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Effect of N, P and K on productivity and soil fertility in pearlmillet (*Pennisetum glaucum*)—wheat (*Triticum aestivum*) cropping system

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ABSTRACT

A field experiment was conducted at Bichpuri, Agra, during 1990-93 on sandy loam soil low in available N, medium in available P and high in available K. The highest productivity and profitability of pearlmillet [*Pennisetum glaucum* L.]—wheat (*Triticum aestivum* L. emend. Fiori & Paol.) sequence could be sustained when both crops in sequence were fertilized separately with 120 kg N, 40 kg P_2O_5 and 40 kg K_2O/ha, registering highest net return (Rs 10,364/ha) and B : C ratio (Rs 1.12). The fertilizer application at higher levels resulted in building up of the fertility of the soil.

Key words : N, P, K, Soil fertility, Rice, Wheat, Cropping system

Pearlmillet—wheat cropping sequence has gained popularity in semi-arid agroclimatic condition of Agra region of Uttar Pradesh with the invent of high yielding and fertilizer responsive cultivars of these 2 staple food crops. However, both the crops are quite exhaustive and require heavy fertilization for higher and sustainable yield level. Information on nutrient management on individual crops is available, while on cropping system, it is lacking. Moreover, the single nutrient approach has been replaced by multinutrient to provide balanced nutrients to boost up crop productivity and plant nutrient use efficiency. Besides, nutrient management in cropping system is more efficient and judicious than individual crop, as following crop takes care of the residual effects of nutrients, particularly P and to some extent K. So much so, multinutrient approach in a cropping system seems to be quite rational at a time of high prices of chemical fertilizers and short supply. Keeping these considerations in view, the present field investigation was undertaken.

MATERIALS AND METHODS

A field experiment was conducted for 3 consecutive seasons (1990-91 to 1992-93) on sandy-loam soil at R.B.S. College Bichpuri, Agra. The soil was low in organic carbon

(0.37%) and available N (127 kg N/ha), medium in available P (10 kg P/ha) and high in available K (283 kg K/ha). The experiment was laid out on permanent site in 3 × 2 factorial partially confounded design with 4 replications. The treatment consisted of 3 levels, each of N (40,80 and 120 kg/ha) and P_2O_5 (0,40 and 80 kg/ha) and 2 levels of K_2O (0 and 40 kg/ha) along with 1 absolute control ($N_0P_0K_0$) in each block. Half dose of N and full dose of P and K were applied as basal to both the crops at the time of sowing. The remaining half dose of N was top—dressed 25-30 days after sowing to both crops. Pearlmillet cv. 'ICTP 8203' was sown at the onset of mosson in the second week of July followed by wheat cv. 'HD 2329' in the third week of November during each season.

RESULTS AND DISCUSSION

Response of pearlmillet to N, P and K

The grain yield of pearlmillet increased significantly with increasing levels of N up to 120 kg N/ha in 1991-92 and 1992-93, and up to 80 kg N/ha in 1990-91 (Table 1). On an average, application of N increased the grain yield by 74, 109 and 120% with 40,80 and 120 kg N/ha respectively over absolute control. These findings confirm the results of Singh and Singh (1979) and Patel *et al.* (1991).

Application of P was effective in 1 (1992-93) out of the 3 seasons, where marked response was observed up to 40 kg P_2O_5/ha

Table 1. Grain yield of perlmillet and wheat and productivity of pearlmillet-wheat cropping sequence as influenced by N,P and K fertilization

Treatment	Grain yield of pearlmillet (q/ha)			Grain yield of wheat (q/ha)			Average productivity of sequence (q/ha)
	1990-91	1991-92	1992-93	1990-91	1991-92	1992-93	
Nitroen (kg/ha)							
N_{40}	22.2	11.9	15.0	20.7	23.7	24.3	40.7 (117)
N_{80}	25.1	15.0	18.6	33.2	34.0	38.9	58.5 (212)
N_{120}	24.5	17.3	20.4	38.5	39.8	42.9	61.1 (226)
CD (P = 0.05)	1.6	10.1	4.6	2.0	3.2	2.9	
P_2O_5 (kg/ha)							
P_o	23.5	14.4	15.9	27.1	27.8	32.4	47.0
P_{40}	23.9	14.7	18.7	32.9	35.4	36.3	53.9 (15)
P_{80}	24.4	15.1	19.4	32.6	34.3	37.5	54.4 (16)
CD (P = 0.05)	NS	NS	1.6	2.0	3.2	2.9	
K_2O (kg/ha)							
K_o	24.0	14.5	17.7	30.6	32.9	35.4	51.7
K_{40}	23.9	15.0	18.3	31.1	32.1	35.2	51.9
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	
Control	12.4	7.6	8.1	6.0	10.6	11.5	18.8 (100)
CD (P = 0.05)	2.4	1.6	2.3	3.1	4.9		

only (Table 1). This might be attributed to more P-fixing capacity of soil of experimental plot. These results are in conformity with the findings of Patel *et al.* (1991). The grain yield of pearlmillet remained unaffected by potash application in all the 3 seasons. This might be due to sufficient potash reserve and high potash-buffering capacity of experimental plot. Similar results were also reported by Patel *et al.* (1991).

Response of wheat to N, P and K

The yield of wheat increased significantly with increasing levels of N (Table 1), and a linear response to N was observed up to 120 kg N/ha in all the seasons. On an average, 40, 80 and 120 kg N/ha increased the wheat yields by 145, 278 and 311% over no N. Raghuwanshi *et al.* (1988) and Patel *et al.* (1991) also obtained similar results. The wheat crop responded favourably up to 40 kg P_2O_5/ha in all the seasons. On an average, application of 40 kg P_2O_5/ha increased the grain yield by 19% over control. Reghuvanshi *et al.* (1988) and Patel *et al.* (1991) also reported beneficial effect of P on wheat crop up to 40 kg/ha.

Application of K had no effect on grain yield of wheat, probably due to more reserve and more potash–buffering capacity of soil of experimental field.

Productivity of pearlmillet–wheat sequence

On an average, the productivity of sequence increased with increasing levels of N (Table 1). The percentage increase being 117, 212 and 226 with 40, 80 and 120 kg N/ha respectively over absolute control. However, the productivity of sequence with P fertilization increased by 14.6 and 15.7% with 40 and 80 kg P_2O_5/ha over control. Application of K had no effect on total productivity of the sequence.

Economics of cropping sequence

The net return from the sequence was the highest (Rs 10,364/ ha) with N_{120} P_{40} K_{40} treatment. It was also noted that there was a net loss of Rs 1,268 in absolute control ($N_oP_oK_o$) (Table 2).

The B:C ratio was also the highest with N_{120} P_{40} K_{40} (Rs 1.12), followed by N_{120} $P_{40}K_0$. The B : C ratio was negative, showing a loss due to this cropping sequence under no fertilization ($N_0P_0K_0$). Thus, it may be inferred from these findings that to get maximum return and benefit: cost ratio from pearlmillet—wheat cropping sequence, both crops should be fertilized with 120 kg N, 40 kg P_2O_5 and 40 kg K_2O/ha, when this sequence is adopted over years continuously (Table 2).

Change in soil–fertility status

The change in soil–fertility status was assessed after completion of 3 cycles of crop sequence (Table 2). There was a net loss (-) of soil N under control plot ($N_0P_0K_0$) and lower level of N, whereas positive balance was observed at 80 and 120 kg N/ha due to residual build up. The maximum available N was recorded with 120 kg N applied with P and K. The available P after 3 years was found to decrease at lower level of 40 kg P_2O_5/ha. There was a negative trend under absolute control and control plot, where no P was applied. However, a gain was observed when higher rate of 80 kg P_2O_5/ha was

Table 2. Economics and changes in soil fertility status in pearlmillet-wheat sequence as influenced by N, P and K fertilization

Treatment* ($N:P_2O_5:K_2O$)	Economics of sequence (Pooled mean of 3 years)		Available nutrient status (kg/ha)					
	Net return (Rs/ha)	B:C ratio	1990-91 (Before *kharif*)			1992-93 (After *rabi*)		
			N	P	K	N	P	K
0:0:0	-1,343.63	-0.17	94	8.0	242	89	8.2	237
0:0:0	-1,039.88	-0.15	97	8.8	237	91	8.2	233
0:0:0	1,422.18	-0.19	96	8.2	239	91	7.7	235
1:0:0	2,519.92	0.34	111	9.2	242	109	8.7	238
1:0:1	2,633.54	0.37	114	9.3	269	110	8.7	274
1:1:0	4,437.35	0.54	113	10.8	254	111	11.2	251
1:1:1	3,080.02	0.39	112	10.9	283	110	11.6	287
1:2:0	2,240.92	0.26	113	11.2	254	109	12.1	249
1:2:1	3,511.77	0.39	115	11.7	280	112	12.6	286
2:0:0	4,686.97	0.63	123	9.9	250	124	9.5	246
2:0:1	6,191.32	0.80	124	9.4	287	125	8.4	294
2:1:0	7,719.79	0.91	126	10.7	253	128	11.1	247
2:1:1	6772.65	0.78	125	10.8	276	128	11.5	282
2:2:0	6,871.47	0.75	127	11.9	242	129	12.8	238
2:2:1	8,081.77	0.85	126	12.0	274	130	12.9	279
3:0:0	8,636.15	1.08	132	9.9	247	135	9.4	241
3:0:1	7,219.52	0.89	134	9.6	292	139	8.9	299
3:1:0	9318.35	1.06	133	10.7	248	139	11.2	243
3:1:1	10,364.11	1.12	136	10.9	289	142	11.5	295
3:2:0	10,140.09	1.04	135	12.9	251	141	12.9	243
3:2:1	7,619.49	0.75	136	11.9	290	141	12.8	296

*Treatment details are given in Materials and Methods

applied. Similar trend in respect of available K after 3 cycles of crop sequence was observed. There was net loss of K under absolute control and no K application.

It may thus be inferred that continuous cropping of pearlmillet—wheat sequence over a fixed site, reduced the available soil NPK year after year at lower levels of fertilizers, but same was sustained at higher levels.

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