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Studies on Bio-intensive Multiple Cropping System Module in Kymore Satpura Plateau under Irrigated Condition

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ABSTRACT

Keywords

Cropping system, Multiple cropping, Residual effect, Rice equivalent yield and Green manuring

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The field experiment entitled “Studies on bio-intensive multiple cropping system module in Kymore Satpura Plateau under irrigated condition” was taken under All India Coordinated Research Project on Farming System, Kuthulia farm of JNKVV, College of Agriculture, Rewa (M.P.) during 2017-18 to 2019-20. The study reveals that rice crop performed better under the residual effect of different cropping system module significantly and grain yield of rice was increased by 2% to 14.83% as compared to existing rice-wheat system. Maximum grain yield of rice 52.79 q/ha was obtained in rice-barley-bajra cropping system followed by 50.68 q/ha in rice-gram+mustard-green manure cropping system. Rice equivalent yield (275.29 q/ha) and gross return (Rs.495520/ha) were obtained in rice-garlic cropping system followed by 149.42 q/ha REY and gross return Rs.268969/ha under rice-potato-green gram cropping system. The net profit Rs.321880/ha was maximum in rice-garlic followed by Rs.192342/ha in rice-potato-green gram cropping system. Benefit cost ratio 3.28 was maximum in rice-berseem followed by 3.19 under rice-gram+mustard-green manure cropping system while rice-pea-green gram and rice-toria-onion gave lower B:C ratio than existing rice-wheat system.

Introduction

Rice and wheat are dominant crop in Kymore Satpura Plateau agro-climatic zone of Madhya Pradesh. Rice-wheat, rice-gram and rice-barley are the major cropping system adopted in Rewa region. Rice-wheat cropping system occupies 3.19 lakh hectares area while rice-gram cropping system occupies 1.55 lakh hectares. Rice-barley cropping system covers an area of 0.45 lakh hectares. These cropping system are widely adopted by the farmers due

to stable production and less labour requirement (Kumar *et al.*, 2001). These cropping system are continue since long by which it creates problem of specific weed, insect, disease and soil sickness with loss of soil fertility which ultimately resulted in lower productivity (Katyal, 2003 and Kumar and Yadav, 2005). The problem is further aggravated as irrigation facilities in Rewa region are limited in *Rabi* season which affect the wheat cultivation to a great extent. Rice-pea+mustard and rice-gram+mustard are

found water efficient cropping system as compared to rice-wheat existing cropping system. The inclusion of pulses, oilseed, vegetables, garlic, onion, mustard and intercropping are found more beneficial than cereal after cereal cropping system (Kumpawat, 2001).

Different cropping systems in cropping system module under the farming system of Rewa region for soil fertility restoration, family nutrition requirement, income enhancement for better livelihood and fodder requirement for livestock have been found beneficial for different regions of India as reported by Chouriya *et al.*, (2016), Jugnahake *et al.*, (2018) and Maurya *et al.*, (2011). Different cropping systems on farming system module based have not been studied at Rewa region of Madhya Pradesh. Keeping above facts in view present study has been taken.

Materials and Methods

The present field investigation was conducted at Kuthulia farm of JNKVV, College of Agriculture, Rewa (M.P.) under All India Coordinated Research Project on Farming system during *Kharif* and *Rabi* seasons of 2017 to 2019-20. The texture of experimental field was silty clay loam, neutral in reaction (pH 7.1), low in organic carbon (4.2 g/kg), low in available nitrogen (180.3 kg/ha) and phosphorus (16.9 kg/ha) and higher in available potash (283.6kg/ha).

Ten cropping systems (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-bajra, rice-garlic and rice-toria- onion) were taken in Randomized block design with 3 replications. All the recommended package of practices were adopted for irrigated conditions. After

harvesting of previous crops, succeeding crops were sown immediately under different cropping systems.

Results and Discussion

Residual effect of different cropping system modules on rice

The grain yield of rice in response to residual effect of different cropping system has been given in Table 1. After perusal of the result, it is evident that grain yield of rice was affected significantly due to residual response of different cropping system module in different year. Grain yield of rice was increased by 2% to 14.83% under different cropping system on pooled basis as compared to existing rice-wheat cropping system. Rice yield 52.79 q/ha was maximum in rice-barley-bajra cropping system followed by 50.86 q/ha in rice-gram+mustard-green manure cropping system. These treatments gave 10.63% to 14.83% higher grain yield of rice over existing rice- wheat cropping system. It may be due to better residual response of these cropping system. This experiment was started in the year 2017-18 therefore, different cropping system exerted residual effect on rice by which rice crop gave higher number of productive tillers and superior yield attributes as compared to existing rice-wheat system. It may also be due to increase in organic carbon status in soil and availability of more nitrogen to the rice crop. The similar findings were also reported by Jugnahake *et al.*, (2018) and Sirse *et al.*, (2019). The grain yield of rice was decreased by 5.37% in rice-garlic cropping system as compared to existing rice-wheat system. It is because of the fact that rice and garlic both crop were exhaustive which leave lesser nutrient as compared to rice-wheat system. Available organic carbon status was reduced by 9.52%, available nitrogen 26.34%, and available phosphorus 5.32% over initial status in rice-garlic system

(Table 3). The similar result was also reported by Sirse *et al.*, (2019).

Effect on different Rabi and Summer crops

The economical yield of different *Rabi* and summer crops have been given in Table 2 reveals that garlic crop was found more remunerative and profitable as it gave garlic bulb yield 143.99 q/ha which was superior than all crops taken in *Rabi* and summer. All the *Rabi* crops were converted to rice equivalent yield for easy comparison and annual rice equivalent yield was calculated which is given in Table 2.

Effect on rice equivalent yield

The rice equivalent yield of different cropping system module has been presented in Table 2 reveals that maximum rice equivalent yield 275.29 q/ha was noted in rice-garlic followed by 149.42 q/ha in rice-potato-green gram cropping system.

These cropping systems gave 183.24% and 53.74% higher rice equivalent yield than existing rice-wheat system. It may be due to higher yield and higher market price of garlic and scented rice which play important role on rice equivalent yield. Similar findings were also reported by Jugnahake *et al.*, (2018) and Sirse *et al.*, (2019). All other cropping system were found superior than rice- wheat system as rice equivalent yield was increased by 3.52% 39.89% over rice-wheat system. Rice equivalent yield 97.19 q/ha was minimum under rice-wheat cropping system which was at par to rice- pea-green gram, rice-pea+mustard-green manure and rice-barley-bajra cropping system. But rice equivalent yield was higher by 3.52% to 6.43% over rice- wheat system. The similar findings were also reported by Jugnahake *et al.*, (2018) and Sirse *et al.*, (2019).

Effect on gross and net profit

The gross return, net return and benefit cost ratio of different cropping system have been presented in Table 2. It is clear from the result that gross return Rs.495520/ha was maximum under rice-garlic followed by Rs.268969/ha in rice- potato-green gram and Rs.209219/ha in rice-gram+mustard-green manure cropping system. All other cropping systems also gave higher gross return than existing rice- wheat cropping system. Net profit under different cropping system module reveals that net profit Rs.321880/ha was maximum in rice-garlic followed by Rs.192342/ha in rice-potato-green gram. These cropping systems gave 165.48% and 58.64% higher net return than existing rice-wheat system. Similar finding was also reported by Sirse *et al.*, (2019). The net profit Rs. 118934 was minimum in rice- toria-onion which was 2% lower than existing rice-wheat system. It may be due to higher cost of cultivation and lower market price at harvesting time.

The benefit cost ratio 3.28 was maximum under rice-berseem followed by 3.19 under the rice-gram+mustard-green manure cropping system. The rice wheat cropping system gave B:C ratio 2.52 which was higher than the rice-pea-green gram and rice-toria-onion cropping system. The findings are in conformity with the findings of Maurya *et al.*, (2011) and Jugnahake *et al.*, (2018).

Effect on chemical properties of the soil

The chemical properties of the soil after completion of 3 year crop cycle have been given in Table 3. After perusal of the result, it is evident that soil pH and electrical conductivity of the soil were unaffected as compared to initial status.

Table.1 Economical yield of different crops as influenced by different cropping system module

Treatment	Yield (q/ha)											
	Kharif – I				Rabi – II				Rabi / Summer - III			
	2017-18	2018-19	2019-20	Mean	2017-18	2018-19	2019-20	Mean	2017-18	2018-19	2019-20	Mean
T₁ Rice (Danteshwari) – Wheat (HD-2864)	50.29	38.94	48.67	45.97	55.53	56.30	54.78	55.54				
T₂ Rice (Danteshwari) – Green manure – Barley (Geetanjali)	54.54	40.45	54.14	49.71 (+8.13)	146.60	128.40	158.80	144.60	56.62	55.10	46.38	52.70
T₃ Rice (Danteshwari) – Gram (JG-322) + Musatard (Pusa bold) – GM	56.62	45.73	50.22	50.86 (+10.63)	G 13.43 M 23.23	G 12.30 M 19.90	G 9.57 M 12.60	G 11.77 M 18.58	125.90	132.20	119.47	125.85
T₄ Rice (Danteshwari) – Pea (Arkel) – Green Gram (PDM-139)	53.91	44.13	51.90	49.98 (+8.72)	82.14	60.90	70.75	71.26	9.16	11.90	10.58	10.54
T₅ Rice (Danteshwari) – Potato (Kufri chandramukhi) - Green gram	54.97	42.19	51.76	49.64 (+7.98)	219.23	193.4	190.27	200.97	7.86	10.66	11.85	10.12
T₆ Rice (Danteshwari) – Pea (Arkel) + mustard (Pusa bold) + green manure	50.63	38.36	53.06	47.35 (+3.00)	P 19.00 M 15.05	P 14.20 M 17.30	P 12.75 M 10.90	P 15.32 M 14.32	116.80	129.30	132.52	126.20
T₇ Rice (PS-5) – Berseem (JB-1)	45.84	47.27	50.16	47.76 (+3.89)	751.73	721.90	750.23	741.29	1.50	3.40	4.46	3.12
T₈ Rice (Danteshwari) – Barley fodder (JB-58) –Bajra fodder (WCC-75)	57.04	45.84	55.50	52.79 (+14.83)	458.73	568.60	408.30	478.54	502.33	490.10	655.10	549.17
T₉ Rice (PS-5) – Garlic (G-1)	42.06	43.12	45.33	43.50 (-5.37)	131.55	150.20	150.22	143.99				
T₁₀ Rice (Danteshwari) – Toria (T-9) – Onion (AFLR)	56.18	40.36	44.25	46.93 (+2.08)	7.86	9.30	10.44	9.20	173.50	193.70	187.10	184.76
SEM ±	1.13	1.5	1.07	1.23								
CD at 5%	3.13	4.44	3.16	3.57								

Where G = Gram, M = Mustard, P = Pea
 Figures in parentheses are % increase / decrease over T₁

Table.2 Rice equivalent yield, gross profit, net profit and B:C ratio of different cropping system module.

Treatment	Rice equivalent yield (q/ha)				3 Years Pooled		
	2017-18	2018-19	2019-20	Mean	Gross return Rs./ha	Net return Rs./ha	B:C ratio
T ₁ Rice (Danteshwari) – Wheat (HD-2864)	117.67	61.23	112.66	97.19	175359	121244	2.52
T ₂ Rice (Danteshwari) – Green manure – Barley (Geetanjali)	129.73	71.81	120.63	107.39 (+10.49)	193307 (+10.23)	138244 (+14.02)	2.78 (+10.31)
T ₃ Rice (Danteshwari) – Gram (JG-322) + Mustard (Pusa bold) – GM	151.52	85.15	112.02	116.23 (+19.59)	209219 (+19.30)	161915 (+33.54)	3.19 (+26.58)
T ₄ Rice (Danteshwari) – Pea (Arkel) – Green Gram (PDM- 139)	117.66	59.90	124.30	100.62 (+3.52)	181124 (+3.28)	123131 (+1.55)	2.42 (-3.96)
T ₅ Rice (Danteshwari) – Potato (Kufri chandramukhi) - Green gram	165.06	108.75	174.45	149.42 (+53.74)	268969 (+53.38)	192342 (+58.64)	2.95 (+17.06)
T ₆ Rice (Danteshwari) – Pea (Arkel) + mustard (Pusa bold) + green manure	124.33	72.70	113.28	103.44 (+6.43)	186195 (+6.17)	132190 (+9.02)	2.90 (+15.07)
T ₇ Rice (PS-5) – Berseem (JB-1)	128.78	78.78	142.88	116.81 (+20.18)	210278 (+19.91)	170049 (+40.25)	3.28 (+30.15)
T ₈ Rice (Danteshwari) – Barley fodder (JB-58) –Bajra fodder (WCC-75)	98.80	87.84	119.11	101.92 (+4.86)	183467 (+4.62)	141145 (+16.41)	2.92 (+15.87)
T ₉ Rice (PS-5) – Garlic (G-1)	195.64	249.33	380.89	275.29 (+183.24)	495520 (182.57)	321880 (+165.48)	2.56 (+1.58)
T ₁₀ Rice (Danteshwari) – Toria (T-9) – Onion (AFLR)	148.69	105.86	153.32	135.96 (+39.89)	244718 (+39.55)	118934 (-1.90)	1.72 (-31.74)
SEM ±	2.50	3.72	3.85	3.35			
CD at 5%	7.40	11.01	5.73	8.04			

Figures in parentheses are % increase / decrease over T₁

Table.3 Chemical properties of soil in different cropping systems after completion of three crop cycle

Treatment	pH	Ec	OC (g/kg)	Available Nutrient (kg/ha)		
				N	P	K
T ₁ Rice (Danteshwari) – Wheat (HD-2864)	7.30	0.21	3.90 (-7.14)	112.60 (-37.54)	10.20 (-39.64)	312 (+10.01)
T ₂ Rice (Danteshwari) – Green manure – Barley (Geetanjali)	6.60	0.26	4.20 (0)	109.20 (-39.43)	11.70 (-30.76)	368 (+29.76)
T ₃ Rice (Danteshwari) – Gram (JG-322) + Musatard (Pusa bold) – GM	6.70	0.28	5.80 (+38.09)	198.40 (+10.03)	15.20 (-10.05)	416 (+46.68)
T ₄ Rice (Danteshwari) – Pea (Arkel) – Green Gram (PDM- 139)	7.30	0.41	5.70 (+35.71)	197.90 (+9.76)	18.80 (+11.24)	380 (+33.99)
T ₅ Rice (Danteshwari) – Potato (Kufri chandramukhi) - Green gram	6.60	0.48	4.60 (+9.52)	116.30 (-35.49)	12.60 (-25.44)	295 (+4.01)
T ₆ Rice (Danteshwari) – Pea (Arkel) + mustard (Pusa bold) + green manure	6.40	0.33	4.80 (+14.28)	119.40 (-33.77)	14.30 (-15.38)	332 (+17.06)
T ₇ Rice (PS-5) – Berseem (JB-1)	6.20	0.41	6.20 (+47.61)	193.60 (+7.37)	16.20 (-4.14)	410 (+44.56)
T ₈ Rice (Danteshwari) – Barley fodder (JB-58) –Bajra fodder (WCC-75)	7.90	0.32	4.40 (+4.76)	121.20 (-26.34)	15.30 (-9.46)	418 (+47.39)
T ₉ Rice (PS-5) – Garlic (G-1)	6.70	0.38	3.80 (-9.52)	132.80 (-26.34)	16.00 (-5.32)	381 (+34.34)
T ₁₀ Rice (Danteshwari) – Toria (T-9) – Onion (AFLR)	7.20	0.69	3.70 (-11.90)	136.20 (-24.45)	13.60 (-19.50)	363 (+27.99)
Initial	7.10	0.50	4.20	180.30	16.90	283.60

Figures in parentheses are % increase / decrease over initial

Organic carbon status was increased in rice-pea+mustard-green manure, rice-potato-green gram, rice-pea-green gram and rice-gram+mustard-green manure cropping system. While organic carbon status was decreased in rice-wheat, rice-garlic and rice-toria-onion cropping system. Available nitrogen status and phosphorus status was increased in rice-pea-green gram, rice-berseem, rice-gram+mustard-green manure cropping system as compared to initial status. Available potash status was increased by 4% to 47.39% over initial status under different cropping system and maximum increase were observed rice-barley-bajra, rice-berseem and rice-gram+mustard-green manure cropping system.

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