Original Research Article

Identification of Cropping System Module for Irrigated Farming System of Rewa Region

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A B S T R A C T

The field study entitled "Identification of cropping systems module for irrigated farming system of Rewa region" was taken under All India Coordinated Research Project on Integrated Farming System during 2017-18. The study reveals that rice crop performed better under the residual effect of rice-gram + mustard-green manure, rice-barley-*bajra* and rice-*toria*-onion cropping systems as compared to existing rice-wheat cropping system. Rice-garlic cropping system gave maximum rice equivalent yield (195.64 q/ha) and net profit (211188/ha) followed by rice-potato-green gram and rice-gram + mustard intercropping in 3:1-green manure cropping system. These cropping systems were found superior than existing rice-wheat system.

Introduction

Rice is an important crop of rice-wheat crop zone of Madhya Pradesh which occupies an area of 16.75 lakh hectares. The average productivity is 1194 kg/ha. In Rewa region of Madhya Pradesh, rice is cultivated in 6.09 lakh hectares with the production of 4.47 lakh tonnes and the average productivity of rice is 917 kg/ha. It is very low as compared to national and state average productivity (Rao 2012). It is due use of local varieties, erratic and uneven distribution of rains as well as prolong dry spells observed frequently.

Introduction of pulses and oil seed in the system are more beneficial than cereal-cereal sequence (Umarani *et al.,* 1992). In cropping system inclusion of pulses, oilseed and vegetables are more beneficial than cereals after cereals (Kumpawat, 2001). Rice is predominated crop in Rewa region of Madhya Pradesh. It is difficult to replace the rice by any other crop in rainy season due to soil and climatic condition. Hence, only option left is to replace the wheat and gram crop in winter season by mustard, barley, potato, *toria*, onion, garlic, pea, pea + mustard and berseem.

Experimental evidences show that rice-wheat, rice-green manure-barley, rice-gram + mustard-green manure, rice-pea-green gram, rice-potato-green gram, rice-pea + mustard-green manure, rice-berseem, rice-barley fodder-*bajra* fodder, rice-garlic and rice-*toria*-onion have been found effective and

remunerative cropping sequence in different parts of the country.

Rice-potato-wheat system utilizes the water most efficiently closely followed by medium duration rice-berseem system. The growing of vegetable pea and potato between rice and wheat increased the organic carbon by 8.9% to 17.1%, available N by 6.3% and 8.3% Olsen's production by 6.3% and 19%, respectively in soil as compared to rice-wheat sequence (Kharub *et al.,* 2003).

Development of soil sickness for rice and wheat crop has also been observed due to continuous cropping (Kharub *et al.,* 2003). The soil productivity is declining day by day because both crops are exhaustive (Choudhary *et al.,* 2007). The rice followed legume crop sequence has the ability to ameliorate the soil fertility by fixing atmospheric nitrogen. Different *rab*i crops have some residual effect on succeeding crops. Annual report (2010-11) of All India Coordinated Research Project on IFS Modipuram indicates that rice yield was maximum when rice was grown after wheat-*dhaincha* and mustard as compared to rice-wheat cropping system at Varanasi (U.P). The grain yield of rice was 11.58% higher when grown after wheat-*dhaincha* and 10.86% higher when rice was grown after mustard-green gram.

Materials and Method

The present field investigation was made under all India coordinated research project on farming system at Kuthulia farm of JNKVV, college of agriculture Rewa (M.P.) during *kharif* season of 2017-18 in which ten cropping system (rice-wheat, rice-green manure-barley, rice-gram + mustard-green manure, rice-pea-green gram, rice-potato-green gram, rice-pea + mustard-green manure, rice-berseem, rice-barley fodder-*bajra* fodder, rice-garlic and rice-*toria*-onion) were taken.

The rice variety was Danteshwari and PS-5 (rice-berseem and rice-garlic). The experiment was started in the year 2007-08 and same layout was adopted for present study. The experimental design was RBD with three replications.

The soil of experimental field was silty clay loam in texture, neutral in reaction (soil pH 7.10), low in organic carbon (0.39%), low in available nitrogen (163.83 kg/ha), medium in available phosphorus (16.33 kg/ha) and available potash was (219.7 kg/ha). The total rainfall during crop season was 856.9mm received in 42 rainy days. The dry spells were observed in month of September to October.

The rice crop was transplanted on 06/07/2017 at planting geometry of 20cm×15cm in which two seedling per hill was transplanted. The fertilizer dose for rice crop was 120kg N, 60kg P_2O_5, and 40kg K_2O/ha under all cropping system. All the recommended package of practices were adopted for the irrigated condition. The rice variety Danteshwari was harvested on 27/09/2017 and PS-5 on 08/10/2017. After harvest of *kharif* crops different *rabi* crops were sown on 1st week of October. Garlic and berseem were sown on 19th October while wheat crop was sown on 24th November in 2017-18.

Results and Discussion

Residual effect on rice

The yield contributing character of rice under the residual effect of different cropping systems has been given in Table 1. After perusal of results it is evident that yield contributing characters of rice were influenced significantly. It is clear from the result that yield attributing characters were superior in rice variety Danteshwari grown after Rice-gram + mustard-green manure, rice-barley-*bajra* and rice-*toria*-onion cropping system as

compared to existing rice-wheat system. The number of productive tillers per meter row length was significantly maximum in rice-gram + mustard-green manure and rice-*toria*-onion cropping system. These cropping systems gave 13.75 to 14.32% higher number of productive tillers/m^2 as compared to existing rice-wheat system. Productive tillers/m^2 were higher by 10.3% in rice-green manure-barley, 12.42% in rice-barley-*bajra* and 7.32% in rice-potato-green gram cropping systems over rice-wheat existing cropping system. The number of sound grains and grain yield/panicle were maximum in rice-garlic and rice-gram + mustard-green manure cropping systems. These cropping systems gave more than 20% higher number of sound grains and grain yield/panicle as compared to existing rice-wheat system. Rice variety PS-5 gave higher yield/panicle in rice-garlic than rice-berseem cropping system. It may be due to positive residual effect of preceding *rabi* crops on succeeding rice. It may be due to enhancement of organic carbon in soil by 25% to 51% and potash as compared to initial status. The crop like mustard, garlic, *toria*-onion, green manure-barley grown in *rabi* and summer have good residual and cumulative effect on succeeding rice by providing favorable soil atmosphere and enhancing the organic carbon and potassium by which growth of rice were increased in these cropping systems (Table 3).These findings are in conformity with the findings of Maurya *et al.,* (2011), Dhakad (2013), Yadav *et al.,* (2014) and Chouriya (2016).

The data on grain yield of rice under the residual effect of different cropping systems is given in Table 2 reveals that rice yield was increased by 7.19% in rice-pea-green gram, 8.45% in rice-green manure-barley, 9.3% in rice-potato-green gram, 13.42% in barley fodder-*bajra* fodder and 11.71% in rice-*toria*-onion cropping systems as compared to existing rice-wheat cropping system. Rice variety PS-5 gave 8.48% lower grain yield in rice-berseem and 16.36% in rice-garlic cropping systems as compared to rice variety Danteshwari in rice-wheat system. It may be due to positive residual effect of preceding *rabi* and summer crops like green manure-barley, gram + mustard-green manure, potato-green gram, barley-*bajra* and *toria*-onion by which growth and yield contributing characters of rice were increased significantly. The yield contributing character as number of productive tillers/m^2, number of sound grains/ panicle and grain yield per panicle were increased significantly as compared to rice grown after wheat. It may be due to amelioration of organic matter in soil by green manure-barley, gram + mustard-green manure, pea-green gram, potato-green gram, barley-*bajra* and *toria*-onion cropping system. The present experiment was started in the year 2006-07, therefore, there was buildup of residual effect by different *rabi* and summer crops. The positive effect of preceding berseem, pea-wheat, mustard-green manure, potato-wheat and *toria*-onion on rice were also reported by Sharma and Jain (1997), Upadhyay (2007), Yadav *et al.,* (2014) and Chouriya (2016).

Performance of different *rabi* crops and cropping systems

Data pertaining to economical yield of different *rabi* and summer crops have been given in Table 2. It is clear from the result that garlic crop performed better after rice followed by gram + mustard intercropping in 3:1. These crops were found superior than existing wheat in *rabi.* Rice equivalent yield under different cropping systems has been given in Table 2 reveals that rice-garlic cropping system gave maximum rice equivalent yield 195.64 q/ha followed by rice-potato-green gram (165.06 q/ha) and intercropping of gram + mustard in 3:1 (151.52 q/ha).

Table.1 Yield contributing character of rice as influenced by residual effect of different cropping system

Treatment	Plant height (cm)	Number of productive tillers/m^2 at harvest	Panicle length (cm)	Weight of panicle (g)	Number of sound grains/panicle at harvest	Grain yield/panicle (g)	Test weight (g)
T$_1$ Rice(Danteshwari)-Wheat(HD-2864)	60.99	348.88(0.00)	23.7	2.59	89.00(0.00)	2.22(0.00)	25.38
T$_2$ Rice(Danteshwari)- Green manure-barley(Gitanjali)	66.99	384.98(10.34%)	23.14	2.64	96.33(8.23%)	2.40(8.10%)	25.33
T$_3$ Rice(Danteshwari)-Gram(JG-322)+Mustard(Pusa bold)-Green manure	64.68	398.86(14.32%)	22.29	2.45	107.00(20.22%)	2.67(20.27%)	25.90
T$_4$ Rice(Danteshwari)-Pea(Arkel)-Green gram(PDM-139)	62.55	363.66(4.23%)	23.24	2.56	88.00(-1.12%)	2.20(-0.90%)	25.16
T$_5$ Rice(Danteshwari)-Potato(Kufri chandramukhi)-Green gram(PDM-139)	61.38	374.43(7.32%)	22.55	2.33	81.33(8.61%)	1.95(-12.16%)	24.71
T$_6$ Rice(Danteshwari)-Pea(Arkel)+Mustard(pusa bold)-Green manure	62.94	352.60(1.06%)	23.77	2.38	79.86(-10.26%)	1.97(-11.26%)	24.78
T$_7$ Rice(PS-5)-Berseem(JB-1)	74.55	371.10(6.36%)	27.09	3.12	92.00(3.37%)	2.57(15.76%)	28.90
T$_8$ Rice(Danteshwari)-Barley fodder(JB-58)-Bajra fodder(WCC-75)	65.33	392.22(12.42%)	23.59	2.72	103.00(15.73%)	2.75(23.87%)	26.46
T$_9$ Rice(PS-5)Garlic(G-1)	68.83	356.49(2.18%)	25.09	3.10	107.33(20.59%)	2.99(34.87%)	28.00
T$_{10}$ Rice(Danteshwari)-Toria(T-9)-Onion(AFLR)	63.38	396.88(13.75%)	21.23	2.39	87.86(-2.24%)	2.28(2.70%)	26.29
S.Em+	2.08	0.68	0.58	0.17	2.99	0.17	1.74
CD at 5%	2.14	25.68	1.70	0.48	8.84	0.48	NS

Figures in parentheses are % increase or decrease over T$_1$ (rice-wheat existing cropping system)

Table.2 Grain yield, REY, gross and net profit and B: C ratio of different cropping systems

Treatment	Yield q/ha			REY	Gross return Rs/ha	Net return Rs/ha	B:C ratio
	Kharif	Rabi	Rabi/ Summer				
T$_1$ Rice (Danteshwari)- Wheat(HD-2864)	50.29	55.53		117.67	211815	133613	2.7
T$_2$ Rice (Danteshwari)- Green manure-barley (Gitanjali)	54.54 (8.45%)	146.6	56.62	129.73 (10.24%)	233520	161335 (20.74%)	3.23
T$_3$ Rice (Danteshwari)-Gram (JG-322)+Mustard (Pusa bold)-Green manure	56.62 (12.58%)	13.43 23.23	125.9	151.52 (28.76%)	272739	201229 (50.60%)	3.81
T$_4$ Rice (Danteshwari)-Pea (Arkel)-Green gram (PDM-139)	53.91 (7.19%)	82.14	9.16	117.66 (0.00)	211804	139774 (4.61%)	2.94
T$_5$ Rice (Danteshwari)-Potato (Kufri chandramukhi)- Green gram (PDM-139)	54.97 (9.30%)	219.23	7.86	165.06 (40.27%)	297112	170327 (27.47%)	2.34
T$_6$ Rice (Danteshwari)-Pea (Arkel)+Mustard (pusa bold)- Green manure	50.63 (0.67%)	19.00 15.05	116.8	124.33 (5.65%)	223808	153423 (14.82%)	3.17
T$_7$ Rice(PS-5)-Berseem (JB-1)	45.84 (-8.84%)	751.73	1.5	128.78 (9.44%)	231804	160789 (20.33%)	3.26
T$_8$ Rice (Danteshwari)-Barley fodder (JB-58)-Bajra fodder (WCC-75)	57.04 (13.42%)	458.73	502.33	98.80 (-16.03%)	177849	115284 (-13.71%)	2.84
T$_9$ Rice (PS-5) Garlic (G-1)	42.06 (-16.36%)	131.55		195.64 (66.26%)	352153	211188 (58.05%)	2.49
T$_{10}$ Rice (Danteshwari)-Toria (T-9)-Onion (AFLR)	56.18 (11.71%)	7.86	173.5	148.69 (26.36%)	267648	121959 (-8.72%)	1.97
S.Em+	1.13			2.50			
CD at 5%	3.13			7.40			

Figures in parentheses are % increase or decrease over rice-wheat systems.

Table.3 Chemical properties of soil in different cropping system

Treatment	pH	Ec Mmhos/cm^2	Oc g/kg	Available nutrient kg/ha		
				N	**P**	**K**
T$_1$ Rice (Danteshwari)- Wheat (HD-2864)	6.52	0.39	4.9 (25.6%)	145.9 (-10.94%)	11.9 (-27.12%)	315.8 (43.70%)
T$_2$ Rice (Danteshwari)- Green manure-barley (Gitanjali)	6.61	0.42	5.2 (33.33%)	139.9 (-14.60%)	11.5 (-29.57%)	319.9 (45.56%)
T$_3$ Rice (Danteshwari)-Gram (JG-322)+Mustard (Pusa bold)-Green manure	6.72	0.48	4.9 (25.64%)	142.7 (-12.89%)	12.6 (-22.84%)	316.9 (44.20%)
T$_4$ Rice (Danteshwari)-Pea (Arkel)-Green gram (PDM-139)	6.90	0.51	5.0 (28.20%)	145.3 (-11.31%)	13.7 (-16.10%)	320.7 (45.95%)
T$_5$ Rice (Danteshwari)-Potato (Kufri chandramukhi)- Green gram (PDM-139)	7.11	0.49	5.1 (30.76%)	142.9 (-12.77%)	14.1 (-13.65%)	321.1 (46.11%)
T$_6$ Rice (Danteshwari)-Pea (Arkel)+Mustard (pusa bold)- Green manure	6.91	0.48	5.1 (30.76%)	140.9 (-13.99%)	14.1 (-13.65%)	319.8 (45.52%)
T$_7$ Rice(PS-5)-Berseem (JB-1)	6.63	0.28	5.1 (30.76%)	130.1 (-20.58%)	17.2 (5.32%)	220.1 (0.15%)
T$_8$ Rice (Danteshwari)-Barley fodder(JB-58)-Bajra fodder(WCC-75)	6.29	0.49	5.9 (51.28%)	129.8 (-20.77%)	15.8 (-3.24%)	311.2 (41.60%)
T$_9$ Rice (PS-5) Garlic (G-1)	6.86	0.42	5.8 (48.71%)	146.2 (-10.76%)	16.1 (-1.40%)	315.3 (43.47%)
T$_{10}$ Rice (Danteshwari)-Toria (T-9)-Onion (AFLR)	6.71	0.47	5.6 (43.58%)	169.5 (3.46%)	13.2 (-19.16%)	228.3 (3.88%)
Initial	**7.10**	**0.53**	**3.9**	**163.83**	**16.33**	**219.76**

Figures in parentheses are % increase (+) or decrease (-) over initial status.

Rice-barley-*bajra* cropping system was found inferior than existing rice-wheat system.

Net profit and B:C ratio have been given in Table 2 make it clear that maximum net profit Rs 211188/ha was obtained in rice-garlic cropping system followed by Rs 201229/ha in rice-gram + mustard intercropping in 3:1. These cropping systems gave 50.6% to 58.05% higher net profit than existing rice-wheat system. It may be due to higher productivity of these crops having more market rate. Similar findings were also reported by Maurya *et al.,* (2011) and Choriya *et al.,* (2016).

Effect on chemical properties of soil

The chemical properties of soil after completion of 14 crop cycle have been given in Table 3 reveals that soil pH was reduced in rice-barley-*bajra* and rice-wheat cropping system as compared to initial status. Electrical conductivity of soil was constant. Organic carbon status was increased in all cropping system by 25 to 51% and maximum organic carbon was noted in rice-barley-*bajra* cropping system. The available nitrogen and phosphorus status were decreased while available potash status was increased considerably under different cropping system.

On the basis of above it has been concluded that rice-garlic, rice-gram + mustard intercropping in 3:1 and rice-potato-green gram cropping system were better than existing rice-wheat cropping system in Rewa region of Madhya Pradesh under irrigated condition.

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