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Performance of Paddy Cultivation under Different Methods in South-Western Part of Punjab, India

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ABSTRACT

To find out the most appropriate method of paddy sowing in Ferozepur district, a field experiment was conduct with different sowing methods at three locations including direct seeded, bed transplanting and mechanical rice transplantation. The maximum grain yield was found in conventional (80.67 q/ha) followed by, mechanical transplanted (78.35 q/ha), bed transplanted 24 plants per m^2 (71.96 q/ha) sowing method as compared to DSR (77.40 q/ha). However, the ratio of benefit-cost was higher by direct seeded rice method (4.42:1) as compared to mechanical transplanted method (3.35:1), bed transplanted method (2.63:1) and conventional transplanted method (2.88:1). Higher Benefits cost ratio of direct seeded rice method was due to its lesser cost of field preparation, labour saving and water saving as compared to conventional method of sowing. The better net return obtained from direct seeded rice method Rs. 107881.94/ha as compared to mechanical transplanted method (Rs. 98975.00), conventional transplanted method (Rs. 94777.78/ha) and bed transplanted method (Rs. 80286.11/ha). Although the grain yields under conventional method of sowing was higher but it was unsuccessful to produce better net return and benefits of cost ratio. Direct seeded rice method provided timely sowing operation with better net return of paddy in Punjab.

INTRODUCTION

Main cropping structure of Indo-Gangetic Plains is Rice (*Oryza sativa* L.) and Wheat (*Triticum aestivum* L.) and also of the Punjab. However, productivity of rice and wheat has declined owing to climate variation and abbreviated soil productivity, affected the sustainability of the rice-wheat cropping structure (Ladha et al., 2009). Low ranks of soil organic matter, over mining from soil and crop residues burning are some of the major causes for decreasing rice-wheat productivity in the region (Singh and Sidhu, 2014). Almost 19 per cent of the wheat and 11 per cent of paddy production in India arises only from Punjab, which accounts for only 1.5 per cent of the geographical area of the country. Thus, Punjab also recognized as the 'Granary of India' has carried a great responsibility in promising the food security for the nation. However intensive agricultural practices have led to the degradation of natural resources like soil, water, and air. Disorganized pumping of under-ground water in Punjab diagonally the past few decades has in risk of destruction the sustainability of not only the ecosystem but also of the tilling of rice crop. The share of water for agriculture is declining very fast because of the increasing population, lowering of the water table, declining water quality, inefficient irrigation systems, competition with non-agricultural sectors. At present, irrigated agriculture accounts for 70 and 90 per cent of total freshwater withdrawal globally and in Asia, respectively (Molden et al., 2007). In the major rice-growing Asian countries, per capita water availability reduced by 34-76 per cent between 1950 and 2005, and is likely to decline by 18-88 per cent by 2050. In Asia, the share of water in agriculture declined from 98 per cent in 1900 to 80 per cent in 2000, and is expected to further decline

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to 72 per cent by 2020 (Kumar et al., 2011). It was reported that the ground water is declining by 0.6 m per year in Punjab (Hira et al., 2004) and in addition to the water-stress, agricultural practices such as extensive and imbalanced use of chemicals and fertilizers have deteriorated the soil fertility and ground water quality. Residue burning is another problem which has not only resulted in soil fertility loss but also contributed to severe air pollution thereby leading to global warming. Direct seeding with zero till drill technology is one such practice that possibly addresses the issues of water, labor, soil health etc. (Malik et al., 2005; Gupta and Sayre, 2007; Jat et al., 2009; Gathala et al., 2011; Jat et al., 2013). Similarly inclined plate metering mechanism is capable of direct seeded rice without nursery preparation also puddled field preparation. Mechanization is crucial for improving rice production. The DSR method can be suitable and applicable in the state of Punjab, where labor wages are higher than those in other states (Kumar and Ladha, 2011). The established technologies, which fundamentally require less water, and are more effective in water use are demanded by the grim water scenario in agriculture together with the highly inefficient traditional transplanting system. Both methods of DSR (Dry and Wet) are more water efficient, and have an advantage over conventional transplanting (Tabbal et al., 2002). However, with increasing shortage of water, Dry-DSR with minimum or zero tillage (ZT) further enhances the benefits of this technology by saving labour. Direct Seeded Rice should be promoted, and enhance farmer capability and improve resilience in response to climate change (Brar et al., 2020). Objective of the study was to work out the comparative returns in different sowing tillage practices of rice.

METHODOLOGY

A field experiment was conducted during *kharif* 2018-2020 in three villages Malwal, (Block: Ghal Khurd); Dhana Sahid and Boole (Block: Zira) District of Ferozepur (Punjab), to find out the most appropriate method of paddy cultivation technology after wheat crop in Ferozepur district of Punjab state. The area is characterized by Semi-arid, arid type of climate with hot and dry early summers from April June followed by hot and humid period during July September and cold winters during December-January. The annual rainfall of the area is 430.7 mm, most of which is received during July to September (Anonymous, 2018).

The experiment was laid out in randomized complete block design with three locations. In the area combine harvesting of rice and wheat is now a common practice leaving large amount of residues in the fields. Farmers generally burnt the rice residue onto their fields to get rid of it and to ensure timely sowing of the wheat crop as delayed sowing decreases the final grain yields (Singh and Sidhu, 2014). Wheat was grown as the previous rabi crop in these experimental plot during all the three years. To find out the solution of this problem field experiment was carryout with four sowing methods *viz.* T1 = Conventional method (Manual Transplanting), T2 = Bed Transplanting (24 plants per m^2), T3 = Mechanical Transplanting and T4 = Direct Seeded Rice (DSR)

The variety PR-114 were transplanted in the second fortnight of June and for DSR technology also PR-114 variety sown last week of May. Crop was harvested in the month of October according to the maturity of the variety during all the study period of three years. All the other agronomic practices (Kumar et al., 2021) recommended by PAU, Ludhiana were adopted. The data on number of effective tillers per square meter, plant height, number of grains per panicle, 1000 grain weight and grain yield were collected through field observations. Collected data were further analyzed by using randomize block design. Economic analysis was done by calculating the gross income considering the market rates of paddy and straw. Varying cost of all the sowing methods were added in each treatment. Net income was calculated by formula as a difference of gross income and variable cost. Cost Benefit Ratio (CBR) was calculated by dividing gross income (Kumar and Meena, 2021) by total cost of production. The data obtained were subjected to analysis of variance technique by using SPSS software and means were separated by LSD test (Steel et al., 1997).

RESULTS AND DISCUSSION

Growth and yield

Among the all sowing technologies failed to create any significant product on the plant height of the paddy crop (Table 1). However, the effective tillers per square meter were significantly higher among the planting method of hand transplanting (447.00), which was statistically at par with mechanical transplanting (441.78) and DSR (435.33) technology. The lower effective tillers were obtained with bed transplanting (427.67) method. The number of grains per ear was significantly superior in conventional method (151.89) which was statistically at par with mechanical transplanting (148.78) and DSR technology (146.00) but significantly differed with bed transplanting (135.67) method. Whereas, the 1000 grain weight was non-significantly higher with the incorporation treatment and conventional method treatment from the treatment zero tillage method (Table 1).

Among the different planting methods maximum grain yield was obtained with the conventional method (80.67 q/ha), mechanical transplanting method (78.35 q/ha) and DSR method (77.40 q/ha) which was significantly higher from bed transplanting (71.96 q/ha). DSR will provide a better option for management of water resources in rice-wheat cropping system. Though the grain yield obtained by DSR was significantly comparable with conventional transplanting, mechanical transplanting and bed transplanting.

Cost benefit ratio and economics

Among the entire different paddy sowing technologies the maximum gross return was obtained with the conventional transplanting (Rs. 145261.11) technology followed by mechanical transplanting (Rs. 141083.33), DSR technology (Rs. 139365.28) and bed transplanting (Rs. 129519.44). Gross returns among sowing technology were higher due to higher grain yield obtained. The net return was maximum in DSR technology (Rs. 107881.94) followed by mechanical transplanting (Rs. 98975.00) and conventional transplanting (Rs. 94777.78) from the bed transplanting (Rs. 80286.11). Higher net return with DSR technology was due to its lesser cost of cultivation (Rs. 31483.33) as compared to conventional transplanting (Rs. 50483.33). Lowest net return was also obtained with the bed transplanting (Rs. 80286.11). However,

Table 1. Year Wise effect of different technologies on yield parameters

Technology	Year	Yield Component				
		Plant height (cm)	Effective tillers/m^2	No. of grains /panicle	1000 grain wt (g)	Grain yield (q/ha)
Conventional transplanting	2018	105.38	417.00	149.56	24.90	78.75
	2019	105.40	441.00	151.56	24.95	80.83
	2020	105.42	469.00	153.56	25.00	82.42
	Average	105.40	442.33	151.56	24.95	80.67
Bed type transplanting	2018	104.97	408.78	133.78	24.72	72.50
	2019	104.99	432.78	135.78	24.77	71.72
	2020	105.00	460.78	137.78	24.82	71.67
	Average	104.99	434.11	135.78	24.77	71.96
Mechanical transplanting	2018	105.09	414.00	144.33	24.78	76.83
	2019	105.11	438.00	146.33	24.83	78.39
	2020	105.14	466.00	148.33	24.88	79.83
	Average	105.11	439.33	146.33	24.83	78.35
Direct seeded rice (DSR)	2018	104.98	415.00	144.11	24.67	76.25
	2019	105.02	439.00	146.11	24.72	76.78
	2020	105.05	467.00	148.11	24.77	79.17
	Average	105.01	440.33	146.11	24.72	77.40
SEm	2018	0.029	7.861	4.896	0.021	3.906
	2019	0.037	7.754	4.762	0.020	5.059
	2020	0.032	7.932	4.981	0.022	2.969
	Average	0.033	7.849	4.880	0.021	3.978
Sig. ($p<0.05$)	2018	9.830	NS	NS	NS	15.776
	2019	9.327	NS	NS	NS	26.396
	2020	11.259	NS	NS	NS	64.721
	Average	10.139	NS	NS	NS	35.631

Table 2. Cost benefit ratio of different sowing methods of paddy

Technology	Year	Total cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Cost benefit ratio (Rs/ha)
Conventional transplanting	2018	49650.00	137812.50	88162.50	2.78
	2019	50050.00	145500.00	95450.00	2.91
	2020	51750.00	152470.83	100720.83	2.95
	Average	50483.33	145261.11	94777.78	2.88
Bed type transplanting	2018	48400.00	126875.00	78475.00	2.62
	2019	48800.00	129100.00	80300.00	2.65
	2020	50500.00	132583.33	82083.33	2.63
	Average	49233.33	129519.44	80286.11	2.63
Mechanical transplanting	2018	41275.00	134458.33	93183.33	3.26
	2019	41675.00	141100.00	99425.00	3.39
	2020	43375.00	147691.67	104316.67	3.40
	Average	42108.33	141083.33	98975.00	3.35
Direct seeded rice (DSR)	2018	30650.00	133437.50	102787.50	4.35
	2019	31050.00	138200.00	107150.00	4.45
	2020	32750.00	146458.33	113708.33	4.47
	Average	31483.33	139365.28	107881.94	4.42

the benefit cost ratio was higher with DSR technology (4.42:1) as compared to mechanical transplanting (3.35:1), conventional transplanting (2.88:1) and bed transplanting (2.63:1). Higher B: C ratio with DSR technology was also due to its lesser cost of cultivation as compared to mechanical transplanting and conventional method of paddy sowing (Table 2).

CONCLUSION

DSR technology provided the facility of paddy sowing against without puddled condition. This technology is also time savings because the DSR can be brought into the field immediately and is environment friendly. Among the different planting methods maximum grain yield was obtained with the conventional, mechanical and DSR as compared to bed transplanting. Whereas, higher B: C ratio was obtained by DSR as compared to conventional, mechanical and bed transplanting due to its lesser cost of cultivation as well as maintenance. Thus DSR can play an important role in retaining water and environmental health in Punjab.

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