EFFECTOF OF NITROGEN AND PHOSPHORUS ON THE YIELD OF WHEAT

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ABSTRACT

Effect of different levels of nitrogen and phoshorus on the yield of ARZ, WL–711 and Khyber–79 varieties of wheat was studied at the Agricultural Research Station, Dera Ismail Khan, during 1980–81 to 1982–83. The yield data indicated that application of 100 kg N plus 90 kg P_2O_5 /ha proved better for ARZ and WL–711 varieties and 150 kg N in combination with 90 kg P_2O_5 /ha for Khyber–79 variety.

INTRODUCTION

For obtaining self sufficiency in food improved wheat varieties were introduced. Efforts were made to evolve new varieties with high yield potential and greater response to fertilizer application. Inspite of these efforts the yields per hectare are still low.

The gap between the demonstrated yield obtained at the Government farms and experimental stations and that on the farmers' land is quite wide. The major constraint to higher wheat yields in Pakistan has been the inadequate and unblanced use of fertilizers. Kemmeler considered a nutrient ratio of 1.0:0.28:0.01 ($N:P_2O_5:K_2O$) to be optimum for Pakistan.[1]

It has been reporte by Rehman (1982) that fertilizer contribution towards yield is about 38 to 66 percent. Moreover, it has been found that the soils of N.W.F.P. are deficient in nitrogen and phosphorus for cereal crops (Bhatti, 1980, and Rehman et al, 1982 and 1983). Optimum levels of these nutrients for Panjamo and Mexipak wheat varieties have been given as 120 lbs N plus 90 P_2O_5/ acre (Rehman et al, 1970).

With the shift from traditional to modern technology, the requirements of inputs are also increased. Continuous cultivation of high yielding varieties without balanced fertilizer application causes soil to be depleted of essential plant nutrients. Eventually, the fertilizer requirement for profitable yields is changed. Keeping these in view, the present investigation was under-taken to study the effect of nitrogen and phosphorus in different combinations on the yield of some important varieties of wheat.

MATERIALS AND METHODS

The experiments reported in this paper were conducted at the Agricultural Research Station, D. I.Khan. These were initiated during 1980–81 with ARZ and WL–711 varieties and continued during 1981–82 and 1982–83 on Khyber–79 as a test variety of wheat.

The land was thoroughly prepared and the cal-

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culated quantities of fertilizers were broadcast and worked into the soil. Fertilizer treatments comprised of four levels of nitrogen (0,100,150 and 200 kg N/ha) and three levels of phosphorus (0,90 and 135 kg P_2O_5 /ha), applied in different combinations.

Urea and single superphosphate were used as sources of nitrogen and phosphorus, respectively. All the fertilizers were applied at the time of sowing.

The experimental design used for these studies was Split Plot during 1980–81, keeping varieties in the main plots and fertilizer treatments in sub–plot, and Randomized Complete Block in 1981–82 and 1982–83. Gross plot size was 6,7.5 and 10m^2 during 1980–81, and 1982–83 with 4,5 and 5 rows 30 cm apart from each other, respectively. The crop was planted in the second week of November and harvested in the last week of April. Grain yield was obtained from a net plot of 2.4, 3.6 and 4.5 m^2, respectively. Threshing was done manually.

The soil on which the experiment was conducted belongs to the Zindani series which comprises calcareous clay loams (Ashraf Ali et al. 1969). Soil analysis of the experimental sites was made according to the methods given by Black (1965) and the data are given in Table 1.

Analysis of variance of the yield data was done according to Panse and Sukhatme (1967). The means were compared by using Duncan's Multiple Range Test of significance.

RESULTS AND DISCUSSION

The yield data of both the experiments have been summarized in Table 2. The data indicated that the application of fertilizer increased the yield of all the test varieties significantly over the control. Application of nitrogen alone at different levels increased the yields and the addition of phosphorus resulted in further increases, indicating response to both nitogen and phosphorus application.

In the case of first experiment, the results for varieties and fertilizer treatments were highly significant, while interactions between varieties and fertilizer were non-significant. The variety WL–711 produced significantly higher yield than ARZ. As regards the fertilizer effects, all the fertilizer treatments increased the yields significantly over the control. The maximum yield of 3,011 kg/ha was obtained with treatment No. 6 (150 kg N plus 90 P_2O_5/ha) and it differed significantly from T_{10}, T_7 and T_2. Overall, the treatment receiving 100 kg N plus 90 kg P_2O_5/ha seems better than the other treatments.

In the second experiment using Khyber–79 variety, all the fertilizer treatments increased the yields significantly over the control during both the years. By comparing the treatment means with one another, the higest yield was obtained from treatment with 200 kg N plus 135 kg P_2O_5/ha but it was at par with all the other combinations of the two nutrients except the three levels of nitrogen applied alone during 1981–82. In the second year, the treatment with 150 kg N plus 90 P_2O_5/ha produced the highest yield. It differed significantly from all the fertilizer treatments except T_3,T_4,T_9 and T_10 The result of both the years indicated that nitrogen application increased the yield significantly over control and the addition of phosphorus increased the yields significantly over nitrogen alone. Analysis of the two years combined data showed that the higher levels of both the nutrients gave significantly higher yields than nitorgen alone as well as lower levels of both the nutrients. The yields during 1982–83 were significantly higher than those in 1981–82. This might have due to difference in climatic elements such as rainfall and temperatures of the two years.

By separating the means for nitrogen and phosphorus and doing statistical analysis (Table 3), it can be seen that the yield increased significantly with the application of phosphorus over no phosphorus during both the years. However, 90 kg P_2O_5 was comparable with 135 kg P_2O_5/ha. These results clearly indicate that the soils under experiments were low in phosphorus and needed fertilization with

TABLE–1.

SOIL ANALYSIS

		1980–81	1981–82	1982–83
1.	EC X 10^6 (1:5)	1000	720	600
2.	pH (1 : 5)	8.3	7.8	7.9
3.	Ca + Mg(meq/1)	6.6	—	4.4
4.	CO_3 "	Nil	Nil	Nil
5.	HCO_3 "	3.0	2.4	4.1
6.	Cl "	2.3	1.85	2.0
7.	Organic matter (%)	0.60	0.65	0.50
8.	N (%)	0.03	0.032	0.029
9.	Available P (ppm)	12	1.5	5.0
10.	Available K "	195	—	—
11.	$CaCO_3$ %	—	12.5	12.0
12.	Texture	Clay loam	Clay loam	Clay loam

— = Not tested

TABLE–3.

SEPARATION OF MEANS FOR NITROGEN AND PHOSPHORUS

1981–82

	N_{100}	N_{150}	N_{200}	P Means
P_0	1730	1667	1641	1679 a
P_{90}	2146	2172	2336	2218 b
P_{135}	2172	2588	2740	2500 b
N Means	2016	2142	2239	

1982-83

P_0	2400	2267	2267	2311 a
P_{90}	2667	3067	2956	2563 b
P_{135}	2822	2489	2689	2666 b
N Means	2530	2608	2637	

TABLE–2.

EFFECT OF VARIOUS COMBINATIONS OF NITROGEN AND PHOSPHORUS ON THE YIELD OF WHEAT

EXPERIMENT–I (1980–81)

S. No.	Treatments		Yield(kg/ha)		
	N (kg/ha)	P_2O_5	ARZ	W–711	Average
1.	0	0	1250	1539	1395 c
2.	100	0	1953	2782	2368 b
3.	100	90	2086	3137	2630 ab
4.	100	135	2027	3226	2627 ab
5.	150	0	2031	2974	2503 ab
6.	150	90	3107	2915	3011 a
7.	150	135	2175	2737	2456 b
8.	200	0	2116	3181	2649 ab
9.	200	90	2042	3048	2545 ab
10.	200	135	2116	2885	2501 b
			2090b	2842 a	

EXPERIMENT–II(KHYBER–79 VARIETY)

			1981–82	1982–83	Average
1.	0	0	443 c	822 e	633 d
2.	100	0	1730 b	2400cd	2065bc
3.	100	90	2146 ab	2667 abcd	2407 bc
4.	100	135	2172 ab	2822 abc	1967 bc
5.	150	0	1667 b	2267 d	2497 c
6.	150	90	2172 ab	3067 a	2620 ab
7.	150	135	2588 a	2489 bcd	2539 bc
8.	200	0	1641 b	2067 d	1954 c
9.	200	135	2740 a	2956 ab	2646 ab
10.	200	135	2740 a	2689 abcd	2715 a
			1824 b	2445 a	

Means followed by similar letter(s) do not differ significantly from one another.

phosphorus in addition to nitrogen for getting profitable yields of wheat.

It can be concluded that 150 kg N plus 90 kg P_2O_5/ha seems to be the best combination of N and P, indicating the deficiency of both these nutrients as is clear from the soil analysis also. By studying the economics of fertilizer on Khyber–79 variety of wheat (Table 4), it can be concluded that the highest net return was obtained with T_6 which was Rs.2,211/ha with a CFR of 1.89.

It can be recommended on the basis of these results that 150 kg N in combination with 90 kg P_2O_5/ha should be applied to get profitable yields of improved varieties of wheat when the soil is deficient in both the elements. If farmer has limited resources and cannot apply N and P at these rates, he may use 100kg N plus 90 kg P_2O_5/ha.

YIELD RESPONSE AND ECONOMICS OF APPLIED N & P

The data for the three varieties were pooled and statistically analysed to determine the yield response to N and P. The following equation was derived from the data:

Yield $= 935 + 17.75\ N + 8.59\ P - 0.0561\ N^2 - 0.0465\ P^2$

From the equation, the N and P rates to get the maximum agronomic yield and the recommended fertilizer level at a given economic return (in terms of MRR=1) are ashown as follows:—

	Agro. At Max./Yield level (MRR=–1)	At Economic level MRR = 1
$N + P_2O_5$ Rate (kg/ha)	168 N + 92 P_2O_5	99 N + 35 P_2O_5
Yield (kg/ha)	2735	2386
Inc. in yield due to N + P (kg/ha)	1800	1451
Value of yield Increase(Rs)	3060	2467
Cost of N + P, (Rs)	1299	712
Net return to N+P, (Rs)	1761	1755
Value Cost rato	2.36	3.46

Normally, the recommended level of fertilizer is not the rate giving the maximum agronomic yield. Rather, it is in that portion of the yield curve where it is more economical, usually at a point where the marginal rate of return is 1(MRR=1), which means an additional profit of one rupee for the last invested on additional kilo of fertilizer. In the above experiments, the fertilizer recommendation to give a profitability level at MRR=1 is around 100kg N + 35 kg P_2O_5/ha.

The results of these experiments are supported by the findings of Rehman et al (1970), Bhatti (1980), and Rehman et al (1982 and 1982) who emphasized upon the addition of phosphorus to nitrogen for getting profitable yields of wheat.

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TABLE–4.

ECONOMICS OF FERTILIZER USE (KHYBER–79)

S.No.	Treatments		Grain yield	Increased grain yield	Value of yield increased	Cost of fertilizer	Net return	Value cost ratio
	kg/ha		kg/ha	kg/ha	Rs/ha	Rs/ha	Rs/ha	
1.	0	0	633	–	–	–	–	–
2.	100	0	2065	1432	2434	556	1878	3.37
3.	100	90	2407	1774	3016	889	2127	2.39
4.	100	135	2497	1864	3169	1056	2113	2.00
5.	150	0	1967	1334	2268	834	1434	1.72
6.	150	90	2620	1987	3378	1167	2211	1.89
7.	150	135	2539	1906	3240	1334	1906	1.42
8.	200	0	1954	1721	2926	1112	1814	1.63
9.	200	90	2646	2013	3422	1445	1977	1.36
10.	200	135	2715	2122	3607	1612	1995	1.23

Price of Wheat = Rs. 85.00/50 kg

N = Rs. 5.56/kg

P_2O_5 = Rs. 3.70/kg.