Indian J. Agron. **40** (4) : 544–548 (December 1995)

Production potential, economics and fertility status of soil as influenced by wheat (*Triticum aestivum*)-based cropping system

E. N. PATIL[1], S. M. JAWALE AND M. S. MAHAJAN

Agricultural Research Station, Mahatma Phule Krishi Vidyapeeth, Niphad, Maharashtra 422 303

Received: December 1993

ABSTRACT

An experiment was conducted to study the comparative production potential, economics and fertility status of soil as influenced by wheat (*Triticum aestivum* L. emend. Fiori & Paol.)-based cropping systems, under different fertility levels and addition of organic manures during 1988–89 to 1991–92. The gross as well as net monetary returns of pigeonpea [*Cajanus cajan* (L.) Millsp.]–wheat sequence with recommended dose of fertilizer to both the crops were found remunerative and beneficial than other sequences tried. This crop sequence recorded more land-use efficiency and production efficiency over the others. Fertility status of the soil was also improved by adoption of pigeonpea–wheat sequence, but reduced by cereal–cereal sequence. The recycling of organic waste was found beneficial in saving the applied as well as efficient in enriching the soil health. Amongst the recycled organic manures, farmyard manure was more efficient and followed by wheat straw.

As the cost of nitrogenous fertilizers is increasing day by day, it becomes imperative to substitute nitrogen by some other cheap sources of organic manures, which can at least partially meet the crop requirement and improve the soil properties. The isolated data on performance of different cropping systems, viz. cereal–cereal, legume–cereal, are available in plenty. However, data on comparative performance of such sequences coupled with possibility of economizing applied nitrogen through recycling organic wastes at one place over a considerable time, are meagre. Hence an experiment was conducted to study the effect of different wheat (*Triticum aestivum* L. emend. Fiori & Paol.)-based cropping systems on productivity, economics and their effect on soil fertility, under different fertility levels with conjunctive recycling of organic wastes.

MATERIALS AND METHODS

A field experiment was conducted for 3 years during 1988–89 to 1991–92 at Agricultural Research Station, Niphad. The Vertisol soil had organic carbon 0.53%, available nitrogen 240.12 kg/ha, available P_2O_5 16.40 kg/ha and available K_2O 756.20 kg/ha, with pH 8.2. The bulk density was 1.38 g/cm^3. The soil-moisture constant at $^1/_3$ bar and 15 bar were 38.16 and 16.37% respectively. The experiment was conducted on same site without changing the randomization in randomized block design, replicated thrice. The gross and net plot size was 5.4 m x 7.0 m and 4.5 m x 6.0 m

Present address: [1]College of Agriculture, Dhule, Maharashtra 424 001 (M. S.)

respectively. The details of sequences and fertilizer levels tried are given in Table 1.

In treatments T_2, T_3 and T_4 the quantity of organic matter of green-leaf manure, farmyard manure and wheat-straw equivalent to have 25 kg N/ha was added at 10 cm deep in soil, a month before sowing of rainy-season crops. Details of N content, quantity added and its cost are given in Table 2.

The crops were raised with recommended package of practices. During the crop-growth period in the rainy season 377.3, 398.3 and 221.4 mm rainfall was received during 1988–89, 1990–91 and 1991–92 respectively. However, only 15.5 mm rainfall was received in the winter season during 1990–91. Wheat received 5 irrigations at critical crop-growth stages.

The data of 3 years were pooled. The land-use efficiency (LUE) and production efficiency (PE) were worked out:

$$\text{LUE} = \frac{\text{Duration of sequence (days)}}{\text{Number of days in 2 years}} \times 100$$

$$\text{PE (Rs/day/ha)} = \frac{\text{Net monetary returns of sequences}}{\text{Duration of sequence (days)}}$$

RESULTS AND DISCUSSION

Effect of season

The season during first and second years was normal and favourable for satisfactory

Table 1. Cropping sequences and fertilizers used

Treatment	Crop sequence			Fertilizer dose (kg/ha)					
	Summer	Rainy season	Winter season	Rainy season			Winter season		
				N	P_2O_5	K_2O	N	P_2O_5	K_2O
T_1	Fallow	Pearlmillet	Wheat	60	30	0	120	60	40
T_2	Addition of GLM	Pearlmillet	Wheat	45	30	0	120	60	40
T_3	Addition of FYM	Pearlmillet	Wheat	45	30	0	120	60	40
T_4	Addition of WS	Pearlmillet	Wheat	45	30	0	120	60	40
T_5	Fallow	Groundnut	Wheat	20	40	0	120	60	40
T_6	Fallow	Groundnut	Wheat	20	40	0	90	60	40
T_7	Fallow	Pigeonpea	Wheat	25	40	0	120	60	40
T_8	Fallow	Pigeonpea	Wheat	25	40	0	90	60	40

GLM, Green-leaf manuring with *subabul*; FYM, farmyard manure; WS, wheat straw

Table 2. Quantity of green-leaf manure (GLM), farmyard manure (FYM) and wheat straw added in soil

Treatment	Source of organic matter	N content (%)	Organic matter (q) required for gaining 25 kg N/ha	Cost of organic matter (Rs/ha)
T_2	GLM (*subabul*)	0.49	30.60	1,530
T_3	FYM	0.60	25.00	500
T_5	Wheat straw	0.45	33.33	333

Rate of organic matter added (Rs/q): GLM, 50; FYM, 20; wheat straw, 10

yield due to timely and well-distributed rainfall. During the third year the rainfall was below normal (221.4 mm), which affected the yield of groundnut and pigeonpea adversally, but favoured the yield of pearlmillet. In all the 3 years yield of wheat was quite normal.

Effect of addition of organic matter

Though the addition of green-leaf manure, farmyard manure and wheat straw as the recycling methods of organic manure was not efficient to improve the benefit : cost ratio as well as land-use efficiency of the sequence. However, these treatments had definite positive effect on production efficiency as well as on N-use economy. These treatments not only saved 25% of applied N but also proved beneficial in improving the N status of the soil considerably as compared with cereal—cereal sequence. The status of P and K could also improved in these treatments, indicating the favourable effect of addition of organic matter in the cropping sequence.

Amongst the treatments of organic recycling, the farmyard manure was the most efficient one. However, its availability and cost are the major constraints in adoption. Recycling of wheat straw and green-leaf material seems to be viable in saving the applied N as well as in enriching the soil health.

Crop productivity and economics

The grain and straw yields of wheat were not significantly affected by different cropping sequences. During 1988—89 groundnut followed by wheat with 120 kg N + 60 kg P_2O_5 + 40 kg K_2O/ha gave the highest grain yield of wheat than other crop sequences. Similar trend was noticed when the data were pooled over the seasons. During 1990—91 the grain yield of wheat was the highest with pigeonpea [*cajanus cajan* (L.) millsp.] —wheat sequence coupled with application of 120 kg N + 60 kg P_2O_5 + 40 kg K_2O/ha. However, during 1991—92 pigeonpea—wheat sequence recorded the highest grain yield of wheat combined with application of 90 kg N + 60 kg P_2O_5 + 40 kg K_2O/ha. The wheat yield was normal in all the years; might be due to inclusion of legume in crop sequences like groundnut (*Arachis hypogaea* L.) and pigeonpea and addition of green-leaf manure, farmyard manure and wheat straw in summer with recommended dose of fertilizer in pearlmillet [*Pennisetum glaucum* (L.) R. Br. emend. stuntz]—wheat sequence.

The pigeonpea—wheat cropping sequence with recommended fertilizer dose to wheat produced significantly higher gross and net returns over all the cropping sequences. This sequence with 75% N to wheat was the second in order, followed by groundnut—wheat cropping sequence. The benefit : cost ratio was also higher (1.96) with pigeonpea—wheat cropping sequence, indicating higher profitability (Table 3). This might be due to higher production potential and higher prices of pigeonpea than other crops tried in sequences. Similar findings were also reported by Kurlekar *et al.* (1993) and Morey and Bagde (1982).

The values of land-use efficiency and production efficiency indicated that the pigeonpea—wheat cropping sequence with recommended dose of fertilizer established its superiority over rest of the sequences.

Fertility status

The data on fertility status of soil after the end of third cycle revealed that all the sequences showed beneficial effect on fertility status of nitrogen, except pearlmillet —wheat sequence (Table 4). This clearly

Table 3. Productivity, economics, land use and production efficiency of different crop sequences (pooled data of three years)

Crop sequence	Rainy-season crop		Winter-season wheat					Gross returns (Rs/ha)	Net returns (Rs/ha)	Benefit: cost ratio	Land-use efficiency (%)	Production efficiency (Rs/day-ha)
	Grain (q/ha)	Fodder (q/ha)	Grain yield (q/ha)				Straw yield (q/ha)					
			1988–89	1990–91	1991–92	Pooled mean						
Pearlmillet–wheat	24.28	29.08	30.62	28.39	25.63	28.21	49.93	17,112	6,412	1.60	28.08	31.28
Pearlmillet–wheat (GLM)	26.69	29.11	29.34	27.63	28.05	28.34	46.99	18,264	6,115	1.50	28.08	29.83
Pearlmillet–wheat (FYM)	28.04	28.62	31.85	26.58	27.97	28.80	52.98	18,458	7,339	1.66	28.08	35.80
Pearlmillet–wheat (WS)	26.77	29.20	32.84	27.63	24.94	28.47	48.11	17,867	6,915	1.63	28.08	33.73
Groundnut–wheat	13.16	24.96	35.31	25.92	25.47	28.90	52.92	20,529	8,056	1.64	30.82	35.80
Groundnut–wheat	13.50	27.92	33.70	27.10	22.66	27.82	51.68	20,356	8,045	1.65	30.82	35.76
Pigeonpea–wheat	13.59	20.12	29.75	29.01	26.74	28.50	47.91	21,293	10,422	1.96	31.51	45.31
Pigeonpea–wheat	13.80	21.30	27.28	28.36	29.71	28.45	46.99	20,423	9,714	1.91	31.51	42.23
CD (P = 0.05)			NS	NS	NS	NS	NS	855	704			

GLM, Green-leaf manure (*subabul*); FYM, farmyard manure; WS, wheat straw added in soil before 30 days after sowing of rainy-season crops for gaining 25 kg N/ha

Table 4. Fertility status of soil after completion of 3 years

Crop sequence	Fertility status after 3 years of cycle (kg/ha)		
	N	P_2O_5	K_2O
Pearlmillet–wheat	230.13	14.82	753.15
Pearlmillet–wheat (GLM)	245.34	16.68	758.63
Pearlmillet–wheat (FYM)	248.38	16.78	757.18
Pearlmillet–wheat (WS)	243.37	16.60	757.16
Groundnut–wheat	248.40	16.55	758.32
Groundnut–wheat	247.33	16.74	757.73
Pigeonpea–wheat	249.10	16.85	759.63
Pigeonpea–wheat	247.23	16.58	756.32

Initial N, P_2O_5 and K_2O status of soil: 240.12,16.40 and 756.20 kg/ha respectively

indicated that inclusion of legumes in the sequence or addition of organic manures to the crop improved the fertility status of available N in soil. The results corroborate the findings of Sonar and Zende (1984). The P and K status in the soil was also maintained by these sequences. The cereal–cereal sequence however exhausted large amount of NPK from the soil and resulted in imparing the fertility status of soil. These results are in agreement to those reported by Jadhav (1989).

Considering the superiority in respect of sustainability, profitability, land-use efficiency, production efficiency and soil fertility, pigeonpea–wheat sequence with recommended dose of fertilizer to both the crops was found not only more remunerative but also beneficial to improve fertility of soil than other sequences. The recycling of organic waste like green-leaf manure, farmyard manure and wheat straw was beneficial in saving the applied N. The farmyard manure was found more efficient, followed by wheat straw.

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