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Productivity and Soil Properties under System of Rice Intensification in Rice-Rice Cropping System

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Abstracts

A field experiment was conducted at Agriculture Instructional cum Research Farm, IGKV Raipur during kharif and Rabi seasons three consecutive years of 2015-16, 2016-17, 2017-18 to study the effect of nutrient management practices on productivity of rice and soil chemical properties under system of rice intensification in rice-rice cropping system. The experiment was laid out in randomized block design with four replications. The treatments were- T1-100%RFD + 10t FYM/ha, T2-100%RFD + 5t FYM/ha + Green Manuring + Microbes, T3 -75%RFD+ Treatment with neem product + 10t FYM/ha, T4 -75%RFD + Treatment with neem product + 5t FYM/ha+ Green Manuring + Microbes T5 -STBR + 10t FYM/ha, T6 -STBR + 5t FYM/ha + Green Manuring + Microbes, T7 -100% RFD, T8 -100% Organic (N equivalent), T9- control and T10- Normal transplanting with RFD. Results indicated that application of fertilizers based on STBR along with 5tFYM+5t Green manure+Microbes produced the maximum grain yield of rice, which was however at par with application of fertilizers based on STBR along with 10 t FYM/ha. STBR based fertilizer application recorded 8.62-10.20% and 8.64-11.29% higher grain yield during Kharif and rabi season, respectively, compared to application of recommended fertilizer dose. Application of fertilizers based on STBR along with 5tFYM+5t Green manure+ Microbes (PSB and Azospirillum) registered 50.58 and 50.55% % increase in grain yield compared to application of nutrients through organic sources only during Kharif and rabi season, respectively. There was no significant difference in soil pH due to different nutrient management during all the three years of study. Moreover, after three seasons of experimentation soil has increased carbon, available nitrogen, and available phosphorus but available potassium decreased slightly. The raise in soil organic carbon content, available nitrogen, and available phosphorus were to the tune of 0.10 to 0.12%, 35.1 to 58.9 kg/ha and 5.82 to 6.90 kg/ha, respectively whereas decrease in soil available potassium was to the tune of 24.3 to 38.5 kg/ha. **Keywords:** System of rice intensification, Nutrient management, Rice-Rice cropping system, Green manure, PSB, Azospirillum, STBR, Grain yield, Soil quality

Introduction

Rice (*Oryza sativa* L.) is the main staple food of India with an area under cultivation of 431.94 lakh ha and productivity of 2550 kg/ha during 2016-17 (Anonymous 2017). It covers about 70% area during in Chhattisgarh during Kharif season. It has 37.45 lakh ha during Kharif and 1.96 lakh ha during rabi with productivity of 2212 and 2910 kg/ha, respectively 2016-17 (Anonymous, 2018). The decreasing water availability for agriculture and increasing population need to produce more yield with lesser quantity of water. System of rice intensification (SRI) has been reported with saving of water by 25 to 50 percent along with increased productivity of 20 to 30 percent or even more, thus it can help in solving the problems. However, better performance of SRI under organic and integrated nutrient management (Sonboir *et al.* 2016) and lack of sufficient quantity of farmyard manure, declares to find out alternate sources of organic manures. Application of Soil test based application of fertilizers and combination of FYM, green manure, and microbes can solve the problem of organic manure availability. However, the information for rice-rice cropping system is lacking.

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Therefore, an experiment was conducted to study the effect of nutrient management practices on growth, yield and soil chemical properties in rice-rice cropping system under system of rice intensification

Materials and methods

A field experiment was conducted at Agriculture Instructional cum Research Farm, IGKV Raipur during Kharif and rabi seasons of three consecutive years (2015-16, 2016-17, 2017-18) in same field. The experimental soil was clay in texture, neutral in reaction, normal in electrical conductivity, low in available nitrogen, medium in available phosphorus, and high in available potassium. The experiment was laid out in randomized block design with four replications. The treatments were- T1-100%RFD + 10t FYM/ha, T2-100%RFD + 5t FYM/ha +Green Manuring +Microbes, T3 -75%RFD+ Treatment with neem product + 10t FYM/ha, T4 -75%RFD + Treatment with neem product + 5t FYM/ha+ Green Manuring + Microbes, T5 -STBR + 10t FYM/ha, T6 -STBR + 5t FYM/ha + Green Manuring + Microbes, T7 -100% RFD (Inorganic), T8 -100% RFD (Organic N equivalent), T9- control and T10- Normal transplanting with RFD. The recommended fertilizer dose (RFD) was 100:60:40 kg NPK/ha for Kharif season and 120:60:40 kg NPK/ha for rabi season experimentation. PSB and Azospirillum @ 400g/ha each were used as soil application and Nimin (Neem product) @ 1% to treat the urea were used as per treatments. In STBR (Soil test based recommendation), nitrogen was applied 50% higher, phosphorus was normal, and potassium was 50% lesser as per soil test value. The test variety was Swarna (140-145 days) during Kharif and IR 64 (120 days) during rabi. Ex-situ grown dhaicha was incorporated as green manuring @ 5t/ha at the time of field preparation as per treatments. Twelve days old seedlings were used for transplanting for SRI and transplanted at 25x25 cm spacing. In the normal transplanting treatment, during Kharif and rabi 25 days and 30 days old, respectively, 2-3 seedlings were transplanted at 20x10 cm spacing, and continuous water of 5±2 cm was maintained till dough stage. Ambika paddy weeder (rotary weeder) was run at 15, 25 and 35 days after transplanting of rice in SRI, whereas chemical weed control was adopted for normal transplanting. The soil samples were taken before start of experiment and after harvesting of rice in each season. The samples were analysed for pH (Glass electrode pH meter, Jackson, 1973), EC (Conductivity bridge, Jackson, 1973), organic carbon (Wet digestion method, Walkley and Black, 1934), available nitrogen (Alkaline permanganate method, Subbiah and Asija, 1956), phosphorus (Olsen's method, Olsen *et al.*, 1954) and potassium (Flame photometry, Jackson, 1973). The crop was harvested at maturity from the net plot area, and grain yield was recorded at 14% moisture content. The data were statistically analysed as suggested by Gomez and Gomez (1983) for interpretation of the result.

Results and discussion

Effect on tillering: Normal transplanting produced more number of tillers/m² as compared to SRI during Kharif and rabi season. However, among SRI, application of fertilizers based on STBR along with 5tFYM+5t Green manure+ Microbes (PSB and Azospirillum) produced the maximum number of tillers of rice under SRI, which was however at par with the application of fertilizers based on STBR along with 10 t FYM/ha (Table 1).

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Table 1: Number of tillers at maximum tillering as influenced by different nutrient management under SRI during Kharif season.

Treatments		2015-16		2016-17		2017-18		Mean	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
T1	100%RFD + 10t FYM	388.0	331.1	375.9	392.6	361.3	347.3	375.1	357.0
T2	100%RFD + 5t FYM +GM +Microbes	393.6	334.1	421.0	405.5	371.5	383.0	395.4	374.2
T3	75%RFD+ Neem Product + 10t FYM	330.4	315.8	336.0	347.8	353.5	329.0	340.0	330.9
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	358.4	346.3	384.5	397.8	366.5	351.3	369.8	365.1
T5	STBR + 10t FYM	450.4	358.7	450.4	431.3	375.3	385.5	425.4	391.8
T6	STBR + 5t FYM + GM + Microbes	439.2	363.0	461.4	467.2	383.8	408.8	428.1	413.0
T7	100% RFD	382.4	325.6	367.2	386.3	355.0	336.8	368.2	349.6
T8	100% Organic	404.0	315.5	294.5	308.4	308.8	301.5	335.8	308.5
T9	Control	183.2	209.3	222.4	250.4	256.8	256.0	220.8	238.6
T10	Normal transplanting	478.4	482.6	487.9	612.1	447.8	564.3	471.4	553.0
CD(P=0.05)		37.0	11.1	37.1	42.3	23.9	31.5	-	-

Effect on yield attributes: Normal transplanting produced number of panicles/m² and a lesser number of grains/panicle as compared to SRI during Kharif and rabi season. The test weight of rice was found non-significant during both the seasons. However, among SRI, application of fertilizers based on STBR along with 5tFYM+5t Green manure+ Microbes (PSB and Azospirillum) produced the maximum number of tillers per panicle and number of grains per panicle of rice under SRI, which were however at par with application of fertilizers based on STBR along with 10 t FYM/ha (Table 2, 3, 4).

Table 2 : Number of panicles as influenced by different nutrient management under SRI during Kharif season.

Treatments		2015-16		2016-17		2017-18		Mean	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
T1	100%RFD + 10t FYM	224.0	222.4	275.2	317.3	251.2	128.4	250.1	222.7
T2	100%RFD + 5t FYM +GM +Microbes	227.2	228.9	287.9	331.6	254.5	137.7	256.5	232.7
T3	75%RFD+ Neem Product + 10t FYM	194.5	198.0	254.1	300.5	246.4	124.9	231.7	207.8
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	199.2	225.8	280.8	327.9	253.0	132.5	244.3	228.7
T5	STBR + 10t FYM	230.7	235.9	320.0	340.8	260.2	139.9	270.3	238.9
T6	STBR + 5t FYM + GM + Microbes	234.4	240.5	328.0	378.4	270.6	144.7	277.7	254.5
T7	100% RFD	197.6	210.6	269.6	309.7	248.2	119.8	238.5	213.4
T8	100% Organic	193.7	194.2	221.9	255.9	201.4	113.4	205.7	187.8
T9	Control	131.2	135.4	157.6	200.8	182.1	109.4	157.0	148.5
T10	Normal transplanting	265.3	282.6	358.0	418.0	300.3	99.0	307.9	266.5
CD(P=0.05)		22.9	13.4	26.0	25.9	26.5	16.7	-	-

Table 3 : Number of filled grains/panicle as influenced by different nutrient management under SRI during Kharif season.

Treatments		2015-16		2016-17		2017-18		Mean	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
T1	100%RFD + 10t FYM	160.7	130.2	172.5	124.3	162.2	128.4	165.1	127.6
T2	100%RFD + 5t FYM +GM +Microbes	162.3	138.9	180.0	133.3	168.3	137.7	170.2	136.6
T3	75%RFD+ Neem Product + 10t FYM	151.1	126.5	166.9	120.0	156.1	124.9	158.0	123.8
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	153.5	131.2	176.4	128.6	164.3	132.5	164.7	130.8
T5	STBR + 10t FYM	169.9	148.6	183.9	140.8	170.3	139.9	174.7	143.1
T6	STBR + 5t FYM + GM + Microbes	175.6	152.4	194.3	148.6	172.9	144.7	180.9	148.6
T7	100% RFD	152.3	129.5	169.7	122.4	160.1	119.8	160.7	123.9
T8	100% Organic	144.4	120.3	148.0	118.4	147.4	113.4	146.6	117.4
T9	Control	132.7	108.6	133.9	116.5	138.4	109.4	135.0	111.5
T10	Normal transplanting	110.6	101.5	125.3	108.1	111.0	99.0	115.6	102.9
CD(P=0.05)		13.7	5.5	11.9	12.4	14.5	9.4	-	-

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Table 4 : Test weight of rice as influenced by different nutrient management under SRI during Kharif season.

Treatments		2015-16		2016-17		2017-18		Mean	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
T1	100%RFD + 10t FYM	18.88	27.58	20.25	22.81	19.55	22.10	19.56	24.16
T2	100%RFD + 5t FYM +GM +Microbes	19.13	27.69	20.13	23.46	19.13	22.00	19.46	24.38
T3	75%RFD+ Neem Product + 10t FYM	18.13	27.64	20.25	22.89	19.38	21.95	19.25	24.16
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	18.88	27.59	20.25	23.35	19.80	22.58	19.64	24.51
T5	STBR + 10t FYM	19.13	28.32	20.25	23.60	19.28	22.15	19.55	24.69
T6	STBR + 5t FYM + GM + Microbes	19.13	28.41	20.38	23.68	19.30	22.55	19.60	24.88
T7	100% RFD	19.00	26.92	20.13	22.79	19.28	22.20	19.47	23.97
T8	100% Organic	18.75	26.87	20.38	22.20	19.50	22.15	19.54	23.74
T9	Control	18.38	26.51	20.13	22.06	19.85	22.30	19.45	23.62
T10	Normal transplanting	18.60	26.68	20.17	23.15	19.45	21.75	19.41	23.86
	CD(P=0.05)	0.6	0.73	NS	NS	NS	NS	-	-

3. Effect on grain yield, straw yield, and harvest index of rice:

Grain yield of rice was significantly influenced by nutrient management practices. Among SRI, application of fertilizers based on STBR along with 5tFYM+5t Green manure+ Microbes (PSB and Azospirillum) produced maximum grain yield of rice during Kharif and rabi season, which was however at par with application of fertilizers based on STBR along with 10 t FYM/ha. On the basis of three years data, it was observed that STBR based fertilizer application recorded 8.62-10.20% and 8.64-11.29% higher grain yield, respectively during Kharif and rabi, as compared to application of fertilizer based on general recommendation with respective organic source of manures. The best performing treatment, application of fertilizers based on STBR along with 5tFYM+5t Green manure+ Microbes (PSB and Azospirillum) registered 50.55 - 50.58% increase in grain yield compared to application of nutrients through organic sources only. It was also noted that highest yielding SRI treatment of the application of fertilizers based on STBR along with 5tFYM+5t Green manure+ Microbes (PSB and Azospirillum) produced 27.16% and 29.82% higher grain yield as compared normal transplanting with recommended fertilizer dose. The lowest grain yield of rice was recorded under control with significant difference (Table 5). Regarding straw yield among SRI, application of fertilizers based on STBR along with 5tFYM+5t Green manure+ Microbes (PSB and Azospirillum) produced the maximum straw yield, which was however at par with application of fertilizers based on STBR along with 10 t FYM/ha. The lowest grain yield of rice was recorded under control with a significant difference (Table 6). The harvest index of rice was noticed higher under SRI as compared to normal transplanting (Table 7).

Table 5: Grain yield of rice as influenced by different nutrient management under SRI during Kharif season

Treatments		2015-16		2016-17		2017-18		Mean	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
T1	100%RFD + 10t FYM	56.40	69.11	77.10	63.67	62.17	58.72	65.22	63.83
T2	100%RFD + 5t FYM +GM +Microbes	60.66	73.41	79.83	67.82	65.67	61.86	68.72	67.70
T3	75%RFD+ Neem Product + 10t FYM	52.00	64.90	68.41	58.38	58.74	54.08	59.72	59.12
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	59.70	71.41	77.69	65.33	63.61	59.75	67.00	65.50
T5	STBR + 10t FYM	65.00	77.10	82.25	70.83	68.38	65.19	71.88	71.04
T6	STBR + 5t FYM + GM + Microbes	66.90	79.20	85.72	73.54	71.31	67.89	74.64	73.54
T7	100% RFD	54.50	67.40	76.24	62.10	60.85	57.30	63.86	62.27
T8	100% Organic	48.54	61.20	54.14	45.78	46.03	39.58	49.57	48.85
T9	Control	30.36	40.30	39.06	27.22	32.47	22.26	33.96	29.93
T10	Normal transplanting	55.62	57.43	61.38	56.10	59.10	56.42	58.70	56.65
	CD(P=0.05)	3.15	2.50	4.35	4.60	4.21	3.37	-	-

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Table 6: Straw yield of rice as influenced by different nutrient management under SRI during Kharif season

Treatments		2015-16		2016-17		2017-18		Mean	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
T1	100%RFD + 10t FYM	39.60	61.54	82.15	61.15	76.98	58.09	66.24	60.26
T2	100%RFD + 5t FYM +GM +Microbes	45.14	63.45	81.10	63.31	81.32	61.08	69.19	62.61
T3	75%RFD+ Neem Product + 10t FYM	37.00	64.27	75.12	58.80	70.19	52.88	60.77	58.65
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	46.10	61.69	81.91	62.77	78.24	57.61	68.75	60.69
T5	STBR + 10t FYM	50.80	62.29	82.59	63.50	84.98	62.63	72.79	62.81
T6	STBR + 5t FYM + GM + Microbes	58.70	63.77	83.71	65.68	87.21	65.36	76.54	64.94
T7	100% RFD	42.10	63.06	82.65	59.07	75.95	54.03	66.90	58.72
T8	100% Organic	47.66	62.20	62.84	49.42	59.63	39.59	56.71	50.40
T9	Control	22.44	43.10	46.84	32.10	43.28	22.61	37.52	32.60
T10	Normal transplanting	50.00	58.97	68.03	51.88	77.13	55.97	65.05	55.61
	CD(P=0.05)	7.81	3.87	6.28	3.38	7.54	4.75	-	

Table 7: Harvest index of rice as influenced by different nutrient management during Kharif season

Treatments		2015-16		2016-17		2017-18		Mean	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
T1	100%RFD + 10t FYM	58.83	52.89	48.42	51.01	44.75	50.28	50.67	51.39
T2	100%RFD + 5t FYM +GM +Microbes	57.35	53.69	49.61	51.71	44.74	50.31	50.57	51.90
T3	75%RFD+ Neem Product + 10t FYM	58.47	50.24	47.68	49.83	45.68	50.54	50.61	50.20
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	56.77	53.64	48.68	50.98	44.82	50.90	50.09	51.84
T5	STBR + 10t FYM	56.12	55.32	49.90	52.73	44.65	51.01	50.22	53.02
T6	STBR + 5t FYM + GM + Microbes	53.55	55.40	50.63	52.82	45.02	51.01	49.73	53.08
T7	100% RFD	56.55	51.66	47.99	51.22	44.47	51.51	49.67	51.46
T8	100% Organic	50.55	49.61	46.28	48.00	43.58	50.02	46.80	49.21
T9	Control	57.60	48.32	45.49	45.93	42.91	49.58	48.67	47.94
T10	Normal transplanting	52.66	49.34	47.43	51.95	43.45	50.21	47.85	50.50
	CD(P=0.05)	3.96	1.51	1.67	2.91	0.80	0.95	-	

4. Effect on soil chemical properties:

a. Effect on soil pH: Soil reaction was not influenced by different methods of establishment viz. normal transplanting and SRI. There was also no difference in soil pH due to different nutrient management during all the three years of study in both Kharif as well as rabi season. The difference was also not observed over the year of experimentation (Table 8).

Table 8: Effect on soil pH after harvest of as influenced by different nutrient management.

Treatment		pH (1:2.5)						
		Initial	Kharif 2015	Rabi 2015-16	Kharif 2016	Rabi 2016-17	Kharif 2017	Rabi 2017-18
T1	100%RFD + 10t FYM	7.27	7.36	7.25	7.32	7.31	7.29	7.25
T2	100%RFD + 5t FYM +GM +Microbes	7.27	7.36	7.22	7.33	7.31	7.28	7.24
T3	75%RFD+ Neem Product + 10t FYM	7.27	7.37	7.28	7.32	7.32	7.28	7.25
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	7.27	7.41	7.28	7.36	7.34	7.29	7.25
T5	STBR + 10t FYM	7.27	7.41	7.24	7.35	7.34	7.29	7.25
T6	STBR + 5t FYM + GM + Microbes	7.27	7.42	7.26	7.36	7.35	7.31	7.27
T7	100% RFD	7.27	7.45	7.25	7.37	7.35	7.30	7.26
T8	100% Organic	7.27	7.45	7.21	7.36	7.35	7.31	7.26
T9	Control	7.27	7.44	7.22	7.34	7.33	7.29	7.25
T10	Normal transplanting	7.27	7.38	7.26	7.35	7.34	7.30	7.24
	CD(P=0.05)	-	NS	NS	NS	NS	NS	NS

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c. Effect on Organic carbon: In initial years, soil organic carbon content was not influenced due to different nutrient management practices. However, after three seasons of experimentation, soil has increased carbon content, and it was significantly influenced by nutrient management also. Application of heavy organic manures @ 10t/ha exhibited higher soil organic content followed by combined application of 5t FYM, green manuring, and microbes. Application of only chemical fertilizers decreased the soil organic content as compared to organic manure application. The raise in soil organic carbon content to the tune of 0.10 to 0.12% was also noted after six cycles of research on SRI (Table 9).

Table 9: Effect on soil organic carbon (%) after the harvest of as influenced by different nutrient management.

Treatment		Soil organic carbon (%)						
		Initial	Kharif 2015	Rabi 2015-16	Kharif 2016	Rabi 2016-17	Kharif 2017	Rabi 2017-18
T1	100%RFD + 10t FYM	0.530	0.627	0.633	0.638	0.643	0.649	0.652
T2	100%RFD + 5t FYM +GM +Microbes	0.530	0.613	0.615	0.629	0.632	0.636	0.643
T3	75%RFD+ Neem Product + 10t FYM	0.530	0.632	0.629	0.64	0.648	0.633	0.643
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	0.530	0.604	0.614	0.618	0.623	0.629	0.634
T5	STBR + 10t FYM	0.530	0.633	0.632	0.641	0.649	0.651	0.653
T6	STBR + 5t FYM + GM + Microbes	0.530	0.614	0.623	0.632	0.642	0.648	0.651
T7	100% RFD	0.530	0.603	0.613	0.613	0.627	0.628	0.629
T8	100% Organic	0.530	0.643	0.643	0.649	0.651	0.653	0.654
T9	Control	0.530	0.593	0.584	0.583	0.581	0.580	0.574
T10	Normal transplanting	0.530	0.620	0.614	0.615	0.620	0.621	0.621
CD(P=0.05)		-	NS	NS	NS	0.036	0.022	0.017

Effect on soil available nitrogen: Soil available nitrogen was significantly influenced due to different nutrient management practices, and after three season of experimentation soil has increase in soil available nitrogen. Application of heavy organic manures @ 10t/ha exhibited higher soil available nitrogen followed by combined application of 5t FYM, green manuring, and microbes. Application of only chemical fertilizers had lesser soil available nitrogen compared to organic manure application. The raise in soil available nitrogen was to the tune of 35.1 to 58.9 kg/ha after six cycles of research on SRI (Table 10).

Table 10: Effect on available soil nitrogen (kg/ha) after harvest of as influenced by different nutrient management.

Treatment		Soil available nitrogen (kg/ha)						
		Initial	Kharif 2015	Rabi 2015-16	Kharif 2016	Rabi 2016-17	Kharif 2017	Rabi 2017-18
T1	100%RFD + 10t FYM	139.4	158.9	162.4	182.4	189.7	193.5	197.3
T2	100%RFD + 5t FYM +GM +Microbes	139.4	155.2	159.7	178.6	185.3	189.3	193.6
T3	75%RFD+ Neem Product + 10t FYM	139.4	149.1	153.8	173.3	183.3	178.4	183.2
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	139.4	144.9	151.5	167.7	178.4	176.4	179.5
T5	STBR + 10t FYM	139.4	159.6	162.5	183.5	191.7	195.3	198.3
T6	STBR + 5t FYM + GM + Microbes	139.4	156.8	158.4	181.3	187.1	193.4	196.6
T7	100% RFD	139.4	142.2	152.6	150.2	161.4	170.4	174.5
T8	100% Organic	139.4	150.6	157.6	173.6	183.2	178.5	181.4
T9	Control	139.4	130.2	138.9	128.2	127.4	128.4	129.5
T10	Normal transplanting	139.4	141.4	153.2	175.3	162.3	169.5	175.2
CD(P=0.05)		-	14.5	10.0	10.0	9.2	7.2	7.4

Effect on soil available phosphorus: Soil available phosphorus was significantly influenced due to different nutrient management practices, and after three season of experimentation soil has increase in soil available phosphorus. Application of heavy organic manures or combined application of 5t FYM, green manuring and microbes did not show effect on soil available phosphorus. However, application on inorganic fertilizer exhibited more increase in soil available phosphorus. The rise in available soil phosphorus was to the tune of 5.82 to 6.90 kg/ha after six cycles of research on SRI (Table 11).

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Table 11: Effect on available soil phosphorus (kg/ha) after harvest of as influenced by different nutrient management.

Treatment		Soil available phosphorus (P kg/ha)						
		Initial	Kharif 2015	Rabi 2015-16	Kharif 2016	Rabi 2016-17	Kharif 2017	Rabi 2017-18
T1	100%RFD + 10t FYM	21.52	23.42	23.45	24.53	24.98	26.76	28.34
T2	100%RFD + 5t FYM +GM +Microbes	21.52	23.14	23.12	24.21	24.86	26.34	28.21
T3	75%RFD+ Neem Product + 10t FYM	21.52	22.53	22.89	23.01	24.12	25.71	27.37
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	21.52	22.32	22.75	22.98	24.03	25.48	27.34
T5	STBR + 10t FYM	21.52	23.54	23.61	24.38	24.88	26.57	28.31
T6	STBR + 5t FYM + GM + Microbes	21.52	23.14	23.45	24.24	24.84	26.85	28.38
T7	100% RFD	21.52	23.49	23.41	24.46	24.99	26.83	28.42
T8	100% Organic	21.52	21.83	22.52	21.97	22.05	21.78	21.62
T9	Control	21.52	20.58	21.01	20.05	19.48	18.57	18.21
T10	Normal transplanting	21.52	23.43	23.53	24.45	24.87	26.58	28.13
	CD(P=0.05)	-	NS	1.92	2.65	2.64	2.06	2.12

Effect on soil available potassium: Soil available potassium was significantly influenced due to different nutrient management practices, and after three season of experimentation soil has slight decrease in soil available potassium. Application of heavy organic manures showed slightly higher soil available potassium. The decrease in available soil potassium was to the tune of 24.3 to 38.5 kg/ha after six cycles of research on SRI (Table 12).

Table 12: Effect on soil available potassium (kg/ha) after harvest of as influenced by different nutrient management.

Treatment		Soil available potassium (K kg/ha)						
		Initial	Kharif 2015	Rabi 2015-16	Kharif 2016	Rabi 2016-17	Kharif 2017	Rabi 2017-18
T1	100%RFD + 10t FYM	461.9	517.7	443.8	489.4	464.2	457.3	437.6
T2	100%RFD + 5t FYM +GM +Microbes	461.9	515.7	440.4	488.5	460.0	453.5	433.2
T3	75%RFD+ Neem Product + 10t FYM	461.9	531.5	457.3	501.5	477.5	445.6	428.4
T4	75%RFD + Neem Product + 5t FYM + GM + Microbes	461.9	528.2	453.4	500.9	475.8	442.7	425.2
T5	STBR + 10t FYM	461.9	516.8	439.9	489.2	464.2	452.5	431.6
T6	STBR + 5t FYM + GM + Microbes	461.9	512.7	430.4	485.4	458.3	450.7	428.9
T7	100% RFD	461.9	524.3	452.2	497.7	469.2	450.4	429.8
T8	100% Organic	461.9	520.3	447.9	491.3	462.5	446.6	423.4
T9	Control	461.9	473.9	415.6	447.4	420.8	415.6	406.8
T10	Normal transplanting	461.9	525.6	556.3	496.4	465.3	453.2	432.5
	CD(P=0.05)		NS	NS	15.8	14.9	11.8	10.5

Conclusion

SRI was found to be superior as compared to normal transplanting in grain yield of rice during both seasons. Application of fertilizers based on STBR along with 5tFYM+5t Green manure+ Microbes (PSB and Azospirillum) and STBR along with 10 t FYM/ha are the two better nutrient management practice for SRI cultivation with higher grain yield and without adverse effect on soil properties.

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