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EFFECT OF RATIO OF APPLIED N AND P ON THE YIELD OF WHEAT IN TWO SOIL SERIES

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A field experiment was conducted with four promising mutants of wheat to study the influence of three N: P ratios at each of the three levels of applied N in the Shahdara and Sultanpur series.

The results obtained showed that nitrogen and phosphorus fertilizers applied at the rates of 120 kg N and 90 kg P_2O_5 per ha. at the N: P ratio of 1: 0.75 statistically produced the same yield as the higher rates of application in the same ratio. The yield from other ratios including the previously adopted ratio of 1: 0.5 (120 kg N: 60 kg P) was lower. The increased P requirements are mainly due to depletion of the element from soil as a result of intensive cultivation and to introduction of high yielding varieties having high nutritional requirements. The sultanpur series produced about 50 % more yield per kg of the nutrient applied than the Shahdara series.

Key words: Promising mutants, N and P on the yield of wheat, Nutritional requirements.

INTRODUCTION

Optimum plant growth and high yield of grain is a function of balanced and plentiful nutrition. In the early 1960s, soil scientists of West Pakistan emphasized the use of the nitrogen fertilizer only, especially for wheat production. Phosphorus was not considered as a yield limiting factor. Field experiments conducted at the Atomic Energy Agricultural Research Centre, Tandojam during late 1960, however, established that phosphorus was a yield limiting factor [1]. Yields increased by 25-30 % in 1966-67 and by 108 % in 1967-68 when 112 kg of N was applied along with 56 kg of P_2O_5 per ha (N: P ratio of 1:0.5) compared to addition of 112 kg of N alone [1]. The same N: P ratio was adopted in most of the later experiments and recommended to farmers [2,3]. Now, there are indications that higher P rates are needed with the N rates being recommended because about 70 % of the soils show available P ($NaHCO_3$-extractable) in the deficient range of 6-10 mg/kg of soil (T.M. Chaudhry, personal communication).

In view of the above, there is need to establish optimal rates of N and P for wheat production in the soils of Pakistan.

MATERIALS AND METHODS

The experiment was conducted with four promising mutants of wheat at the Experimental Farm of the Centre during the rabi season of 1981-82. The objective was to study the influence of three ratios of N to P fertilizer at three levels of N in two soil series. The treatments were:

Mutants:

(i) P-94, (ii) P-89. (iii) M-9. (iv) M-5.

NApplication rates

(i) 60 kg N per ha. as urea; (ii) 120 Kg N. per hr. as urea; (ii 160 Kg N. per hr. as urea.

N: P ratios (at each rate of N)

(i) 1:05; (ii) 1:0.75; (iii) 1:1.

Treatments (N: P combinations)

No.	N (kg/ha)	P (kg P_2O_5/ha)	N:P ratio
1	60	30	1: 0.5
2	60	45	1: 0.75
3	60	60	1: 1
4	120	60	1: 0.5
5	120	90	1: 0.75
6	120	120	1: 1
7	160	80	1: 0.5
8	160	120	1: 0.75
9	160	160	1: 1

Half of the nitrogen and all of P (as single superphosphate) was applied at the time of sowing by broadcast followed by incorporation into soil whereas the remaining half of nitrogen was applied at boot stage by topdressing.

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Soil series. (i) *Shahdara.* Consists of well drained, calcareous, medium-textured soil developed on mixed alluvium from the Himalayas. It has no B horizon. Silt loam topsoil is overlain by very fine sandy loam or silt loam. The soil at the experimental site was a silty clay loam.

(ii) *Sultanpur.* Similar to Shahdara series except that it has a structural B horizon and silt loam topsoil is underlain by silt loam B horizon. The texture of the soil at the experimental site was silt loam.

The physicochemical characteristics of the soil series are given in Table 1. The Sultanpur series was poorer in organic matter, total nitrogen, available P and available K contents. The total soluble content of both the series was low.

Table 1. Physiochemical characteristics of the soil series under study.

Property	Shahdara series	Sultanpur series
pH	8.2	8.2
Total soluble salts (%)	0.13	0.11
Organic matter (%)	1.14	0.95
Total N (%)	0.0812	0.0644
Available P (ppm)	17.5	14.5
Available K (ppm)	235	195
Clay (%)	34.9	25.9
Textural class	Silty clay loam	Silt loam

The plots were laid according to the split plot design with mutants forming the main plots of size 6.5 x 3 m and treatments (N: P combinations) forming the subplots of size 3 x 3 m. There were four replications. The data were analyzed statistically for analysis of variance according to the procedure described by Little and Hills [4]. The statistical analyses were performed on per plot yield basis. The final average figures were converted to metric tons/ha.

RESULTS AND DISCUSSION

Grain yield. The influence of N:P combinations (treatments) on the grain yield of wheat is shown in Table 2. The mutant P-89 gave the highest average yield from all the treatments combined in either of the experimental site. However, at a particular treatment, other mutants outyielded the mutant P-89. It is credible that at higher rates of N and P, grain yields from P-89 were consistently higher than those from the other mutants and that there was a consistent response to P at a given N level and a consistent response to N at a given P level except for treatment 9 (160 N plus 160 P). The yields of P-89 and other mutants (except P-94 in the Sultanpur series) from T_9 were consistently lower than T_8 suggesting that at 160 P rate, N may have been limiting. Even though the N rate used was high, the amount available to the crop could have been limiting because of nitrogen loss or some other N inefficiency factor.

The treatment 8 (N:P ratio of 1: 0.75 at 160 N: 120 P) gave significantly the highest average yield in both series. However, the yield at this treatment was not significantly different from T_5 (the same N:P ratio at the rates of 120 : 90) and the higher ratios at the rates of 120 and 160 kg N per ha. The yield from the remaining ratios, particularly the previously recommended/ adopted ratio of 1: 0.5 at 120 N: 60 P, was lower. Also, the yield from treatment 8 was highest for some mutants but not for others. It is apparent that interaction between N and P is a function of variety and levels of N and P. Where either N or P are deficient for a particular mutant, the requirement for P increases when N is added and conversely so.

Harvest index. Harvest index (HI) is a ratio between the economic (grain) yield and the total biological (dry matter) yield [5]. The total dry matter is a measure of crop's photosynthetic performance and the harvest index is a measure of the economically useful fraction of the biological yield. HI is a good indicator of the influence of fertilization on grain production. A higher index showing production of more grain than straw is preferable. The HI of the wheat mutants under study as influenced by various N:P combinations are given in Table 3. In the Shahdara series, the mutant P-94 produced the highest average HI but the differences among the mutants were not statistically significant. The differences were also non-significant within treatments and between interactions of mutants x treatments.

In the Sultanpur series, the mutants M-5, M-9 and P-89 exhibited statistically similar harvest indices which were higher than that of P-94. The mutant M-9, however, had the highest HI at the lowest N rate whereas M-5 had the highest HI at the highest N rate.

Like grain yield,the effect of treatments was significant. The treatment 8 (N : P ratio of 1: 0.75 at 160 N: 120 P) gave the highest HI which was statistically similar to treatment 5 (same N:P ratio at 120 N: 90 P) but significantly higher than T_2 (same N:P ratio at 60:45). The HI from other ratios were either similar or lower than T_8. The HI was obviously infouenced by N and P rates. At particular N rates, the HI increased with an increase in P level

Table 2. Grain yield (metric tons/ha) of four wheat mutants as influenced by N and P combinations (treatments) in Shahdara and Sultanpur soil series

Mutants	Treatments (Please see text for details)									Mutant average
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	
					Shahdara series					
P-94	1.44	1.66	1.73	2.16	2.23	2.10	2.23	2.32	2.10	2.00 ab
P-89	1.53	1.62	1.88	2.21	2.72	2.74	2.68	2.75	2.66	2.31 a
M-9	1.46	1.69	1.78	1.99	2.04	2.07	2.15	2.29	2.00	1.94 ab
M-5	1.37	1.45	1.51	1.55	1.48	1.67	1.55	1.82	1.71	1.57b
Treat average	1.45 e	1.60 de	1.72 cd	1.98 bc	2.12 ab	2.14 ab	2.15 ab	2.29 a	2.13 ab	
					Sultanpur series					
P-94	1.99	2.42	2.20	2.66	2.65	2.52	2.48	2.84	2.83	2.51 b
P-89	2.36	2.94	3.45	3.51	3.98	3.65	4.12	4.35	3.14	3.50 a
M-9	2.30	2.32	2.45	2.78	3.29	3.29	3.26	3.76	2.44	2.99 ab
M-5	2.38	2.78	2.49	3.16	3.85	2.74	3.71	4.10	3.00	3.14 a
Treat average	2.26 d	2.62 cd	2.65 cd	3.03 bc	3.45 ab	3.05 bc	3.39 ab	3.76 a	3.10 b	

LSD (5 %):	*Shahdara*	*Sultanpur*
Mutants =	0.47	0.56 tons/ha
Treatments =	0.26	0.43 "
Mut.x Treatments =	N.S.	N.S.

The figures followed by the same letters in vertical and horizontal columns are not statistically different at 5 % level of significance

Table 3. Harvest indices of four wheat mutants as influenced by N and P combinations (Treatments) in Shahdara and Sultanpur soil series

Mutants	Treatments									Mutant average
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	
					Shahdara series					
P-94	0.285	0.305	0.298	0.327	0.347	0.323	0.322	0.342	0.328	0.319
P-89	0.265	0.294	0.277	0.299	0.312	0.288	0.314	0.319	0.282	0.295
M-9	0.261	0.248	0.274	0.285	0.251	0.284	0.277	0.262	0.264	0.267
M-5	0.247	0.258	0.300	0.273	0.271	0.269	0.274	0.309	0.263	0.274
Treat. average	0.264	0.276	0.287	0.296	0.295	0.291	0.297	0.308	0.284	

(..... continued)

(Table 3, continued)

Sultanpur series

P-94	0.243	0.247	0.265	0.261	0.246	0.235	0.242	0.245	0.242	0.247 b
P-89	0.253	0.308	0.323	0.321	0.331	0.327	0.315	0.334	0.325	0.315 a
M-9	0.296	0.305	0.323	0.320	0.318	0.340	0.346	0.350	0.333	0.326 a
M-5	0.321	0.323	0.326	0.319	0.333	0.336	0.327	0.339	0.317	0.327 a
Treat. average	0.278 c	0.296 b	0.309 ab	0.305 ab	0.307 ab	0.309 ab	0.307 ab	0.317 a	0.304 ab	

LSD (5 %)	*Shahdra*	*Sultanpur*
Mutants =	N.S.	0.037
Treatments =	N.S.	0.016
Mut.x Treatments =	N.S.	N.S.

The figures followed by the same letters in vertical and horizontal columns are not statistically different at 5 % level of significance.

except at 160 N at N:P ratio of 1:1 (treatment 9). The HI from this treatment was always lower than T_8 suggesting that comparatively less N was available for grain formation despite the fact that the same amount of N was applied to both treatments (160 kg/ha). This might be due to the loss of N or due to some other factor which caused poor efficiency of utilization.

To sum up, at the N rate of 120 kg N/ha, a significantly higher grain yield of wheat was produced at the P rate of 90 kg (N:P ratio of 1: 0.75) than at the previously recommended rate of 60 kg P (N:P ratio of 1: 0.5). The yield from the same or higher N:P ratios at the other N rates were statistically similar or lower. The increased requirements of P in relation to N are mainly due to the depletion of the element from the soil as a result of intensive cultivation made possible through improved irrigation facilities and cultivation machinery [6] and to introduction of high yielding varieties of crops having high nutritional requirements [7].

Effect of soil series. The Sultanpur silty loam soil produced about 50 % more grain per kg of each nutrient applied compared to the Shahdara silty clay loam. The harvest indices of the mutants, except of P-94, were upto 22 % higher and of the treatments upto 8 % higher in the Sultanpur series, indicating that the applied fertilizers were utilized by the plants for the production of more grain than straw. The Sultanpur series was comparatively poorer in the nutrient elements, particularly nitrogen, phosphorus and organic matter (Table 1); hence the crop grown on it responded markedly to the added fertilizers.

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