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Research Article

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 Dept. of Agronomy Farm of Dr. B. S. K. K. V., Dapoli (Maharastra) 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 qha^{-1}), straw yield (59.89, 64.07 and 61.98 qha^{-1}), gross returns (Rs. 60447.5, Rs. 65847.1 and Rs. 63147.33 ha^{-1}), net returns (Rs. 20547.5, Rs. 17457.8 and Rs. 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 qha^{-1}), straw yield (59.16, 62.97 and 61.07 qha^{-1}), maximum gross returns (Rs. 59132.8, Rs. 63643.9 and Rs. 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) compared to rest of the treatments during year 2009, 2010 and pooled mean, respectively.

Key Words : Establishment methods, Fertilizer sources, Yield, Soil fertility and hybrid rice

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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 40^0S and 50^0N of the equator. In the world, rice is cultivated on about 155.3 million hectares of area with total production of 426.00 million tonnes (Anonymous, 2009a). In India, rice occupies an area of 43.75 million hectares with production of 85.3 million tonnes (Anonymous, 2009b). 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 hectares with annual production of 28.55 lakh tonnes. In Konkan region of Maharashtra state, rice occupies an area of 4.30 lakh hectares with production 10.25 lakh tonnes (Anonymous, 2008). Average productivity of rice is 2.13 tones/ha in India and 1.68 tonnes ha^{-1} in Maharashtra, which are far below the world's average of 3.7 tonnes 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

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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 favourable 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 reveled from the studies that use of briquette fertilizers improves fertilizer use efficiency (Tondon, 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.

EXPERIMENTAL METHODS

The field experiments were conducted at the Agronomy farm, College of Agriculture, Dapoli, dist. Ratnagiri during *Kharif* 2009-10 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.*, T_1: Transplanting, T_2 : Pre-monsoon dibbling of seeds, T_3 : Dibbling of seeds on the onset of monsoon, T_4: Transplanting of seedling by *Thomba* method and T_5 : System of rice intensification technique)

Sub plot treatment:

(Fertilizer source *viz.*, F_1 : RDF(120:60:60 NPK kg ha^{-1}), F_2 : Placement of urea-DAP briquettes and F_3 : Placement of urea-suphala briquettes)

Raising of seedling 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 @ 1 kg 100 sq.m^{-1} at the time of sowing. The seed of rice variety Sahyadri-4 which was treated with thirum @ 2.5 g kg^{-1} seed was sown in line 10 cm apart at 2-3 cm depth. Germination started from third day and completed by the fifth day. Top dressing with urea @ 1 kg 100 sq.m^{-1} 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 hours and kept in moist gunny bag for 24 hours 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 cm × 15-25 cm. Thirty days old seedlings were transplanted with the spacing of 15-25 cm × 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 cm × 20 cm.

Application of fertilizers and briquettes:

This comprised of three treatments as 100 per cent RDF (120:60:60 NPK kg ha^{-1}) through straight fertilizers to rice crop. 40 per cent 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 per cent nitrogen dose was applied at maximum tillering (30 DAT) and other 20 per cent 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 @ one briquette for every four hills of rice. Urea-DAP briquettes(@ 168.75 kg ha^{-1}) provides about 47.97 kgNha^{-1} and 32.04 kg P ha^{-1}. Urea-suphala briquettes (@ 168.75 kg ha^{-1}) provides 46.69kg N ha^{-1}, 22.83 kg P ha^{-1} and 15.57 kg K ha^{-1}.

Other cultural practices and plant protection measures were given according to the recommended package of practices. 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.

EXPERIMENTAL RESULTS AND ANALYSIS

The results obtained from the present study have been presented under following heads :

Effect of crop establishment methods:

The data presented in Table 1 revealed that transplanting methods of crop establishment gave higher grain yield (50.21, 54.95 and 52.58 qha^{-1} during year 2009, 2010 and pooled mean, respectively) followed by *Thomba* method and SRI technique which were at 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 at par with pre monsoon dibbling of seeds but found significantly superior to dibbling of seeds on the onset of monsoon. In case of first 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 at par with dibbling of seeds on the onset of monsoon. The increase in grain yield recorded 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, 3.73, 10.64 and 17.43 per cent, 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 $hill^{-1}$, length of panicle, number of filled grains $panicle^{-1}$, number of unfilled grains $panicle^{-1}$, weight of filled grains $panicle^{-1}$ and test weight. The grain yield of rice is a function of yield attributes of an individual plant *viz.,* number of panicles $hill^{-1}$, length of panicle, number of filled grains $panicle^{-1}$, weight of filled grains $panicle^{-1}$ 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 qha^{-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 at 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 per cent, respectively. This might be due to increased morphological characters *viz.,* plant height, number of leaves $hill^{-1}$, number of tillers and dry matter production $hill^{-1}$ observed under transplanting. Similar findings were also reported by Singh *et al.* (2003) and Mangat 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 gave the highest gross returns (Rs. 60447.5, Rs. 65847.1 and Rs. 63147.33 ha^{-1}), net returns (Rs. 20547.5, Rs. 17457.8 and Rs. 19002.72 ha^{-1}) and benefit to cost ratio (1.52, 1.36 and 1.44) followed by *Thomba* method,

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})			Net returns (Rs. ha^{-1})			B: C ratio		
	2009	2010	Pooled mean	2009	2010	Pooled mean	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	20547.5	17457.8	19002.72	1.52	1.36	1.44
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	18302.1	14559.8	16431.00	1.49	1.33	1.41
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	14683.8	11761.8	13222.89	1.42	1.27	1.34
T_4 *Thomba* method	49.76	54.34	52.05	58.92	63.86	61.39	59630.4	65162.8	62396.67	19455.0	16065.1	17760.06	1.48	1.32	1.40
T_5 SRI technique	48.92	52.32	50.62	59.08	62.95	61.02	58723.3	62852.2	60787.78	17202.3	13191.0	15196.67	1.41	1.26	1.33
S.E.	1.12	1.32	1.21	1.31	1.23	1.26	1386.25	1560.81	1452.99	1117.28	1298.86	1197.16			
C.D. (P=0.05)	3.66	4.32	3.95	4.26	4.00	4.11	4520.12	5089.31	4737.76	NS	4235.18	NS			
Fertilizer sources															
F_1 RDF	44.91	49.19	47.05	54.47	59.19	56.83	53980.6	59028.2	56504.43	14186.6	11055.0	12620.83	1.36	1.23	1.29
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	20640.6	17587.2	19113.93	1.53	1.38	1.45
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	19287.2	15179.2	17233.23	1.51	1.33	1.42
S.E.	0.98	0.99	0.97	0.94	0.97	0.95	1187.68	1179.33	1168.54	959.58	982.86	958.24			
C.D. (P=0.05)	2.88	2.92	2.85	2.78	2.87	2.81	3503.14	3478.50	3446.66	2830.34	2898.99	2826.37			
Interaction effect															
S.E.	2.18	2.21	2.16	2.10	2.17	2.12	2655.7	2637.0	2612.93	2145.69	2197.73	2142.68			
C.D. (P=0.05)	NS	NS	NS	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	18038.18	14607.16	16322.67	1.46	1.31	1.38

NS=Non significant

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 Mangat 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 qha^{-1} during year 2009, 2010 and pooled mean, respectively) followed by urea-suphala briquettes which were at par with each other but found significantly superior to RDF. The treatment receiving urea-suphala briquettes and RDF were at 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 per cent, 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 $hill^{-1}$, length of panicle, number of filled grains $panicle^{-1}$, weight of filled grains $panicle^{-1}$ 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 qha^{-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 per cent, respectively. The increase in straw yield could be attributed to increase in growth characters like plant height, number of functional leaves $hill^{-1}$, 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, Rs. 63643.9 and Rs. 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 Pillai (2004) and Ghodake (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 concluded 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.

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