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Assessment of yield and yield attributes of rice under different crop establishment methods and nutrient management

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Abstract
A field experiment was conducted in two consecutive years (2019-20 and 2020-2021) at College of Agriculture, JNKVV, Jabalpur for assessing the yield and yield attributes of rice under different crop establishment methods and nutrient management practices. Experiment was laid out in split plot design replicated thrice. The treatments consisted of three crop establishment methods (Transplanting, SRI and Wet seeded rice) in main plot and six nutrient management practices (F_1:100% NPK, F_2:50% RDN + 50% N through sunhemp+100% P+100%K, F_3:75% RDN + 25% N through sunhemp+ 100%P+100%K, F_4: 50% RDN + 50% N through vermicompost + 100%P+100%K, F_5:75% RDN + 25% N through vermicompost + 100%P+100%K and F_6:100% NPK as recommended dose + two spray of PGPR (*Pseudomonas*) were allocated to subplot. Result of study reveal that the yield attributes, grain and straw yields were significantly higher in system of rice intensification over transplanting and wet seeded rice. The highest net returns and B:C ratio was recorded under SRI method of planting. Among the various nutrient management practices, application of 75% RDN+ 25% N through vermicompost, significantly enhanced the yield attributes *viz*., effective tillers m^2 (350.19), panicle length (24.81 cm), weight of panicle (4.33 g) and grains/panicle (117), respectively as compared with 75% RDN+ 25% N through green manuring. Moreover, grain and straw yields were significantly higher under the treatment in which 75% RDN+ 25% N through vermicompost was applied followed by 75% RDN+ 25% N through green manuring. The net returns and B:C ratio was maximum with the application of 75% RDN + 25% N through VC being at par with application of 75% RDN + 25% N through green manuring.

Keywords: Rice, SRI, transplanting, wet seeded rice, vermicompost, green manuring

Introduction

Rice is the most consumed cereal in the world, constituting the dietary staple food for more than half of the human population of the planet. Low productivity of rice in India is a major with respect to food and nutritional security for more than 60% population which is dependent on rice. In such situations, the use of water-saving approaches such as aerobic, direct-seeded rice and system of rice intensification (SRI) may prove beneficial while improving rice productivity as well.

The cultivation of rice requires plenty of water during its growth and development. On the other hand water scarcity is another constraints in harnessing the yield potential of rice. These operations are taken into consideration with the aim of providing optimal conditions for the plant, to get better yield and enhanced the resource use efficiency (Stoop e*t al*. 2002) [8]. SRI practices are reported to increase the yields of irrigated rice by 25-40% or even more (Thakur *et al.*, 2010) while reducing water requirements (Satyanarayana *et al.*, 2007) [4]. In most of the area, rice is growing by transplanting method in puddled soils that involves raising of nursery, uprooting and transplanting of seedlings. Direct wet seeding is another way of rice growing. In this method, pre germinated seeds are used to sow on well prepared puddled field.

In cultivation of rice, apart from the yield and quality of produce health and nutrient status of soil deteriorating due to use of inadequate and unbalanced quantity of fertilizers (Sharma *et al*., 2003) [5]. The chemical fertilizers may be supplemented with the locally available organic sources of nutrients, *viz*., manures, compost, green manures, crop residues, bio-fertilizer. These supplemental sources are able to supply nutrients, in a desired quantity and improves the physical and biological properties of soil, by which increase the availability of applied and native nutrients (Dick and Gregorich, 2004) [1]. The integrated use of organic and chemical fertilizers along with biofertilizers has been reported not only to meet the nutrients needs of crop but also found to sustain large scale productivity.

Bio-fertilizer alone or in combinations with organic and inorganic fertilizers have great prospect for increasing the productivity and quality of rice. Therefore, the experiment was conducted to assess the yield and yield attributes of rice under different crop establishment methods and nutrient management practices.

Materials and Methods

A field experiment was carried out at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh during two consecutive *Kharif* seasons of 2019 and 2020. The soil of experimental field was sandy clay loam in texture having pH 7.3 and electrical conductivity (EC 0.33 dSm^{-1}). The soil was medium in organic carbon (0.65%), available N (249 kg ha^{-1}), available P (11.18 kg ha^{-1}) and K (278.30 kg ha^{-1}).The experiment was laid out in split plot design with three replications. The eighteen treatments comprised of three crop establishment methods (M_1:transplanting, M_2:SRI and M_3:wet seeded rice) put in main plots and six nutrient management practices (F_1:100% NPK, (F_2:50% RDN + 50% N through sunhemp+100% P+100%K), (F_3:75% RDN + 25% N through sunhemp+ 100%P+100%K), (F_4: 50% RDN + 50% N through vermicompost + 100%P+100%K), (F_5:75% RDN + 25% N through vermicompost + 100%P+100%K), (F_6:100% NPK as recommended dose + two spray of PGPR (*Pseudomonas*) were allocated in subplot. The rice variety JR-81 was used for sowing. Modified rice mat nursery was raised for producing robust, healthy seedlings and 12 days old seedlings were used for transplanting under SRI method. One seedling per hill was transplanted manually by using index finger and thumb at 20 cm x 20 cm spacing raised under SRI method. In conventional transplanting 22 days old seedlings were transplanted at 20 cm x 10 cm spacing. For wet seeded method, healthy seeds of rice variety were soaked for 24 hours in normal water incubate the seed in a gunny bag for an about 4-6 hours in order to facilitate sprouting. After this direct seeding of wet seeded rice at 20 cm row apart. Recommended dose of rice @ 120, 60 and 40 kg N,P and K ha^{-1}, respectively. Were supplied through urea, diammonium phosphate (DAP) and, murate of potash, as per treatments. Phosphorus and potash were made to all the plots as basal. Half dose of nitrogen was applied through basal and remaining half dose of applied in 2 equal splits at tillering and panicle initiation stages as per treatments. The treatment wise N was applied through urea, VC and green manure. Quantity of vermicompost and sunhemp was calculated as per their treatment and thoroughly mixed in respective plots. Green manuring crop (sunhemp) was incorporated in soil before transplanting. Weeding was done as per treatments with the use of Tauchi gurma at 30 after transplanting and irrigation was done as and when required. Data on yield attributes and yield were recorded at crop maturity and statically analyzed by using F-test as per the procedure given by Snedecor and Cochron (1967). The nutrient content in vermicompost and green manure were analyzed and presented in Table 1.

Table 1: Nutrient composition of different organic manures

Manures	Nutrient composition (%)		
	Nitrogen	P_2O_5	K_2O
Vermicompost	1.70	0.63	0.86
Green manure	1.09	0.14	0.50

Results and Discussion

Yield attributes

The statistically analyzed data pertaining to yield attributes are presented in Table 2. On the basis of two year pool data it is clear that yield attributes with respect to effective tillers m^2, panicle length, weight of panicle and grains per panicle were significantly affected due to methods of crop establishment. The significantly higher counts of effective tillers m^2 (375.8) longer panicle (24.54 cm) heavier panicle (4.47 g) and higher number of grains per panicle (128.7) were recorded under SRI and proved significantly superior over rest of the methods except in case of effective tillers and grains per panicle. However conventional transplanting and SRI were found at par to each other for panicle length and panicle weight.

Similarly the various combinations of nutrient pose significantly effect on yield attributes and markedly higher values of these parameters were recorded under where 75% RDN through chemical fertilizer and 25% N through vermicompost was given to crop. The top ranking treatment possessed the values (350.2 m^2, 24.81 cm, 4.33 g and 117.0 /panicle) of effective tillers, panicle length, weight of panicle and filled grains/panicle, respectively. These treatment proved superior over rest of the treatments except in case of effective tillers m^2 and panicle length. Moreover all the treatment combinations proved our superiority with respect to yield attributes over 100% RDF alone. This might be owing to increase in plant growth parameters that provide more photosynthetic area, resulted in synthesis of more food materials consequently better development of yield attributes. Moreover, greater survival of tillers under integration of nutrients with vermicompost could be owing to continuous but controlled supply of nutrients particularly N commensurate with the requirement at various stages. (Yadav and Yadav, 2015) [9]. These findings are in close conformity with the finding of Singh *et al*. (2005) [6].

Table 2: Effect of crop establishment methods and nutrient management on yield attributes of rice. (Pooled data of 2 years)

Treatments	Effective tillers m^{-2}	Panicle length (cm)	Weight of panicle (g)	Grains/ panicle	Test weight (g)
Crop establishment methods					
M_1- Transplanting	307.51	23.04	4.06	108.3	23.29
M_2- SRI	375.82	24.54	4.47	128.7	23.44
M_3- Wet seeded rice	276.97	21.51	3.35	92.9	22.93
SEm ±	3.41	0.42	0.11	1.88	0.22
CD(P=0.0 5)	13.39	1.65	0.43	7.36	NS
Nutrient Management					
F_1 – 100% NPK (RD)	295.26	21.64	3.64	102.3	22.58
F_2 - 50% RDN+ 50% N through sunhemp + 100% P+100% K	313.39	22.61	3.89	109.4	23.06
F_3 - 75% RDN+ 25% N through sunhemp + 100% P+100% K	334.86	23.93	4.07	114.6	23.65

F_4 - 50% RDN+ 50% N through vermicompost + 100% P+100% K	318.78	22.92	4.00	111.1	23.39
F_5 - 75% RDN+ 25% N through vermicompost + 100% P+100% K	350.19	24.81	4.33	117.0	23.87
F_6-100% NPK (RD) +PGPR (*Pseudomonas florescens*)	308.12	22.27	3.82	105.6	22.79
SEm ±	7.79	0.37	0.10	2.51	0.32
CD(P=0.0 5)	22.49	1.08	0.28	7.24	NS

Table 3: Effect of crop establishment methods and nutrient management on grain, straw yields and economics of rice (pooled data of 2 years)

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	GMR (Rs./ha)	NMR (Rs./ha)	B:C ratio
Sowing methods						
M_1- Transplanting	42.61	68.33	38.47	85332	37227	1.78
M_2- SRI	48.65	75.27	40.69	97151	52392	2.17
M_3- Wet seeded rice	35.72	58.81	37.92	71723	31013	1.76
SEm ±	0.64	1.18	0.62	1245	1183	0.03
CD(P=0.0 5)	2.52	4.62	NS	4888	4645	0.10
Nutrient Management						
F_1 – 100% NPK (RD)	37.99	62.00	38.01	76184	34947	1.85
F_2 - 50% RDN+ 50% N through sunhemp + 100% P+100% K	41.19	65.79	38.94	82497	37295	1.82
F_3 - 75% RDN+ 25% N through sunhemp + 100% P+100% K	44.46	69.82	39.39	88909	45294	2.04
F_4 - 50% RDN+ 50% N through vermicompost + 100% P+100% K	42.99	67.27	39.41	85947	35670	1.71
F_5 - 75% RDN+ 25% N through vermicompost + 100% P+100% K	47.10	74.96	40.00	94256	49274	2.09
F_6-100% NPK (RD) +PGPR (*Pseudomonas florescens*)	40.23	64.96	38.39	80619	38782	1.92
S Em ±	0.45	1.44	0.55	976	840	0.02
CD(P=0.0 5)	1.30	4.16	NS	2820	2427	0.06

Yield

Grain and Straw yield (q ha^{-1})

Grain and straw yields of rice was influenced significantly by planting methods. The crop established with wider spacing under SRI method (48.65 q ha^{-1}) resulted in significantly higher grain yield followed by transplanting method (42.61 q ha^{-1}) while the lowest yield of (35.72 q ha^{-1}) was recorded under wet seeded rice (Table 3). Higher yield of rice under SRI method was due to better crop growth and development resulting in to higher value of yield attributes resulted in higher grain yield. Higher number of panicle per unit area, panicle size and filled grains percentage in case of SRI method as compared to other method of crop establishment might be responsible for superiority of this treatment over other in respect of grain yield. Similar results have been reported by Krishna *et al.* (2008) [3]. Straw yield (75.27 q ha^{-1}) of rice was also higher where rice crop was established by SRI method followed by transplanting method and wet seeded rice methods. Higher number of tiller m^{-2} better performance of yield attributing ultimately led the increase the biomass in the SRI method of rice establishment. The lowest grain and straw yields (35.72 and 58.81 q ha^{-1}) were recorded under wet seeded method due to less number of effective tiller m^{-2} and increased inter and intra plant competition for available resources on account of heavy weed infestation. Grain and straw yields were affected significantly due to various integrated nutrient management practices. Significantly higher grain and straw yield of rice were obtained with the application of 75% RDN+ 25% N through vermicompost which was at par with 75% RDN+ 25% N through sunhemp. The increase in yield was due to the promotion of number of panicles, panicle length and weight with the supply of vermicompost. Nitrogen application results in increased amount of interception of photo synthetically active radiation and greater photosynthesis by crop and the supply of secondary nutrient like magnesium as well as micronutrients through vermicompost improved the chlorophyll content and caused reduction of chaffy percentage. (Sudha and Chandini, 2003) [7].

Economics

The statistically analyzed data pertaining to GMR, net returns and B: C are presented in Table 3. Among the methods of sowing the maximum GMR of (Rs. 97151/ha) was computed under SRI method and proved significantly superior over transplanting and wet seeded rice. The highest net returns (Rs. 52392 /ha) and B: C ratio (2.17) was found in SRI method and found significantly superior over transplanting and wet seeded rice method of cultivation. In SRI method highest net returns obtained due to higher grain and straw yields and lower the cost of production under SRI method as compared to transplanting and wet seeded rice. The reduction in seed rate and irrigation requirement in SRI reduced the cost of cultivation. Similar result was also reported by Hugar *et al.* (2009).

The nutrient management practices showed significant variation in gross returns, net returns and B:C ratio. The maximum GMR of (Rs. 94256/ha) was noticed under application of 75% RDN through chemical fertilizer and 25% N through vermicompost significantly superior over rest of the nutrient management practices. The highest net returns (Rs. 49274 /ha) and B:C ratio (2.09) was found in application of 75% RDN through chemical fertilizer + 25% N through vermicompost followed by application of 75% RDN through chemical fertilizer + 25% N through green manuring.

Conclusion

Based on two years study, it could be concluded that system of rice intensification is better method than transplanting and wet seeded of rice cultivation and 75% RDN through chemical fertilizer + 25% N through vermicompost proved economical than others.

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