

Original Research Article

<https://doi.org/10.20546/ijcmas.2019.812.310>

## Evaluation of the Rice Establishment Methods for Higher Productivity and Profitability under Dry Seeded Condition

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### ABSTRACT

#### Keywords

Establishment method, Drum seeder, Direct seeded rice, Aerobic rice

#### Article Info

##### Accepted:

20 November 2019

##### Available Online:

10 December 2019

A field experiment was conducted during *kharif* 2018 at Instructional cum Research Farm of Shaheed Gundadhoor College of Agriculture and Research Station, Jagdalpur, Chhattisgarh under AICRIP in *Alfisols* to study grain yield of rice as influenced by different methods of establishment. Results revealed that significantly highest grain yield was registered under treatment dry direct seeded drum seeder (T<sub>1</sub>) which was at par with treatments aerobic rice (T<sub>3</sub>), semi dry rice (T<sub>4</sub>) and transplanted rice (T<sub>5</sub>). However, the lowest grain yield was recorded under treatment dry direct seeded rice (T<sub>2</sub>). Further, significantly highest net return was recorded under treatment dry direct rice drum seeder method (T<sub>1</sub>) which was at with treatment aerobic rice unpuddled condition (T<sub>3</sub>). While lowest net return was noticed under treatment transplanted rice (T<sub>5</sub>). Further, significantly highest B: C ratio was recorded under treatment dry direct rice drum seeder method (T<sub>1</sub>) over rest of the treatments. Further, the lowest B: C ratio was noticed under treatment transplanted rice (T<sub>5</sub>).

### Introduction

Rice (*Oryza sativa* L.) is monocot plant belonging to genus *Oryza* under grass family Poaceae. Rice has the distribution of being the most extensively cultivated crop in the world and important staple food of more than 60% of the world population. Rice occupies an important among food crops under diversified situation. About 90% of all rice grown in the world is produced and consumed in the Asian

region. In the world, 85% of the total rice area is in Asia. India is the second largest producer and consumer of rice in the world. The Chhattisgarh is known as “rice bowl of India” and about 82% population of the state is dependent on agriculture for their livelihood. The total rice grown area is 3.71 million hectares with the production of 7.29 million tonnes and productivity of 1.96 tonnes ha<sup>-1</sup> (Krishi Darshika, 2019). Rice is grown by mainly two methods *i.e.* transplanting and

direct seeding. Direct seeding can be done by either broadcasting or line sowing. In Chhattisgarh most of the rice growing area is under direct seeded rice. Direct seeded rice offers the advantage of faster and easier planting, ensure proper plant population, reduce labour and hence less drudgery 10-12 days earlier crop maturity, more efficient water use and higher tolerance to water-deficit, and often high profit in areas with assured water supply (Datta, 1986). Drum seeder is an effective mean for timely sowing of rice. Also direct seeded rice may mature 7 to 10 days earlier than transplanted rice (Subbaiah *et al.*, 2002). Dry direct seeding of rice allows early establishment of the succeeding crop and higher profit in areas with assured water supply by utilizing short duration modern varieties and cost efficient herbicides. So, there is need to search for suitable crop establishment methods to increase the productivity and profitability of rice (Farooq *et al.*, 2011).

## Materials and Methods

The location of the experimental site was Instructional cum Research Farm of Shaheed Gundadhoor College of Agriculture and Research Station, Jagdalpur, Chhattisgarh. It comes under Bastar plateau of Chhattisgarh which comprises of large plateau having elevation of 553 m above mean sea level and lies between 17°46' N and 20°34' N latitudes and 80°15' and 82°15' E longitudes. The five different methods of establishment *viz.* dry direct seeded rice unpuddled soil by drum seeder (T<sub>1</sub>), dry direct seeded rice unpuddled condition by broadcasting (T<sub>2</sub>), aerobic rice unpuddled condition by line sowing (T<sub>3</sub>), semi-dry rice (unpuddled rice 12 hrs water soaking) (T<sub>4</sub>) and transplanted under puddled condition (T<sub>5</sub>) were adopted. The experiment was laid out randomized block design with tree replications. The variety Samleswari was taken as a test crop. Matures in 105-112 days,

grain type medium size grain, resistance to blast, moderately resistant/tolerant against blight, gall-midge, tolerate to drought and suitable for summer cultivation and yield potential is 35-45 q ha<sup>-1</sup>. The soil of the experimental site is characterized as silty loam (fairly leveled). The soil was locally known as Mal (*Alfisols*). It is well fertile soil belongs to mid land situation of topography in Jagdalpur. During *kharif* season 2018, a total of 1085 mm rainfall was recorded against the normal rainfall of 1195 mm. With the onset of monsoon, 117.4 mm of rainfall was received during 23rd SMW. Total rainfall received during the June month was 178.1 mm. In the months of July, August, September and October rainfall of 269.4, 421.4, 233.9 and 6.2 mm was received, respectively. The evapo-transpiration, maximum and minimum temperature and wind velocity ranged between 1.2 to 7.9 mm, 26.8 to 37.2 °C, 8.7 to 24.3 °C, and 1.7 to 7.9 km ph respectively.

## Results and Discussion

Plant height, number of tillers hill<sup>-1</sup>, leaf area index as influenced by different establishment methods shown in Table 1.

The significantly taller plant was observed in treatment aerobic rice line sowing (T<sub>3</sub>) at 30 DAE which was at par with treatments dry direct rice drum seeder method (T<sub>1</sub>), dry direct seeded rice broadcasting method (T<sub>2</sub>) and semi-dry rice method (T<sub>4</sub>). While, shortest plant was recorded under transplanted rice method (T<sub>5</sub>). At 60 DAE significantly taller plant noticed under treatment dry direct rice using drum seeder method (T<sub>1</sub>) which was on par with treatments dry direct seeded rice broadcasting method (T<sub>2</sub>), aerobic rice line sowing method (T<sub>3</sub>) and semi-dry rice method (T<sub>4</sub>), and at 90 DAE plant height was found statistically non significant. In general, the plant height, dry matter production was found to increase with the age of the crop. While,

tiller production starts slowly in the beginning, increases steadily and attains to its peak during panicle initiation stage and then started to decline as the age of the crop. The decrease in tiller number on aging resulted from death of the late forming tillers due to their incompetency for light and nutrients (Barik *et al.*, 2006). Halder *et al.*, (2010) stated that maximum plant height was recorded in SRI method, which was on a par with transplanting but significantly superior over broadcasting and drum seeding.

The significantly highest number of tiller hill<sup>-1</sup> was registered with treatment aerobic rice unpuddled condition (T<sub>3</sub>) at all the growth stages which was at par with treatments dry direct rice drum seeder method (T<sub>1</sub>) and semi dry rice (T<sub>4</sub>) at 30 DAE and 60 DAE and dry direct rice drum seeder method (T<sub>1</sub>) at 90 DAE. Awan *et al.*, (2007) reported maximum productive tillers m<sup>-2</sup> (336) was found in direct seeded rice than manual transplanted crop (229 tillers m<sup>-2</sup>).

The leaf area index increased progressively from 30 DAE to 90 DAE. The leaf area index was more pronounced from 30 DAE to 90 DAE. Table 1 shows that significantly higher leaf area index was recorded in treatments dry direct rice by drum seeder (T<sub>1</sub>) which was on par with aerobic rice line sowing unpuddled condition (T<sub>3</sub>), semi dry rice (T<sub>4</sub>) and transplanted rice (T<sub>5</sub>) at 30, 60 and 90 DAE and minimum leaf area index was recorded in treatment dry direct seeded rice by broadcasting. Transplanting shock can be avoided in direct rice than transplanting this result in growth delays and hastens physiological maturity and reduces vulnerability to late-season drought (Tuong 2008).

The dry matter accumulation was significantly influenced by different crop establishment methods. At all the growth

stages, dry direct rice drum seeder method (T<sub>1</sub>) registered significantly highest dry matter accumulation at 30, 60, and 90 DAE, which was at par with treatments. Kumar *et al.*, (2018) revealed that among rice crop establishment methods direct seeded rice with drum seeder (DSR) was found most economic feasible method with high grain yield. Direct-seeded rice with drum seeder (DSR) had shorter crop duration, required less water and therefore had higher water-use efficiency than the transplanting method. Halder. (2009) observed that dry matter accumulation was significantly higher in direct seeded rice under puddle condition and SRI respectively compared to regular transplanting.

The significantly more time was required to 50 % flowering was observed under treatment transplanted rice (T<sub>5</sub>) which was at par with treatments dry direct seeded rice unpuddled condition (T<sub>2</sub>), aerobic rice unpuddled condition (T<sub>3</sub>) and semi dry rice (T<sub>4</sub>). However, lowest days to 50 % flowering was recorded under treatment dry direct rice drum seeder method (T<sub>1</sub>) Table 2. The number of panicle m<sup>-2</sup> observed significantly highest under treatments dry direct seeded rice unpuddled condition (T<sub>2</sub>), and lowest number of panicle m<sup>-2</sup> was noticed under treatment semi dry rice (T<sub>4</sub>) (Table 2). Root volume, root dry weight given in Table 3.

The significantly highest root volume was registered in treatment dry direct rice drum seeder method (T<sub>1</sub>) during all the stages of observations which was at par with treatment dry direct seeded unpuddled condition (T<sub>2</sub>) at 30 DAE and 90 DAE. Lowest root volume was recorded under treatment transplanted rice (T<sub>5</sub>) at all the durations (Table 3). The significantly highest root dry weight was observed under treatment semi dry rice (T<sub>4</sub>) which was at par with treatments dry direct rice drum seeder method (T<sub>1</sub>), dry direct seeded rice unpuddled condition (T<sub>2</sub>) and

aerobic rice unpuddled condition (T<sub>3</sub>) at 30 DAE. Moreover, the lowest root dry weight was recorded under treatment transplanted rice (T<sub>5</sub>) 30 at DAE. While, 60 DAE and 90 DAE the highest root dry weight were observed under treatment. Further, the lowest root dry weight dry direct rice drum seeder method (T<sub>1</sub>) recorded under treatment transplanted rice (T<sub>5</sub>) during 60 DAE and 90 DAE.

Test weight, grain yield, straw yield and harvest index as influenced by different establishment methods (Table 4).

The highest test weight was recorded under treatment transplanted rice (T<sub>5</sub>) which was at par with treatments dry direct seeded rice drum seeder (T<sub>1</sub>) and aerobic rice (T<sub>3</sub>). Further, the lowest test weight was observed under treatment semi dry rice (T<sub>4</sub>). Drum seeding 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. Direct seeding of rice allows early establishment of the succeeding crop and higher profit in areas with assured water supply by utilizing short duration modern varieties and cost efficient herbicides (Balasubramanian and Hill, 2002). The significantly highest grain yield was registered under treatment dry direct rice drum seeder (T<sub>1</sub>) which was at par with treatments aerobic rice (T<sub>3</sub>), semi dry rice (T<sub>4</sub>) and transplanted rice (T<sub>5</sub>). However, the lowest grain yield (kg ha<sup>-1</sup>) was recorded under treatment dry direct seeded rice (T<sub>2</sub>). The significantly highest straw yield was noticed under treatment dry direct seeded drum seeder (T<sub>1</sub>) which was at par with rest of the treatments. Higher grain and straw yield in drum seeding was due to more mobilization of photosynthetic to grain. This is confirmation with the finding of Reddy (2010). Bautista and Gagelonia (1994)

reported that row seeding using drum seeder was reported to have increased grain yield of 425 to 750 kg ha<sup>-1</sup> compared with broadcasting and transplanting and farmers income was increased by an average of 7.5 and 28% respectively, compared with broadcasting and transplanting. The significantly highest harvest index was recorded under treatment aerobic rice (T<sub>3</sub>) which was at par with treatments dry direct rice drum seeder method (T<sub>1</sub>), semi dry rice (T<sub>4</sub>) and transplanted rice (T<sub>5</sub>). The lowest harvest index was observed under treatment dry direct seeded rice unpuddled condition (T<sub>2</sub>) (Table 4). Direct-seeding of rice has the potential to provide several benefits to farmers and the environment over conventional practices of puddling and transplanting. This may be due to the transplanting shock which may take about one week for establishment in transplanted rice.

Economics of rice as influenced by different establishment methods (Table 4).

Economics of rice influenced by different treatments is shown in Table 4. Significantly highest was gross return, net return and B: C ratio was recorded in treatments dry direct rice by drum seeder (T<sub>1</sub>) among all the treatments and lower net return and B:C ratio was observed in treatments transplanted rice (T<sub>5</sub>). Similar finding was reported by Ramasamy *et al.*, (2006) 60 percent saving of labour during crop establishment stage (sowing, transplanting and weeding) as compared to transplanted rice. Rashid *et al.*, (2009) obtained higher gross returns and B: C ratio in drum seeded rice than in transplanted rice. Farooq *et al.*, (2011) noticed that dry direct seeding of rice allows early establishment of the succeeding crop and higher profit in areas with assured water supply by utilizing short duration modern varieties and cost efficient herbicides.

**Table.1** Plant height, number of tiller plant<sup>-1</sup> and leaf area index at different durations of rice as influenced by different crop establishment methods

Treatment	Plant height (cm)			Number of tiller plant <sup>-1</sup>			Leaf area index		
	30 DAE	60 DAE	90 DAE	30 DAE	60 DAE	90 DAE	30 DAE	60 DAE	90 DAE
<b>T1 : Dry direct seeded rice unpuddled soil (Drum seeder)</b>	47.97	62.60	76.35	9.45	8.50	8.45	2.79	3.88	5.01
<b>T2 : Dry direct seeded rice unpuddled condition (Broadcasting)</b>	47.72	61.05	73.55	6.05	5.15	4.20	2.49	3.27	4.18
<b>T3: Aerobic rice unpuddled condition (Line sowing)</b>	48.82	62.20	74.95	10.40	9.70	8.90	2.76	3.73	4.86
<b>T4 : Semi-dry rice (unpuddled rice 12 hrs water soaking)</b>	46.87	62.20	76.85	8.75	7.90	6.75	2.60	3.74	4.69
<b>T5 : Transplanted (puddle condition)</b>	39.52	57.02	73.45	8.20	7.40	6.65	2.56	3.78	4.98
<b>SEm±</b>	0.86	0.96	1.79	0.66	0.59	0.67	0.06	0.05	0.08
<b>CD(P=0.05)</b>	2.70	3.01	NS	2.06	1.84	2.11	0.20	0.17	0.27

**Table.2** Dry matter accumulation (g hill<sup>-1</sup>), days to 50 % flowering, number of panicle (m<sup>-2</sup>) at different durations of rice as influenced by different crop establishment methods

Treatment	Dry matter accumulation (g hill <sup>-1</sup> )			Days to 50% flowering	Number of panicle (m <sup>-2</sup> )
	30 DAE	60 DAE	90 DAE		
<b>T1 : Dry direct seeded rice unpuddled soil (Drum seeder)</b>	9.20	40.78	47.26	77	277.5
<b>T2 : Dry direct seeded rice unpuddled condition (Broadcasting)</b>	5.72	31.44	36.90	82	517.8
<b>T3: Aerobic rice unpuddled condition (Line sowing)</b>	8.26	37.22	40.89	81	344.3
<b>T4 : Semi-dry rice (unpuddled rice 12 hrs water soaking)</b>	7.68	36.11	38.88	80	268.0
<b>T5 : Transplanted (puddle condition)</b>	7.47	39.41	43.13	84	310.0
<b>SEm±</b>	0.61	1.32	1.47	1.29	43.57
<b>CD(P=0.05)</b>	1.92	4.11	4.59	4.04	135.76

**Table.3** Root volume and root dry weight as influenced by different crop establishment methods

Treatment	Root volume (cc)			Root dry weight (g)		
	30 DAE	60 DAE	90 DAE	30 DAE	60 DAE	90 DAE
<b>T1 : Dry direct seeded rice unpuddled soil (Drum seeder)</b>	10.58	13.00	11.08	7.91	12.44	13.09
<b>T2 : Dry direct seeded rice unpuddled condition (Broadcasting)</b>	8.99	11.01	9.25	7.61	9.35	10.55
<b>T3: Aerobic rice unpuddled condition (Line sowing)</b>	7.66	10.50	8.83	7.45	8.48	9.24
<b>T4 : Semi-dry rice (unpuddled rice 12 hrs water soaking)</b>	7.49	10.25	8.64	9.85	9.29	9.89
<b>T5 : Transplanted (puddle condition)</b>	3.38	10.08	8.60	1.39	7.92	9.15
<b>SEm±</b>	0.61	0.47	0.44	1.56	0.67	0.45
<b>CD(P=0.05)</b>	1.91	1.48	1.38	4.88	2.10	1.42

**Table.4** Test weight, Grain yield, Straw yield, harvest index, gross return, net return and B: C ratio as influenced by different establishment methods

Treatment	Test weight (g)	Grain yield (kg ha <sup>-1</sup> )	Straw yield (kg ha <sup>-1</sup> )	Harvest Index (%)	Gross return (000 ₹ ha <sup>-1</sup> )	Net return (000 ₹ ha <sup>-1</sup> )	B:C ratio
<b>T1 : Dry direct seeded rice unpuddled soil (Drum seeder)</b>	26.75	4651.5	5953.9	43.85	119263	89674	3.03
<b>T2 : Dry direct seeded rice unpuddled condition s(Broadcasting)</b>	25.75	3721.2	5395.7	40.81	95727	65534	2.17
<b>T3: Aerobic rice unpuddled condition (Line sowing)</b>	26.25	4437.3	5591.0	44.24	113727	82773	2.67
<b>T4 : Semi-dry rice (unpuddled rice 12 hrs water soaking)</b>	25.50	4079.7	5344.5	43.29	104664	73710	2.38
<b>T5 : Transplanted (puddle condition)</b>	27.25	4344.4	5647.7	43.47	111433	63194	1.30
<b>SEm±</b>	0.323	188.4	197.8	0.65	96317	3.00	0.07
<b>CD(P=0.05)</b>	1.006	587.2	617.1	2.02	NS	10556	0.23



In addition to labour savings, the demand for labour is spread out over a longer period in DSR than in transplanted rice (Kumar and Ladha, 2011). The test at Kerala Agricultural University showed that 77-81 per cent saving of labour and 48 per cent saving of cost as compared to manual transplanting (including nursery raising). The manual transplanting required 360 man (Anonymous 2000). Direct seeding helps reduce water consumption by about 30% (0.9 million liters acre<sup>-1</sup>) as it eliminates raising of seedlings in a nursery, puddling, transplanting under puddled soil and maintaining 4-5 inches of water at the base of the transplanted seedlings. The farmer saves about ₹ 1400 acre<sup>-1</sup> in cultivation cost. Direct seeding (both wet and dry), on the other hand, avoids nursery raising, seedling uprooting, puddling and transplanting, and thus reduces the labour requirement (Pepsico International, 2011).

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**How to cite this article:**

Om Prakash Bhaskar, M. Kumar, A.K. Thakur, T. Chandrakar and Singh, D.P. 2019. Evaluation of the Rice Establishment Methods for Higher Productivity and Profitability under Dry Seeded Condition. *Int.J.Curr.Microbiol.App.Sci*. 8(12): 2654-2663. doi: <https://doi.org/10.20546/ijcmas.2019.812.310>