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Effect of integrated nutrient management in clusterbean (*Cyamopsis tetragonoloba*)–wheat (*Triticum aestivum*) cropping system under western Rajasthan condition

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ABSTRACT

A field experiment was carried out during 1997–98 and 1998–99 to study the effect of nutrient management on crop productivity and soil fertility in clusterbean [*Cyamopsis tetragonoloba* (L.) Taubert]–wheat (*Triticum aestivum* L. emend. Fiori & Paol.) cropping systems. The highest clusterbean seed yield (608 kg/ha) was obtained under FYM 2.50 tonnes/ha + $N_{10}P_{25}$ (10 kg N and 25 kg P_2O_5/ha). Grain yield of succeeding wheat crop increased by 292 and 427 kg/ha with the residue of FYM 5 tonnes/ha than the residue of $N_{20}P_{50}$ kg/ha and control respectively. Application of FYM 5 tonnes/ha to the preceding crop of clusterbean increased wheat-grain-equivalent yield by 20% over the control. The highest benefit : cost ratio (3.63) and net returns over the control (Rs 5,040) were also accrued with the application of FYM 5 tonnes/ha in clusterbean–wheat cropping systems.

Key words : Clusterbean–wheat cropping, Nutrient management, Benefit : cost ratio, Wheat-equivalent yield, Residual effect

Excessive use and continuous increase in cost of fertilizers inspired the scientists to the explore the possibilities to restrict the fertilizers use and way for economy. Inclusion of legumes with the use of organic manure in the cropping sequence results in improvement of base as well as succeeding crop (Balyan and Seth 1985). Clusterbean–wheat cropping system have an ample scope in the Rajasthan state. Clusterbean being drought resistant can be grown successfully under rainfed condition and wheat can be succeeded to clusterbean by providing irrigation. The soil of the state is very poor in nitrogen and phosphorus (Joshi, 1993), therefore adequate supply of nutrient is must for obtaining good harvest, the knowledge of left–over nutrients in the soil after harvesting of preceding crop and its effect on succeeding crop may be helpful in manipulating the fertilizer requirement. Therefore a field experiment was conducted to evaluate the effect of nutrients on the clusterbean crop and its residual effect on the succeeding crop (wheat) in clusterbean–wheat cropping systems.

MATERIALS AND METHODS

A field experiments was conducted during 1997–98 and 1998–99 at the Satheen, Jodhpur (Rajasthan). The soil was sandy loam with pH 8.1, organic carbon 0.32%, available nitrogen 109 kg/ha, P and K, 6.9 and 352 kg/ha respectively. The total rainfall received during the rainy *(kharif)* season of 1997 and 1998 was 360,30 and 377.40 mm respectively. Five treatments comprised FYM @ 2.5 tonnes/ha , FYM @ 2.5 tonnes/ha + $N_{10}P_{25}$ 10 kg N and 25 kg P_2O_5/ha), FYM @ 5 tonnes/ha, $N_{20}P_{50}$ kg/ha. and control were laid out in randomized block design with 3 replications (Table 1). All the treatments were applied during both the rainy seasons to clusterbean crop only. The FYM was applied at the time of land preparation, whereas nitrogen and phosphorus were supplied as basal dose through inorganic fertilizers. The clusterbean cv. 'RGC 936' was sown in rows 45 cm apart using 12 kg seed/ha on 27 and 8 July and harvested on 8 October and 25 September during 1997 and 1998 respectively.

Wheat '(Raj 3077)' was sown in rows 30 cm apart with seed rate of 100 kg/ha. The wheat crop was sown on 27 and 29 November during respective years in the existing layout used during both the seasons for clusterbean crop. The half dose of recommended fertilizer for wheat (50 kg N and 30 kg P_2O_5/'ha) was applied uniformly in all the plots. Half dose of N (25 kg/ha) along with full dose of P_2O_5 (30 kg/ha) was applied as basal dose. The remaining N was top-dressed at the second irrigation. Soil samples were collected at 0–15 and 15–30 cm depth at the initial and after harvesting of each crop, to work out the available nitrogen and phosphorus content in the soil. The available nitrogen and phosphorus were estimated by using standard procedures, described by Sibbiah and Asija (1956) and Olsen *et al.* (1954). Observations on yield and yield attributes were recorded at harvesting during both the cropping seasons. Total biological yields of both the crops were further computed with prevailing rate of market by converting into wheat-grain-equivalent yield and calculating benefit : cost ratio.

RESULTS AND DISCUSSION

Clusterbean

The pods/plant, seeds/pod, 1,000-seed weight and seed yield were significantly influenced by different treatments (Table 1). Application of FYM 2.5 tonnes/ha + $N_{10}P_{25}$ kg/ha resulted in maximum seed yield, followed by FYM 5 tonnes/ha and recommended dose of $N_{20}P_{50}$ kg/ha. The partial substitution of nitrogen and phosphorus through organic manure (FYM) might have resulted the higher seed yield under FYM 2.5 tonnes + $N_{10}P_{25}$ kg/ha. Rao and Singh (1993) reported that substitution of 50% of fertilizer requirement by FYM resulted in yield levels nearly similar to those obtained with complete fertilization. Application of FYM 2.5 tonnes/ha only significantly reduced the seed yield compared with FYM 2.5 tonnes $N_{10}P_{25}$ kg/ha. FYM 5 tonnes and $N_{20}P_{50}$ kg/ha, but gave statistically higher seed yield over the control. Similarly, straw yield was also affected due to the response of various treatments.

Table 1. Yield and yield-attributing characters of clusterbean and wheat in clusterbean–wheat cropping system (mean data of 2 years)

Treatment	Clusterbean					Wheat				
	Pods/ plant	Seeds/ pod	1,000-seed weight (g)	Seed yield (kg/ha)	Straw yield (kg/ha)	Effective tillers/m²	Grains/ spike	1,000-seed weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
Control	58.20	6.20	28.28	427	780	280	35.40	38.10	3,045	4,350
FYM 2.5 tonnes/ha	71.40	6.80	29.50	496	958	294	37.40	38.30	3,215	4,620
FYM 5 tonnes/ha	85.20	7.10	30.10	594	1,125	311	39.50	38.60	3,472	4,910
FYM 2.5 tonnes/ha + $N_{10}P_{25}$ kg/ha	88.80	7.70	30.40	608	1,182	298	38.10	38.40	3,262	4,540
$N_{10}P_{25}$ kg/ha	84.40	7.40	29.90	581	1,078	301	38.20	38.40	3,180	4,430
CD (P=0.05)	7.20	0.91	0.86	64	147	8.76	1.20	NS	132.60	265

Table 2. Available N and P in soil (kg/ha) as influenced by different treatments in clusterbean–wheat cropping system (mean data of 2 years)

Treatment	0–15 cm soil depth						15–30 cm soil depth					
	Initial		After clusterbean		After wheat		Initial		After clusterbean		After wheat	
	N	P	N	P	N	P	N	P	N	P	N	P
Control	109.20	6.90	120.40	7.10	94.3	5.10	102.20	5.10	113.4	6.20	91.40	4.30
FYM 2.5 tonnes/ha	109.20	6.90	127.10	10.40	97.7	5.80	102.20	5.10	118.1	8.50	94.10	4.50
FYM 5 tonnes/ha	109.20	6.90	137.50	12.20	98.8	6.10	102.20	5.10	122.8	9.70	96.20	4.70
FYM 2.5 tonnes/ha+ $N_{10}P_{25}$ kg/ha	109.20	6.90	135.20	13.80	96.3	6.00	102.20	5.10	121.7	9.40	95.50	4.80
CD (P=0.05)	109.20	6.90	121.00	14.20	96.4	5.80	102.20	5.10	118.3	9.10	92.0	4.40

Wheat

Application of different treatments to the preceding crop had a beneficial effect on the yield and yield attributes of succeeding crop (Table 1). Effective tillers/m^2 and grains/spike increased significantly due to effect of residual fertility, but 1,000-grain weight was not affected significantly. The maximum grain yield of wheat obtained with residue of FYM 5 tonnes/ha applied to preceding crop (clusterbean) and was significantly superior to all other treatments. The increase in grain yield was 9 and 14 % than $N_{20}P_{50}$ kg/ha and the control respectively. Significant increase in the grain yield of wheat might have attributed due to low nitrogen and phosphorus availability to the preceding crop from the FYM and adequate use by the succeeding crop (wheat). Gaur (1982) concluded that less than 30 % of N and small fraction of P from FYM is available to current season crop and rest to subsequent crops. The grain yield under the residue derived by the application of FYM 2.5 tonnes + $N_{10}P_{25}$ kg/ha, FYM 2.5 tonnes/ha and $N_{20}P_{50}$ kg/ha were statistically at par, but recorded significantly superior yield to the control. The maximum straw yield was also obtained with FYM 5 @ tonnes/ha applied during the rainy season and was significantly superior to rest of the treatments.

Wheat-equivalent yield

The wheat-grain-equivalent yield was considerably higher owing to residual effect of different treatments (Table 3). The maximum increase (20%) in wheat-grain-equivalent yield was obtained with the application of FYM 5 tonnes/ha, followed by 16 and 12% with FYM 2.5 tonnes + $N_{10}P_{25}$ and $N_{20}P_{50}$ kg/ha over the control respectively. The increases in wheat equivalent-grain yield may be attributed to the improvement of clusterbean and wheat grain yield owing to direct and residual effect of nutrients.

Nutrient status of the soil

After the harvesting of clusterbean crop available N and P markedly increased in all the treatments compared to initial content. However, at 0–25 cm soil layer, maximum

Table 3. Effect of treatments on economic returns in clusterbean–wheat cropping systems (mean data of 2 years)

Treatment	Wheat-equivalent yield (kg/ha)	Additional yield over control (kg/ha)	Additional cost of treatment (Rs/ha)	Additional return over control (Rs/ha)	Net return over treatment (Rs/ha)	Benefit : cost ratio
Control	5,394.00					
FYM 2.5 tonnes/ha	5,849.50	455.50	700	2,733	2,033	2.90
FYM 5 tonnes/ha	6,467.75	1,073.25	1,400	6,440	5,040	3.60
FYM 2.5 tonnes/ha+ $N_{10}P_{25}$ kg/ha	6,212.50	818.00	1,300	4,908	3,608	2.77
$N_{20}P_{50}$ kg/ha	6,009.00	614.50	1,000	3,687	2,687	2.69

increase in available N and P was recorded under FYM 5 tonnes/ha, followed by FYM 2.5 tonnes + $N_{10}P_{25}$ kg/ha and $N_{20}P_{50}$ kg/ha. The increase in build up of available soil N and P content might have attributed to maximum left-over N and P content into the soil due the application of various treatments. This result confirms the findings of Mishra and Maheshwari (1998). The available N and P content in the soil decreased in all the treatments at the harvest of succeeding crop (wheat) compared to the initial value and value after clusterbean harvesting. The decrease might be due to uptake of nitrogen and phosphorus by wheat crop as per the requirement, as the crop was supplied 50 kg N and 30 kg P_2O_5 against the recommended dose of 100 kg N and 60 kg P_2O_5/ha.

The status of available nitrogen and phosphorus at 15–30 cm layer was lower than of that observed at 0–15 cm. However, the pattern of available nitrogen and phosphorus recorded at 15–30 cm was almost similar to that recorded at 0–15 cm.

Economics

Economics of different treatments showed that highest net profit (Rs 5,040) and Benefit : cost ratio (3.60) were obtained with the use of FYM 5 tonnes/ha, followed by the application of FYM 2.5 tonnes/ha + $N_{10}P_{25}$ kg/ha. The minimum net profit was however recorded with the application of FYM 2.5 tonnes/ha only. The higher net returns with FYM 5 tonnes/ha were lower owing to its residual effect on wheat crop.

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