

Effect of integrated nutrient management on productivity of pearl millet (*Pennisetum glaucum*)-wheat (*Triticum aestivum*) cropping system

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ABSTRACT

In a field experiment conducted at Hisar from 1984-85 to 1996-97, integration of chemical fertilizers and organic manures in the form of FYM or green manure in the ratio of 50:50 or 75:25 applied in pearl millet (*Pennisetum glaucum* L.) and followed by 100% recommended dose of fertilizer in wheat (*Triticum aestivum* L. emend Fiori & Paol) crop gave the yield at par to that of when 100% recommended dose of fertilizers was applied to both the crops of the sequence. These treatments were significantly better than control and farmer's practice. The 4.63-43.27% and 35.27-47.18% higher yields were obtained in pearl millet-wheat respectively over farmer's practices. In general, the NPK status decreased successively after harvesting of both the crops of the sequence due to removal of nutrients in large quantity by the crops. After more than one decade of experimentation at permanent site the nutrient status of soil under control and lower doses of fertilizer application declined to a much higher degree as compared to the application of either 100% recommended dose of chemical fertilizers or combination of organic and inorganic fertilizers.

Key words: Pearl millet-wheat sequence, Integrated nutrient management

Sufficient information is available on response of pearl millet and wheat crops to fertilizer application in the sole crops. However, limited information is available on integrated nutrient management on pearl millet-wheat cropping system. It is being realised that system based research would be more advantageous for optimising the use of different sources of plant nutrients. Also due to escalation of fertilizer prices, the integrated nutrient supply approach would be more remunerative for getting higher returns with considerable ferti-

lizer economy and better soil health. Keeping in view these facts, the present investigation was carried out to study the effect of organic manure in combination with chemical fertilizers on yields and nutrient uptake by pearl millet-wheat crops in sequence of the region. This study was started in 1984-85 as a long term experiment on the fixed site so that the changes in soil parameters can also be monitored.

MATERIALS AND METHODS

A field experiment was conducted at

Agronomy research farm of CCS Haryana Agricultural University, Hisar from 1984-85 to 1996-97. The soil of the experimental field was analysed before and after each crop, treatment wise of permanently laid out plots. The experiment was laid out in R.B.D. keeping plot size of 80 m² with 4 replications. The crop sequence of pearl millet-wheat was followed with 12 treatments. The treatment details are given in Table 1.

The pearl millet and wheat crops of sequence were sown in July and November respectively. According to the treatments the calculated quantity of FYM, green manure and wheat straw was applied before sowing of pearl millet crop and required quantity of nitrogen (half at sowing and half at knee high stage in pearl millet and at the time of first irrigation in wheat crop) was applied

through urea. All other practices including basal doses of P and K were applied in both the crops. The yield and nutrient uptake data of pearl millet-wheat are given in Tables 2 and 3 for selected years of 1984-85, 1990-91, 1993-94 and 1996-97 as the representative data of the experimental field.

RESULTS AND DISCUSSION

The results of the experiment for the last 14 years have been compiled. However, the data for the selected years (1990-91, 1993-94 and 1996-97 along with 1984-85 base year) have been considered in the present paper (Tables 2 and 3). The grain yields of both the crops (pearl millet equivalent yield) indicated that total yield declined from 39.76 q/ha in 1984-85 to 27.04 q/ha during 1996-97 under control treatment (T₁). Under treat-

Table 1. Treatment details of pearl millet-wheat cropping system

Treatment	<i>Kharif</i>	<i>Rabi</i>
T ₁	Control (no fertilizer)	Control (no fertilizer)
T ₂	50% recommended NPK dose through fertilizers	50% recommended NPK through fertilizers
T ₃	50% -do-	100% -do-
T ₄	75% -do-	75% -do-
T ₅	100% -do-	100% -do-
T ₆	50% recommended NPK through fertilizers + 50% N through FYM	100% -do-
T ₇	75% recommended NPK through fertilizers + 25% N through FYM	75% -do-
T ₈	50% recommended NPK through fertilizers + 50% N through wheat straw	100% -do-
T ₉	75% recommended NPK through fertilizers + 25% N through wheat straw	75% -do-
T ₁₀	50% recommended NPK through fertilizers + 50% N through G.M.	100% -do-
T ₁₁	75% recommended NPK through fertilizers + 25% N through G.M.	75% -do-
T ₁₂	Farmers' practice (80 kg N/ha)	Farmers' practice (90 kg N/ha)

Table 2. Effect of different treatments on yield (q/ha) of pearl millet-wheat cropping system

Treatment	Yield (q/ha) 1984-85			Yield (q/ha) 1990-91			Yield (q/ha) 1993-94			Yield (q/ha) 1996-97			% increase over control	
	Pearl- millet	Wheat	Total equivalent yield of pearlmillet	Pearl- millet	Wheat	Total equivalent yield of pearlmillet	Pearl- millet	Wheat	Total equivalent yield of pearlmillet	Pearl- millet	Wheat	Total equivalent yield of pearlmillet	Pearlmillet	Wheat
T ₁	13.55	20.97	39.76	10.38	13.13	26.79	14.25	15.81	34.01	9.90	13.71	27.04		
T ₂	20.66	48.15	80.85	13.66	26.56	46.86	17.99	36.16	63.19	17.11	31.69	56.72		
T ₃	20.83	58.26	93.66	12.09	36.56	57.79	14.05	43.06	67.88	17.90	37.81	65.16		
T ₄	24.88	55.77	94.59	14.23	33.13	55.64	18.23	41.94	70.66	18.92	37.06	65.25		
T ₅	28.13	59.71	102.77	17.27	42.50	70.40	19.96	48.88	81.06	22.00	39.81	71.76	32.36	47.18
T ₆	23.10	63.30	102.22	17.56	41.25	69.12	17.62	47.38	76.83	24.76	41.63	76.79		
T ₇	25.32	57.65	97.38	18.55	37.81	65.81	22.58	44.00	77.58	24.60	36.00	69.60	43.27	35.28
T ₈	21.20	59.56	95.65	14.56	38.91	63.20	14.04	44.94	70.36	16.69	39.31	65.83	4.63	40.47
T ₉	21.97	55.98	91.94	17.66	37.50	64.54	22.27	40.31	72.66	22.41	40.69	73.27		
T ₁₀	21.03	61.04	97.33	18.00	43.28	72.10	16.84	46.19	74.58	20.02	39.56	69.47		
T ₁₁	24.84	56.91	95.98	19.45	33.75	61.64	18.93	40.25	69.24	21.15	37.38	67.87		
T ₁₂	15.18	32.90	56.28	12.56	32.07	52.65	17.78	36.19	63.02	18.05	28.56	53.75		
CD (P = 0.05)	1.02	3.41	3.96	2.41	4.32	6.51	4.60	5.75	8.96	3.15	2.71	5.14		

Table 3. Effect of different treatments on N, P and K uptake.

Treatment	Nutrient uptake (kg/ha)																							
	1984-85						1990-91						1993-94						1996-97					
	Pearlmillet			Wheat			Pearlmillet			Whe.			Pearlmillet			Wheat			Pearlmillet			Wheat		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
T ₁	48.8	13.5	160.0	26.2	5.1	62.8	25.5	8.3	86.6	25.0	7.3	39.0	28.9	7.7	105.4	20.3	5.7	57.9	27.6	5.7	69.1	27.8	4.7	34.7
T ₂	75.9	19.6	328.8	68.1	14.2	176.1	30.6	9.7	108.6	54.6	13.2	83.0	34.7	8.3	121.9	63.5	13.8	132.5	48.8	9.5	122.3	67.6	11.2	84.2
T ₃	68.2	13.2	356.5	80.9	16.7	190.2	31.2	9.9	94.4	76.1	18.9	130.0	30.1	8.8	110.9	62.0	15.7	174.0	50.3	8.8	115.8	87.4	14.4	77.4
T ₄	85.2	15.4	302.6	70.7	16.3	167.9	33.5	12.4	119.7	63.5	16.0	104.7	38.7	8.9	126.6	87.2	14.4	153.0	55.2	10.2	123.7	75.6	16.5	100.2
T ₅	77.8	21.6	326.2	76.1	16.0	193.0	39.5	11.9	135.1	83.4	11.6	143.7	44.7	11.0	108.9	73.0	17.5	182.2	60.1	11.6	130.2	85.6	15.5	111.9
T ₆	74.4	20.0	260.9	87.9	20.2	215.0	36.0	16.2	132.9	69.8	19.9	133.4	34.4	8.5	116.4	80.9	17.8	175.6	75.1	14.0	162.1	92.5	16.0	117.6
T ₇	79.3	17.9	299.1	78.4	14.8	187.0	40.1	13.0	155.4	78.6	17.9	161.1	42.6	9.8	124.2	93.6	16.9	189.0	66.5	15.2	142.1	81.7	15.5	101.2
T ₈	65.5	15.5	257.0	79.9	17.7	182.6	37.6	11.9	138.5	75.7	19.7	182.9	24.0	8.1	99.9	71.8	17.6	176.3	52.7	11.0	122.7	83.6	16.2	111.1
T ₉	66.4	12.6	292.7	82.7	12.2	170.6	45.0	17.8	151.1	76.7	12.5	116.3	36.5	10.2	131.7	60.9	13.7	134.4	60.3	13.3	155.5	85.9	16.5	112.4
T ₁₀	69.5	16.0	304.1	84.9	21.4	220.3	41.5	15.7	146.2	89.4	15.5	175.9	31.3	7.4	107.5	89.8	13.5	164.0	54.5	10.7	144.0	86.4	16.1	118.2
T ₁₁	67.9	19.0	247.0	63.2	14.2	174.1	46.7	16.0	153.3	70.5	10.3	126.6	40.6	10.0	104.7	84.2	13.2	163.7	60.2	11.6	139.3	80.5	13.5	100.2
T ₁₂	51.6	11.0	176.6	43.0	8.9	121.3	30.0	11.7	112.5	69.0	11.6	93.3	42.5	8.8	104.6	69.6	11.3	131.3	46.4	10.1	119.4	59.8	10.0	74.9
CD (P = 0.05)	9.4	2.1	42.6	10.7	2.9	36.9	8.8	1.9	35.4	9.90	2.67	36.5	9.9	NS	NS	26.7	2.7	27.1	7.4	1.6	19.8	6.8	1.3	18.3

ment T_5 where 100% recommended dose of NPK was applied through chemical fertilizer, the corresponding yields were 102.77, 70.40, 80.06 and 71.76 q/ha of pearl millet equivalent indicating thereby a continuous decrease in the yield of the crops of the system. However, decline in yield under control plot (T_1) was more than that of application of recommended dose of fertilizers (T_5). The recommended dose of fertilizer to both the crops of the sequence gave the highest yield and significant reduction in yield was observed with the decrease in fertilizer doses to 75% or 50% in one and/or both the crops of the sequence. Integration of nutrients @ 50% recommended dose through chemical fertilizers with 50% nitrogen through FYM or green manure in pearl millet and 100% recommended dose of NPK in wheat through chemical fertilizers (T_6) produced grain yield of both pearl millet and wheat at par with that of recommended dose of fertilizers (T_5) in both the crops of the system. The treatment T_5 where 100% recommended dose of NPK was applied to both the crops gave significantly higher yield over farmers' practice and no fertilizer treatment. But the yield obtained in treatments T_6 and T_7 where the fertilizer was applied in 50:50 and 25:75 ratios of organic sources and chemical fertilizer were statistically at par with that of 100% recommended dose through chemical fertilizers. Among the organic sources the FYM and green manure proved to be better than the wheat straw in all the years of investigation. The reason for the poor performance of wheat straw may be the wider C : N ratio, initial immobilization and delayed decomposition of wheat straw. The response to organic sources was recorded in pearl millet as well as its residual effect in succeeding wheat crop. The similar findings were also reported by Singh *et al.* (1998),

Balyan (1996) and Hegde (1992) in cereal based cropping system.

In general, fertility status (N P K) of the soil decreased successively after harvesting of each crop. The major nutrients i.e. nitrogen, phosphorus and potash were removed in large amount by the crops. All the nutrients were depleted more in control treatment and farmers' practice and also suboptimal doses of fertilizer application than under the treatment receiving recommended dose of fertilizer application. Organic sources (FYM or green manure or wheat straw) could not improve nitrogen status of the soil after 14 years of experimentation. Similarly, there was more depletion of phosphorus after 14 years of study, but it declined more in control and lower doses of fertilizers as compared to recommended doses of fertilizers and under integrated organic manures with fertilizer treatments (Table 3). Similarly potash status of the soil was also depleted more after 14 years. During winter the higher uptake of NPK nutrients was recorded where the crop received 100% of the recommended doses of the fertilizer preceded by the treatment receiving 50% through inorganic source and 50% through organic sources. Similar results were reported by Singh *et al.* (1998), Gill *et al.* (1994) and Singh and Singh (1997). It is evident that higher uptake of nutrients by the crops has contributed towards the increase in grain yield contrary to control (no fertilizer treatment).

It may be concluded that under semi arid and sub-tropical conditions of Hisar, the productivity of pearl millet-wheat cropping system could not be maintained to its initial level (1984-85) even with the application of 100% recommended dose through chemical fertilizers. However, it is evident that to maintain relatively higher level of productivity, after more than one decade, either

100% recommended dose of NPK fertilizers or combination of organic (FYM or green manure) and inorganic fertilizers proved better than farmers' practice and/or control. Also any reduction in recommended fertilizer dose applied to either of these crops has adverse effect on their productivity.

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