Thus it may be concluded from this study that the omission of the recommended practices in safflower lowers down the seed yield significantly. Hence, for getting maximum seed yield all the recommended practices have to be followed.

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Research Notes

Influence of cereal-legume, legume-cereal and cereal-cereal sequences on productivity, economics and soil fertility status

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Continuous cropping of cereal-cereal sequence has declining effects on crop productivity and nutrient status of the soil in the long run. Inclusion of legumes in a cropping system helps in improving the soil fertility, which results in higher yield of the succeeding crops as compared to preceding exhaustive cereal or non-legume. Similarly incorporation of green manures not only substitutes the -fertilizer N requirement of the crops but also improves the fertility status of the soil (Mahapatra *et al.* 2002). The productivity and net return of cropping sequences increase with effective and economic utilization of residual and commutative carry over effect of nutrients. In Chhattisgarh, rice-fallow is the most prevailing cropping system which has more than 60 per cent fallow land during rabi. Secondly, lathyrus taken in rice fields as a relay crop to exploit residual moisture and nutrients, has very poor crop stand and productivity. Therefore, there is a thrust for evaluating the effect of different systems consisting common legumes and green manures with non-legume crops of the region. Keeping these in view, an experiment was designed and conducted with the objectives to compare the productivity and economics of different systems and monitor the changes in soil fertility status as influenced by legume-cereal, cereal legume and cereal-cereal sequences with special attention to green manuring.

The experiment was conducted at IGAU, Raipur under hot sub humid climate during *kharif* and *rabi* season of 2000-01 and 2001-02 in a silty clay loam soil with a pH of 6.80, EC of 0.20 dSm^{-1}, organic carbon 0.46 per cent, available N 224, available P_2O_5 13 and available K_2O 242 kg ha^{-1}. The total rainfall received by the system from June to May was 822 and 960 mm respectively for two years. The experiment was laid out in RBD with four replications with a net plot area of 7.0 x 9.0 m. The treatments consisted four cropping sequences *viz.* rice-wheat, rice-chickpea, rice-wheat-green manuring (Dhaincha) and soybean-wheat with different fertilizer levels. Test crops were rice (Var. Mahamaya), soybean (Var. PK-472) in *kharif* and wheat (Var. Sujata) and chickpea (Var. JG - 74) in rabi respectively. The recommended dose of fertilizer (RDF) for rice, soybean, wheat and chickpea were 120:80:60;

Table 1. Productivity and net return of systems as influenced by different treatment combinations after two crop cycles

Treatments	Rice equivalent yield of the system (q ha^{-1})				Total productivity (q ha^{-1})		Net return (Rs. ha^{-1})	
	A		B		A	B	A	B
	Kharif	*Rabi*	*Kharif*	*Rabi*				
Rice-Wheat 100-100% RDF	60.5	34.4 (21.0)	60.2	43.1 (26.4)	94.9	103.4	30740	35170
Rice-Chickpea 100-100% RDF	63.0	23.3 (9.5)	63.5	27.8 (11.3)	86.3	91.3	26629	30074
Rice-Chickpea 75-100% RDF	58.2	21.3 (9.1)	58.8	26.2 (10.7)	79.5	85.0	23738	27553
Soybean-Wheat 100-100% RDF	35.3 (16.8)	42.1 (25.7)	47.4 (22.7)	46.8 (28.6)	77.4	94.2	25687	34282
Soybean-Wheat 100-75% RDF	34.3 (16.4)	37.2 (22.7)	41.9 (20.1)	43.7 (26.7)	71.5	85.7	22928	29576
Rice-Wheat-GM 100-100% RDF	66.4	38.1 (23.3)	68.9	45.6 (27.9)	104.5	114.5	35442	41545
Rice-Wheat-GM 75-75% RDF	62.1	32.8 (20.0)	63.6	40.0 (24.5)	94.9	103.6	30919	36848
Rice-Wheat-GM 50-50% RDF	58.4	27.1 (16.5)	57.3	30.1 (18.4)	85.5	87.4	24458	27781
SEd ±	3.1	3.3	0.74	1.51	3.51	2.19	-	-
CD 5%	6.5	6.8	1.55	3.15	7.31	4.57		

A : 2000-01 B : 2001-02

* Figures in parentheses show actual yield of respective crops.

20:60:30; 100:60:40 and 20:50:00 kg NPK ha^{-1} respectively. During both years, rice equivalent yield of all the crops was calculated and compared on the basis of assumed prices *i.e.* Rs. 550 for rice, Rs. 1150 for soybean, Rs. 900 for wheat and Rs. 1350 for chickpea q^{-1}.

Rice equivalent yield (REqY) was significantly influenced by the different treatment combinations. Among the four cropping sequences with different fertility levels, significantly higher grain yield (REqY) of rice (Table 1) was obtained under the rice-wheat sequence at 100% RDF which received extra nourishment through GM during both the years of study. However in year 2000-01 it was at par with same sequence followed with 75% of RDF level with green manures and rice-chickpea sequence only with 100% RDF. Green manuring apart from its N-fixation capacity would have helped in adding organic manure and mining the nutrients from sub soil and increased the rice yield in the system. The significantly lower REqY was recorded where soybean-wheat sequences followed with 100% RDF given to soybean and 100% (T_4) and 75% (T_5) of RDF supplied in wheat. Further during the second year of experiment, REqY (47.4 q ha^{-1}) of soybean-wheat sequences with 100% RDF was significantly superior over soybean-wheat sequence with 75% RDF, which might be due to greater depletion and less carry over of nutrients against the lesser supplied RDF under T_5 in *rabi* season.

In the *rabi* season, REqY of wheat was maximum in soybean-wheat sequence with 100%

RDF for both the crops followed by rice-wheat system at 100% RDF level with GM (T_6) during both the years. The increase in REqY of wheat in legume-cereal cropping system was due to carry over of N for succeeding rabi cereal in rabi (T_4 and T_5) and adding nutrient in soil by GM in T_6. The finding of Sharma (1995) corroborates with the results that the GM crop of Dhaincha incorporated in kharif increased the seed yield of rice and had beneficial residual effect on the succeeding wheat crop.

The results showed that wherever green manuring was done along with RDF, there was a significant increase in total productivity. Rice-wheat-GM with 100% RDF to rice and wheat attained the highest total productivity (104.5 and 114.5 q ha^{-1}). However by reducing the fertilizer level by 25% in GM added treatment, there was a significant reduction in total productivity but it was at par to the rice-wheat system with 100% RDF without GM.

Considering the whole system into account for total net return, rice wheat-green manuring sequences at 100% RDF level (T_6) proved best and provided Rs. 35442 and Rs. 41545 ha^{-1} for the year 2000-01 and 2001-02, respectively. Application of 75% of RDF with GM in rice-wheat system (T_7) provided almost equal return and proved economical as compared to the sariie system which was given 100% RDF without GM. Thus showing the opportunity for saving 25% of fertilizers. Dhiman *et al.* (2000) also recorded significantly higher net return with rice-wheat-GM sequence over traditional rice-wheat system.

Table 2. Changes in available nutrient status as affected by legume-cereal, cereal-legume sequences as compared to cereal-cereal sequence (with green manuring) after two crop cycles

	Available nutrient status (kg ha^{-1})									
	Nitrogen (N)				Phosphorus (P_2O_5)				Potassium (K_2O)	
	A		B		A		B		A	A
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
Rice-Wheat 100-100% RDF	220	208	220	212	32.1	29.8	31.6	28.5	265	264
Rice-Chickpea 100-100% RDF	232	249	232	254	33.4	32.7	32.6	32.3	268	270
Rice-Chickpea 75-100% RDF	221	238	228	250	29.6	29.5	30.26	30.5	270	270
Soybean-Wheat 100-100% RDF	268	227	263	238	33.5	31.5	33.0	29.8	278	275
Soybean-Wheat 100-75% RDF	264	222	258	234	32.2	28.6	32.7	28.7	272	270
Rice-Wheat-GM 100-100% RDF	260	228	257	242	34.5	32.2	34.6	32.3	273	276
Rice-Wheat-GM 75-75% RDF	258	220	253	234	31.4	29.0	31.3	28.8	270	267
Rice-Wheat-GM 50-50% RDF	249	218	245	215	26.2	24.2	27.2	25.1	263	260
SEd ±	12.5	9.6	9.7	7.3	1.3	1.73	0.67	1.04	-	-
CD 5%	26	20.0	20.3	15.17	2.7	3.6	1.39	2.16	NS	NS

A : 2000-01 B : 2001-02

After completion of two crop cycles, available N and P but not K status of the soil was significantly affected due to different treatments. Improvement in available N and P status was noted due to increase in fertilizer rate from 75 to 100% of RDF. These results are similar to the findings of Budhar *et al.* (1991). Legume crops including GM provided considerable amount of residual N to the forthcoming cereal crops. Soybean and GM added rice at the end of kharif season and chickpea only with 100% RDF at the end of rabi season left significant amount of nitrogen over cereal crop of the respective season. The inclusion of GM with 100% RDF increased the available P status of the soil due to mobilization of phosphorous from the subsoil to the upper region. Bellakki and Bedanur (1997) and Dhiman *et al.* (2000) also found similar results.

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Research Notes

Studies on the effect of potassium humate on the biological properties of the soil with Green gram

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Microbial population is often used as a guide for evaluation of soil fertility status. The microbial biomass constitutes the active fraction of soil organic matter whose fast turn over makes it important as potential source of nutrients. Mathur and Paul (1966) stated that *Pseudomonas* could use humic acid as a source of carbon and nitrogen. Humic substances may influence the growth of micro-organisms by virtue of their chelation properties.

The field experiment was conducted at Sundapalayam Village of Coimbatore district on Alfisol (Typic Haplustalf) of Somayanur series to study the effect of humic acid on the biological properties of soil, with and without fertilizers on green gram Var. Vamban GG2 during March-May 2001. The following main plot treatments were imposed namely No fertilizers (M_1), 100% recommended dose of fertilizer (M_2) and 75% recommended dose of fertilizer (M_3). The sub plot treatments were no humic acid, foliar spray (0.1%), seed soaking (1%), 10, 20, 30 and 40 kg ha^{-1} of humic acid as potassium humate designated as S_1, S_2, S_3, S_4, S_5, S_6 and S_7 respectively. The soil samples were collected from the green gram field on 45th day after sowing and the microbial population was estimated. The results on microbial population clearly indicated the significant effect of application