman-98 was chosen after collecting composite soil samples for physico-chemical analysis. Soil texture and saturation parentage (sp) was determined. The pH of saturated extract and electrical conductivity (Ec) of the soil sample were determined as described by Mclean (1982). The alkaline earth carbonates (Lime CaCo3 eq) was first decomposed with excess of an acid and extra acid was determined by back titration with a standard alkali. Then the actual amount of acid utilized was determined by the method as described by Nelson (1982). Likewise the gypsum requirement (GR) of the soil sample was also determined by Nelson (1982) method while the soil organic matter (SOM) was determined by Nelson and Somer (1982) method. SAR and exchangeable sodium was determined by the methods as described by Knudsen *et al.,* (1982) respectively. Total N & soil available P in soil was determined by Kjeldahl's, while available k in soil was determined by (NH4OAC-PH7) Ammonium acetate extraction method as descried by Knudsen, *et al* (1982). The data on different yield parameters colleted after providing similarly cultural practices during the growing season, was analyzed Statistically according to Steel *et al.*, (1997). The comparison of means was done by applying Duncan's new multiple range test (MRT) using Mstate computer programs. Statistical analysis of all the data were computed in two ways as follows;

i. Two locations combined analysis treating year as main plot, location sub- plot and NPK rate as sub-sub plots.
ii. Location-wise treating year as main plot and NPK rates as sub-plots.

RESULTS AND DISCUSSION

Physico-chemical properties of soil: The result of Physico–chemical character illustrated in Table I shows alkaline, normal salinity/ sodicity and moderately to strongly calcareous soil of both the sites. Soils of both sites were found deficient in organic matter. N and P were sufficient but found adequate in K. Overall consolidated textural class of site L1 was found silty clay loam while that of L2 was loamy after harvesting.

Table 1: Physico-chemical characteristics of soils of experimental sites

Characteristic	L-1 (Abi Zar)	L-2 (Wanda Feroze)
pH	8.27	8.30
ECe (dS m-1)	2.37	2.25
Na (mmolc/100 g)	9.87	5.50
CaCO3 (%)	12.75	11.36
SAR	4.72	3.80
GR (t. ha-1)	Nil	Nil
O.M. (%)	0.52	0.72
N (mg kg-1)	26.00	36.00
P (mg kg-1)	3.2	3.8
K (mg kg-1)	187	165
Sand (%)	15.2	35.8
Silt (%)	52.8	45.4
Clay (%)	32.0	18.8
Textural Class	Silty clay loam	Loam

Number of Productive Tillers m^{-2}: The two years data of two locations indicated that the number of productive tillers m^{-2} ranged from 230.70 to 367.95 and 255.05 to 388.85 during 1st and 2nd years of the study respectively (Table 2). The fertilizers application enhanced the number of productive tillers significantly. On average the highest number of productive tiller m^{-2} (378.400) was reported in T7 (NPK @ 100-50-40 kg ha^{-1}) followed by T6 (NPK @ 80-40-30 kg ha^{-1}) where 369.125 tillers m^{-2} were recorded. However, both treatments differed significantly from one another. The number of productive tillers was greater in second years (333.632) as compared to first year (312.665). Likewise, the plants growing at L-2 had statistically more number of productive tillers m^{-2} (366.504) in comparison with plants grown in L-1 where 279.794 productive m^{-2} were recorded (Table 2). The interactive effect of years x locations and year x treatment was non significant while the interactive effect of locations x treatments and years x locations x treatments was significant. The results are in close association with Geleto *et al*., (1995) and Ayoub *et al*., (1994). The statistically greater number of productive tillers m^{-2} (437.00) were observed in L-2 during 2nd year in plots receiving NPK @ 100-50-40 kg ha-1 (T7) which differed significantly from all other combinations.

The statistical analysis of location wise data regarding number of productive tillers m^{-2} in L-1 is presented in Table 3. The perusal of table indicated that fertilizers application in different rate significantly affected the number of productive tillers m^{-2}. It varied from 180.40 to 325.20 and 210.00 to 340.70 during 2006-07 and 2007-08 respectively. The plants receiving NPK @ 100-50-40 kg ha-1 (T7) produced highest number of productive tillers m^{-2} (332.950) followed by T6 (NPK @ 80-40-30 kg ha-1) and T5 (NPK @ 60-30-20 kg ha^{-1}).

The T7 and T6 were statistically similar while T5 differed from them. The unfertilized plants produced the lowest number of productive tillers m^{-2} (195.200). Significantly different number of tiller m^{-2} was recorded in two years study being higher (290.029) during 2nd year as compared to 1st year (269.559). The interactive effect of years x treatments was non significant. The coefficient of variation was 9.09%.

Table 2: Effect of variable rates of NPK fertilizers on number of productive tillers m^{-2} of wheat at different locations during two years of study

Year	Location	Treatments							Mean
		T_1	T_2	T_3	T_4	T_5	T_6	T_7	
					Y X L X T				Y X L
Y-1	L-1	180.400^{s}	220.160^{r}	260.200^{p}	280.450^{o}	300.500^{n}	320.500^{kl}	325.200^{jk}	269.559
Y-1	L-2	281.000^{o}	322.200^{k}	340.500^{ghi}	355.600^{f}	380.200^{e}	400.200^{d}	410.700^{c}	355.771
Y-2	L-1	210.000^{r}	237.200^{q}	281.500^{o}	310.400^{lm}	320.200^{kl}	330.200^{ijk}	340.700^{gh}	290.029
Y-2	L-2	300.100^{mn}	335.000^{hij}	350.250^{fg}	380.000^{e}	412.700^{c}	425.600^{b}	437.000^{a}	377.236
					L x T				L
	L-1	195.200^{l}	228.680^{k}	270.850^{j}	295.425^{i}	310.100^{h}	325.350^{g}	332.950^{f}	279.794^{b}
	L-2	290.550^{i}	328.600^{fg}	345.375^{e}	367.800^{d}	396.450^{c}	412.900^{b}	423.850^{a}	366.504^{a}
									(30.99%)
					Y X T				Y
Y-1		230.700	271.180	300.350	318.025	340.100	360.350	367.950	312.665^{b}
Y-2		255.050	286.100	315.875	345.200	366.450	377.900	388.850	333.632^{a}
									(6.73%)
Treatment Mean		242.875^{g}	278.640^{f}	308.113^{e}	331.613^{d}	353.275 c	369.125^{b}	378.400^{a}	-
% increase over T1		-	14.73	26.86	36.54	45.46	51.98	55.80	

LSD @ P = 0.05 for Location | LSD @ P = 0.05 for Year | LSD @ P = 0.05 for Treatment
LSD for Location X Year | LSD for Location X Treatment | LSD for Year X Treatment
LSD for Location X Year X Treatment | Coefficient of Variation = 9.60%

Table 3: Effect of variable rates of NPK fertilizers on number of productive tillers m^{-2} of wheat at Abi Zar (L-1) during two years

S.#	Treatment	Y-1 (2006-07)	Y-2 (2007-08)	Treat Mean	% Increase over control
	N – P – K (Kg/ha)				
T_1.	0 - 0 - 0	180.400	210.000	195.200^{f}	-
T_2.	20 - 0 - 0	220.160	237.200	228.680^{e}	17.15
T_3.	40 - 20 – 0	260.200	281.500	270.850^{d}	38.75
T_4	40 - 20 – 10	280.450	310.40	295.425^{c}	51.34
T_5.	60 - 30 – 20	300.000	320.200	310.100^{b}	58.86
T_6.	80 - 40 – 30	320.500	330.200	325.350^{a}	66.67
T_7	100 – 50 – 40	325.200	340.700	332.950^{a}	70.57
	Year Mean	269.559^{b}	290.029^{a}		

LSD at P = 0.05 for Treatments = 9.347
LSD at P = 0.05 for Years
T X Y = Non-significant
Coefficient of Variation = 9.09%

At L-2, fertilizers application had significant effect on production of productive tillers m^{-2} yet year's effect was non significant (Table 4). It varied from 281.00 to 410.70 and 300.10 to 437.00 with an average of 290.55 to 423.85 during 2006-07 and 2007-08 respectively. The number of productive tillers m-2 increased with the increasing rates of fertilizers. The maximum (423.85 productive tillers m^{-2}) were recorded in T7 followed by T6 and T5. However, T7 and T6 were statistically similar while T6 and T5 were significantly identical. The interactive influence of treatments x years was also significant.

Table 4: Effect of variable rates of NPK fertilizers during two years on number of productive tillers m-2 of wheat at wanda feroze (L-2)

S.#	Treatment	Y-1 (2006-07)	Y-2 (2007-08)	Treat Mean	% Increase over control
	N – P – K (Kg/ha)				
T_1.	0 - 0 - 0	281.000^{h}	300.100^{gh}	290.550^{e}	-
T_2.	20 - 0 - 0	322.200^{fg}	335.000^{ef}	328.600^{d}	13.09
T_3.	40 - 20 – 0	340.500^{ef}	350.250^{def}	345.375^{d}	18.87
T_4	40 - 20 – 10	355.600^{de}	380.000^{cd}	367.800^{c}	26.59
T_5.	60 - 30 – 20	380.200^{cd}	412.700^{ab}	396.450^{b}	36.45
T_6.	80 - 40 – 30	400.200^{bc}	425.600^{ab}	412.900^{ab}	42.11
T_7	100 –50 –40	410.700^{ab}	437.000^{a}	423.850^{a}	45.88
	Year Mean	355.770	377.236		

LSD at P = 0.05 for Treatments = 21.22
LSD at P = 0.05 for Years = Non-significant
LSD at P = 0.05 for Treat X Year = 30.01
Coefficient of Variation = 7.84%

Cost benefit analysis of fertilizers application on wheat revealed that maximum benefit of Rs.7358.54/- per hectare was received from the application of NPK @ 80-40-30 kg ha^{-1} (T6) followed by T7 (NPK @ 100-50-40 kg ha-1) and T5 (NPK @ 60-30-20 kg ha^{-1}) which gave benefits of Rs.7013.14/- and Rs.6210.97/- per hectare, suggesting that the most economical dose of fertilizers for achieving maximum grain yield of wheat is NPK @ 80-40-30 kg ha^{-1} under Rod Kohi conditions of D.I.Khan as reflected in Table 5.

Table 5: Cost benefit analysis of fertilizers application on wheat

S. #.	Treatment $N-P_2O_5-K_2O$	Yield Kg/ha	Value of Produce Rs.	Cost of Fertilizer Rs.	Net Return Rs.	Net Profit Rs.
T_1.	0-0-0	3141.983	31419.83	-	31419.83	-
T_2.	20-0-0	3315.133	33151.33	220.00	32931.33	1511.5
T_3.	40-20–0	3501.708	35017.08	602.00	34415.08	2995.25
T_4.	40-20–10	3640.155	36401.55	842.60	35558.95	4139.12
T_5.	60-30–20	3901.500	39015.00	1384.20	37630.80	6210.97
T_6.	80-40–30	4070.417	40704.17	1925.80	38778.37	7358.54
T_7.	100–50-40	4090.037	40900.37	2467.40	38432.97	7013.14

Value of Wheat @ Rs.10/- per kg
Cost of N @ Rs.11/- per kg viz urea @ Rs. 550/- per bag
Cost of P_2O_5 @ Rs.8.10 per kg viz SSP @ Rs.810/- per bag
Cost of K_2O @ Rs.24.06 per kg viz SOP @ Rs. 1200/- per bag

Conclusion: An experiment was conducted on two variable textured soils of farmer fields in the hill- torrent irrigated area of Dera Ismail Khan Division (Khyber Pakhtoonkhwa) Pakistan during the years 2006-2007 and 2007-2008 with aim of observing the impact of NPK applications on number of productive tillers m^{-2}. Maximum benefit worth Rs: 7358.54 ha^{-1} was calculated from the yield of T6 (NPK @ 80-40-30 kg ha^{-1}) followed by T7 and T5 giving of Rs:7013.14 Rs: 6210.97ha^{-1} respectively, suggesting T6 as the most economical NPK dose for wheat under hill- torrent irrigated area of Dera Ismail Khan (Pakistan).

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