Pakistan J. Sci. Ind. Res., Vol. 30, No. 11, November 1987

EFFECT OF DIFFERENT COMBINATIONS OF N AND P ON SOME AGRONOMIC CHARACTERS OF WHEAT MUTANTS

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(Received July 26, 1987; revised November 19, 1987)

The performance of five newly evolved promising wheat (*Triticum aestivum* L.) mutants of variety Lu-26, i.e. WM-89-1, WM-56-1-2, WM-6-17, WM-81-2 and WM-120-3 along with the standard commercial cultivar (Pak-81), was studied under combined levels of 0-0, 95-35, 115-45, 135-55, 155-65, 175-75 and 195-85 kg ha^{-1} of N – P, during 1984-85. Days to heading, plant height, lodging and grain yield of all the mutants significantly increased ($P < 0.05$) with increasing levels of N and P. However, high doses of fertilizer had no significant effect on spike length and spike-lets per spike. The highest grain yield was recorded in almost all mutants by the combined application of N (135 kg ha^{-1}) and P (55 kg ha^{-1}) as P_2O_5. Mutant WM-89-1 outyielded all mutants and the standard variety at 5032 kg ha^{-1}) was followed by the mutant WM-81-2, which also showed a high level of resistance to lodging under all levels of N and P fertilization.

Key words: Combined effect, Fertilizer (N and P), Wheat mutants.

INTRODUCTION

Wheat accounts for almost 70 % of the total cereal intake in Pakistan [1]. It has been extensively studied for increased yield, chappati quality and resistance to diseases. However, average yields are only about 1600 kg ha^{-1} in Pakistan. The gap between actual and potential yields of the improved varieties is wide but can be bridged by improved geometry in planting, optimum plant population and increased fertilization [5].

High yielding varieties of wheat tend to deplete soil fertility. This nutritional drain can, however, be replenished by the application of artificial fertilizer [6]. Sherma *et al.* [13] reported that yields can be increased by 40-69 % with the application of 44.86 to 67.26 kg ha^{-1} of N. Increase in the wheat grain production after fertilization with N has also been reported by Berger [4], Gardner [8] and Barg [3]. More tillers/plant, high grain weight and higher straw and grain yield were noted by Mukhtiar and Mian [12] after giving N in combination with P to a short duration wheat variety (Mexi-Pak-65). Tahir [14] reported a significant increase in grain and straw yields of wheat by the application of straw with P and N fertilizers to different soils. The application of 134 kg N along with 90 kg P_2O_5 ha^{-1} to the variety, Khushal, resulted in a significant increase in the grain yield [3]. Gandapur and Bhatti [7] reported that the highest grain yields were obtained by the combined application of N and P at the rate of 180 kg N plus 65 kg P_2O_5 ha^{-1}. Khan *et al.* [11] studied the performance of four short duration wheat varieties under different combined levels of N and P and concluded that number of tillers/plant, plant height, grains/ear and grain yield ha^{-1} was increased by the application of 175 + 150 kg ha^{-1} N and P combination.

Information regarding the optimal levels of different fertilizer application for obtaining maximum yield from improved varieties is essential. The present study was, therefore, undertaken to explore the genetic potential and response of new, genetically stable, wheat mutants to different combination of N and P under local agroclimatic conditions.

MATERIALS AND METHODS

The experiment was conducted at the Nuclear Institute for Food and Agriculture, Tarnab, Peshawar, under irrigated conditions during 1984-85. The trial was carried out on clay loam soil with a pH of 8.1 and with 0.921 % organic matter, 13.67 % total alkaline earth carbonate, 0.046 % nitrogen, 14.21 ppm P_2O_5 and 205 ppm of K_2O. The electric conductivity of the experimental plot was 0.40 mmhos/cm at 25° which shows that the experimental site was non saline. The mutants used in the test were WM-89-1, WM-56-1-2, WM-6-17, WM-81-2 and WM-120-3. These mutant genotypes were achieved by irradiating wheat variety, Lu-26 with 250 Gy ^{60}Co gamma radiation.

The mutants were tested in a micro yield trial in comparison with the parent (Lu-26) and the commercial variety (Pak-81) during 1983-84. The results published elsewhere [16,17] showed that the parent was inferior to both the mutants and Pak-81 (Check) regarding rust resistance and grain yield ha^{-1}. However, these mutant genotypes together with the commercial variety Pak-81 (as check) were evaluated for their response to N and P fertilization in the present study. The fertilizer doses applied were 0-0, 95-35, 115-45, 135-55, 155-65, 175-75 and 195-85 kg ha^{-1} of N – P_2O_5 in the form of urea and single super-phosphate. The phosphate fertilizer and half of the nitrogenous fertilizer were thoroughly mixed and ploughed in before sowing, while the rest of N fertilizer was applied at the second irrigation.

The experiment was conducted in a split-plot design with three replicates. Wheat mutants and varieties were allotted to the main plots and fertilizer treatments were confined to sub-plots. A sub-plot comprised 6 rows 30 cm apart and 3 m long, thus having a plot size of 3 x 1.8 m. A net area of 3 x 1.2 m was harvested for determining grain yield. Data were recorded regarding heading time, plant height, spike length, spikelets per spike, lodging and grain yield. Days to heading was estimated as when the ears of 50 % of the plants had emerged. Plant height was recorded in the field at maturity from ground level to the tip of the spike excluding awns, on 10 plants selected at random from each treatment and replication. Observations regarding spike length and number of spikelets/spike were made on 10 random spikes from each treatment and replication. Scoring for the lodging was on a 0 – 5 scale. The analysis of variance of the data was done according to the procedure given by Gomez [15].

RESULTS AND DISCUSSION

Data with respect to days to heading and plant height of the mutants along with the standard cultivar are presented in Table 1. It is clear from the results that both mutants and fertilizer doses significantly affected days to heading ($P < 0.05$). All the mutants were earlier maturing than the standard check variety (Pak-81). Among the mutant lines, WM-81-2 and WM-56-1-2 were earlier with 125 and 126 days to heading respectively, whereas mutant WM-6-17 was late, taking 134 days.

Significant delay in heading was observed by different levels of fertilizers. Plots receiving no fertilizers took less time to heading and hence matured earlier as compared to other treatments. It is also evident from the results that each increment of N and P caused simultaneous delay in heading time and maximum time (134 days) was taken by plots receiving the highest dose.

Significant differences in plant height were noted between mutants and different levels of N and P. Mutant WM-81-2 exhibited the shortest stem length, whereas the other three mutants, WM-89-1, WM-56-1-2 and WM-120-3, were taller than the standard check cultivar ($P < 0.05$). Regarding the effect of fertilizer levels on plant height, it was observed that an increase in the N – P level resulted in the corresponding increase in the plant height up to 155-65, beyond which each increment in the dose slightly decreased the plant height.

Mean values for lodging and spike length of the mutants and the check are given in Table 2. It is evident from the results that both varieties and fertilizer doses significantly affected the lodging of the plants. Mutant WM-81-2 expressed the highest level of resistance to lodging compared to the standard check cultivar and other mutants. Pak-81 and WM-56-1-2 was also resistant to lodging at all levels of the fertilizer, whereas WM-89-1 and WM-120-3 ranked third and fourth respectively. The effect of different combinations of N and P on this trait was also studied. No lodging was observed in the plots receiving no fertilizer. However, each increment in the fertilizer dose caused lodging of the plants and higher degree of lodging was observed at the higher fertilizer level. It can, therefore, be safely concluded that high doses of N and P fertilizers increase lodging tendencies up. Significant differences ($P < 0.05$) were observed in the mean values of spike length due to varieties. Longer spikes were observed in the mutant WM-6-17 (13.8 cm) followed by WM-56-1-2 with an average spike length of 13.2 cm. All the mutants exhibited significantly longer spikes than the standard check variety. However, application of the N and P fertilizers had no effect on spike length.

Table 3 shows the data with respect to spikelets/spike and grain yield of the mutants and Pak-81. Different combinations of N and P have no effect on spikelets/spike, whereas mutants differed significantly regarding this trait. Mutant WM-6-17, with 24 spikelets per spike, outclassed the standard check variety as well as all the mutants, followed by mutant WM-89-1. However, the standard (Pak-81) ranked third in this respect.

Grain yield was affected by both the genotype and the fertilizer. Mutant WM-89-1 significantly outyielded all the mutants and the standard with 5032 kg ha^{-1} followed by WM-81-2 and WM-6-17, which gave significantly higher grain yields (4621 and 4560 kg ha^{-1} respectively) than the standard variety. Mutant WM-120-3 was the only mutant which yielded significantly lower than Pak-81. Different

Table 1. Effect of different levels of N and P on days to 50 % heading and plant height of wheat mutants.

Varieties	N–P doses 0–0	95–35	115–45	135–55	155–65	175–75	195–85	Varieties mean
				Days to heading				
WM-89-1	128	132	133	133	134	135	133	132.57b
WM-56-1-2	125	125	125	126	127	129	128	126.43d
WM-6-17	131	132	134	134	134	135	136	133.71b
WM-81-2	124	124	124	124	125	126	129	125.14d
WM-120-3	128	128	128	129	129	130	130	128.86c
Pak-81 (Check)	140	142	143	143	145	145	146	143.43a
Dose mean	129.33d	130.5cd	131.17c	131.5bc	132.33b	133.3ab	133.67a	
				Plant height (cm)				
WM-89-1	110.3	117.8	118.5	119.3	119.5	121.0	120.5	118.1b
WM-56-1-2	114.2	119.2	119.1	119.1	120.9	119.4	120.0	118.8b
WM-6-17	119.7	121.1	121.9	121.9	123.7	122.8	121.5	121.8a
WM-81-2	82.9	89.8	90.0	95.4	93.6	89.4	90.5	90.2d
WM-120-3	119.9	121.3	123.1	123.8	122.4	122.7	122.5	122.2a
Pak-81 (Check)	109.3	111.6	112.7	114.1	114.3	113.5	112.5	112.6c
Dose mean	109.4c	113.5b	114.2ab	115.6a	115,7a	114.8ab	114.6ab	

Any two means of the same category followed by at least one common letter are not significantly different at 5 % level, using Duncan's New Multiple Range Test.

Table 2. Effect of different levels of N and P on the lodging and spike length of wheat mutants.

Varieties	N–P doses 0–0	95–35	115–45	135–55	155–65	175–75	195–85	Varieties mean
				Lodging score (0–5 scale)				
WM-89-1	1.3	2.3	1.0	3.0	3.0	3.0	2.0	2.2b
WM-56-1-2	1.0	1.0	1.3	1.0	2.0	2.3	2.3	1.6c
WM-6-17	1.0	1.0	1.7	2.3	1.7	2.7	3.6	2.0b
WM-81-2	1.0	1.0	1.0	1.0	1.3	1.0	1.3	1.1d
WM-120-3	1.3	1.7	2.0	3.0	2.3	4.0	4.0	2.6a
Pak-81 (Check)	1.0	1.0	1.0	1.3	2.3	2.0	2.0	1.5c
Dose mean	1.1d	1.3c	1.3c	1.9b	2.1b	2.5a	2.5a	

(continued.....)

(Table 2, continued)

				Spike length (cm)				
WM-89-1	11.4	12.6	12.7	13.1	13.1	12.7	12.6	12.6cd
WM-56-1-2	12.8	12.6	13.1	13.3	13.4	13.5	13.6	13.2b
WM-6-17	12.9	13.8	13.8	13.3	14.2	14.1	14.2	13.8a
WM-81-2	11.0	12.0	12.2	12.1	11.9	12.4	12.9	12.1d
WM-120-3	12.8	12.7	12.6	12.5	12.7	13.1	12.6	12.7c
Pak-81 (Check)	10.4	10.7	11.7	11.8	11.7	11.1	11.5	11.3e
Dose mean	11.9a	12.4a	12.7a	12.7a	12.8a	12.8a	12.9a	

Any two means of the same category having at least one common letter are not significantly different at 5 % level, using Duncan's New Multiple Range Test.

1 = No plant lodged; 2 = 5-25 % plants lodged; 3 = 25-50 % plants lodged; 4 = 50-75 % plants lodged; 5 = More than 75 % lodged.

Table 3. Effect of different levels of N and P on the spikelets per spike and grain yield of wheat mutants.

Varieties	N–P doses 0–0	95–35	115–45	135–55	155–65	175–75	195–85	Varieties mean
				Spikelets/spike				
WM-89-1	22	23	23	22	23	23	24	22.86a
WM-56-1-2	20	20	20	19	20	20	19	19.71c
WM-6-17	24	24	23	25	23	25	24	24.0 a
WM-81-2	20	21	21	21	21	21	22	21.0bc
WM-120-3	20	19	20	20	20	20	20	19.86c
Pak-81 (Check)	22	23	21	23	22	22	22	22.14b
Dose mean	21.22a	21.67a	21.33a	21.67a	21.5a	21.83a	21.83a	
				Grain yield (kg/ha^{-1})				
WM-89-1	4673	4939	5551	5208	4911	4967	4976	5032a
WM-56-1-2	4031	4602	4717	5053	4633	3910	3975	4417d
WM-6-17	4383	4736	4772	4763	4948	4318	4003	4560c
WM-81-2	3512	4837	5097	5032	4726	4568	4578	4621b
WM-81-3	3818	4207	4549	4772	4429	3892	3873	4220e
Pak-81 (Check)	3975	4578	4976	5236	4235	4040	3911	4422d
Dose mean	4055e	4650c	4944b	5011a	4647c	4282d	4170e	

Any two means of the same category having at least one common letter are not significantly different at 5 % level, using Duncan's New Multiple Range Test.

fertilizer levels had pronounced effect on the grain yield of different mutants. Significantly lower yields were obtained from plots receiving no fertilizer. However, as the fertilizer level was increased from 0-0 onwards upto 135-55 kg ha^{-1}, a simultaneous increase in the grain yield was observed. Beyond 135-55 a gradual decrease in the yield was noted and the lower yields were given by treatments receiving the highest fertilizer dose of N and P.

In conclusion, it is clear that in order to attain profitable yields N should be applied in combination with P. Khan [10] Gandapur [7], Ghafoor and Khan [9] and Khan *et al.* [11] reported similar results. This study also revealed that the wheat mutants expressed encouraging response to various levels of N and P and these mutants responsive to fertilizers should be tested under large scale cultivation. Mutants WM-89-1 and WM-81-2 seem promising and should be fertilized with 135 kg N along with 45 kg P_2O_5 ha^{-1} to obtain optimum yields.

Acknowledgement. The authors are highly indebted to Dr. Ismail Khan, Director, NIFA, for providing facilities for this research study and for reviewing the manuscript.

REFERENCES

1. M.A.A. Ansari, Wheat in Pakistan, Commodity Report, Pakistan Agr., **1**, 12 (1979).
2. G.S. Barg, "The Effect of high rates of nitrogen on the yield and protein quality of Mexi-Pak wheat in the Baqa' a Valley", M.Sc. thesis submitted to the American Univ., Beirut, Lebanon (1976).
3. G.S. Barg and A. Hamid, Effect of different levels of nitrogen, phosphorus and potash on the grain yield of wheat var, Khushal-69. Frontier J. Agr. Res., 3, 80 (1976).
4. K.C. Berger, *Effect of nitrogen on crop yield and quality* in "Sun, Soil and Survival", Norman Univ., Oklahoma Press, USA.
5. M.R. Chatta, and M.S. Nazir, Pakistan J. Agr. Res., **5**, (2): 138 (1984).
6. F.M. Chaudhry, and M. Rafiq, Pakistan J. Agr. Res., **5**, 43 (1984).
7. M.A.K. Gandapur, and A. Bhatti, Pakistan J. Agr. Res., **4**, 141 (1983).
8. B.R. Gardner, and E.B. Jackson, Fertilization, nutrient composition and yield relationship in irrigated spring wheat, Agr. J. **68** (1): 75-78 (1976).
9. A. Ghafoor and A.N. Khan, Response of wheat (*Triticum aestivum* L.) to N–P fertilization sown after nonleguminous kharif fodders, Sarhad J. Agr. **1**, 2: 399-403 (1985).
10. A.A. Khan, Chemical fertilization of wheat in Peshawar region, Agr. Pakistan, **12**: 693 (1961).
11. S. Khan, M. Iqbal, Khanzada and M. Jamil, Performance of short duration wheat varieties under combined levels of N and P fertilization, Sarhad J. Agr., **1**, 111-16 (1985).
12. M. Mukhtiar, and M. Aslam, Pakistan J. Sci. Ind. Res., **13**, 30 (1970).
13. K.C. Sherma, B.P. Singh and V. Kumar, Comparative study of soil versus foliar application of urea on wheat, Indian. J. Agron., **11**, 219-22 (1966).
14. M. Tahir, Pakistan J. Agr. Res., **4**, (4), 216 (1983).
15. K.A. Gomez and A.A. Gomez, "Statistical Procedures for Agricultural Research", 2nd ed., John Wiley and Sons, Inc. (1984).
16. T. Mohammad, S.A. Shah, S. Hassan and K. Rahman, Induction of stripe rust resistant mutants in wheat Cv. Lu-26, Nucl. Inst. Fd. & Agr., Ann. Rep., 105-18 (1983-84).
17. S.A. Shah, T. Mohammad, S. Hassan and K. Rahman, Pakistan J. Sci. Ind. Res., **30**, 298 (1987).