

Productivity and Economics of Rice Influenced by Different Crop Establishment Methods and Fertilizer Sources

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Abstract: The influence of different crop establishment methods and fertilizer sources on productivity, quality and economics of rice was studied at Department of Agronomy Farm of Dr. B.S.K.K.V., Dapoli (Maharashtra) during the Kharif season 2009 and 2010 in lateritic soils. The experiments were laid out in split plot design replicate thrice with five crop establishment methods in the main plot and three fertilizer sources were assigned in the sub plots. The results revealed that transplanting of rice recorded significantly higher grain yield (50.21, 54.95 and 52.58 q ha⁻¹), straw yield (59.89, 64.07 and 61.98 q ha⁻¹), gross returns (Rs. 60447.5, 65847.1 and 63147.33 ha⁻¹), net returns (Rs. 20547.5, 17457.8 and 19002.72 ha⁻¹) and benefit to cost ratio (1.52, 1.36 and 1.44) during year 2009, 2010 and pooled mean, respectively compared to rest of the crop establishment methods. Among the fertilizer sources, application of Urea-DAP briquettes recorded significantly higher grain yield (49.29, 53.04 and 51.17 q ha⁻¹), straw yield (59.16, 62.97 and 61.07 q ha⁻¹), maximum gross returns (Rs. 59132.8, 63643.9 and 61388.37 ha⁻¹), net returns (Rs. 20640.6, 17587.2 and 19133.93 ha⁻¹) and B:C ratio (1.53, 1.38 and 1.45) compared to rest of the treatments during year 2009, 2010 and pooled mean, respectively.

Key words: Establishment methods, fertilizer sources, yield, soil fertility, hybrid rice, India

INTRODUCTION

Rice is one of the most important food grain crop of the world and staple food of most of the peoples in Asia. Rice grows from the tropics to the subtropical warm temperate countries up to 40°S and 50°N of the equator. In the world, rice is cultivated on about 155.3 million ha of area with total production of 426.00 million ton. In India, rice occupies an area of 43.75 million ha with production of 85.3 million ton. India has the largest area under rice crop in the world. In Maharashtra, rice ranks third in respect of acreage among the important cereal crops. The total area occupied by this crop is about 15.50 lakh ha with annual production of 28.55 lakh ton. In Konkan region of Maharashtra state, rice occupies an area of 4.30 lakh ha with production 10.25 lakh ton.

Average productivity of rice is 2.13 ton ha⁻¹ in India and 1.68 ton ha⁻¹ in Maharashtra which are far below the world's average of 3.7 ton ha⁻¹. The main reasons of low productivity and profitability are mainly viz., vagaries of nature, low fertilizer use efficiency, poor crop management and adherence of farmers to traditional crop management practices. The productivity of rice is low due to delay in nursery sowing and late transplanting, faulty methods of

cultivation and little or no use of fertilizers. The secret of boosting its yields mainly lies in timely transplanting and properly fertilizing the crop. At the time of transplanting availability of labours is the main constraint in the region. Under the scarcity of labours farmers give priority for drilling of rice. Therefore, the establishment of crop is very slow in drilling method as a result, the yield of crop is reduced to greater extent. The systematic study on the performance of rice grown by direct pre monsoon and post monsoon seed sowing in comparison with transplanting, Thomba Method and SRI Technique is not conducted in the region.

Among the various agronomic practices judicious use of manures and fertilizers is one of the important strategies for increasing production of rice per unit area. The breeding of high yielding varieties have laid the basis for rice production in India. These improved varieties can give the anticipated yield per unit area when grown under favorable environmental conditions without which they are not able to manifest their maximum yield potential. The high yielding varieties are highly responsive to fertilizers. Fertilizer is the key input in increasing agricultural production and productivity of the land. Therefore efficient fertilizer use has to be followed to increase the

same. But the price of fertilizer is going up because of higher cost of production due to energy crisis all over the world. On the other hand, the fertilizer use efficiency in transplanted rice is generally low. Therefore, efficient use of fertilizer is of great importance in developing countries where agricultural production has to be kept reasonably at higher level. Major rice growing areas in the region are highly sandy clay loams. Poor fertility and low moisture holding capacity are the characteristics of these soils. Fertilizer input is one of the major determinants of the profitability of the rice grown on these soils. Fertilizer use efficiency is low in the region due to heavy rainfall and it is revealed from the studies that use of briquette fertilizers improves fertilizer use efficiency (Tondan, 1992). Hence, use of briquette fertilizers is one of the key component of intensive agriculture.

The straight fertilizers are no doubt, important and easily available fertilizer source of nutrients which can meet the nutrient requirement of plants but there low availability to crop due to leaching and other losses leads to low yield. Majority of farmers in Konkan are small and marginal. Therefore, it will be advisable to optimize the use of briquette fertilizers for getting high yields of better quality and keeping the cost of production at sustainable level. The information on nutrient requirements of the crop to be supplied through straight fertilizers is available. However, the information on requirement of nutrients in rice established by comparing different fertilizer sources is lacking. Hence to study the impact of crop establishment methods and fertilizer sources on productivity and economics of rice, the present investigation was undertaken.

MATERIALS AND METHODS

The field experiments were conducted at the Agronomy farm, College of Agriculture, Dapoli, District Ratnagiri during Kharif 2009-2010 and 2010-2011 to evaluate the studies on the response of hybrid rice (Sahyadri-4) to different crop establishment methods and sources of fertilizer application under Konkan upland situation. The experiment was laid out in Split-plot design with three replications. The treatments comprised of five main plot treatments and three sub plot treatment. There were 15 treatment combinations. The details of the treatment and notification used as follows:

Main plot treatment: Crop establishment methods; viz., T₁: Transplanting; T₂: Pre-monsoon dibbling of seeds; T₃: Dibbling of seeds on the onset of monsoon; T₄: Transplanting of seedling by Thomba Method and T₅:

System of rice intensification technique and sub plot treatment fertilizer source viz., F₁: RDF (120:60:60 NPK kg ha⁻¹), F₂: Placement of Urea-DAP briquettes and F₃: Placement of Urea-supphala briquettes).

Raising of seedlings on nursery bed: For transplanting and thomba method, the soil was ploughed twice by tractor and subsequently brought under fine tilth. The raised beds of 10 m length, 1 m breadth and 10 cm height were prepared. Good quality poultry manure was spread and mixed with soil over the beds. Urea was applied at 1 kg 100 m⁻² at the time of sowing. The seed of rice variety Sahyadri-4 which was treated with thirum at 2.5 g kg⁻¹ seed was sown in line 10 cm apart at 2-3 cm depth. Germination started from 3rd day and completed by the 5th day. Top dressing with urea at 1 kg/100 m area was done 15 days after sowing. The need based plant protection and weed control measures were carried out in the nursery.

For Sri Technique: The seedlings were raised by modified mat nursery. Bed is prepared by using plastic sheet of 1.5 m width. Plastic paper spread on the soil. Boundaries of the paper raised up to 5-6 cm height with half of bricks. Then fine soil and FYM mixture of 1:1 proportion was spread on the plastic paper. Seeds were first soaked in water for 24 h and kept in moist gunny bag for 24 h sprouted seeds are then spread on the bed and covered with fine soil. Bed was watered as and when required. Seedlings became ready for transplanting within 12 days.

Dibbling and transplanting: Dibbling of seeds were done before monsoon and onset of monsoon as per the treatment with the spacing of 15-25×15-25 cm. A 30 days old seedlings were transplanted with the spacing of 15-25×15-25 cm for Transplanting and Thomba Method. In Thomba Method, seedlings were planted in the holes made by a pointed stick (Thomba) on ploughed field without carrying out the puddling operation. While in SRI Technique the healthy and vigorous seedlings were uprooted on 12 days after sowing. While uprooting the seedlings care was taken that seed should remain attached to the seedlings along with the roots. One seedling was transplanted per hill. Transplanting was done in lines at spacing 20×20 cm.

Application of fertilizers and briquettes: This comprised of three treatments as 100% RDF (120:60:60 NPK kg ha⁻¹) through straight fertilizers to rice crop. About 40% nitrogen dose (Urea) and full dose of phosphorus

(SSP) and potassium (MOP) were applied to rice by broadcasting at the time of dibbling/transplanting. Remaining 40% nitrogen dose was applied at maximum tillering (30 DAT) and other 20% at panicle initiation stage (65 DAT) as per the treatments. In case of briquettes fertilizers, briquettes were applied through deep point placement method. Briquettes were manually placed at about 5-6 cm soil depth at one briquette for every four hills of rice.

Urea-DAP briquettes at 168.75 kg ha⁻¹) provides about 47.97 kg N ha⁻¹ and 32.04 kg P⁻¹. Urea-Suphala briquettes (at 168.75 kg⁻¹) provides 46.69 kg N ha⁻¹, 22.83 kg P ha⁻¹ and 15.57 kg K ha⁻¹.

Other cultural practices and plant protection measures was given according to the recommended package of practice. At maturity, the observations on ancillary characters were recorded on five randomly selected plants in each plot. The total yield/ha were recorded on net plot basis.

RESULTS AND DISCUSSION

Effect of crop establishment methods: The data shown in Table 1 revealed that transplanting methods of crop establishment gave higher grain yield (50.21, 54.95 and 52.58 q ha⁻¹ during year 2009, 2010 and pooled mean, respectively) followed by Thomba Method and SRI Technique which were on par with each other but found significantly superior to pre monsoon dibbling of seeds and dibbling of seeds on the onset of monsoon. However, SRI Technique was on par with pre monsoon dibbling of seeds but found significantly superior to dibbling of seeds on the onset of monsoon.

In case of 1st year and pooled mean, pre monsoon dibbling of seeds was found significantly superior to dibbling of seeds on the onset of monsoon whilst during second year pre monsoon dibbling of seeds was found on par with dibbling of seeds on the onset of monsoon. The increase in grain yield recorded under transplanting over

Table 1: Grain yield (q ha⁻¹), straw yield (q ha⁻¹), gross returns (Rs. ha⁻¹), net returns (Rs ha⁻¹) and B:C ratio of rice as influenced by different treatments

Treatments	Grain yield (q ha ⁻¹)			Straw yield (q ha ⁻¹)			Gross returns (Rs. ha ⁻¹)		
	2009	2010	Pooled mean	2009	2010	Pooled mean	2009	2010	Pooled mean
Crop establishment methods									
T ₁ -Transplanting	50.21	54.95	52.58	59.89	64.07	61.98	60447.5	65847.1	63147.33
T ₂ -Pre monsoon dibbling of seeds	45.81	48.18	46.99	55.69	58.85	57.27	54956.0	57878.4	56417.22
T ₃ -Dibbling of seeds on the onset of monsoon	41.50	45.33	43.42	52.39	56.57	54.48	50113.5	54520.8	52317.22
T ₄ -Thomba Method	49.76	54.34	52.05	58.92	63.86	61.39	59630.4	65162.8	62396.67
T ₅ -SRI Technique	48.92	52.32	50.62	59.08	62.95	61.02	58723.3	62852.2	60787.78
±SE	1.120	1.320	1.210	1.310	1.230	1.260	1386.25	1560.81	1452.99
CD at 5%	3.660	4.320	3.950	4.260	4.000	4.110	4520.12	5089.31	4737.76
Fertilizer sources									
F ₁ -RDF	44.91	49.19	47.05	54.47	59.19	56.83	53980.6	59028.2	56504.43
F ₂ -Placement of Urea-DAP briquettes	49.29	53.04	51.17	59.16	62.97	61.07	59132.8	63643.9	61388.37
F ₃ -Placement of Urea-suphala briquettes	47.53	50.84	49.18	57.95	61.62	59.79	57209.0	61084.8	59146.93
±SE	0.980	0.990	0.970	0.940	0.970	0.950	1187.68	1179.33	1168.54
CD at 5%	2.880	2.920	2.850	2.780	2.870	2.810	3503.14	3478.50	3446.66
Interaction effect0									
±SE	2.18	2.21	2.16	2.10	2.17	2.12	2655.7	2637.0	2612.93
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
General mean	47.24	51.02	49.13	57.19	61.26	59.23	56774.18	61252.3	59013.2
	Net returns (Rs. ha ⁻¹)					B:C ratio			
Treatments	2009		2010	Pooled mean		2009	2010	Pooled mean	
Crop establishment method									
T ₁ -Transplanting	20547.5		17457.8	19002.72		1.52	1.36	1.44	
T ₂ -Pre monsoon dibbling of seeds	18302.1		14559.8	16431.00		1.49	1.33	1.41	
T ₃ -Dibbling of seeds on the onset of monsoon	14683.8		11761.8	13222.89		1.42	1.27	1.34	
T ₄ -Thomba Method	19455.0		16065.1	17760.06		1.48	1.32	1.40	
T ₅ -SRI Technique	17202.3		13191.0	15196.67		1.41	1.26	1.33	
±SE	1117.28		1298.86	1197.16		-	-	-	
CD at 5%	NS		4235.18	NS		-	-	-	
Fertilizer Sources									
F ₁ -RDF	14186.6		11055.0	12620.83		1.36	1.23	1.29	
F ₂ -Placement of Urea-DAP briquettes	20640.6		17587.2	19113.93		1.53	1.38	1.45	
F ₃ -Placement of Urea-suphala briquettes	19287.2		15179.2	17233.23		1.51	1.33	1.42	
±SE	959.58		982.86	958.24		-	-	-	
CD at 5%	2830.34		2898.99	2826.37		-	-	-	
Interaction Effect									
±SE	2145.69		2197.73	2142.68		-	-	-	
CD at 5%	NS		NS	NS		-	-	-	
General mean	18038.18		14607.16	16322.67		1.46	1.31	1.38	

Thomba Method, SRI Technique, pre monsoon dibbling of seeds and dibbling of seeds on the onset of monsoon was to the tune of 1.00, 3.73, 10.64 and 17.43%, respectively. The increased yield attributes might be due to increased growth and development parameters which ultimately resulted in increased grain. The beneficial effect of transplanting method in enhancing the growth through increased height, leaves, number of tillers, leaf area and dry matter production ultimately reflected in higher yield attributing characters viz., number of panicles per hill, length of panicle, number of filled grains per panicle, number of unfilled grains per panicle, weight of filled grains per panicle and test weight.

The grain yield of rice is a function of yield attributes of an individual plant viz., number of panicles per hill, length of panicle, number of filled grains per panicle, weight of filled grains per panicle and test weight and ultimately the grain yield obtained from the plant.

The present results are in consonance with those of Singh *et al.* (2006). Higher straw yield (Table 1) recorded by transplanting of rice (59.89, 64.07 and 61.98 q ha⁻¹ during year 2009, 2010 and pooled mean, respectively) was significantly superior over pre monsoon dibbling of seeds and dibbling of seeds on the onset of monsoon and was on par with Thomba Method and SRI Technique.

Increase in mean straw yield observed under transplanting over Thomba method, SRI technique, pre monsoon dibbling of seeds and dibbling of seeds on the onset of monsoon was to the tune of 1.00, 1.55, 7.6 and 12.11%, respectively. This might be due to increased morphological characters viz., plant height, number of leaves per hill, number of tillers and dry matter production per hill observed under transplanting.

Similar findings were also reported by Singh *et al.* (2003) and Ram *et al.* (2006). Thus, the results clearly showed that transplanting method of establishment was superior which was followed by Thomba method for obtaining higher grain and straw yield ha⁻¹ from rice. Transplanting of rice (Table 1) gave the highest gross returns (Rs. 60447.5, 65847.1 and 63147.33 ha⁻¹), net returns (Rs. 20547.5, 17457.8 and 19002.72 ha⁻¹) and benefit to cost ratio (1.52, 1.36 and 1.44) followed by Thomba Method pre monsoon dibbling of seeds, dibbling of seeds on the onset of monsoon and SRI technique during year 2009, 2010 and in case of pooled mean, respectively. Among all these establishment methods transplanting was found to be economically most profitable as its mean B:C ratio was 1.44. The B:C ratios recorded under Thomba method, pre monsoon dibbling of seeds, dibbling of seeds on the onset of monsoon and SRI technique were 1.41, 1.40, 1.34 and 1.33, respectively. The increased gross returns, net returns and benefit to

cost ratio due to transplanting method were mainly due to increased grain and straw yield under transplanting over rest of the establishment methods. Similar findings were also reported by Ram *et al.* (2006) and Sanjay *et al.* (2006).

Effect of fertilizer sources: Data furnished in Table 1 stipulated that the grain yield of rice was significantly influenced due to various fertilizer sources. Among all these sources, treatment receiving Urea-DAP briquettes gave higher grain yield (49.29, 53.04 and 51.17 q ha⁻¹ during year 2009, 2010 and pooled mean, respectively) followed by Urea-suphala briquettes which were on par with each other but found significantly superior to RDF. The treatment receiving Urea-suphala briquettes and RDF were on par with each other during both the years and in the pooled mean.

The mean increase in grain yield recorded under the application of Urea-DAP briquettes over Urea-suphala briquettes and application of RDF was to the tune of 3.89 and 8.06%, respectively. The increase in grain yield of rice due to application of Urea-DAP briquettes may be accounted for significant improvement in yield attributes viz., number of panicles per hill, length of panicle, number of filled grains per panicle, weight of filled grains per panicle and test weight which finally resulted in increased grain yield. Similar results were reported by Talashilkar *et al.* (2000), Dhane *et al.* (2002) and Bulbule *et al.* (2008).

The straw yield of rice followed the similar trend like grain yield (Table 1). The maximum straw yield (59.16, 62.97 and 61.07 q ha⁻¹ during year 2009, 2010 and pooled mean, respectively) of rice recorded under Urea-DAP briquettes. The increase in straw yield recorded under Urea-DAP briquettes over the Urea-suphala briquettes and RDF was to the tune of 2.10 and 6.95%, respectively. The increase in straw yield could be attributed to increase in growth characters like plant height, number of functional leaves hill ha⁻¹, total number of tillers, dry matter accumulation and finally straw yield due to application of Urea-DAP briquettes.

These results are in line with those reported by Talashilkar *et al.* (2000), Dhane *et al.* (2002) and Bulbule *et al.* (2008). Application of Urea-DAP briquettes gave maximum gross returns (Rs. 59132.8, 63643.9 and 61388.37 ha⁻¹), net returns (Rs. 20640.6, Rs. 17587.2 and Rs. 19133.93 ha⁻¹) and B:C ratio (1.53, 1.38 and 1.45) over rest of fertilizer sources treatments during year 2009, 2010 and pooled mean, respectively. These increased economic parameters were due to significant improvement in grain and straw yield of rice. Similar results were also reported by Bulbule *et al.* (2006) and Ghodke *et al.* (2008).

Interaction effects between crop establishment methods and fertilizer sources treatments:

None of the growth characters and yield attributes was markedly influenced by interaction effects of crop establishment methods and fertilizer sources treatments. Similarly, grain and straw yields were also not influenced significantly due to interaction effect of crop establishment methods and fertilizer sources treatments.

CONCLUSION

From the results, it can be said that to get higher grain yield, straw yield, gross returns, net returns and benefit to cost ratio crop should be established by transplanting and supplied with Urea-DAP briquettes as compared to rest of the methods and sources of fertilizers.

REFERENCES

- Bulbule, A.V., V.S. Patil, G.D. Jangle and J.K. Purkar, 2006. Efficient management of nitrogenous fertilizer in lowland rainfed transplanted rice under rainfed rice ecosystem. *Agric. Sci. Digest*, Vol. 26, No. 1.
- Bulbule, A.V., A.G. Durgude, V.S. Patil and R.V. Kulkarni, 2008. Fertilization of lowland transplanted rice through briquettes. *Crop Res. J.*, 35: 1-5.
- Dhane, S.S., A.N. Yadav and D. Mahale, 2002. Urea briquettes containing diammonium Phosphate an important NP source for coastal saline soils. *J. Maharashtra Agric. Univ.*, 27: 226-228.
- Ghodke, S.B., A.C. Sawant, P.G. Chavan and P.P. Pawar, 2008. Integrated nutrient management in transplanted hybrid rice Sahyadri-2. *J. Maharashtra Agri. Univ.*, 33: 325-327.
- Ram, M., H. Om, S.D. Dhiman and D.P. Nandal, 2006. Productivity and economics of rice-wheat cropping system as affected by establishment methods and tillage practices. *Indian J. Agron.*, 51: 77-80.
- Sanjay, M.T., T.K. Prabhakar Shetty and H.V. Nanjappa, 2006. Investigation of crop establishment methods and weed management practices on productivity and economics in rice. *Mysore J. Agric. Sci.*, 42: 60-66.
- Singh, R.P., C.M. Singh and A.K. Singh, 2003. Effect of crop establishment methods, weed management and splitting of N on rice and associated weeds. *Indian J. Weed Sci.*, 35: 33-37.
- Singh, Y.P., G. Singh, S.P. Singh, A. Kumar and G. Sharma *et al.*, 2006. Effect of weed management and crop establishment methods on weed dynamics and grain yield of rice. *Indian J. Weed Sci.*, 38: 20-24.
- Talashilkar, S.C., D.S. Savant, V.B. Dhamapurkar and N.K. Savant, 2000. Yield and nutrient uptake by rice as influenced by integrated use of calcium silicate slag and UB-DAP in acid lateritic soil. *J. Indian Soc. Soil Sci.*, 48: 847-849.
- Tondan, H.L.S., 1992. Non-Traditional Sectors for Fertilizer Use. FDCO, New Delhi, India, Pages: 132.