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AGRO-ECONOMIC PERFORMANCE OF DIVERSIFIED RICE-BASED RELAY CROPPING SYSTEMS AT ZERO AND CONVENTIONAL TILLAGE UNDER STRIP PLANTATION

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A field study was conducted to evaluate the performance of diversified rice-based relay cropping systems at zero and conventional tillage on a sandy-clay loam soil at the University of agriculture, Faisalabad for two consecutive years. The relay cropping systems comprised rice/fallow, rice/wheat, rice/barley, rice/forage oats, rice/gram, rice/lentil, rice/linseed, rice/fenugreek (methra), rice/sunflower, rice/canola, rice/forage maize and rice/Egyptian clover. The tillage treatments were zero and conventional tillage. The results revealed that although all the rice-based relay cropping systems included in this study proved to be more productive, economically viable and remunerative than the rice/fallow cropping systems but rice/grain or forage legumes relay cropping system like rice/fenugreek (methra), rice/chickpea, rice/lentil and rice/Egyptian clover were found to be superior to rice/non-legumes relay cropping systems such as rice/wheat, rice/barley, rice/forage oats, rice/canola, rice/sunflower and rice/forage maize in terms of sustainability, total rice grain yield equivalent (TRGYE) and net field benefits ha^{-1} both at zero and conventional tillage. However, yield benefits on an average were 9.85 % higher with conventional tillage than zero tillage. Among the relay cropping systems, the highest TRGYE of 7.48 and 9.27 t ha^{-1} and net monetary gain of Rs.40620 and 45120 ha^{-1} was recorded for rice/fenugreek (methra) relay cropping system both at zero and conventional tillage, respectively.

Key words: Rice-based relay cropping systems, strip plantation, zero tillage, conventional tillage, agro-economic performance.

INTRODUCTION

Rice-wheat is the most common cropping system in rice growing areas of the Punjab, Pakistan occupying 1.1 million hectares (Amir & Aslam, 1992). However, the yield of wheat after rice is very low because of poor soil tilth and exhaustive nature of both rice and wheat crops (Hamid *et al.* 1987). Rice yield have also stagnated despite of steadily increasing dosages of fertilizers (Amir, 1985). Previously due to growing of long duration fine cultivars of rice, it was not possible to test other cropping systems involving leguminous and other crops of immediate economic value like pulses, oil seeds and forages. The introduction of an early maturing, high yielding and fertilizer responsive rice cultivar Basmati-385 made it possible to test other rice-based cropping systems of equal economic importance as it facilitated timely sowing of the relay crops. Low wheat yield after Basmati rice is mainly because of late planting, poor agronomic management and improper soil tilth. Hence there is a need to diversify the old rice-wheat cropping system and to explore/develop an economically viable, more productive and sustainable substitute for a rice-wheat cropping system acceptable to farmers under these agro-ecological conditions for efficient utilization of agro-resources. The present study was, therefore, planned to evaluate the agro-economic performance of different rice-based relay cropping systems at zero and conventional tillage under strip plantation of base rice crop in irrigated upland environments of Faisalabad.

MATERIALS AND METHODS

The proposed study was conducted at the research area of Agronomy Department, University of Agriculture, Faisalabad on a sandy-clay loam soil having on an average 0.042% N, 6.93 ppm P_2O_5 and 138 ppm K_2O for two consecutive years (1998-99 and 1999-2000). The relay cropping systems comprised rice/fallow, rice/wheat, rice/barley, rice/fodder oats, rice/gram, rice/lentil, rice/linseed, rice/fenugreek, rice/sunflower, rice/canola, rice/fodder maize and rice/Egyptian clover. The tillage treatments were zero tillage and conventional tillage. The experiment was triplicated in a randomized complete block design with split arrangement keeping the tillage treatments in the main plots and the relay cropping systems in the subplots using a net plot size of 3.6 m x 6.0 m. The previous base rice crop was planted on a well puddled soil in standing water in the pattern of 75 cm spaced 4-row strips with 15 cm space between the rows in a strip (15/45 cm). Soon after the harvest of the transplanted rice crop two to four rows of the respective relay crops depending on the nature of each crop were seeded on the space between the rice-vacated strips both at zero and normally prepared seed bed with the help of a single row hand drill at optimum residual soil moisture conditions "Wad Vattar". A uniform dose of 50-100 kg NP ha^{-1} was applied as a basal dose to all the relay crops at sowing while additional dose of 50kg N ha^{-1} was applied with first irrigation only to the strips of non-

legume crops like wheat, barley, oats, linseed, sunflower, canola and maize. Thinning was done manually at 3-4 leaf stage to maintain a plant to plant distance of 15 cm and 20 cm in case of canola and sunflower respectively while no thinning was done in rest of the relay crops. Irrigation was applied to all the crops as and when needed according to the need of each crop. All other agro-management practices like weeding etc. were kept normal and uniform for all the treatments.

RESULTS AND DISCUSSION

The data regarding agro-economic traits of the component crops in different upland rice-based relay cropping systems at zero and conventional tillage presented in Table 1 evinced that the performance of diversified rice- based relay cropping systems were highly variable both at zero and conventional tillage. Rice/legumes relay cropping systems such as rice/fenugreek, rice/chickpea, rice/Egyptian clover, and rice/lentil proved to be more productive, economically viable and promotive to residual soil nitrogen and soil health than rice/wheat, rice/barley, rice/sunflower, rice/canola, rice/linseed, rice/forage maize and rice/forage oats irrespective to zero and conventional tillage. The results further indicated that inclusion of upland crops of high agro-economic values such as lentil, chickpea, fenugreek and Egyptian clover into the rice-based cropping system is highly profitable as they have shown proven superiority to the old rice/wheat relay cropping system in terms of yield advantages and efficient utilization of geo-agronomic resources both under zero and conventional tillage. However, yield benefits on an average were 9.85 % higher with conventional tillage than zero tillage. These results are in line with those of Joy *et al.* (1986) & Sharma *et al.* (1987) who reported that legumes grown after rice at zero tillage are less affected by the compact puddled soil than the cereal crops probably due to their deep rooting system.

The data on total rice grain yield equivalent (TRGYE) of different rice-based relay cropping systems revealed that all the relay cropping systems gave substantially higher TRGYE than the sole cropping of rice. Among relay cropping systems, the highest TRGYE of 7.97 t ha^{-1} and 9.27 t ha^{-1} was recorded for rice/fenugreek (methra) relay cropping system both under zero and conventional tillage, respectively and was closely followed by rice/linseed (7.18 and 7.19 t ha^{-1}), rice/clover (7.13 and 8.13 t ha^{-1}), rice/forage oats (6.55 and 7.62 t ha^{-1}), rice/lentil (6.98 and 7.47 t ha^{-1}), rice/sunflower (6.39 and 8.64 t ha^{-1}) and rice/wheat (5.66 & 6.52 t ha^{-1}) relay cropping systems while rest of the relay cropping systems intermediated. The lowest TRGYE was recorded for rice/forage maize relay cropping system which amounted to 4.64 and 5.03 t ha^{-1} at zero and conventional tillage respectively. These results are in line with Torres et al. (1986) who reported that relay cropping of maize in rice was not reliable.

In terms of net monetary gain ha^{-1}, all the relay cropping systems generated substantially higher net income ha^{-1} than the rice/fallow system. Within the relay cropping systems, the highest net income of Rs.40620 and 45120 ha^{-1} was obtained from rice/fenugreek (methra) relay cropping system at zero and conventional tillage, respectively. Khan (2000) also reported that cotton/fenugreek cropping system gave the highest net income. The next best relay cropping systems appeared to be rice/chickpea, rice/linseed, and rice/lentil which gave an average net benefit of Rs.35820 and 36420, 34444 & 37894 and 33395 & 34845 ha^{-1} at zero and conventional tillage, respectively. Agarwal & Shrivasta (1986) also reported that the highest net income was obtained from rice peas cropping systems. The rest of the relay cropping systems intermediated and gave net income ranging from Rs.15689 to 32581 and from 16699 to 35484 ha^{-1} at zero and conventional tillage, respectively. However, the lowest net income of Rs.15661 ha^{-1} was recorded for rice/fallow cropping system.

In conclusion, although all the rice-based relay cropping system included in this study proved to be more productive, economically viable and remunerative than the rice/fallow cropping system but rice/grain or forage legumes relay cropping systems like rice/fenugreek (methra), rice/chickpea, rice/lentil and rice/Egyptian clover were found superior to rice/non-legumes relay cropping systems such as rice/wheat, rice/barley, rice/forage oats, rice/canola, rice/sunflower and rice/forage maize in terms of residual soil fertility, total rice grain yield equivalent and net field benefits ha^{-1} both at zero and conventional tillage.

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Table 1. Comparative agro-economic performance of diversified upland rice-based relay cropping systems at zero and conventional tillage

(2-year average data)

Relay cropping systems	Rice grain yield (t ha^{-1})	Mean grain & forage yield of relay crops (t ha^{-1})		Rice grain yield equivalent of relay Crops (t ha^{-1})		Total rice grain yield equivalents of the system (t ha^{-1})		Net monetary gain (Rs. ha^{-1})	
		Zero tillage	Conventional tillage	Zero tillage	Conventional tillage	Zero tillage	Conventional tillage	Zero tillage	Conventional tillage
Rice/fallow	3.65	-	-	-	-	3.65	3.65	15661	15661
Rice/wheat	3.65	2.44	3.48	2.01	2.87	5.46	6.58	23772	26733
Rice/barlay	3.65	3.34	4.29	3.14	4.04	6.45	7.69	32581	35488
Rice/chickpea	3.65	1.97	2.10	3.71	3.95	6.96	7.60	35820	36420
Rice/lentil	3.65	1.01	1.16	3.33	3.82	6.61	7.47	33395	34845
Rice/fenugreek	3.65	1.53	1.99	4.32	5.62	7.48	9.27	40620	45120
Rice/linseed	3.65	1.50	1.93	3.53	4.54	6.79	8.19	34444	37894
Rice/sunflower	3.65	1.94	2.26	2.74	3.19	6.10	6.84	29219	29819
Rice/canola	3.65	0.88	1.18	1.66	2.22	5.15	5.87	20503	22303
Rice/forage oats	3.65	41.0	56.29	2.90	3.97	6.24	7.62	28413	31711
Rice/forage maize	3.65	14.04	19.59	0.99	1.38	4.57	5.03	15684	16699
Rice/Egyptian clover	3.65	49.25	63.44	3.48	4.48	6.75	7.13	29436	35542
					Average	6.54	7.34		

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