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Long-term effect of manuring in pearlmillet (*Pennisetum glaucum*)–wheat (*Triticum aestivum*) cropping system on soil fertility and yield stability

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ABSTRACT

A long-term field experiment was conducted during the rainy and winter seasons of 1977–78 to 1988–89 on sandy-loam soil to evaluate the effect of continuous pearlmillet [*Pennisetum glaucum* (L.) R. Br. emend Stuntz]–wheat (*Triticum aestivum* L. emend. Fiori & Paol.) cropping sequence on soil fertility and yield stability. Application of 120 kg N/ha and 40 kg P_2O_5/ha to each crop was found effective for cereal-based cropping sequence under the condition of north-western Rajasthan. The continuous fertilizer application built up the fertility status of the soil.

In Rajasthan the maximum area under pearlmillet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz]–wheat (*Triticum aestivum* L. emend. Fiori & Paol.) sequence is concentrated. Therefore it is essential to find out optimum dose of nitrogen, phosphorus and potassium for this system. The present experiment was therefore undertaken to find out the long-term effect of cropping sequence and manuring for getting higher production without impairing the soil health.

MATERIALS AND METHODS

A field experiment was conducted to study the long-term effect of continuous cropping and manuring with nitrogen, phosphorus and potassium in selected pearlmillet (rainy season)–wheat (*rabi*) crop sequence for 11 consecutive years from rainy season 1977 to winter season 1989–90 under irrigated condition at Agricultural Research Sub-Station, Hanumangarh. The soil was sandy-loam soil (sand, silt and clay 68.25, 14.75 and 16.0% respectively). The climate of the region is semi-arid. The average annual precipitation received was 200–250 mm. Long-dry spell is of common occurrence in the rainy season. The experiment soil had initial organic carbon 0.12%, available P_2O_5 9.12 kg/ha and available K_2O 298 kg/ha, pH 8.0, electrical conductivity 0.45 mmhos/cm at 25°C and cation-exchange capacity 9.5 meq/100 g soil. Total 19 treatment combinations consisted of 3 levels each of N and P and 2 levels of K along with the control ($N_0P_0K_0$) were tried in $3^3 \times 2$ factorial partially confounded design in fixed plots, having 1 control plot in each block with 4 replications. Nitrogen, phosphorus and potash were applied through urea, sin-

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Table 1. Effect of nitrogen, phosphorus and potash on grain yield of pearlmillet (q/ha) at Hanumangarh

Treatment	Pearlmillet yield (q/ha)													
	1977–78	1978–79	1979–80	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	Pooled mean
N_{40}	11.53	13.97	23.94	16.20	14.78	22.38	28.21	20.11	25.15	20.84	21.39	20.64	21.53	20.10
N_{80}	14.02	16.91	27.37	20.99	16.39	28.86	33.50	26.03	30.96	24.81	27.19	27.95	26.58	24.79
N_{120}	15.15	18.81	35.37	20.67	21.78	32.44	36.00	32.63	34.98	28.52	28.60	30.40	29.15	28.15
CD (P = 0.05)	0.580	0.72	1.43	2.18	0.95	2.15	0.83	1.64	1.75	0.95	1.48	1.14	1.05	0.66
P_0	12.87	16.42	28.88	18.54	16.97	24.05	31.48	24.69	29.45	24.02	23.41	25.00	24.96	23.15
P_{40}	14.28	16.63	29.22	19.30	17.11	28.50	32.53	26.58	30.59	24.71	26.77	26.86	25.98	24.62
P_{80}	13.55	16.65	28.59	20.01	18.87	31.15	31.71	27.50	31.02	25.48	26.99	27.13	26.32	25.28
CD (P = 0.05)	0.580	NS	NS	NS	NS	2.15	0.83	1.64	NS	0.95	1.48	1.14	1.05	0.61
K_0	13.73	16.28	29.53	18.80	17.33	6.97	32.3	26.24	30.10	24.28	25.79	25.99	25.26	24.06
K_{40}	13.40	16.85	28.26	19.77	17.96	28.83	32.85	26.27	30.60	25.16	25.66	26.67	26.25	24.64
CD (P = 0.05)	NS	NS	NS	NS	NS	1.76	NS	NS	NS	NS	NS	NS	0.86	NS
Control mean		7.28	16.56	13.70	11.94	19.78	24.09	15.36	19.50	16.77	18.42	17.00	16.39	15.88

gle supperphosphate and muriate of potash respectively. Full dose of P and K and half dose of N was applied as basal to pearlmillet and wheat crops at the time of sowing. The remaining half quantity of N was applied 25—30 days after sowing at first irrigation to both these crops.

'BJ 04' pearlmillet was sown in the second week of July, followed by 'Raj 1482' wheat in the second week of November in each year. Representative soil samples from each plot from depth of 0–15 and 15–30 cm were drawn for analysis before and after harvest of each crop every year and were analysed for N, P and K.

RESULTS AND DISCUSSION

Response of pearlmillet to N, P and K

The grain yield of pearlmillet increased significantly with an increase in N level in all the seasons (Table 1). Application of 120 kg N/ha gave significantly higher grain yield over 40 and 80 kg N/ha, except during 1980–81 when it was at par with 80 kg N/ha. In average data, application of 120 kg N/ha increased the grain yield up to 11.93 and 28.69% over that of 80 and 40 kg N/ha respectively. The findings confirm the results of Singh and Singh (1979) and Patel *et al.* (1991).

The application of P was not found effective during initial years up to 1980–81 but afterwards P @ 40 kg/ha and 80 kg/ha gave significantly higher yields over no P application during 1983–84, 1984–85, 1987–88 and 1988—89. However, the difference between 40 and 80 kg P/ha was found significant only during 1981–82 and 1982–83. This might be attributed to low P-fixing capacity of the experimental soil.

The yield data (Table 1) of pearlmillet in all the seasons of 11 years showed that K application did not increase the grain yield except during 1982–83 and 1989–90. This might be due to sufficient K reserve and high, K buffering capacity of the soil. The response of pearlmillet to N and P is attributed to the low status of organic carbon and available P in the experimental soil. However, no response of K might be due to high status of native available K in the soil.

Response of wheat to N, P and K

The response of wheat to N application increased significantly with increasing level of N (Table 2). The linear response of N was observed up to 120 kg N/ha in all the years. The highest mean grain yield of wheat (33.10 q/ha) was recorded under 120 kg N/ha which was significantly superior to 80 kg N/ha, giving 19.19% higher grain yield. Chandrasekharaiah *et al.* (1985), Raghuwanshi *et al.* (1988) and Patel *et al.* (1991) also reported similar findings.

Phosphorus @ 40 and 80 kg/ha significantly enhanced the grain yield of wheat in all the years over that of without P. The grain yield increased with increase in level of P from 0 to 80 kg/ha. However, differences between 40 and 80 kg P/ha were found non-significant during 1984–85, 1987–88, 1988–89 and pooled analysis. The enhancement due to 40 and 80 kg P/ha over no P amounted to 3.75 and 5.3 q/ha mean grain yield of wheat, as indicated by pooled results. Godyni and Tiwari (1985) and Raghuwanshi *et al.* (1988) also reported beneficial effect of P on wheat crop.

The application of K did not increase the grain yield of wheat significantly during all the years.

Soil-fertility status

The data (Table 3) for soil-fertility status showed that after completion of 11-year continuous cropping of pearlmillet–wheat, the

Table 2. Effect of nitrogen, phosphorus and potash on the grain yield of wheat (q/ha) at Hanumangarh

Treatment	Wheat yield (q/ha)													
	1977—78	1978—79	1979—80	1980—81	1981—82	1982—83	1983—84	1984—85	1985—86	1986—87	1987—88	1988—89	1989—90	Pooled mean
N_{40}	17.20	15.41	18.40	15.68	21.30	25.72	23.49	17.10	13.66	16.78	8.27	23.86	20.45	17.65
N_{80}	27.30	24.01	27.38	18.79	31.50	33.41	31.34	25.45	21.27	23.90	12.26	21.98	23.63	25.13
N_{120}	33.20	31.00	36.00	21.16	40.16	43.79	37.22	30.23	28.07	29.43	14.94	28.78	25.35	31.10
CD (P = 0.05)	2.59	1.00	1.43	1.64	0.74	1.13	1.40	3.35	1.13	0.78	0.88	0.91	1.68	2.19
P_0	23.49	21.45	22.44	17.54	28.87	30.75	27.02	20.19	18.05	19.53	9.94	17.10	20.03	21.58
P_{40}	27.17	23.68	28.92	18.87	31.67	25.35	30.30	25.39	21.55	24.11	12.46	22.57	24.71	25.33
P_{80}	27.05	24.79	30.51	19.29	32.89	37.33	35.06	27.21	23.41	26.47	13.08	24.95	24.69	26.97
CD (P = 0.05)	2.59	1.00	1.43	NS	0.74	1.13	1.40	3.35	1.11	0.78	0.88	0.91	1.68	2.19
K_0	25.22	23.60	27.59	18.39	31.44	34.50	30.34	24.36	20.95	23.12	11.85	21.49	23.23	24.53
K_{40}	26.58	23.36	26.98	18.17	30.84	34.30	31.29	24.14	21.05	23.62	11.80	21.59	23.06	24.72
CD (P = 0.05)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control mean					7.64	15.31	11.87	10.69	5.77	6.97	4.63	6.15	16.24	8.87

Table 3. Long-range effect of continuous cropping and manuring on soil-fertility changes under pearlmillet–wheat sequence after the completion of the experiment (winter1989–90).

Treatment	Organic carbon (%)	Available P (kg/ha)	Available K (kg/ha)
N (kg/ha)			
40	0.13	9.76	210.43
80	0.19	10.82	228.75
120	0.24	12.85	256.99
P_2O_5 *(kg/ha)*			
0	0.17	9.18	217.26
40	0.18	10.94	234.73
80	0.21	13.41	244.18
K_2O *(kg/ha)*			
0	0.18	10.90	218.04
40	0.19	11.46	246.08
Absolute control	0.08	8.60	187.88
Initial soil Analysis	0.12	9.12	198.57

organic carbon and available P and K improved due to continuous application of fertilizers to pearlmillet and wheat crop as compared to initial soil-fertility status. Organic carbon, available P and K status were higher in plots received the different levels of nutrients compared with absolute control receiving no nutrient to both the crops. The built up of soil fertility in respect to organic carbon, available P and K may be attributed to addition of biomass in the form of roots and plant residues due to continuous cropping and manuring. Similar observations were also reported by Ghosh (1987).

REFERENCES

Chandrasekharaiah, M. A., Palled, Y. B. and Radder, G. D. 1985. Response of wheat to irrigation and nitrogen. *Indian Journal of Agronomy* **30** (3) : 300–304.

Ghosh, A. B. 1987. Some aspects of stability and fertility and crop production. *Journal of Indian Society of Soil Science* **35** : 552–67.

Godyani, B. M. and Tiwari, B. P. 1985. Effect of irrigation and fertilizer on growth and yield of wheat. *Indian Journal of Agronomy* **30** (3) : 342–344.

Patel, S. K., Patel, M. M., Kerelia, G. N., Patel, M. P., Upadhyay, S. M. and Patel, B. A. 1991. Long term effect of continuous pearlmillet (*Pennisetum glaucum*)—wheat (*Triticum aestivum*) cropping system and manuring on soil fertility and yield stability. *Indian Journal of Agronomy* **36** (3) : 86–90.

Raghuwanshi, R. K. S., Nema, M. L., Dubey, D. D., Umat, R. and Thakur, H. S. 1988. Manurial requirement of a long term hybrid sorghum wheat cropping sequence. *Indian Journal of Agronomy* **33** (3) : 295–299.

Singh, J.P. and Singh, K. 1979. Studies on the effect of some cultural practices on growth, yield and nitrogen uptake by hybrid bajra. *Indian Journal of Agricultural Research* **13** (3) : 180–186.