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Full Length Research Paper

Impact of various rice based cropping systems on soil fertility

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Field experiments with ten cropping systems were evaluated during 2002 to 2006 at Soil and Water Management Research Institute, Thanjavur, Tamil Nadu, India during Kharif (June to Sep), rabi (Oct to Jan) and summer seasons (Feb to Apr). The cropping systems were evaluated for their productivity, and to assess their effect on the soil organic carbon content and soil available nitrogen. Inclusion of legumes in the cropping system improved the organic carbon status of the soil. The cropping systems rice (*Oryza sativa*) – rice – blackgram (*Vigna mungo*), onion (*Allium cepa*) – rice – blackgram, groundnut (*Arachis hypogea*)– rice – blackgram and rice – rice – greengram, (*Vigna radiata)* improved the soil organic carbon content and soil available N status. Inclusion of blackgram and greengram in rice based cropping system increased the yield of succeeding crop of rice.

Key words: Cropping systems, soil organic carbon, soil available N.

INTRODUCTION

Rice (*Oryza sativa*) is a component of widely varying cropping systems. Rice – based cropping systems form an integral part of agriculture in Tamil Nadu. Several intensive rice based cropping systems have been identified and are being practiced by the farmers. While intensive agriculture, involving exhaustive high yielding varieties of rice and other crops, has led to heavy withdrawal of nutrients from the soil, imbalanced and discriminate use of chemical fertilizers has resulted in deterioration of soil health (John et al., 2001). Suitable rice based cropping has to be evaluated, to assess the stability in production. Inclusion of pulses vegetable in the cropping system is more beneficial than cereals after cereals (Kumpawat, 2001). Rice-rice-pulse and rice-rice-sesame are the existing dominant cropping system of Thanjavur district. Continuous cropping results in rapid decline in soil fertility and thus require a special attention. Thus, the existing rice based cropping system has to be diversified with the inclusion of vegetables, pulses, maize and oilseed crops in kharif and summer seasons, to meet the problem of water and labour scarcity and to sustain the soil health. Experiments on cropping systems are ultimate solution to overcome the drawbacks of mono cropping system. Hence, the present study was conducted to assess the impact of various rice based cropping systems on the soil health, in terms of the soil organic carbon content and soil available nitrogen.

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MATERIALS AND METHODS

Field experiments were conducted at Soil and Water Management Research Institute, Kattuthottam, Thanjavur during the kharif (June to Sep), rabi (Oct to Jan) and summer (Feb to Apr) seasons of 2002 to 2006. The geographical location of the research institute has the reference to 79° east longitude,10°45 North latitude and 50 m above mean sea level. The average annual rainfall is 930 mm. The mean maximum and minimum monthly temperature vary from 39.9℃ in May to 29.4℃ in December and from 27.1℃ in May to 20.8℃ in January respectively. The soil was sandy clay loam, neutral in reaction (pH 6.5), low in available nitrogen (217 kg/ha), high in available phosphorus (265 kg/ha) and medium in available potassium (153 kg/ha) with organic carbon content 0.390%.

The experiment was laid out in randomized complete block design with four replications in the same location throughout the study period. Treatments comprised of ten rice based cropping

Table 1. Details of fertilizer program.

Crop	Fertilizer recommendation (kg / ha)		
	N	P	K
Rice	125	50	50
Rice	150	60	60
Black gram	25	50	-
Green gram	25	50	-
Sesame	35	23	23
Maize	135	62.5	50
Onion	100	50	100
Bhendi	50	50	30
Radish	50	100	50
Groundnut	17	34	54
Lab-Lab	*25*	*50*	--

systems, namely, rice (*O. sativa*)– rice – blackgram *(Vigna mungo)*, rice – rice – sesame (*Sesamum indicum)*, rice – rice – bhendi *(Abelmoschus esculentus)*, lab-lab *(Dolichus lablab)* – rice – maize, onion (*Allium cepa*)– rice – black gram, rice – rice – onion, bhendi – rice – radish *(Raphanus sativus)*, maize (*Zea mays)* – rice – sesame, groundnut (*Arachis hypogea*)– rice – black gram and rice – rice – green gram were evaluated. The crops were raised under irrigated condition with recommended package of practices. The grain yield was recorded from the net plot and computed to kg / ha at 14% moisture for rice and at 8% moisture for other component crops.

Details of fertilizer program

The soil was analyzed for organic carbon (wet digestion method, Walkley and Black, 1934) and available nitrogen (Subbaiah and Asija, 1956) after the completion of cropping system in the first, second, third and fourth years of study. The data for the characters studied under various treatments were analysed statistically using the Agres Software Version 3.01 (1994) (Table 1).

RESULTS AND DISCUSSION

Organic carbon content of soil

The organic carbon status of the soil increased after all the crop sequences tested at the end of each year. The maximum organic carbon build up was observed with the inclusion of leguminous crops. Among the ten cropping systems tested rice – rice – black gram, onion – rice – black gram, groundnut – rice – black gram and rice – rice – green gram cropping sequences recorded higher organic carbon content in the first, second, third and fourth year respectively. These cropping systems contributed to an increase of 0.04% organic carbon content at the end of the fourth year. This increase in organic carbon content was found to be superior than the other cropping systems.

Such an increase in the organic carbon content is attributed to the accumulation of root residues and shedding of leaves by the leguminous crops (Thakur and Sharma, 1988). Kumar et al. (2001) also reported that, inclusion of leguminous crops in the system increased the organic carbon and available nitrogen phosphorus, potassium and sulphur content of the soil. This may be due to the addition of nutrients by biological N fixation of these crops. The minimum increase in the organic carbon content was noticed in rice – rice – sesame (0.006%), rice – rice – onion (0.001%) bhendi – rice – radish (0.008%) and rice-rice-onion (0.005%) cropping system over four years.

Post harvest soil available N

The initial available nitrogen status of the soil was 217 kg/ha. Progressive increase in available N status after each year was observed with the inclusion of leguminous crop in the rotation. Among the cropping systems tested rice – rice – black gram, onion – rice – black gram, groundnut – rice – black gram and rice – rice – green gram cropping systems significantly improved the soil available nitrogen status in the first, second, third and fourth year respectively. The fixation of atmospheric nitrogen by the leguminous crops might have contributed for the increased soil N status (Mongia et al., 1989). When compared to first year, the soil available N status was improved in groundnut – rice – blackgram (14 kg/ha), rice – rice – greengram (12 kg/ha), rice – rice – blackgram (9 kg/ha) onion – rice – blackgram (8 kg/ha) at the end of the fourth year. Though the quantity of available nitrogen contributed was not huge, positive trend was observed with the maintenance of soil available nitrogen status. The soil available N status was depleted in maize – rice – sesame (20 kg/ha) and rice – rice – sesame (19 kg/ha) due to the exhaustive nature of maize and sesame. This was followed by bhendi-rice-radish (13 kg/ha), rice-rice-onion (8 kg/ha) cropping systems. Rice – rice – blackgram, onion – rice – blackgram, groundnut – rice – blackgram and rice – rice – greengram cropping systems improved the post harvest soil available N status. Increase in available nitrogen, phosphorus, potassium and sulphur content in cropping sequences involving vegetable, pea, green gram were reported by Gangwar and Ram (2005). Cultivation of legume crop is viewed more as a soil fertility improver than as independent crops grown for their grain output. This is because legume crops are self sufficient in N supply (Kanwarkamla, 2000). (Table 2).

The preceding crop species can have a beneficial or detrimental effect on the performance of the succeeding crop. The well known beneficial effects of preceding legume crop on cereal are also found in multiple cropping systems, but the magnitude of the effects varies with management practices and the legume species used. Progressive increase in the grain yield of kharif crops preceded by pulses was recorded in rice-rice- blackgram and rice-rice- green gram cropping systems in the

Table 2. Influence of cropping sequence on soil organic carbon and post harvest available N.

Trs.	Crop sequence	Organic carbon content of soil (%) after completion of cropping system				Soil available N (kg/ha)			
		I Year	II Year	III Year	IV Year	I Year	II Year	III Year	IV Year
T_1	Rice – rice – blackgram	0.416	0.426	0.430	0.453	215	218	220	224
T_2	Rice – rice – sesame	0.395	0.398	0.399	0.401	196	190	186	177
T_3	Rice – rice – bhendi	0.397	0.399	0.400	0.402	195	190	189	186
T_4	Lab-lab – rice – maize	0.396	0398	0.399	0.401	190	182	180	178
T_5	Onion – rice – blackgram	0.413	0.423	0.431	0.453	217	219	221	225
T_6	Rice – rice – onion	0.392	0.395	0.398	0.402	193	190	188	185
T_7	Bhendi – rice – radish	0.393	0.396	0.399	0.401	197	192	188	184
T_8	Maize – rice – sesame	0.395	0.398	0.402	0.404	192	187	179	172
T_9	Groundnut – rice – blackgram	0.415	0.425	0.433	0.450	215	218	224	229
T_{10}	Rice – rice – greengram	0.416	0.426	0.435	0.454	216	219	223	228
	Initial	0.390				217			
	CD (P=0.05)	0.010	0.014	0.016	0.015	7.26	8.30	9.65	10.40

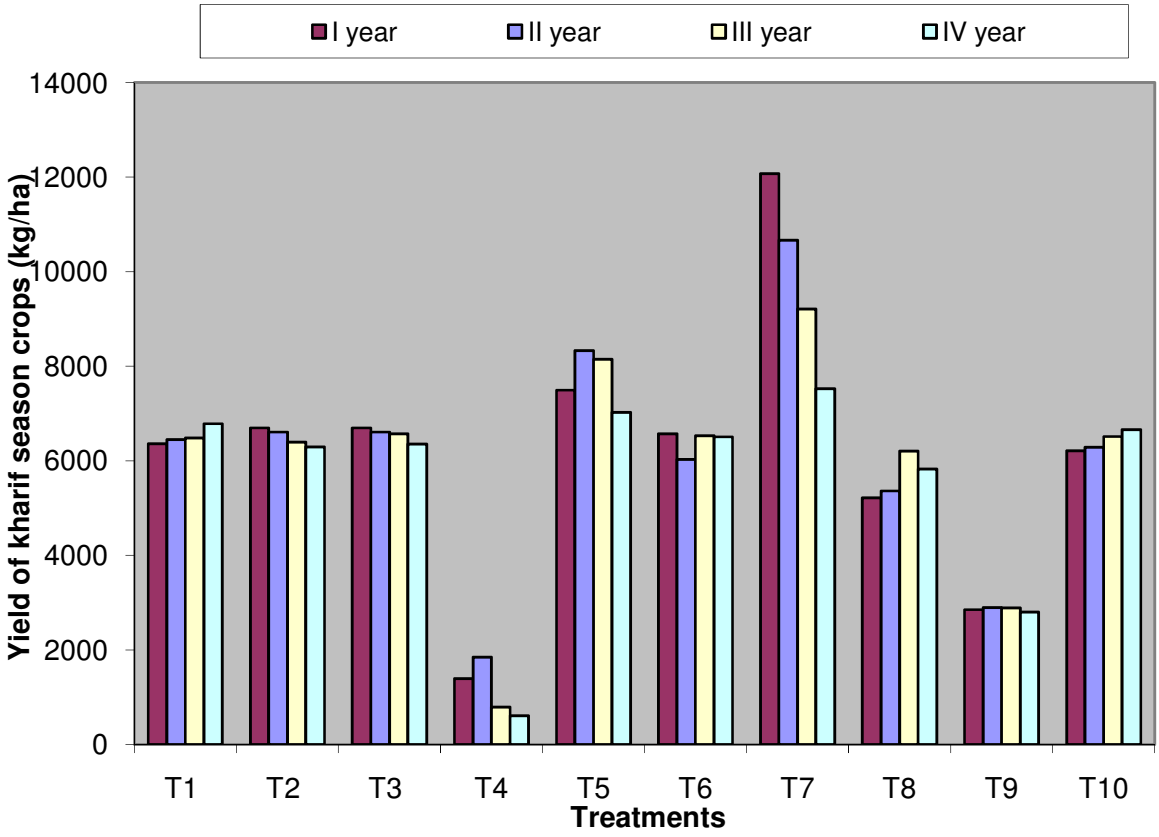

Figure 1. Influence of summer crop on the yield of Kharif season crop.

second, third and fourth year. When compared to the first year, the yield increase of 430 to 446 kg was recorded in the fourth year (Figure 1). Kumar et al. (1993) reported similar result, pointing out the superiority of leguminous crops in increasing the yield of the succeeding crops of rice. They also observed a reduction in the yield of rice grown after sesame. The grain yield of kharif season crops decreased in rice-rice-sesame, rice-rice-bhendi, lab-lab-rice- maize, bhendi-rice-radish, maize-rice-sesame cropping systems. The grain yield of kharif

season crops are maintained without any reduction in onion-rice-black gram, rice-rice-onion and groundnut-rice-black gram cropping systems. Legumes were potentially important to diversify cereal based mono cropping into cereal-legume sequences which had nutrient cycling advantages.

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