IJASVM

International Journal of Agricultural Sciences and Veterinary Medicine

ISSN : 2320-3730
Vol. 5, No. 3, August 2017

www.ijasvm.com

E-Mail: editorijasvm@gmail.com or editor@ijasvm.comm@gmail.com

International Journal of Agricultural Sciences and Veterinary Medicine

ISSN 2320-3730 www.ijasvm.com
Vol. 5, No. 3, August 2017

Research Paper

EFFECT OF CROP ESTABLISHMENT METHODS AND NUTRIENT MANAGEMENT OPTIONS FOR ENHANCEMENT OF RICE PRODUCTIVITY UNDER NEW ALLUVIAL ZONE

Dhiman Mukherjee[1*]

*Corresponding Author: Dhiman Mukherjee, ✉ dhiman_mukherjee@yahoo.co

Received on: 24th April, 2017 Accepted on: 8th June, 2017

A field experiment was conducted during the kharif season of 2015 and 2016 under the aegis of Bidhan Chandra Krishi Viswavidayalaya, Kalyani, to find out the effect of different crop establishment methods and nutrient management options for enhancement of rice productivity under new alluvial zone of West Bengal. The experiment was laid out in a split plot design, replicated thrice. The treatment comprised three crop establishment methods (i.e., Direct Seeded Rice (DSR), normal transplanting and system of rice intensification (SRI)) and with five nutrient management method (i.e., control, 50% RDF, 75% RDF, 100% RDF and 125% RDF) as assigned to main plots. Each main plot were further divided into four subplot to accommodate four biofertilizer treatments (i.e., contorl, Azospirillum, PSB (phosphate solubilizing bacteria and Azospirillum + PSB)). Highest grain and straw yield found with the SRI methods and was at par with the normal transplanting condition and significantly superior to direct seeded rice cultivation. SRI method enhances rice grain and straw yield by 67.02 and 48.23% over the direct seeded rice cultivation, respectively. However, maximum biological yield found with the SRI methods of cultivation. With various fertility levels, more grain yield observed with the 125% RDF and was at par with the 100% RDF and 75% RDF, and significantly better to other treatments. Further, straw yields revealed that, highest amount registered with the 100% RDF and was statistically similar only with the 125% RDF and significantly better to other options. Grain and straw yield was 65.02 and 20.17% more registered with 125% RDF compared to control (no fertilizer application). Amongst various biofertilizers application, Azospirillum + PSB, more grain, straw and biological yield and was at par with the PSB application for grain and biological yield and statistically better to all other options under subplots treatments. Economics revealed that, highest B:C ratio registered with the SRI method (2.24) and was followed by direct seeded rice (1.94). With various fertility levels more B:C ratio registered with the 75% RDF (2.12) and was followed by 100% RDF. Amongst various subplot treatments, PSB registered more B: C ratio (2.22) and was closely followed by Azospirillum + PSB. Thus it can be concluded that SRI method of rice cultivation by 75% RDF with PSB application rsulted in higher yield and monetary advantage.

Keywords: Biofertilizers, Crop establishment methods, Economics, Fertility levels, Rice, Yield

[1] Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani,West Bengal 741235.

INTRODUCTION

In dawn of new millennium, challenges in the agriculture sector are quite different from those met in previous decade. Rice is the staple cereal crop in India play a key role in food security. The country has produced approximately 130 million tones of rice by 2025 to feed the evere increasing growing population (Hugar *et al*., 2009). The productivity of rice in India is quite low (2.2 t/ha) compared with China (6.2 t/ha) and Japan (6.5 t/ ha). There are various factors responsible for low productivity of rice in which days old farmer crop sowing methods and improper nutrient and water management are major constraints (Mukherjee, 2015). Rice cultivation is a high water demanding enterprise. It is estimated that around 50% of total irrigation water available is used for rice cultivation. Of late, water table is going down at a very rapid rate throughout the globe which is an indicative of alarming threats, limiting the scope for cultivation of high water requiring crop very seriously.

Direct Dry Seeded Rice (DSR) which excludes puddling and drudgery of transplanting the young rice seedlings provide an option to resolve the edaphic conflict and enhance the sustainability of rice-wheat cropping system. . Transplanted rice has deleterious effects on the soil environment for the succeeding wheat and other upland crop. System of Rice Intensification (SRI) has shown marked increase in yields by suitably modifying certain management practices such as controlled supply of water, planning of younger seedlings an d providing wider spacing. This methodology is gaining momentum all over the world although it is in budding stage in India. In addition to genetic improvement in yield potential of rice cultivars, fertilizer constitutes an important input for increasing the rice production. Application of proper dose of fertilizer in rice played a very important role in increasing food supply and sustains environmental concerns (Mukherjee, 2012). Use of biofertilizer play key role in crop production depends on its suitable species of genuine quality availability. Further, cumulative effect of inorganic sources of nutrients and biofertilizer provide much instrumental in effective photosynthesis (Yadav and Meena, 2014). Therefore the present field experiment was planned to study the effect of different fertility levels along with biofertilizer on the performance of rice under different methods of cultivation for agro climatic region of new alluvial zone of west Bengal.

MATERIALS AND METHODS

Present investigation was conducted under the aegis of Bidhan Chandra Krishi Viswavidyalaya during kharif season of 2015-16 and 2016-17. The field is situated at approximately 22^{o}56'N latitude and 88^{o}32'E longitude with an average altitude of 9.75 m above Mean Sea Level (MSL). The soil had 0.45 and 0.43% organic carbon, 238.34 and 227 .78 kg/ha available nitrogen, 23.21 and 22.36 kg/ha available phosphorus and 241.32 and 236.39 kg/ha available potassium before the transplanting of rice during 2015 and 2016, respectively. The experiment was laid out in a split plot design, replicated thrice. The treatment comprised three crop establishment methods (i.e., Direct Seeded Rice (DSR), normal transplanting and System of Rice Intensification (SRI)) and with five nutrient management method (i.e., control, 50% RDF, 75% RDF, 100% RDF and 125% RDF) as assigned to main plots. Each main plot were further divided into four subplot to accommodate four biofertilizer treatments (i.e., Control, *Azospirillum*, PSB (phosphate solubilizing bacteria and *Azospirillum* + PSB). Recommended

dose of fertilizer, i.e., 80:40:40 kg/ha N, P_2O and K_2O, for rice were applied as per treatments. Phosphorus and potassium were made to all the plots except the control. In direct dry seeded rice, seeds were sown in line, 20 cm apart. For normal transplanting, 25 day-old seedlings were used, nursery bed was raised 14 days before the 10 day-old seedlings used for SRI to synchronized the transplanting of rice at time. Two seedlings for normal transplanting and single seedling/hill for SRI along with soil was transplanting by using index finger and thumb and gently planting them at the spacing was maintained at 20 x 15 cm under normal transplanting plots and 25 x 25 cm under SRI plots in puddle soil on 11th July 2015 and 16th July, 2016. Fertilizer application was done as per treatments through urea, diammonium phosphate and muriate of potash. Full amount of phosphorus and potassium and half of nitrogen were applied basal just before sowing of rice seed/transplanting of rice seedling. Remaining nitrogen was top dressed through urea in 2 splits-first at active tillering and second at panicle initiation stage in all method of rice establishment. Weed management was done manually under normal transplanting method and hand weeding under SRI at 20 and 45 Days After Transplanting (DAT) to reduce the weed infestation, favors root and plant growth and also maintain the soil root zone aerobic. *Azospirillum brasilense* and PSB (*Bacillus megatherium* var. phosphaticum) were used as biofertilizer for fixing atmospheric nitrogen and increasing phosphorus availability, respectively. For inoculation, 10% sugar solution was prepared by dissolving 100 g sugar in 1 litre water and heated for 20-25 min. The solution was cooled at room temperature and mixed with culture treatment wise. The rice seedling were inoculated (1 kg + 10 g culture) with the solution. Data on growth, yield components, yield and crop nutrient uptakes were recorded as per normal procedure. The experimental data were analyzed statistically by applying the technique of analysis of variance (ANOVA) prescribed for the design to test the significance of overall difference among treatments by the F test and conclusions were drawn at 5 % probability level. Economics were also calculated and compared for the selection of superior treatment combination. All the data were statistically analyzed to draw a valid conclusion. Benefit:cost ratio (B:C) was obtained by dividing the gross income with cost of cultivation. The effect of treatments was evaluated on pooled analysis basis on yield attributes and yields.

RESULTS AND DISCUSSION

Growth Parameters

In general, shoot elongation continued to increase with advancement in age of the plants (Table 1). Plant growth parameter notably influenced by various crop establishment methods and other sub plot treatments. Maximum plant height registered with the SRI and was at par with normal transplanting situation and significantly better to direct seeded rice. Shoot dry matter production (g/hill) was more observed with normal transplanting and was at par with the SRI methods and appreciably better to other options. Further, table revealed that, utmost LAI and chlorophyll content was registered with the SRI methods, and significantly superior to other set of main plot treatments. Highest plant height and shoot dry matter production, registered with the 75% RDF and was closely followed by 125 and 100% RDF and at par with each other and significantly better to other treatments. Maximum LAI registered with the 100% RDF and was at par with the 125% RDF and significantly superior to other fertilizer

Table 1: Effect of Various Treatments on Growth, Yield Attribute and Yield of Rice (Pooled Data of Two Years)

Treatments	Plant Growth Parameters				Yield Attributing Parameters						Yield (q/ha)			
	Plant Height (cm)	Shoot Dry Matter Production (g/hill) (60 DAT)	Leaf Area Index (60 DAT)	Chlorophyll Content (SPAD Unit) of Plants	Effective Tillers (no./m^2)	Panicle Length (cm)	Panicle Weight (g)	Filled Grains/ Panicle	Unfilled Grains/ Panicle	1000 Grains Weight (g)	Grain	Straw	Biological	Harvest Index (%)
Crop Establishment Methods														
Direct seeded rice	56.36	9.07	3.46	28.74	177.73	20.67	1.4	39.33	11.93	20.53	30.11	49.69	79.48	37.73
Normal transplanting	75.37	18.29	4.87	32.99	283.8	23.41	1.85	65.7	8.83	22.77	46.29	70.38	116.67	40.69
System of rice intensification	81.38	17.04	5.72	37.23	302.13	25.11	2.11	59.8	7.7	23.67	50.29	73.66	123.95	40.57
SEm±	3.15	1.32	0.34	0.48	5.65	0.65	0.69	2.31	0.43	0.2	2.64	2.86	2.14	0.21
CD (P=0.05)	9.05	4.23	0.99	1.34	16.35	1.95	NS	7.12	1.22	0.61	7.29	7.43	6.72	0.63
Fertility levels (kg/ha)														
Control	61.03	12.54	3.8	24.63	187.7	21.17	1.62	56.98	15.1	21.63	31.1	57.34	88.44	35.17
50% RDF	70.03	14.14	4.17	31.97	229.33	24.9	1.74	70.47	13	23.63	37.85	62.53	100.38	37.71
75% RDF	83.25	15.04	4.2	30.66	394.3	23.53	1.69	75	12.73	23.68	46.82	60.95	107.77	43.44
100% RDF	81.43	14.19	5.14	33.33	372.2	26.07	1.84	78.67	9.73	23.17	50.62	69.4	120.02	42.18
125% RDF	82.21	14.03	4.69	32.41	379	24.63	1.93	81.1	9.4	23.43	51.32	68.91	120.23	42.68
Sem±	0.98	0.33	0.19	0.63	4.32	0.21	0.03	0.84	0.37	0.27	1.56	1.81	5.37	0.23
CD (P=0.05)	2.85	0.97	0.64	1.93	13.25	0.65	0.1	2.11	1.08	0.82	4.51	5.98	16.83	0.61
Biofertiizer														
Control	73.27	11.9	5.01	30.8	209	22.31	1.67	74.33	11.1	19.67	28.56	45.94	74.5	38.33
Asospirillum	80.47	14.33	5.41	31.6	308.67	23.54	1.54	70.11	9.2	23.58	41.39	65.21	106.26	38.83
PSB	83.77	17.27	5.71	36.4	331.11	24.33	1.74	78.7	7.89	23.62	45.41	64.69	110.81	41.24
Azospirillum + PSB	84.2	17.34	5.73	34.6	368.33	26.77	2.06	82	6.03	24.01	46.29	70.38	116.67	39.68
SEm±	0.57	0.21	0.36	0.35	5.11	0.31	0.06	1.7	0.41	0.21	1.23	1.57	3.91	0.56
CD (P=0.05)	1.78	0.66	NS	1.18	16.06	0.95	0.11	3.46	1.25	0.67	3.74	4.89	10.53	1.64

Note: NS = Non Significant.

levels. Chlorophyll content more observed with 100% RDF and was at par with the 125 and 50% RDF and statistically superior to other treatments of fertilizer applications. Various subplot treatments were radically influenced by different biofertilizer application. *Azospirillum* + PSB, showed peak plant height and shoot dry matter production, and was at par with the sole PSB use plots. LAI failed to produce any statistical difference with various biofertilizer incorporation, however highest LAI recorded with the *Azospirillum* + PSB. Utmost chlorophyll content recorded with the sole PSB application and significantly better to other biofertilizer treatments of subplots.

Yield Attributes

All the yield attributing parameter notably influenced by various main and subplot treatments under split plot design. Perusal of Table 1 bare that, amongst various crop establishment methods, more effective tillers (no./m^2) and panicle length was observed with the SRI methods and statistically similar with the normal transplanting and considerably better to direct seeded rice cultivation methods. Moreover,

Table 2: Effect of Various Treatments on Nutrient Uptake and Economics of Rice (Pooled Data of Two Years)

Treatments	Nutrient Uptake (Kg/ha)					Economics (Rs./ha)			B:C Ratio
	N	P	K	Total Nutrient Uptake		Cost of Cultivation	Net Return	Gross Return	
Crop Establishment Methods									
Direct seeded rice	49.03	14.33	69.45	132.81		21948	20563	42511	1.94
Normal transplanting	60.29	18.02	74.95	153.26		30513	26925	57438	1.88
System of rice intensification	61.33	20.91	89.92	173.16		25238	31263	56501	2.24
SEm±	1.45	0.93	1.32	3.54					
CD (P=0.05)	4.98	2.71	3.61	10.04					
Fertility levels (Kg/ha)									
Control	56.89	15.28	75.98	148.15	31.1	19375	18565	37940	1.96
50% RDF	53.12	20.99	84.38	158.49	37.85	21838	20936	42774	1.96
75% RDF	71.78	21.5	89.02	182.3	46.82	24840	27762	52602	2.12
100 % RDF	80.74	22.68	90.66	194.08	50.62	29163	28082	57245	1.96
125% RDF	82.87	23.37	92.72	198.96	51.32	33488	31955	65443	1.95
SEm±	1.36	0.73	1.27	4.31					
CD (P=0.05)	4.65	2.16	4.14	14.65					
Biofertilizers									
Control	41.33	11.43	65.33	118.09	28.56	20696	17300	37996	1.84
Asospirillum	59.02	18.35	70.39	147.76	41.39	21021	23030	44051	2.1
PSB	60.33	19.11	84.32	163.76	45.41	21757	26556	48313	2.22
Azospirillum + PSB	63.49	21.53	90.21	175.23	46.29	22696	27089	49785	2.19
SEm±	1.17	0.54	1.31	4.35					
CD (P=0.05)	4.06	1.61	4.15	11.02					

panicle weight failed to produce any significant response with various crop establishment methods. Filled grains/panicle was highest recorded with the normal transplanting and was at par with the SRI methods of crop cultivation, and significantly better to other treatments. However least unfilled grain/panicle observed with the SRI method of crop management, and was at par with the normal transplanting and statistically better to other treatments. Highest thousand grain weight recorded with the SRI methods and appreciably better to other main plot treatments. Younger seedlings of SRI obtained sufficient nutrients for vegetative growth by effective utilization of phyllochronic concept. Transplanting of younger seedlings provided larger

period for tiller production during vegetative growth as well as reproductive phase. Concomitantly leads to increased growth and yields attributes particularly enhanced grain and straw yield (Shekahr *et al*., 2009). Fertility levels revealed that more effective tillers (no./ m^2) resulted from the 75% RDF and statistically superior to other fertilizers levels. Panicle length was statistically better only with 100% RDF, and notably better to other levels of fertilizer use. Significantly more panicle weight observed with the 125% RDF, and appreciably better to other levels of fertilizer use. This might be owing to transplanting of young seedlings which might have resulted in better availability of nutrients, light and space during growth stages, production of more number of shoot per unit area. Ali *et al*. (2012) also reported similar results. Filled grains/panicle highest observed with the 125% RDF, and radically improved to other levels of fertilizer application. Further, Table 1 revealed that, least unfilled grains/ panicle observed with the 125% RDF, and showed parity with the 100% RDF and statistically superior to other set of treatments. With various fertilizer levels, utmost 1000 grain weight registered with the 125% RDF and was at par with all other levels of fertilizers except 100% RDF. Subplots measurement revealed that, *Azospirillum* + PSB recoded notably more number of effective tillers per meter square, panicle length and panicle weight and significantly better to other set of biofertilizer incorporation. The increase in yield attributing parameter with the *Azospirillum* + PSB might have resulted from the growth regulating substances produced by combined application of organic source beside fixation of additional nitrogen from atmosphere there by increasing the nitrogen availability in the soil throughout the crop growth (Mukherjee, 2015a). The mineralization of nutrients is observed to be enhanced resulting into boosting up of yield attributing parameter and crop productivity (Dosani *et al*., 2006). Filled grain per panicle and test weight was highest registered with the *Azospirillum* + PSB and was at par only with the PSB applied plots. Biofertilizer containing *Azospirillum* providing 30-50% of the crops N requirement enhanced grain activity because better cell division process, which leads to good crop growth and development as reported by Banayo *et a*l. (2012).

Yields and Harvest Index

Yield parameter showed noteworthy response with the various main and subplot treatments. With various crop establishment methods, highest grain and straw yield found with the SRI methods and was at par with the normal transplanting condition and significantly superior to direct seeded rice cultivation. SRI method enhances rice grain and straw yield by 67.02 and 48.23% over the direct seeded rice cultivation, respectively. However, utmost biological yield found with the SRI methods of cultivation. The SRI planting utilized phyllochronic potential in providing significantly higher grain yield, straw yield and biological yield over normal transplanted and direct seeded rice (Table 1) coupled with improved agronomical practices associated with SRI management under irrigated production system, like single seedling/hill, young seedling, and moderate wetting and drying soil condition. These finding confirm the results of Thakur *et al*. (2013). With various fertility levels, more grain yield observed with the 125%RDF, and was at par with the 100% RDF and 75% RDF, and considerably better to other treatments. Further, straw yields more found with the 100% RDF and was statistically similar only with the 125% RDF and

significantly bettered with the normal transplanting condition, and was at par with the SRI methods of crop growth. Amid fertility levels, more harvest index observed with the 75% RDF and was statistically similar with all other treatments except control and 50% RDF use. Use of biofertilizer revealed that, PSB registered more harvest index and statistically similar with the *Azospirillum* + PSB application.

Nutrient Uptake Patterns

Highest NPK uptake registered with the SRI method of crop establishment and was at par with the normal transplanting for nitrogen and phosphorous uptake. However, more total nutrient uptake observed with the SRI methods and statistically better to other establishment methods. Further, fertility levels revealed that, 125% RDF registered more NPK uptake and was at par with the 100% RDF, and only with phosphorus and potassium uptake for 75% RDF, and statistically better to other allotted treatments. Further observation revealed that, more total nutrient uptake registered with the 125% RDF and was at par with the 100% RDF and significantly better to other fertilizers levels. Amongst various biofertiizers application, more NPK and total nutrient uptake registered with the *Azospirillum* + PSB, and was significantly better to other treatments except nitrogen uptake for PSB, where these were at par to each other.

MONETARY ADVANTAGE

The total cost of cultivation, gross return, net returns and benefit: cost ratio was obtained maximum and minimum under establishment methods of SRI and direct seeded rice, respectively. Economics revealed that, more net return observed with normal transplanting followed by SRI method of cultivation. Highest B:C ratio registered with the SRI method (2.24) of crop cultivation due to good yield attributing character and better harvest of crop yield on pooled basis (Table 2). Lowest cost of cultivation with higher grain and straw yields under SRI could have resulted in higher returns (Rs. 31,263) than normal transplanting (Rs. 26,925) and direct seeded rice (Rs. 20,563). More net return observed with 125% RDF (Rs. 31,955) and was followed by 100% RDF (Rs. 28,082) and 75% RDF (Rs. 27,762), however maximum B:C ratio registered with the 75% RDF (2.12) due to low cost of cultivation and good harvest, and was followed by 100% RDF (1.96) and 50% RDF (1.96). More net return with various sub plot resulted from *Azospirillum* + PSB (Rs. 27,089) and PSB (Rs. 26,556), however utmost B:C ratio observed with PSB (2.22) followed by *Azospirillum* + PSB (2.19).

Thus it can be concluded that SRI method of rice cultivation by 75% RDF with PSB application resulted in higher yield and monetary advantage.

REFERENCES

1. Ali R A, Iqbal N, Saleem M U and Akhtar M (2012), “Effect of Different Planting Methods on Economics, Yield and Grain Quality of Rice”, *International Journal of Agriculture and Applied Science*, Vol. 4, No. 1, pp. 28-34.
2. Banayao N P M, Cruz P C S, Aguilar E A, Badayos R B and Haefele S M (2012), “Evaluation of Biofertilizers in Irrigated Rice: Effects on Grain Yield at Different Fertilizer Rates”, *Agriculture,* Vol. 2, pp. 73-86.
3. Dosani A A K, Dhopavkar R V and Talashilkar S C (2006), “Role of Biofertiliser in Organic Farming”, *Trend of Organic Farming in India*, *Agrobios*, pp. 108-133.

4. Mukherjee D (2012), "Studies on Profitability of Efficient Farming System in Midhills Situation of Eastern Himalaya", *Journal of Farming System Research & Development*, Vol. 18, No. 1, pp. 16-21.
5. Mukherjee D (2015), "Food Security: A World Wide Challenge", *Research and Review: Journal of Agriculture and Allied Sciences,* Vol. 4, No. 1, pp. 3-5.
6. Mukherjee D (2015a), "Microbial Diversity for Soil Sustainability and Crop Productivity", in *Microbial Empowerment in Agriculture: A Key to Sustainability and Crop Productivity*, Birichi Kumar Sharam and Akanksha Singh (Eds), pp. 237-268, Biotech Publishers, New Delhi.
7. Netam C R, Singh R, Thakur A K and Netam A K (2016), "Effect of Crop Establishment Methods and Weed Management Options on Weed Dynamics and Productivity of Rice", *Indian Journal of Agronomy*, Vol. 61, No. 3, pp. 326-330.
8. Shekhar J, Mankotia B S and Dev S P (2009), "Productivity and Economics of Rice (*Oryza satiava*) in System of Rice Intensification of North Western Himalayas", *Indian Journal of Agronomy*, Vol. 54, No. 4, pp. 423-427.
9. Thakur A K, Rath S and Mandal K G (2013), "Differential Responses of System of Rice Intensification (SRI) and Conventional Flooded Rice Management Methods to Application of Nitrogen Fertilizer", *Plant and Soil*, Vol. 370, pp. 59-71.
10. Yadav L and Meena R N (2014), "Performance of Aeromatic Rice Genotype as Influenced by Integrated Nitrogen Management", *Indian Journal of Agronomy*, Vol. 59, No. 2, pp. 251-255.

International Journal of Agricultural Sciences and Veterinary Medicine
Hyderabad, INDIA. Ph: +91-09441351700, 09059645577
E-mail: editorijasvm@gmail.com or editor@ijasvm.com
Website: www.ijasvm.com