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Effect of Diversification of Rice-wheat System on Weed Dynamics in Rice

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ABSTRACT

A field experiment was initiated in 2000-01 at Varanasi Centre of AICRP on Cropping Systems to study the effect of diversification of rice-wheat system on weed dynamics in rice. The results of 2002-03 and 2003-04 i. e. 3rd and 4th year of study revealed that diversification of rice-wheat system through inclusion of greengram in summer, though remained at par to sequences involving summer cowpea for fodder or *Sesbania* for green manuring, resulted in significantly lowest population of grasses and sedges in 2003-04 and weed dry matter production in both the years. However, the different cropping sequences failed to affect broadleaf weeds population. Similarly, sequences having grain/fodder legume or *Sesbania* for green manuring produced higher grain and straw yield than rice-wheat sequence. Nevertheless, the differences were significant only in 2003-04 during which rice-wheat-*Sesbania* though remained at par with rice-wheat-greengram, rice-lentil+mustard (3 : 1)-cowpea, rice-maize+pea (1 : 1)-cowpea and rice-potato-greengram produced significantly higher grain yield than other sequences and registered 14.5% higher grain yield than rice-wheat sequence.

Key words : Crop rotation, factor productivity, cropping system, weed dynamics

INTRODUCTION

Development of high yielding, input responsive and photo insensitive varieties of rice and wheat has led to adoption of rice-wheat cropping system covering 10.4 million ha in India, mainly confined to Indo-Gangetic belt (Singh and Sharma, 2001). This system contributes as much as 40% to the rice and wheat production in the country. Although both rice and wheat have registered remarkable growth in terms of area, production and yield since 1960; reports of yield plateauing or even decline in the high productive zones of North India has raised serious concern on sustainability of rice-wheat system (Hobbs *et al.,* 1991). Such declining trend in productivity associated with decline in factor productivity may be attributed largely to emergence of multi-nutrient deficiencies and building up of soil pathogens and weed flora besides increasing soil health problems. Among these factors, weeds pose serious problems in rice under rice-wheat cropping system. The major weeds in rice are *Echinochloa* spp., *Digitaria sanguinalis, Commelina benghalensis, Celosia argentia, Cyperus rotundus, Cyperus iria* and *Cyperus difformis* (Singh and Singh, 1996). In rice-wheat system, yield reduction in rice due to weeds has been reported to the extent of 45% depending upon the soil type and rainfall pattern of a particular area (De Datta, 1981). The diversification of the system even for a short period and intensification by including summer legumes as well as green manuring has resulted in increased profit and sustained productivity of rice-wheat system. However, looking into the agro-climatic and edaphic conditions of Varanasi region, there is limited scope to replace rice by other crops.

The prolonged cultivation of rice and wheat in rice-wheat system, weed species specially the grassy weeds in both the crops and more specifically in rice have increased to a greater extent. Nevertheless, with diversification of the system, the behaviour of weeds in rice as function of preceding **rabi** and summer season crops may change. Therefore, a necessity was felt to study the weed dynamics in rice as influenced by diversification of rice-wheat system.

MATERIALS AND METHODS

A long term field experiment on diversification of rice-wheat system was initiated under AICRP on Cropping systems during 2000-01 at the Agricultural Research Farm, Banaras Hindu University, Varanasi. The impact of different crop sequences on the weed dynamics of rice was studied during 2002-03 and 2003-04. The experimental soil was sandy clay loam having pH 7.4 and 0.34% organic carbon with an electrical conductivity (EC) of 0.30 dS/m. It was characterized as low in available nitrogen (190 kg N/ha), and medium in available phosphorus (19.3 kg P/ha) and potassium (20.6 kg K/ha).

The treatment consisting of 10 crop sequences viz., rice-wheat (S_1), rice-chickpea (S_2), rice-wheat-greengram (S_3), rice-wheat-*Sesbania* for green manuring (S_4), rice-mustard-greengram (S_5), rice-lentil-cowpea fodder (S_6), rice-field pea (S_7), rice-lentil+mustard (3 : 1)-cowpea fodder (S_8), rice-maize (green cob)+vegetable pea (1 : 1)-cowpea fodder (S_9) and rice-potato-greengram (S_{10}) were tested in a randomized block design with four replications. The gross plot size was 7 x 6 m with one metre plot border to avoid the mixing of soil in different treatments; individual plots were thoroughly prepared by power tiller in each season. Cultivation practices were followed as per local recommendations for each crop. The first weeding in each plot was done after recording weed population at 25 DAT. *Sesbania aculeata* as green manure and greengram after last picking were cut from the ground level and green biomass so obtained was incorporated *in situ.* The cowpea for green fodder was harvested from the ground level at 60 days stage. The rest of the crops were harvested at maturity. However, harvesting of maize for green cobs and vegetable pea was done at proper stage. The weather condition during the two years trial was congenial for growth and development of crops. During 2002-03, 577.1 mm rain was received by rice crop and in the second year, the rain recorded during **kharif** was 665.5 mm. Density and dry weight of weeds were recorded at 25 DAT and were subjected to transformation for statistical analysis.

RESULTS AND DISCUSSION

Effect of Crop Sequences on Weed Dynamics in Rice

The experimental field was moderately infested with weeds and the infestation was relatively higher in 2002-03 than 2003-04 (Table 1). This could be attributed to 15.3% higher rain received during 2003-04. The percentage of grassy weeds, sedges and broad-leaved weeds was 46.4, 29.3, 24.3 and 54.0, 28.0, 18.0 during rice growing seasons of 2002-03 and 2003-04, respectively. The lower rainfall (577.1 mm) received during 2002-03 favoured the emergence of broad-leaved

Table 1. Density of grasses, sedges and broad-leaved weeds (No./m^2) and weed dry matter production (g/m^2) in rice at 25 DAT under different crop sequences

Crop sequences	Grasses		Sedges		Broad-leaved weeds		Weed dry matter production	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
S_1–Rice-Wheat	7.44 (56.5)	6.80 (6.80)	5.06 (25.5)	4.43 (20.8)	5.25 (28.0)	4.10 (16.8)	6.12 (37.3)	4.37 (18.7)
S_2–Rice-Chickpea	5.77 (35.5)	5.13 (29.0)	4.72 (22.0)	4.17 (18.5)	4.07 (16.5)	3.03 (10.5)	5.78 (33.9)	4.08 (16.6)
S_3–Rice-Wheat-Greengram	3.29 (13.8)	2.18 (6.0)	2.44 (9.5)	1.97 (5.0)	1.93 (5.5)	1.14 (1.0)	3.15 (10.8)	3.09 (9.1)
S_4–Rice-Wheat-*Sesbania* (GM)	4.19 (20.5)	2.93 (14.3)	3.78 (14.8)	3.36 (11.3)	3.62 (13.5)	2.01 (5.3)	4.75 (25.0)	3.77 (13.8)
S_5–Rice-Mustard-Greengram	4.32 (20.5)	3.04 (11.8)	3.36 (12.8)	2.44 (7.0)	3.00 (10.8)	2.00 (3.5)	4.27 (18.4)	3.72 (13.5)
S_6–Rice-Lentil-Cowpea (F)	3.75 (16.8)	3.29 (14.5)	3.06 (10.8)	2.33 (6.0)	2.58 (7.8)	1.28 (1.5)	3.80 (14.6)	3.52 (12.1)
S_7–Rice-Pea	5.85 (34.8)	5.42 (29.5)	4.41 (22.0)	4.29 (19.3)	4.14 (19.8)	3.36 (13.5)	5.83 (35.0)	4.26 (17.9)
S_8–Rice-Lentil+Mustard (3 : 1)-Cowpea (F)	4.34 (19.8)	3.12 (14.5)	3.30 (15.5)	2.79 (7.5)	2.90 (9.8)	1.76 (3.0)	4.17 (17.5)	3.60 (12.8)
S_9–Rice-Maize+Pea (1 : 1)-Cowpea (F)	4.68 (22.0)	3.71 (16.8)	3.54 (16.3)	2.78 (8.8)	3.75 (14.8)	2.56 (7.3)	5.08 (25.7)	3.84 (14.3)
S_{10}–Rice-Potato-Greengram	3.97 (18.0)	2.38 (7.0)	3.70 (14.0)	2.48 (6.8)	2.84 (8.3)	1.40 (1.5)	4.08 (16.9)	3.52 (12.2)
S. Em±	0.80	0.99	-	0.58	-	0.53	0.58	0.24
LSD (P=0.05)	2.32	2.87	NS	1.69	NS	1.53	1.69	0.71

Figures in parentheses are the original values. NS–Not Significant.

weeds as compared to 2003-04. On the contrary, grassy weeds emergence was favoured during 2003-04.

Among the grassy weeds, *Echinochloa crusgalli* was predominant followed by *E. colona* and *Paspalum conjugatum* with little infestation of *Cynodon dactylon.* As regards the sedges *Cyperus rotundus* was considerably higher than *C. iria.* Whereas the major broad-leaved weed was *Nymphea* sp. closely followed by *Oxalis acetosella* with minor infestation of *Caesulia axillaris* and *Phyllanthus niruri.*

Marked influence of different cropping sequences was observed on weed density and weed dry matter production. In general, intensification of rice-based cropping sequence caused reduction in weed density as well as weed dry matter production. Rice wheat-greengram sequence recorded lowest population of all the three groups of weeds. Though, it remained at par with other crop sequences, insignificantly recorded lower density of grassy weeds than rice-wheat, rice-chickpea and rice-pea sequences in the second year. Similar trend was observed for sedges and broad-leaved weeds but the broad-leaved weeds did not differ significantly in either of the two years of experimentation. This clearly shows that intensification brought about marked decline in weed density in rice. The better impact of crop intensification during 2003-04 could be attributed to the fact that it was the cumulative effect of four years as compared to three years in 2002-03 (ICAR, 2001).

Similar to weed density, the dry matter production of weeds was recorded lowest in rice-wheat-greengram sequence, whereas it was highest in rice-wheat sequence during both the years. Rice-wheat-greengram produced significantly lower weed dry weight than rice-wheat, rice-chickpea and rice-pea sequences. However, it remained statistically at par with other crop sequences. The better performance of rice-wheat-greengram sequence was mainly because it occupied the field for maximum number of days than other crop sequences. It has been reported that intensification of rice-wheat system by including short duration vegetable pea or potato effectively controlled weeds without herbicides application or manual weedings (ICAR, 2001).

Effect on Rice Yield

Marked variation in grain and straw yield of rice was observed in different cropping sequences (Table 2). Cropping sequences involving summer grain/fodder legume or *Sesbania* for green manuring produced higher grain and straw yield than rice-wheat sequence. However, the differences were significant only during 2003-04. As the experiment was initiated in 2000-01, it took four years to exhibit significant legume effect in terms of rice yield. The crop sequences viz., rice-wheat-*Sesbania,* rice-lentil+mustard (3 : 1)-cowpea, rice-potato-greengram, rice-maize+pea (1 : 1)-cowpea, and rice-wheat-greengram though remained comparable among themselves produced significantly higher grain yield of

Table 2. Effect of different crop sequences on grain yield, straw yield and harvest index of rice

Crop sequences	Grain yield (q/ha)		Straw yield (q/ha)		Harvest index (%)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
S_1–Rice-Wheat	36.02	40.11	51.82	53.47	41.00	42.87
S_2–Rice-Chickpea	36.37	41.23	53.04	57.55	40.63	41.76
S_3–Rice-Wheat-Greengram	37.33	44.62	53.99	59.73	40.97	42.79
S_4–Rice-Wheat-*Sesbania* (GM)	38.37	45.92	54.26	62.07	41.44	42.50
S_5–Rice-Mustard-Greengram	38.54	42.55	55.38	58.33	41.02	42.21
S_6–Rice-Lentil-Cowpea (F)	39.24	43.40	56.25	57.12	41.10	43.16
S_7–Rice-Pea	37.50	42.71	53.56	55.90	41.25	43.31
S_8–Rice-Lentil+Mustard (3 : 1)-Cowpea (F)	37.59	45.49	54.86	54.95	40.66	45.29
S_9–Rice-Maize+Pea (1 : 1)-Cowpea (F)	38.28	45.31	54.43	56.34	41.31	44.60
S_{10}–Rice-Potato-Greengram	38.46	45.33	55.30	56.08	41.10	44.68
S. Em±	1.19	1.32	1.78	1.85	1.13	0.68
LSD (P=0.05)	NS	3.83	NS	NS	NS	1.97

NS–Not Significant.

rice-wheat sequence. Regarding straw yield, only rice-wheat-*Sesbania* and rice-wheat-greengram sequences could produce significantly higher straw yield of rice during 2003-04. These results are in close conformity with the findings of Singh and Sharma (2001) and Sharma *et al.* (2004).

Effect of cropping sequences on the harvest index was conspicuous in 2003-04 during which crop sequences viz., S_6, S_7, S_8, S_9 and S_{10} recorded higher harvest index than rice-wheat (S_1). However, the difference was significant only between S_8 [Rice-lentil+mustard (3 : 1)-cowpea] and S_1 (Rice-wheat).

Therefore, the results of the experiment clearly indicated that diversification of rice-wheat system through substitution of wheat by other **rabi** crops and incorporation of summer grain/fodder legumes of *Sesbania* for green manuring could be one of the possible ways to reduce weed infestation and enhance the productivity of rice.

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