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Evaluation of direct-seeded rice drill against Japanese manual transplanter for higher productivity in rice

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ABSTRACT

A field experiment was conducted during 2009 at Ludhiana to test the performance of direct-seeded drill against manual transplanter. Four treatments were evaluated, viz T_1, direct-seeded drill with adjustment of 30 kg/ha seed rate, T_2, direct-seeded drill with adjustment of 15 kg/ha seed rate, T_3, drum-seeded puddled transplanted rice with seed rate of 50 kg/ha, T_4, transplanting with Japanese manual transplanter. Grain yield found to be highest in T_4 treatment (7.85 tonnes/ha), followed by T_1 (7.8 tonnes/ha), T_2 (7.2 tonnes/ha) and T_3 treatments (6.1 tonnes/ha), respectively. However, it was found statistically same in T_1, T_2 and T_4 treatments. Grain yield in drum-seeded puddled transplanted rice decreased due to poor crop establishment which favoured more crop-weed competition at the early stage caused reduction in panicles/m^2 and 1 000-grain weight. Yield attributes were also found statistically same in T_1, T_2 and T_4 method. In direct seeded crop, T_1 showed more superiority than T_2 treatment revealed that 30 kg/ha seed rate in direct-seeded drill is optimum which favoured better plant growth, especially at the early stage due to having smothering effect on weeds.

Key words: Direct-seeded drill, Drum Seeder, Transplanting, Panicles

In many parts of Punjab, water is increasingly becoming scarce. Poor quality irrigation systems and greater reliance on groundwater have led to decline of water-table. Non-development of groundwater in rainy (*kharif*) season, late onset of monsoon and drudgery of operations often delays rice (*Oryza sativa* L.) transplanting which leads to late vacation of fields, forcing farmers to plant wheat after the optimum sowing time (Singh *et al.* 2005). Transplanting operations are usually done by migratory labour, which has an element of seasonality and thus becoming a serious concern for timely transplanting of rice and maintaining a plant population sufficient to achieve the higher rice productivity (Gupta *et al.* 2006). Rice production systems are undergoing various changes, one of which is a shift from transplanting to direct seeding as farmers seek alternatives to offset increasing costs. The main driving force for this changes are the rising wage rates, scarcity of labour and at the same time, the availability of option to manage weeds in direct-seeded rice (Mahajan *et al.* 2009). Direct-seeded rice occupies 26% of the total rice area in South Asia (Gupta *et al.* 2006). Direct seeding of rice avoids puddling and does not need continuous submergence and thus reduces the overall water demand for rice culture. With this objective, research is underway to develop direct-seeded drill that can give proper plant stand. Fluted roller-type seed-cum-fertilizer drills do not facilitate maintaining spacing between the plants and these drills often damage the rice seed coats. Therefore, to maintain spacing between the plants and reduce seed rate, the use of planters having inclined plate devices or a cupped metering system is best. Recently, a direct-seeded rice drill was developed at Punjab Agricultural University, Ludhiana. Hence, the present study was undertaken to evaluate the direct-seeded rice drill against the Japanese manual transplanter.

MATERIALS AND METHODS

A field experiment was conducted at the research farm of Punjab Agricultural University during rainy (*kharif*) season of 2009 to test the performance of direct-seeded drill against Japanese manual transplanter. The drill had inclined plate seed metering mechanism with notched cells and had 9 furrow openers. Japanese manual transplanter is a self-propelled, walk behind type, 4-row machine operated by a 3.2 kW petrol engine. The machine consisted of an engine, power transmission system, handle for operation, main frame

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Figs 1–3 **1.** A view of direct seeded rice drill having inclined plate seed metering mechanism; **2.** A view of Japanese paddy transplanter; **3.** A view of drum seeder

and rice transplanting tray, float and 2 pairs of transplanting units. It has only 2 lugged wheels and the weight of the machine rests on the lugged wheel and float at the time of transplanting. The same lugged wheels were used for transportation. Power from the engine is transmitted to front traction wheels through gear train and to the transmission housing of transplanting unit through universal shaft. A view of direct-seeded drill and Japanese manual transplanter is shown in Figs 1, 2 and brief specifications of the direct-seeded drill and manual transplanter are given in Tables 1, 2 respectively.

Drum seeder (Fig 3) consisted of 2 seed drums mounted on a shaft, a drive wheel in the centre, frame, 2 float and a handle. The shaft was provided with 2 grooved rollers in each drum for agitating the sprouted seeds and dropping the seeds from the openings uniformly. Drum diameter was 16 cm and 3 rows of holes at a distance of 20 cm were drilled on the circumference of each drum for the dropping of sprouted seeds. Two seed filling openings, one on each drum was provided for filling the seeds in the drum. Each float base was provided with 3 V-shaped furrow openers at a distance of 20 cm for making about 2 cm deep depression in the puddle field. Six seed guide chutes above the furrow opener was also provided on the frame to guide the seed to drop in the furrows. Brief specifications of the drum seeder are given in Table 3.

Four treatments T_1 (direct drilling @ 30 kg/ha), T_2 (direct drilling @ 15 kg/ha), T_3 (drum seeding), T_4 (Japanese manual transplanter) was compared in randomized block design replicated thrice. Direct drilling was done on 11 June 2009 and on the same day 20-days-old 'PAU 201' seedling was transplanted with Japanese transplanter in the field. Direct drilling in T_1 and T_2 treatment was done in dried soil and after drilling irrigation was given immediately. Drum seeding and transplanting was done after puddling in the respective plots. In T_1 and T_2 treatment, sequential application of herbicides pendimethalin 1 kg/ha (3 days after sowing), followed by Bispyribac-Na 30 g/ha (18 days after sowing) was used for weed control.

In drum-seeded and transplanted crop only one herbicide Bispyribac-Na (30 g/ha) was used for weed control at 18 days after sowing. In T_3 and T_4 treatments water was kept standing

Table 1 Brief specifications of direct-seeded drill

Parameter	Specification
Type	Tractor-operated mounted type
Power required (hp)	35 or above
Transmission system	Chain and sprocket
No. of rows	9
Row to row spacing (cm)	20
Type of furrow opener	Inverted T type
Type of seed metering mechanism	Inclined plate

Table 2 Specifications of Japanese walk behind type paddy transplanter

Parameter	Specification
Type of machine and make	Self-propelled walk behind/ Kubota
Model	NSP-4W
Engine type	
No.	MZ 175-B-1
Fuel	Petrol (4 cycle OHV gasoline engine)
Type of cooling	Air
Horse power	3.2 kW @ 3000 rpm
Type of steering	Handle type
No. of gear	Forward 1 Reverse 1
Number of rows	4
Row to row spacing (cm)	30
Plant-to-plant spacing (cm)	12, 14, 18, 21 (four settings)
Planting mechanism path	Oblique
Type of planting finger	Plate bar with notch
Material of tray	Plastic
Type and material of traction wheel	2 Iron wheel with rubber lugs
Float type	
Material	Plastic
Type	Split bars

Table 3 Specifications of manually-operated drum type paddy seeder

Parameter	Specification
Type of machine	Manually operated
Overall dimensions (cm)	165 × 122 × 86
Power source	One person
Type and no. of wheels	Cage wheel type / 1
Diameter of wheel (cm)	55
Working width (cm)	90
Row-to-row spacing (cm)	20
No. of rows	6
Diameter of drum (cm)	16
Capacity of each drum (kg)	2
No. of holes/line	10
Hole to hole spacing (cm)	5
Diameter of the holes (mm)	10
Weight of the machine (kg)	13

during first 15 days and thereafter irrigation was applied at 2 days interval.

In T_1 and T_2 treatment, during first 15 days only 3 irrigations were applied and thereafter irrigation was done at 2 days interval. At physiological maturity, panicles/m^2 were recorded with the help of a quadrant (0.8 m × 0.8 m) placed randomly at 2 spots in each plot. At the same time 5 hills were selected randomly from each plot for measuring agronomic characters including 1000-grain weight, total number of grains panicle and spikelet sterility. Plant height was measured by selecting 5 plants randomly in each plot and the data were averaged for each plot. At harvest, rice yield was recorded from 10 m^2 area and adjusted at 14% grain moisture content and then converted into tonnes/ha. Results were statistically analyzed using standard procedure for randomized block design. Means were compared using least significant differences (LSD) at the 5% probability level.

RESULTS AND DISCUSSION

Results in Table 3 revealed that plants in T_4 treatment attained significantly more height as compared to T_3 treatments. In drum seeding treatment, growth of plants was poor because of early crop-weed competition. When weeds were assessed at 18 days after sowing, dry matter accumulation by weeds was more in T_3 treatment as compared to other treatment. It was also observed that germination was patchy in T_3 treatment as compared to other treatments (Table 4). Stagnation of water during germination in T_3 treatment caused mortality of seeds which resulted poor crop establishment. This favoured congenial environment for weeds, as a results weed flourished well in T_3 treatment as compared to other treatments at the initial stages, however latter were controlled with post-emergence application of Bispyribac-Na. Weed dry matter in T_1 and T_2 treatments was found to be less as compared to T_3 treatment. Pre-emergence application of pendimethalin in T_1 and T_2 treatments control most of the weeds at early stage of the crop and further rest of the weeds were controlled when Bispyribac–Na herbicide was applied as post emergence at 18 days after sowing. In T_4 treatment, puddling helped to control most of the weeds at early stages and later with application of Bispyribac–Na, no incidence of weeds was observed. Highest grain yield was found in T_4 treatment (7.8 tonnes/ha), followed by T_1 and T_2 treatment. T_3 treatment registered lowest yield (6.1 tonnes/ha) among all the treatments. Grain yield in T_1, T_2 and T_4 treatment found to be statistically same. It was observed that sink size (grains/m^2) remained statistically same in T_1, T_2 and T_4 treatment, as a results yield did not differ significantly in these treatments. The results are in conformity with the report of (Singh *et al*. 2008), who reported that productivity of the direct-seeded crop is at par with transplanting. Grain yield in T_3 treatment decreased mainly due to less number of panicle/m^2 and lower test weight which resulted in reduced sink size. As T_3 treatment suffered weed competition at early stages, so the growth was poor as

Table 4 Effect of different treatment on initial plant stand, weed dry matter at 15 days after sowing, final plant height, yield attributes and grain yield of rice

Treatment	Parameter								
	Initial plant stand at 15 DAS (plants/m^2)	Weed dry matter at 15 DAS (g/m^2)	Plant height (cm)	Panicle/ m^2	Grain/ panicle	Test wt (g)	Grains/ m^2	Sterility (%)	Grain yield (tonnes/ha)
T_1 Direct drilling 30 kg/ha	81	11.2	100.0	332	162	25.7	53 596	16.5	7.79
T_2 Direct drilling 15 kg/ha	53	19.1	105.3	274	129	25.7	47 630	19.3	7.23
T_3 Drum seeding	25	52.4	89.3	230	173	24.0	29 688	17.0	6.10
T_4 Japanese manual transplanter	32	8.5	111.3	306	198	28.0	60 662	11.6	7.85
LSD (*P*=0.05)	11	22.8	5.2	42	NS	1.8	13 613	NS	1.05

DAS, days after sowing

a result there was poor translocation of photosynthesis at the reproductive stage which resulted into less number of panicles/m^2 and test weight. Benefit : cost ratio for direct-seeded rice was highest at 36.48, followed by drum seeder at 31.23 (excluding additional cost of weedicides) keeping price of 'PAU 201' variety at ₹ 1000/100 kg. Benefit : cost ratio for paddy transplanter was least at 20.40 excluding additional nursery raising cost. It was concluded that direct drilling of rice possible with the direct seeding machine and with 30 kg/ha of seed rate the same yield can be attained as in case of Japanese manual tranplanter. So, direct seeding machine can be used successfully where there is scarcity of labour.

Weed dry matter in direct seeding treatments (T_1 and T_2) was found to be less as compared to drum seeding treatment (T_3). Highest grain yield was found in mechanical transplanting treatment (T_4), followed by T_1 and T_2 treatment. T_3 treatment registered lowest yield among all the treatments.

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