

Productivity, profitability and fertilizer management in different wheat (*Triticum aestivum*)-based cropping systems in silty clay loam soils of Srinagar*

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In Jammu and Kashmir, wheat (*Triticum aestivum* L. emend. Fiori & Paol) is the third important cereal crop and most important in the subtropical zone of the state. It falls in temperate region (Kashmir valley) in area and production is not encouraging as most of the land remains fallow during the winter (*rabi*) season. Self-sufficiency in the state is not possible without introducing wheat as a main *rabi* crop in the valley. Realizing this, a great thrust has been given to popularize the double cropping preferably with wheat being the *rabi* component. Prospects for rice (*Oryza sativa* L.)-wheat rotation exist since early maturing fertilizer responsive wheat varieties with high-yielding ability are available (Trag and Wani 2009). Lower temperature during the winter months, however, check the crop growth, and this may delay the maturity of wheat crop which forces the delaying of sowing operation of succeeding rainy (*kharif*) season crops. Different *kharif* crops therefore may behave differently and this emphasized the need for evaluating the most remunerative wheat-based cropping systems in the valley. Production potential of the cropping system further can be improved by adopting integrated nutrient management approach (Barla and Upasani 2008), which is important to attain sustainable crop production with minimum deleterious effect on soil health and environment. Taking this into consideration a field experiment was conducted during 2004 – 05 and 2005 – 06 at the research farm, Division of Agronomy of the University, Kashmir, on silty clay loam soil with pH 6.93, organic carbon 0.68%, available nitrogen 266.8 kg/ha, available phosphorous 21.5 kg/ha and available potassium 215 kg/ha. The experiment was conducted in a

split-plot design replicated thrice with four fertility levels applied to wheat crop (F₁, recommended fertilizer dose; F₂, recommended fertilizer dose + farmyard manure @ 15 tonnes/ha; F₃, recommended fertilizer dose + biofertilizer *; F₄, recommended fertilizer dose + farmyard manure 15 tonnes/ha + biofertilizer combination of Azospirillum, Azotobacter and PSB in main plots and six crop sequences (C₁, wheat – rice; C₂, wheat – maize; C₃, wheat – sunflower *Helianthus annuus* (L.) ; C₄, wheat – greengram (*Vigna unguiculata* L. walp); C₅, wheat – soybean (*Glycine max* L. Mar); C₆, wheat- rajmash (*Phaseolus vulgaris* L.) in sub plots. The varieties used in different sequences were ‘HS 240’ wheat, ‘Shalimar Rice 1’ rice, ‘Morden’ sunflower, ‘M 86’ green gram, ‘PS 1092’ soybean and ‘Canadian Red’ rajmash. All the *kharif* crops were grown as per the recommended package of practices. The cropping systems were evaluated in terms of wheat grain equivalent, economic returns, and production efficiency. Economics was calculated based on prevailing market rates of inputs and selling prices of the produce. Wheat equivalent yield and production efficiency were computed as:

$$\text{Wheat equivalent yield (tonnes/ha)} = \frac{\text{yield of the produce (tonnes/ ha)} \times \text{price of the produce (₹/tonne)}}{\text{Price of the wheat grain (₹/tonne)}}$$

$$\text{Production efficiency (₹ /day / ha)} = \frac{\text{Net monetary returns of sequence}}{\text{Duration of sequence (days)}}$$

Productivity was judged by converting the yields into wheat equivalent yield which significantly improved with combined application of different sources of nutrients in treatments F₄ (recommended fertilizer dose + farmyard manure + biofertilizer), followed by F₂ (recommended fertilizer dose + farmyard manure) for individual crops and the cropping systems as a whole (Table 1). This may be attributed to the improvement in soil chemical, physical and biological properties and enhanced soil fertility due to use

*Short note

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Table 1 Effect of fertilizer management on productivity, profitability and soil fertility status of different wheat-based cropping systems

Treatment	Wheat equivalent yield (tones/ha)			Production efficiency (₹/day/ha)	Net returns (₹/ha)	B:C ratio	Available NPK (kg/ha) after two years		
	Rabi	Kharif	sequence				N	P	K
<i>Fertility levels</i>									
F ₁ (RFD)*	4.6	4.3	9.0	138.4	48 740	1.62	241.4	20.7	208.6
F ₂ (RFD+FYM)	5.4	4.7	10.1	151.4	53 281	1.44	287.2	22.3	224.1
F ₃ (RFD+biofertilizer)	4.7	4.6	9.3	143.6	50 359	1.67	243.5	23.5	214.4
F ₄ (RFD+FYM+ biofertilizer)	5.5	5.0	10.5	162.3	57 126	1.53	271.1	25.1	232.2
SEm±	0.23	1.42	1.48				2.73	0.54	3.72
CD (P=0.05)	0.7	4.9	5.0				8.4	1.6	12.7
<i>Cropping sequence</i>									
C ₁ (wheat–rice)	5.1	5.0	10.1	160.2	57 627	1.55	248.4	22.2	215.3
C ₂ (wheat–maize)	4.9	4.7	9.6	157.9	56 752	1.72	238.1	22.4	207.5
C ₃ (wheat–sunflower)	5.0	3.5	8.5	121.4	41 521	1.25	242.4	25.3	223.1
C ₄ (wheat–moong)	5.2	4.8	10.0	163.6	54 575	1.71	269.7	22.6	219.2
C ₅ (wheat–soybean)	4.9	5.1	10.0	138.1	50 407	1.36	275.1	23.1	220.0
C ₆ (wheat–rajmash)	5.2	4.8	10.0	152.3	53 757	1.70	260.3	21.9	225.3
SEm±	0.57	1.01	1.52				3.85	0.46	2.90
CD (P=0.05)	2.0	3.5	4.3				12.90	1.3	9.4

*Recommended fertilizer dose

of chemical fertilizer in conjugation with organic and biological sources of nutrients. Similar results were also reported by Sarma *et al.* (2007).

Wheat crop exhibited significant variation in yield in the second year owing to the residual effect of preceding *kharif* crops. Wheat preceded by pulses (greengram and *rajmash*) recorded significantly higher yield (Table 1). This may be presumably due to utilization of nitrogen fixed by the preceding leguminous crops in wheat–pulse legume cropping system. These results are in line with the findings of Miller *et al.* (2003). Poor yield in wheat crop preceded by maize and soybean in general was due to delayed sowing of wheat in these sequences. No significant variation was observed between the wheat equivalent yields of different *kharif* crops with an exception of sunflower, which failed to produce wheat equivalent yield comparable with other crops. This may be due to lower production/unit area and comparatively less market prices due to lack of oil extraction plants in the valley. The higher values, however, were recorded for rice and soybean crops.

Wheat–rice sequence registered significantly higher values for wheat equivalent yield compared to wheat–maize and wheat–sunflower. Other cropping sequences were at par except wheat–sunflower sequence which recorded significantly lower equivalent yield in comparison to rest of sequences. Lower productivity in wheat–sunflower sequence may be attributed to lower production potential and exhaustive nature of the sunflower. In wheat–maize sequence, the lower productivity was attributed to the depressed yield of wheat due to delayed sowing of wheat and exhaustive nature of maize crop. These results are in

conformity with the findings of Tripathi and Rathi (2002) and Bhagat and Dhar (2003).

Production efficiency was maximum for wheat–moong sequence, closely followed by wheat–rice sequence. This may be attributed to more wheat equivalent yield of moong resulted in a comparatively short period and its beneficial residual effect on succeeding wheat. Higher productivity of wheat–rice sequence may be justified with the fact that rice proved to be more productive crop and it did not result in delay of sowing of succeeding wheat crop which otherwise would have a negative impact on wheat yield (Chatrath and Singh 2010), thereby affecting the total yield potential of the sequence as noted in wheat–maize and wheat–soybean sequences.

After two years of field experimentation, combined application of chemical biological and organic sources of nutrients (F₄) resulted in significantly higher nitrogen, phosphorous and potassium status in the soil. The results are in line with the findings of Sharma *et al.* (2001) and Yadav *et al.* (2005). Nitrogen status in the soil was significantly lower with cereal–cereal sequences in comparison to the wheat–pulse sequences, with highest value recorded for wheat–soybean sequence (275.1 kg/ha) which was 10.7, 15.5 and 13.5% higher than recorded for wheat–rice, wheat–maize and wheat–sunflower sequences, respectively. These results indicate that inclusion of leguminous pulses in the system have definite positive effect on nitrogen status in soil. The results are in conformity with the findings of Lupwayi and Kennedy (2007). No significant variation was found in phosphorous status of soil excluding in wheat–sunflower sequence. This may be attributed to the application of

comparatively higher doses of phosphorus to sunflower resulting in greater residual phosphorus in soil. Available potassium in the soil was significantly higher in wheat–soybean, followed by wheat–*rajmash* sequence compared with cereal–cereal sequences. This may be attributed to the exhaustive nature of cereals.

Maximum net profit was recorded with combined application of recommended fertilizer dose + farmyard manure + biofertilizer (Table 1), followed by recommended fertilizer dose + farmyard manure. Ram and Mir (2006) also reported maximum net returns from farmyard manure 15 tonnes/ha + nitrogen 100 kg/ha + biofertilizer (*Azotobacter* + *Azospirillum*). Higher B:C ratio (1.67) was recorded for the combined application of recommended fertilizer dose + biofertilizer. Wheat–rice sequence recorded highest net returns (₹ 57 627/ha). This might be due to higher production potential of this sequence in comparison to others. Wheat–maize sequence recorded maximum values for benefit : cost ratio (1.82) compared with other sequences.

SUMMARY

The combined application of inorganic, organic and biological sources of nutrients to wheat crop significantly improved productivity and monetary returns. Wheat–rice sequence proved more productive and remunerative and could be recommended for maximum profit under temperate Kashmir conditions. Wheat–pulse sequences, on the other hand, produced beneficial residual effect on succeeding wheat crop and resulted into more stability in soil fertility, particularly with respect to nitrogen.

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