J. Agric. Res. Technol., 49 (2) : 266-271 (2024)

Effect of Planting Methods on Economics of Paddy (*Oryza sativa*)

K. K. Jadhav[1*], N. V. Kashid[2], T. V. Bhadre[3] and S. K. Jadhav[4]
Department of Agrochemicals and Fertilizers, Science College, Nanded - 431 605 (India)
*Corresponding author : Email : kartikkjadhav@gmail.com
(Received : 18.01.2024 Accepted : 22.02.2024)

Abstract

An experiment entitled, "Effects of planting methods on growth and yield of paddy (*Oryza sativa* L.)" was carried out during *Kharif*, 2020 at Agricultural Research Station Farm,Vadgaon Maval, Tal. Maval, Dist. Pune. The field experiment was laid out in Randomized Block Design (RBD) with three replications. There were eight treatments comprising of different sowing methods of rice *viz*., T_1 - Sowing as direct seeded rice (DSR) at 22.5cm by bullock drawn seed drill, T_2 - Sowing as direct seeded rice (DSR) at 30cm by bullock drawn seed drill, T_3 - Sowing by dibbling method at 20 x 15 cm^2, T_4 - Direct sowing of rice by tractor operated mechanical seed drill, T_5 - Direct sowing of rice by 'Saguna Rice Technique'(SRT), T_6 - Direct sowing of rice by 'Modified Direct Seeded Rice Technique'(MDSRT), T_7 - University recommended method (Four Point Agro-Technology or Char Sutri Method) and T_8 - Farmers practice-Conventional transplanting method. The gross plot size was 3.60 m x 3.00 m and net plot size was different as per treatments. The highest initial plant population per plot (247531) is observed in the treatment T_8 - Farmer's Practice-Conventional transplanting method as no specific distance is used by the farmers for transplanting the seedlings which was significantly superior over rest of all the treatments. The highest final plant population per plot (245056) is observed in the treatment T_8 - Farmer's Practice-Conventional transplanting method as no specific distance is used by the farmers for transplanting the seedlings. The sowing of paddy with the treatment T_6 - Direct sowing of rice by 'Modified Direct Seeded Rice Technique' (MDSRT) recorded significantly highest gross monetary returns (Rs. 160884 ha^{-1}), net monetary returns (Rs. 109782 ha^{-1}) and B:C ratio (3.15) than rest of all the cultivation methods which was at par with the treatment T_7 - University recommended method (Four Point Agro-technology) having gross monetary returns (Rs. 140357 ha^{-1}), net monetary returns (Rs. 86912 ha^{-1}) with B:C ratio (2.63). Based upon the above findings, it is concluded that T_6 - Direct sowing of rice with 'Modified Direct Seeded Rice Technique' (MDSRT) or transplanting of rice with T_7 - University recommended method (Four Point Agro-technology) are advisable for obtaining higher yield, net monetary returns and benefit: cost ratio in paddy.

Key words : Planting Methods, Paddy,Economics,Direct Seeded Rice, SRT, Char Sutri.

Rice (*Oryza sativa* L.) is one of the most ancient crops being cultivated in 117 countries, hence called as "Global grain". It is the staple cereal food grain of majority of India's over one billion population, contributes to nearly 44 per cent of total food grain production. Rice feeds more people over a longer period of time than any other crop. Rice has been documented in the history books as a source of food and for tradition as well since 2500 B.C. Beginning in China and the surrounding areas, its cultivation spread throughout Sri Lanka and India. Globally, rice is cultivated in 154 million ha area with an annual production of around 426 million tonnes with average productivity of 2.76 t ha^{-1} (Jagtap *et al*., 2019).

In India, it is being cultivated in 44.6 million hectares with a production of about 109.5 million tonnes. In Maharashtra, rice is the second important crop of the people, which is grown over an area of 14.99 lakh hectares with an annual rough rice production of 32.37 lakh tonnes. The average productivity of the state is 2.01 t ha^{-1}. Maharashtra ranks 13th place in rice production in country. The average productivity

1. Assistant Professor, 2. Associate Professor, 3. M. Sc. Agri. Scholar and 4. Ph. D. Scholar.

of the Maharashtra state is low as compared to other rice growing states *viz*. Punjab, Tamil Nadu, Haryana, Andhra Pradesh etc.Global demand for food is rising because of population growth, increasing affluence and changing dietary habits. The UN/FAO forecasts that global food production will need to increase by over 40 per cent by 2030 and 70 per cent by 2050.

The production of conventional puddle transplanted rice faces severe constraints because of water and labour scarcity and climatic changes (Pathak *et al*., 2011). Imminent water crisis, water-demanding nature of traditionally cultivated rice and climbing labour costs ramble the search for alternative management methods to increase water productivity, system sustainability and profitability. Direct seeded rice (DSR) technique is becoming popular nowadays because of its low-input demanding nature. It offers a very exciting opportunity to improve water and environmental sustainability. It is a feasible alternative to conventional puddled transplanted rice with good potential for saving water, mitigating greenhouse gas emissions and adapting to climatic risks and the yield can be comparable with that of transplanted rice if the crop is properly managed (Kumar and Ladha, 2011). It involves sowing pre-germinated seeds into a puddle soil surface (wet seeding), standing water (water seeding) or dry seeding into a prepared seedbed (dry seeding). Recently there is trend towards direct seeded rice because of labour and water scarcity. Although the development of suitable varieties and agronomic packages for promoting direct-seeded rice is under way (Pathak *et al*., 2011), so far no variety has been developed that possess traits specifically needed to high yield under dry direct-seeded conditions, particularly for rainfed systems that may be prone to drought and low fertility. (Muhammad, A. I., 2014)

Resilient practice : Researchers have developed suitable drilled paddy alternatives to transplanted paddy. In drilled paddy cultivation, raising of nursery for transplantation is done away with. The farmer can avoid the major problem faced i.e.,labour shortage for transplanting due to peak demand. In case of delay in monsoon or shortage of water, a drilled paddy gives the farmer flexibility to take up direct sowing of paddy with a suitable duration variety to fit into the left over a season. Drilled paddy consumes relatively less water compared to transplanted flooded rice. Energy demand for pumping of irrigation water is also less and saving can be much higher during deficit rainfall situations compared to transplanted rice. Direct sowing can be practiced for cultivating both coarse rice and basmati rice wherever feasible. (Singh *et al*., 2014) Drilled paddy with reduced tillage is an efficient resource conservation technology that holds great promise in the Indo-Gangetic Plain because of the following advantages.

- Saving in water up to 25% in DSR
- Saving in energy up to 27% of diesel as pumping energy is saved
- Saving of 35-40man days / ha
- Enhanced fertilizer use efficiency due to the placement of fertilizer in the root zone
- Reduction in methane emissions and global warming potential
- Little disturbance to soil structure
- Enhanced system productivity

Agronomic manipulations viz., planting geometry, density may be advantageous for achieving the potential yield of paddy. The optimum planting geometry differed for different planting methods. Hence, determination of suitable establishment method for harnessing the potential yield of different paddy varieties needs

the critical investigations. On the other hand, non-availability of irrigation water, insufficient labour and high wages during the peak period of farm operation invariably delay planting of paddy. To mitigate this problem, many rice farmers are switching to direct seeding of paddy. Direct seeding can reduce the labour requirement, may reduce methane gas emission, shorten the duration of crop by 7 to 10 days and provide comparable grain yield to transplanting (De Datta, 1986).

Materials and Methods

The field experiment was conducted during *Kharif*, 2020 at Agricultural Research Station Farm, Vadgaon Maval, Tal. Maval, Dist. Pune. to study the effects of planting methods on growth attributes and yield of paddy (*Oryza sativa* L.)". The soil of experimental field was clay loam in texture, moderately alkaline in reaction (pH 7.74) with low available nitrogen (239 kg ha^{-1}), medium available phosphorus (16 kg ha^{-1}) and high available potassium (389 kg ha^{-1}).

The experiment was laid out in Randomized Block Design (RBD) with eight treatments and three replications. The paddy variety VDN-99-29 (Phule Samruddhi) is cultivated using eight methods *viz*., T_1 - Sowing as direct seeded rice (DSR) at 22.5 cm by bullock drawn seed drill, T_2 - Sowing as direct seeded rice (DSR) at 30 cm by bullock drawn seed drill, T_3 - Sowing by dibbling method at 20 x 15 cm^2, T_4 - Direct sowing of rice by tractor operated mechanical seed drill, T_5 - Direct sowing of rice by 'Saguna Rice Technique'(SRT), T_6 - Direct sowing of rice by 'Modified Direct Seeded Rice Technique' (MDSRT), T_7 - University recommended method (Four Point Agro-Technology or Char Sutri Method) and T_8 - Farmer's practice-Conventional transplanting method. The gross plot size was 3.60 m x 3.00 m and net plot size was different as per treatments.

RDF of 100:50:50 NPK Kg ha^{-1} was applied during conduct of experiment. Out of which half dose of N and full dose of P and K are applied as basal dose at the time of sowing i.e., 50:50:50 NPK kg ha^{-1}. While remaining dose of N is split into two and applied after each hand weeding. For the treatments T6-Direct sowing of rice 'Modified Direct Seeded Rice Technique' (MDSRT) and T7-University recommended method (Four Point Agro-Technology), the N and P fertilizers are given through 170 kg Urea-DAP briquettes (60:30:00) and 50 kg K2O as straight fertilizer per hectare. Gap filling was done at 15th days after sowing, two manual weedings were done throughout the rice growing period.

Details of cultivation methods of some treatments

Direct sowing of rice by 'Saguna Rice Technique' (SRT) : Raised beds are made of 1m breadth with 8-10cm height. Rack of 1 m x 1m is placed on bed having iron pegs at 25 cm distance is placed on bed and pressed to make holes. Three seeds per hole are placed and covered carefully. Fertilizer Dose- 100:50:50 kg NPK ha^{-1}.

Direct sowing of rice by 'Modified Direct Seeded Rice Technique' (MDSRT) : Raised beds of 1 m breadth with 8-10 cm height are made. Marking is made with help of rope and wooden rod at distance of 15-25 x 15-25 cm^2. Two seeds per hole are dibbled and covered carefully. Then Urea DAP briquettes placed in the square of 15-15 cm. N and P applied through Urea DAP briquettes (60:30:0) + 50 kg K_2O ha^{-1}.

University recommended method (Four Point Agro-Technology or Char Sutri Method)

1. Use of paddy crop residues containing silicon for recycling (Black grey rice hull ash @ 0.5

to 1.0 kg m^{-2}) to rice seedlings and paddy straw @ 2 tonnesha^{-1} at the time of transplanting.

2. Application of Gliricidia as green manure @ 3 tonnes ha^{-1} at the time of transplanting.

3. Controlled transplanting of improved varieties at the spacing of 15-25 x 15-25 cm^2.

4. Use of Urea DAP briquettes (170 kg ha^{-1}). N and P through Urea DAP briquettes (60:30:0) + 50 kg K_2O ha^{-1}.

For recording growth observations, five plants were selected randomly from each net plot. The selected plants were labeled and were marked by fixing pegs near them. All the observations on growth and yield were recorded on these plants. The crop from each net plot was harvested separately at maturity, labeled and tied in bundles according to treatments. The produce of each plot was threshed separately and weight of grain and straw taken separately. The experimental data was statistically analyzed by using analysis of variance in the randomized block design (RBD) (Panse and Sukhatme, 1985).

Result and Discussion

Plant count : The data pertaining to plant count per hectare of paddy as influenced by different treatments is presented and discussed in this chapter.

Initial plant count : The data regarding the initial plant count at 14 days after sowing per plot is presented in Table 1. The mean initial plant count per plot of paddy was 317901 plants. It was observed that the initial plant count was affected significantly due to the different planting methods of paddy. As there were different planting methods having different spacing under studies, it showed variation in plant population per plot. The highest initial plant population per plot (247531) is observed in the treatment T_8 - Farmer's practice-Conventional transplanting method as no specific distance is used by the farmers for transplanting the seedlings which was significantly superior over rest of all the treatments. Due to this more number of seedlings per plot was observed. The lowest numberof seedlings per plot (156790) was observed in the treatment T_5 - Direct sowing of rice by 'Saguna Rice Technique' (SRT).

Final plant count : The data from Table 1

Table 1. Initial and Final Plant Count Per Hectare of Paddy asAffected by Different Treatments

Treatments	Plant count ha^{-1}	
	Initial	Final
T_1 - Sowing as direct seeded rice (DSR) at 22.5 cm by Bullock drawn seed drill	431481	422852
T_2 - Sowing as direct seeded rice (DSR) at 30 cm by Bullock drawn seed drill	324691	318198
T_3 - Sowing by dibbling method at 20 x 15 cm^2	327160	323889
T_4 - Direct sowing of rice by tractor operated mechanical seed drill	323148	316685
T_5 - Direct sowing of rice by 'Saguna Rice Technique' (SRT)	156790	155222
T_6 - Direct sowing of rice by 'Modified Direct Seeded Rice Technique' (MDSRT)	247531	246293
T_7 - University recommended method (Four Point Agro-technology)	484877	475179
T_8 - Farmer's practice-Conventional transplanting Method	247531	245056
S. Em.±	1220	1201
C.D. at 5%	3700	3647
General Mean	317901	312922

revealed that the final plant count per plot of paddy was affected significantly due to different planting methods of paddy. The mean final plant count per plot of paddy was 312922 plants. The highest final plant population per plot (245056) is observed in the treatment T8-Farmer's practice-Conventional transplanting method as no specific distance is used by the farmers for transplanting the seedlings. Due to this more number of seedlings per plot was observed. The lowest plant count per plot (155222) was observed in the treatment T_5 - Directsowingofriceby'SagunaRice Technique' (SRT).

Economic studies : Economics of paddy as influenced by different treatments in respect of the gross monetary returns, net monetary returns and B:C ratio are presented in Table 2.

Gross monetary returns (Rs. ha^{-1}) : The data is presented in Table 2. The gross monetary returns of different treatments were significantly influenced by planting methods. The sowing of paddy with the treatment T_6 - Direct sowing of rice by 'Modified Direct Seeded Rice Technique' (MDSRT) recorded significantly highest gross monetary returns (Rs. 160884 ha^{-1}) than the rest of all cultivation methods. It was at par with the treatment T_7 - University recommended method (Four Point Agro- technology) having gross monetary returns (Rs. 140357 ha^{-1}), T_3 - Sowing by dibbling method at 20 x 15 cm^2 having gross monetary returns of (Rs. 133557 ha^{-1}) and T_4 - Direct sowing of rice by tractor operated mechanical seed drill having gross monetary returns of (Rs. 130125 ha^{-1}).

The lowest gross monetary returns were recorded in treatment of T_8 - Farmer's practice-Conventional transplanting method (Rs. 65280 ha^{-1}).

Net monetary returns (Rs. ha^{-1}) : The data is presented in Table 2. The net monetary return was significantly influenced by various cultivation methods. The treatment T_6 - Direct sowing of rice by 'Modified Direct Seeded Rice Technique' (MDSRT) recorded significantly higher net monetary returns (Rs. 109782 ha^{-1}) than the rest of all other treatments but it was found at par with the T_7 - University recommended method (Four Point Agro-technology) having net monetary returns (Rs. 86912 ha^{-1}). Whereas, the minimum net monetary returns was recorded with treatment

Table 2. Gross monetary returns (Rs. ha^{-1}), net monetary returns (Rs. ha^{-1}) and benefit: cost ratio of paddy as affected by different treatments

Treatments	Gross monetary returns (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	B:C ratio
T_1 - Sowing as direct seeded rice (DSR) at 22.5 cm by Bullock drawn seed drill	123446	54005	69441	2.29
T_2 - Sowing as direct seeded rice (DSR) at 30 cm by Bullock drawn seed drill	126269	52855	73414	2.39
T_3 - Sowing by dibbling method at 20 x 15 cm^2	133557	54805	78752	2.44
T_4 - Direct sowing of rice by tractor operated mechanical seed drill	130125	55985	74140	2.32
T_5 - Direct sowing of rice by 'Saguna Rice Technique'(SRT)	123274	55947	67327	2.20
T_6 - Direct sowing of rice by 'Modified Direct Seeded Rice Technique' (MDSRT)	160884	51102	109782	3.15
T_7 - University recommended method (Four Point Agro-technology)	140357	53445	86912	2.63
T_8 - Farmer's practice-Conventional transplanting Method	65280	52264	13016	1.25
S. Em.±	7367	-	7367	-
C.D. at 5%	31018	-	31018	-
General Mean	125399	53801	71598	2.33

T_8 - Farmer's practice-Conventional transplanting method (Rs. 13016 ha^{-1}).

B:C ratio : The B:C ratio was significantly influenced by the cultivation methods. The treatment T_6 - Direct sowing of rice by 'Modified Direct Seeded Rice Technique' (MDSRT) recorded highest B:C ratio (3.15) than rest of all the treatments. The second best treatment was T_7 - University recommended method (Four Point Agro- technology) (2.63). The lowest B:C ratio observed in T_8 - Farmers practice-Conventional transplanting method (1.25).

The higher values of net monetary returns and benefit cost ratio were obtained with direct sowing of rice by 'Modified Direct Seeded Rice Technique' (MDSRT) (T_7) owing to less tillage operations, less labour requirement and higher grain and straw yield. Whereas, minimum net monetary returns and benefit cost ratio were recorded with T_8 - Farmer's practice-Conventional transplanting method. Similar results were observed by Nirmala *et al*. (2016).

Conclusion

Based on the present investigation, it is concluded that, the highest gross monetary returns, net monetary returns and B:C ratio were obtained through T_6 - Direct sowing of rice with 'Modified Direct Seeded Rice Technique' (MDSRT) followed by transplanting of rice with T_7 - University recommended method (Four Point Agro- technology). Thus, from economic and labour constraint point of view, direct sowing of rice with 'Modified Direct Seeded Rice Technique' (MDSRT) or transplanting of rice with university recommended method (Four Point Agro- technology) are advisable.

Acknowledgement

The authors are thankful to Agronomy Section, College of Agriculture, Pune- 411005, Maharashtra, India and Agricultural Research Station Farm,Vadgaon Maval, Tal- Maval,Dist - Pune for providing necessary facilities to undertake the field experiment.

References

DeDatta, S. K. 1986. Technology development and the spread of direct seeded flooded rice in South East Asia. Fertilizer Research 9:171-186.

Jagtap, D. N., Mahadkar, U. V., and Chavan, L. S. 2019. Productivity and economics of rice influenced by different crop establishment methods and fertilizer sources. Agricultural J.7(1): 32-36.

Kumar, V. and Ladha, J. K. 2011. Direct seeding of rice: recent developments and future research needs. Advances in Agronomy. 111: 297-413.

Muhammad, A. I. 2014. Productivity and Quality of Direct Seeded Rice under Different Types of Mulches and Planting Patterns: A Review. American-Eurasian Journal of Agricultural and Environmental Science. 14(11): 1240-1247.

Nirmala, B., Waris, A. and Muthuraman, P. 2016. Direct Seeded Rice: An impact analysis in tungabhadra command area of Karnataka. Indian Resource Journal of Extension Education. 16(2): 56-68.

Panse, V. G. and Sukhatme, P. V. 1985. Statistical methods for Agriculture work. ICAR, New Dehli. 145-156.

Pathak, H., Tewari, A. N., Sankhyan, S., Dubey, D. S., Mina, U., Singh,V. K., Jain, N. and Bhatia, A. (2011). Direct-seeded rice: Potential, performance and problems - A review. Current Advances in Agricultural Sciences. 3(2): 77-88.

Singh, H., Buttar, G. S., Brar, A. S. and Deol, J. S. 2017. Crop establishment method and irrigation schedule effect on water productivity, quality, economics and energetic of aerobic direct-seeded rice (*Oryza sativa* L.) Paddy Water Environment. 15: 101-109.