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Original Research Article

Efficacy of Crop Establishment Methods on Yield and Economics of Rice (*Oryza sativa* L.) Under Puddled Condition

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Keywords

Rice, Establishment methods, Drum seeding, Yield, Economics

A B S T R A C T

A field experiment was conducted during *kharif* season, 2015 at Birsa Agricultural University, Ranchi, Jharkhand to evaluate efficacy of crop establishment methods on yield and economics of rice under puddled condition. Results revealed that conventional transplanting produced higher panicles/m^2 (282), total (124.10) and filled (106.27) grains/panicle resulting in higher grain yield (44.18qha^{-1}) and straw yield (68.43qha^{-1}) over rest of the establishment methods except drum seeding of sprouted seeds and mechanical transplanting. However, conventional transplanting had edge by 19 and 21 % over broadcasting of either sprouted or dry seeds, respectively whereas drum seeding of sprouted seeds (43.70 q ha^{-1}) was significantly higher by 17.7 and 19.7 % over broadcasting of either sprouted or dry seeds, respectively in grain production. Drum seeding(Rs.49293.61ha^{-1}) being on par with conventional transplanting (Rs.45704.42ha^{-1}) in net return had significant edge by 23.9, 26.9 and 27.1% over broadcasting of sprouted seeds, mechanical transplanting and broadcasting of dry seeds, respectively. The Benefit: Cost ratio (2.34) under drum seeding showed significant edge by 20.6, 23.8, 30 and 55% over broadcasting of either sprouted or dry seeds, conventional and mechanical transplanting, respectively. Hence, for higher productivity, establishment of rice through drum seeding can be a feasible alternative of transplanting method as it gives similar grain yield, straw yield and net return to conventional transplanting with higher benefit: cost ratio.

Introduction

Rice *(Oryza sativa* L.), 'Crop of the Millennium', covering 161.2 million hectares (mha) and contributing 471.09 million tonnes (2015-16) is gaining popularity worldwide. It is now being grown in different parts of the world particularly in South Asia as one of the major cereal crops, having high calorific value. Rice covered about 42 mha during 2015-16 and accounts for about 103.61 million tonnes of the country's total food grain production (Anonymous, 2016 a). However, rice suffered a production fatigue, stagnation or decline during 2015-16 mainly due to erratic rainfall in major rice growing areas (Anonymous, 2016 b). This anticipated year-to-year drop of global production very much reflects the negative expectations in Asia, where the season is expected to close with a minor 0.5 % decline in the total rice stocks. Singularly, India is set to account for much of the region's shortfall, reflecting the overall subdued monsoon performance. The productivity of the crop has to be increased by 0.21% p.a. in order to meet the projected rice demand of the nation of 125 million tonnes by 2025 AD as possibility of expanding the area under rice cultivation is very meagre. Therefore, this extra rice production needed has to come from a productivity gain which is to be achieved with less water, labour, and chemicals, thereby ensuring long-term sustainability in rice production, that still remains a major challenge.

In Jharkhand, a productivity gain of 2.57 t/ha was achieved during 2014-15 from 14.94 lakh hectares of area under rice cultivation. The Chotanagpur plateau is dominated by monocropping of rice being commonly grown by conventional transplanting. Farmers of Jharkhand are facing problems in rice establishment through transplanting because of higher production costs particularly due to shortages of labours (during peak period), water and escalating fuel prices. The rice cultivation is mostly monsoon dependent in Jharkhand, which in turn is extremely erratic in onset, distribution, intensity and cessation. Late monsoon usually delays seedlings raising and transplanting operations thus resulting in lower yield.

In such circumstances, direct seeding comprising of drum seeding, broadcasting of either dry or sprouted seeds under puddled condition may be an alternative to transplanting in boosting the rice production in Jharkhand. Rice can be established well by direct sowing into the main field under puddled condition rather than raising nursery and then transplanting. Direct seeding with drum seeder is a successful method of cultivation which not only saves labour but also contributes in water conservation, thereby increasing the water use efficiency and ultimately enhances the productivity, therefore considered more economical as compared to transplanting. Thus, if the productivity of rice in India in general and Jharkhand in particular is raised by different establishment methods, it can bring about tremendous change in agricultural scenario and on rural economy. Keeping these points in view the present investigation was undertaken to evaluate the comparative effects of different crop establishment methods on yield attributes, yield and economics of rice.

Materials and Methods

A field experiment was conducted at agronomical research farm of Birsa Agricultural University, Ranchi (23°17´ N latitude and 85°10´ E longitude with an altitude of 625 m above the mean sea level) during *kharif* season of 2015, in the clay - loam soil, slightly acidic in reaction (pH 6.1), low in organic carbon (3.6 g/kg) as well as in available nitrogen (200.7 kg/ha), high in available phosphorus (33.54 kg/ha) and medium in potassium (187.04 kg/ha). The climate of Ranchi is sub humid with large water deficiency and is characterized by hot summer and cold winter. The agronomical research farm of Ranchi falls under sub zone V of Agro-climatic zone VII of India i.e. Eastern Plateau and Hill Region. This place receives rainfall from both the streams of monsoon i.e. South-West monsoon and North-East monsoon. The experiment was laid out in Randomized Block Design with four replication and the rice variety used was Naveen (CR-749-20-2). The treatments comprised of five different rice establishment methods – conventional transplanting, mechanical transplanting, drum seeding of sprouted seeds, broadcasting of sprouted seeds and broadcasting of dry seeds. Uniform fertilization (120: 60: 40 kg N: P_2O_5: K_2O ha^{-1}) was done for all the rice establishment methods through urea, diammonium phosphate and muriate of potash, respectively. After ploughing and leveling layout of field was done which followed puddling with the help of tractor drawn puddler, 5 days before as well as on the day of sowing/transplanting and then leveling was done.

In main field half dose of nitrogen and full dose of phosphorus and potassium were applied as basal. Rest of the nitrogen was top dressed in two equal splits at 25 days after sowing/transplanting (tillering stage) and at 50 days after sowing/transplanting (panicle initiation stage). Whereas, in nursery fertilizers was applied @ 12: 6: 4 kg N: P_2O_5: K_2O per 1000 sq m. In conventional transplanting, half dose of N and full dose of P_2O_5 and K_2O were applied as basal and remaining N was top dressed at 15 DAS. While, in case of rice nursery for mechanical transplanting full dose of N was applied as basal. For conventional transplanting, seeds were sown in nursery and seedlings were raised by wet nursery method and 2-3 seedlings/hill (21 days old) were transplanted at 20 x 15 cm spacing. Whereas, in case of mechanical transplanting seedlings were prepared on mat type nursery and 4-5 seedlings/hill (15 days old) were transplanted at 25 x 15 cm spacing. Sprouted seeds were used for direct seeding by broadcasting and drum seeding with 20 cm row spacing. Direct seeding was done on the same day i.e. the day seeds were placed in nursery. Observations on yield attributes and yield were recorded. Collected data was statistically analyzed as per the methods by Gomez and Gomez, 2003.

Results and Discussion

Yield attributes

In the present investigation, crop establishment methods differed significantly in their ability to produce panicles m^{-2}, panicle length and filled grains $panicle^{-1}$. Rice established by conventional transplanting, drum seeding of sprouted seeds and mechanical transplanting had similar yield attributes except 1000 g weight (Table-1). However, conventional transplanting (282 m^{-2}) and drum seeding of sprouted seeds (275 m^{-2}) showed significant edge by 22.9 and 19.8%, respectively over broadcasting of dry seeds (229.50 m^{-2}) in panicle production. Further, broadcasting of dry seeds being similar to broadcasting of sprouted seeds recorded the lowest panicles per unit area which might be due to less availability of nutrients and moisture to the crop at panicle initiation stage resulting from the crop-weed competition (Raj *et al.*, 2013). These findings are also in close conformity with those obtained by Prasad 2001; Aslam *et al.*, (2008) who reported higher yield attributes under transplanted rice than direct seeded.

Among various establishment methods, higher panicle length and filled grains $panicle^{-1}$ were recorded in conventional transplanting (23.46 cm and 106.27) that being similar to drum seeding of sprouted seeds (23.18 cm and 105.28), mechanical transplanting (22.08cm and 100.82) and broadcasting of sprouted seeds (21.73 cm and 96.81), had edge of 9.7 and 10.5 % in panicle length and filled grains $panicle^{-1}$, respectively over broadcasting of dry seeds. Further, broadcasting of dry seeds being similar to that of sprouted seeds registered the minimum panicle length and filled grains $panicle^{-1}$. The panicle length in transplanted rice was significantly longer as compared to direct seeded crop because of more space, sunlight and nutrients availability in transplanted crop, whereas higher weed densities in direct seeded crop hinders the development of panicle length and other yield attributes (Hussain *et al.*, 2013).

Test weight or 1000 grain weight is a function of various production factors that gives an indication of grain development and filling patterns. However, rice establishment methods had no significant affect on this attribute. This result confirms the observations of Gill *et al.,* 2006; Ehsanullah *et al.,* 2007 and Jha *et al.,* 2011.

Yield

Grain and straw yield differed significantly by various rice establishment methods under puddled soil except the harvest index of rice. Rice established through conventional transplanting, drum seeding and mechanical transplanting had similar grain and straw yield (Table 1). Conventional transplanting (44.18 q ha^{-1}) had edge by 19 and 21 %, respectively over broadcasting of either sprouted (37.13 q ha^{-1}) or dry seeds (36.50 q ha^{-1}) whereas drum seeding of sprouted seeds (43.70 q ha^{-1}) was significantly higher by 17.7 and 19.7 %, respectively over broadcasting of either sprouted (37.13 q ha^{-1}) or dry seeds (36.50 q ha^{-1}) in grain production.

Further, among the direct seeded rice, broadcasting of dry seeds being similar to broadcasting of sprouted seeds recorded the lowest grain yield. Rice established through transplanting and drum seeding recorded significantly higher paddy yield because the the beneficial effects of puddling in transplanting as well as in drum seeding together with uniform stand establishment, ideal rhizosphere environment might have contributed to higher nutrient uptake which resulted in the production of greater source and efficient translocation of photosynthates into the larger sink as indicated by higher yield attributes. In case of straw yield, crop established through conventional transplanting (68.43 q ha^{-1}) and drum seeding of sprouted seeds (67.90 q ha^{-1}) showed significant edge by 15.3 and 14.5%, respectively over broadcasting of dry seeds (59.32q ha^{-1}). Further, rice established through broadcasting of dry seeds being similar to that of sprouted seeds recorded the minimum straw yield. Transplanting method of establishment recorded significantly higher straw yield compared to direct sowing of rice under puddled condition due to less crop weed competition in transplanting method which led to taller plants, more number of tillers and dry matter production which in turn resulted in higher straw yield (Parameshwari and Srinivas, 2014). Subramanyam *et al.,* (2007) also reported similar results.

Being a varietal character, harvest index was not influenced by different rice establishment methods under puddled condition, however highest harvest index was recorded with conventional transplanting (39.19%) followed by drum seeding of sprouted seed (39.13%), mechanical transplanting (38.38%), broadcasting of sprouted seeds (38.18%) and broadcasting of dry seeds (38.13%).This confirms the findings of Jha *et al.,* 2011.

Economics

Economic analysis of the treatments shows the relevance to consider the practical adaptability of a particular treatment from the farmers' point of view (Jha *et al.*, 2011). Cost of cultivation for mechanically transplanted and conventionally transplanted rice was Rs.25648.13 ha^{-1} and Rs.25409.58 ha^{-1}, respectively. Whereas rice grown by broadcasting of either sprouted or dry seeds had equal cost of cultivation i.e. Rs.20534.60 ha^{-1}. Establishment of rice with the help of drum seeder required cultivation cost of Rs. 21096.89 ha$^{-1.}$ Rice establishment methods under puddled soil had a significant impact on gross return.

Table.1 Yield attributes, yield and harvest index as influenced by different rice establishment methods under puddled condition

Treatments	Panicles m^{-2}	Panicle length (cm)	Grains $Panicle^{-1}$	Filled Grain $Panicle^{-1}$	1000 Grain Weight (g)	Yield ($q\ ha^{-1}$)		Harvest Index (%)
						Grain	Straw	
T_1 Conventional Transplanting	282.00	23.46	124.10	106.27	22.98	44.18	68.43	39.19
T_2 Mechanical Transplanting	258.00	22.08	118.38	100.82	23.13	39.80	63.76	38.38
T_3 Drum seeding of sprouted seeds	275.00	23.18	122.85	105.28	23.03	43.70	67.90	39.13
T_4 Broadcasting of sprouted seeds	238.25	21.73	113.71	96.81	24.66	37.13	60.21	38.18
T_5 Broadcasting of dry seeds	229.50	21.39	112.25	96.13	24.70	36.50	59.32	38.13
SEm ±	12.98	0.64	3.36	3.10	0.56	1.90	2.62	0.60
CD (P=0.05)	39.84	1.97	10.30	9.50	NS	5.82	8.05	NS

Table.2 Cost of cultivation, gross return, net return, benefit: cost ratio as influenced by rice establishment methods under puddled condition

Treatments	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	Benefit: cost ratio
T_1 Conventional Transplanting	25409.58	71114.00	45704.42	1.80
T_2 Mechanical Transplanting	25648.13	64492.50	38844.37	1.51
T_3 Drum seeding of sprouted seeds	21096.89	70390.50	49293.61	2.34
T_4 Broadcasting of sprouted seeds	20534.60	60304.00	39769.40	1.94
T_5 Broadcasting of dry seeds	20534.60	59313.00	38778.40	1.89
SEm ±	-	2919.33	2919.33	0.13
CD (P=0.05)	-	8958.96	8958.96	0.39

NOTE: selling price of grain: Rs.1300/q,straw: Rs.200/q

The gross return of conventionally transplanted (Rs. 71114 ha^{-1}), drum seeded (Rs.70390.50 ha^{-1}) and mechanically transplanted rice (Rs. 64492.50 ha^{-1}) were on par with one another. However, rice established by conventional transplanting and drum seeding of sprouted seeds had significant edge over broadcasting of either sprouted (Rs.60304.00 ha^{-1}) or dry seeds (Rs. 59313.00 ha^{-1}). The agriculture practices involving lower cost of production and giving higher net return and benefit: cost ratio are preferred for adoption. Direct seeding of sprouted seeds by drum seeder (Rs. 49293.61 ha^{-1}) being on par with conventional transplanting (Rs.45704.42 ha^{-1}) in net return had significant edge by 23.9, 26.9 and 27.1% over broadcasting of sprouted seeds, mechanical transplanting and broadcasting of dry seeds, respectively. The higher net return under drum seeded and conventionally transplanted rice might be due to higher grain and straw yield of the crop. While benefit : cost ratio (2.34) under drum seeded rice was higher than all other methods of rice establishment and had significant edge by 20.6, 23.8, 30 and 55% over broadcasting of sprouted seeds, broadcasting of dry seeds, conventional transplanting, and mechanical transplanting, respectively (Table-2). This confirms the findings of Jha *et al.*, 2011.

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References

Anonymous, 2016 b. USDA, Rice Outlook Report, 2016.

Anonymous, 2016 a. Department of Food & Public Distribution (DoF & PD), Department of Commerce (DoC), Directorate of Economics & Statistics (D&ES), Department of Agriculture & Cooperation (DAC) (Commodity profile for rice- April 2016).

Aslam, M., Hussain, S., Ramzan, M. and Akhter, M. 2008. Effect of different stand establishment techniques on rice yield and its attributes. J. Anim. Plant Sci. 18 (2-3): 80-82.

Baloch, A. W., Soomro A. M., Javed M. A., Ahmed M., Bughio H. R. Bughio M. S. and Mastoi N. N. 2002. Optimum plant density for high yield in rice (*Oryza sativa* L.). Asian journal of plant sciences. 1 (1): 25-27.

Demircan, V., Ekinci, K., Keener, H.M., Akbotat, D., Ekinci. C., 2006. Energy and economic analysis of sweet cherry production in Turkey: A case study from Isparta Province. Energy Conversion and Management. 47, 1761-1769.

Dingkuhn M., Schrier H. F., De Datta S.K., Dorffing K. and Jarvellana C. 1991. Relationship between ripening phase productivity in transplanted, canopy photosynthesis and senescence in transplanted and direct seeded low land rice. Field Crop Research. 26, 327-345.

Gomez, K. A., and Gomez, A. A. 2003. Statistical Procedure for Agricultural Research. John Wiley and Sons, London. Pp. 139-167, 204-207.

International Rice Research Institute (IRRI). 1984. An overview of upland rice research. Proceedings of the 1982 Bouake, Ivory Coast, Upland Rice Workshop. IRRI, Minila, Philippines. Pp. 566.

Jha, A. K., Kewat, M. L., Upadhyay, V. B. and Vishwakarma, S.K. 2011. Effect of tillage and sowing methods on productivity, economics and energetic of rice (oryza sativa L.) - wheat (Triticum aestivum) cropping system. Indian Journal of Agronomy. 56 (1): 35-40.

Mohanty, Tushar Ranjan., Maity, Swapan Kumar., Roul, Pravat Kumar and Sahoo, Kishore Chandra. 2014. Studies on yield, economics and energetics of rice (*Oryza sativa* L.) in relation to crop establishment methods and nutrient management practices. International Journal of Bio-resource and Stress Management. 5 (4): 495-501

Parameswari, Y. S. and Srinivas, A. 2014. Influence of weed management practices on nutrient uptake and productivity of rice under different methods of crop establishment. Journal of Rice Research. 7 (1 & 2).

Prasad, S. M., Mishra, S. S. and Singh, S. J. 2001. Effect of establishment methods, fertility levels and weed management practices on rice (*Oryza sativa*). Indian Journal of Agronomy. 46 (2): 216-221.

Raj, K. Sheeja., Jose, Nimmy., Mathew, Reena. and Leenakumary, S. 2013. Influence of stand establishment techniques on yield and economics of rice cultivation in Kuttanad. International Journal of Scientific and Research Publications. 4 (3): ISSN 2250-3153.

Singh, K. P., Prakash, Ved., Srinivas, K. and Srivastva, A. K. 2008. Effect of tillage management on energy-use efficiency and economics of soybean (*Glycine max*) based cropping systems under rainfed conditions in North-West Himalayan Region.

Subbaiah, S.V., Balsubramanian, V., 2000. Rice situation in India: Present status, future prospects and challenges. In: Wet seeding of rice in India. DRR, Hyderabad. 1-9.

Subramanyam D., Raghava Reddy C. and Srinivasulu Reddy. 2007. Influence of puddling intensity and water management practices on weed dynamics and yield of transplanted rice (*Oryza sativa* L.). Indian Journal of Agronomy. 52 (3): 225-330.