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Performance Evaluation of 4WD Tractor Mounted Paddy Transplanter

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ABSTRACT

The manual rice transplanting method gives the desired result but the labour requirement is very high. High labour demand during the peak transplanting period adversely affects the timeliness of this operation, thereby, reducing the crop yield. The performance of the mechanical transplanters was quite satisfactory and labour requirement is also less even though, to breakeven with the cost of manual operation, the mechanical transplanting would be economical if it is used to cover an area of 28 ha and above per year. The tractor mounted paddy transplanter can be used in paddy transplanting season as an attachment and other time it can used for other agricultural operations. The highest average missing hills, floating hills, buried hills and damaged hills were obtained as 24.3 and 29.3 per cent, 6.1 and 6.5 per cent, 10.1 and 7.5 per cent respectively for P_1G_3 and P_2G_3 PTO and gear combinations due to high rotation speed of transplanting fingers in 3rd forward gear due to transplanting fingers were unable to pick paddy seedlings properly. The highest grain yield was obtained as 6167 kg ha^{-1} for P_1G_2 whereas the lowest grain yield was obtained as 2407 kg ha^{-1} for P_2G_3 of PTO & gear combinations respectively. The highest straw yield was obtained as 16800 kg ha^{-1} for P_2G_1 whereas the lowest grain yield was obtained as 7820 kg ha^{-1} for P_1G_3 of PTO & gear combinations respectively. From the statistical analysis results, It was observed that the optimum hill spacing was obtained by the treatment 2 (P_1G_2) with the spacing of 15.33 cm by transplanted with 4- wheel drive tractor mounted paddy transplanter.

Key words: *Hill Spacing, Paddy transplanter, PTO & Gear combination, 4WD tractor.*

India is the largest grower of rice in the world and it occupies the largest cropped area of 44.2 M ha with a total production of 87.5 Mt and an average productivity of 1.9 t ha^{-1} (Duraisamy *et al.*, 2011 and Manjunatha, 2009). Area under rice in India is about 44.2 M ha with a total production of 106.65 Mt. The manual rice transplanting method gives the desired result but the labour requirement is very high. It is estimated that out of 1780 man-h ha^{-1} required for entire crop production, transplanting alone consumes 320 man-h ha^{-1}. (Pateriya and data, 2012). High labour demand during the peak transplanting period adversely affects the timeliness of this operation, thereby, reducing the crop yield.

The mechanical transplanting of rice is done with self-propelled rice transplanters. Mechanical transplanting requires a special method of raising nursery either in tray or mat type seedlings. The seedling mats were taken and placed on the seedling rack of the paddy transplanter. The machine was operated at low high gear depending upon the type and condition of the field. The performance of the mechanical transplanters was quite satisfactory and labour requirement is also less even though, to breakeven with the cost of manual operation, the mechanical transplanting would be economical if it is used to cover an area of 28 ha and above per year (Manjunatha, 2009). Thus, it is possible to reduce the cost of paddy transplanting by mechanization to almost half the cost of manual transplanting provided the machines are used for their maximum i.e., 90 ha in a year. The available mechanical transplanters were used only in the season other time it was kept ideally moreover, the price of machine is very high and majority of the farmers cannot afford to buy. The tractor mounted paddy transplanter can be used in paddy transplanting season as an attachment and other time it can used for other agricultural operations. Keeping in view of the above facts, the present study was taken up with the following objectives.

i. To evaluate the 4WD tractor mounted paddy transplanter in the field condition.
ii. To investigate the influence of the crop and operational parameters on the efficiency of paddy transplanter.

MATERIALS AND METHODS

The performance evaluation of 4WD tractor mounted paddy transplanter was carried out at Farm Implements and Machinery Scheme, ARI field, Rajendranagar, Hyderabad.

The soil of the experimental site was clay loam soil. A field experiment was laid out in completely randomized design (CRD) in an area of 882 m^2 with plot size 63 x 14 m (L x W) of paddy fields located in Agricultural research institute, Rajendranagar,

Table 1. Specifications of 4 WD 22 hp tractor mounted 8-row paddy transplanter

S. No.	particulars	Specifications
1.	Power source	22 H.P four wheel drive tractor
2.	Number of rows	8
3.	Row to row spacing, cm	24
4.	Optimum Plant to Plant spacing, cm	Oct-15
5.	Type of planting mechanism	crank type
6.	Overall Weight with tractor, kg	750
7.	Weight of planting mechanism without tractor, kg	260
8.	Depth of planting, cm	02-Apr
9.	Type of wheels	Rubber lugged wheels with thick rim
10.	Type of Seedlings	Tray type
11.	Length of planting unit, cm	115
12.	Width of planting unit, cm	192
13.	Height of planting unit, cm	96
14.	Gear box (L x W x H), cm	20 x 12.5 x 26
15.	Type of gears	Spur gear
16.	No. of gears	5
17.	Type of fingers	Fork type
18.	Type of shaft	Telescopic propeller shaft

Hyderabad. In completely randomized design, the treatments were taken as PTO and gear selection i.e., P_1G_1, P_1G_2, P_1G_3, P_2G_1, P_2G_2 and P_3G_3. The paddy field was divided evenly into three main plots for three replications and after each main plot 65 cm spacing was left for irrigation and to provide space for chemical application for plant protection. Each main plot was sub divided evenly into six plots for six treatments and after each sub plot 20 cm spacing was left to provide channel for irrigation. The net area of each sub plot size was 18x1.91m (L x W).

The main field was prepared using common tillage practice, which is first ploughing (primary tillage) twice with cultivator, then puddling and levelling (secondary tillage) was done once with rotavator in 100 mm depth of water with Kubota 4-wheel drive tractor. During the field performance Machine parameters, Operational parameters and Crop parameters were calculated.

Soil bearing seedlings prepared by standard practice of nursery raising were used for the evaluation. The soil bearing seedlings are mostly raised under controlled conditions in seedling boxes or trays and sometimes in special nursery fields. In many cases, seedling boxes contain soil to a depth of 1.5-2.5 cm. seedlings grown in boxes get their roots entangled forming a root-mat. The root-mat, including the seedling, is taken out and placed on the transplanter. In certain cases, however, the seedlings are grown as seedling strips (RNAM test code, 1983). The paddy seed variety of RNR- 15048 was used for preparation of nursery and the plastic trays were used to raise soil bearing seedlings.

The rice seedlings of 21 days were used for transplanting operation and the seedling height at the time of transplanting was 18 cm. The standing water at the time of transplanting was maintained as less than 2 cm (Mohanthy *et al.,* 2010). The tractor was operated in experimental plot with three different load gears at two PTO selections. The specifications of the selected 4-wheel drive tractor mounted paddy transplanter was given in Table 1.

During the field evaluation of 4WD tractor mounted paddy transplanter the machine parameters like operating time for each operation, Speed of operation, Effective field capacity, Theoretical field capacity, Field efficiency, Wheel slip, Field machine index and Fuel consumption were evaluated. Also, the transplanting parameters and crop parameters like hill spacing, number of seedlings per hill, depth of transplanting, missing hills, floating hills, buried hills, damaged hills, standing angle of planted seedlings, grain yield, straw yield and harvest index were evaluated.

RESULTS AND DISCUSSION

The paddy transplanting with 4WD tractor mounted paddy transplanter was done on 18-02-2015 used with 21 days aged nursery. A continuous, turn strips at each end pattern was followed for

transplanting operation and planted in completely randomized design (CRD). The intervel between the puddling and planting was 2 days. The depth of puddling was 16 cm and the depth of water at the time of planting was maintained as 2 cm. Soil bearing seedlings were prepared in trays for transplanting with the machine. The seed required per tray was 130 gm. The height of the seedlings at the time of transplanting was 180 mm.

The field evaluation of 4-wheel drive tractor mounted paddy transplanter was done at FIM scheme, ARI field, Rajendranagar, Hyderabad. The view of paddy transplanting operation with 4WD tractor mounted paddy transplanter is shown in Fig 1.

Fig 1. Testing of 4WD tractor mounted paddy transplanter under actual field condition

The field evaluation of tractor mounted paddy transplanter was operated at 1750 engine RPM based on preliminary trails results with P_1G_1, P_1G_2, P_1G_3, P_2G_1, P_2G_2 and P_3G_3 PTO and forward gear combinations in load selection. The sub plot size for each PTO and gear combination was 34.38 m^2. During the field evaluation, it was observed that the field capacity of the machine was 0.09, 0.12, 0.17, 0.09, 0.12 and 0.17 ha h^{-1} at an average speed of 0.89, 1.08, 1.46, 0.89, 1.14 and 1.50 kmph with the field efficiency of 54.74, 58.25, 60.18, 55.18, 57.38 and 60.47 per cent for P_1G_1, P_1G_2, P_1G_3, P_2G_1, P_2G_2 and P_2G_3 PTO and forward gear combinations respectively. The wheel slip and fuel consumption were observed as 6.7, 9.9, 6.8, 5.7, 13.7 and 8.9 per cent and 1.35, 1.39, 1.34, 1.36, 1.33 and 1.37 l h^{-1} for P_1G_1, P_1G_2, P_1G_3, P_2G_1, P_2G_2 and P_2G_3 PTO and forward gear combinations respectively. The field machine index was obtained as 54.74, 58.25, 60.18, 55.18, 57.38 and 60.48 per cent respectively for P_1G_1, P_1G_2, P_1G_3, P_2G_1, P_2G_2 and P_2G_3 PTO and forward gear combinations. The machine and operational parameters of 4-wheel drive tractor mounted paddy transplanter are given in Table 2.

During the field evaluation, the transplanting parameters like hill spacing, number of seedlings per hill, depth of transplanting, missing hills, floating hills, buried hills, damaged hills and standing angle of planted seedlings were evaluated. During the evaluation, it was observed that the average hill spacing of 10.50, 15.33, 33.73, 6.17, 9.83 and 23.33 cm were obtained at P_1G_1, P_1G_2, P_1G_3, P_2G_1, P_2G_2 and P_2G_3 of PTO gear combinations respectively. The view of various hill spacing's obtained during field evaluation are represented in Fig. 2. The average number of seedlings per hill was obtained as 4.0, 3.33, 3.33, 5.67, 3.0 and 3.33 for P_1G_1, P_1G_2, P_1G_3, P_2G_1, P_2G_2 and P_2G_3 of PTO gear combinations respectively. The depth of transplanting was obtained as 4.83, 4.83, 5.00, 4.83, 4.80 and 4.83 cm for P_1G_1, P_1G_2, P_1G_3, P_2G_1, P_2G_2 and P_2G_3 of PTO gear combinations respectively. The highest average missing hills, floating hills, buried hills and damaged hills were obtained as 24.3 and 29.3 per cent, 6.1 and 6.5 per cent, 10.1 and 7.5 per cent respectively for P_1G_3 and P_2G_3 PTO and gear combinations due to high rotation speed of transplanting fingers in 3rd forward gear due to that the transplanting fingers were unable to pick paddy seedlings properly. During the evaluation the standing angle of planted seedlings were obtained as 82, 83,

Table 2. Machine and operational parameters of 4WD tractor mounted paddy transplanter

Sl. No.	Parameters	Gear and PTO selection					
		P_1G_1	P_1G_2	P_1G_3	P_2G_1	P_2G_2	P_2G_3
1.	Plot area, m^2	34.38	34.38	34.38	34.38	34.38	34.38
2.	Total time taken, h	0.04	0.03	0.02	0.04	0.03	0.02
3.	Speed of operation, kmph	0.89	1.08	1.46	0.89	1.14	1.50
4.	Effective field capacity, ha h^{-1}	0.09	0.12	0.17	0.09	0.12	0.17
5.	Theoretical field capacity, ha h^{-1}	0.17	0.20	0.28	0.17	0.21	0.28
6.	Field efficiency, %	54.74	58.25	60.18	55.18	57.38	60.47
7.	Wheel slip, %	6.70	9.90	6.80	5.70	13.70	8.90
8.	Fuel consumption, l h^{-1}	1.35	1.39	1.34	1.36	1.33	1.37
9.	Field machine index, %	54.74	58.25	60.18	55.18	57.38	60.48

Table 3. Transplanting parameters during field operation

Sl. No.	Parameters	Gear and PTO selection					
		P_1G_1	P_1G_2	P_1G_3	P_2G_1	P_2G_2	P_2G_3
1.	Hill spacing, cm	10.50	15.33	33.73	6.17	9.83	23.33
2.	Row spacing, cm	23.80	23.80	23.80	23.80	23.80	23.80
3.	Number of seedlings per hill	4.00	3.33	3.33	5.67	3.00	3.33
4.	Depth of transplanting, cm	4.83	4.83	5.00	4.83	4.80	4.83
5.	Missing hill, %	7.2	6.5	24.3	7.5	7.3	29.3
6.	Floating hills, %	3.0	3.2	6.1	4.0	3.5	6.5
7.	Buried hills,%	0.53	1.0	3.33	1.2	1.0	3.27
8.	Damaged hills, %	0.00	1.0	10.1	0.00	0.00	7.5
9.	Standing angle of planted seedlings, ^{0}	82	83	84	82	83	83

84, 82, 83 and 83 degrees respectively for P_1G_1, P_1G_2, P_1G_3, P_2G_1, P_2G_2 and P_2G_3 of PTO gear combinations. The details of transplanting parameters are given in Table 3.

The paddy transplanting with 4- wheel drive tractor mounted paddy transplanter was done in completely randomized design (CRD) to find optimum plant spacing. The experimental design assumed null hypothesis as follows. The Null Hypothesis was taken as there is no significant difference between the treatments (spacing's obtained by various PTO & Gear combinations). Whereas the Alternate Hypothesis was taken as there is significant difference between the treatments (spacing's obtained by various PTO & Gear combinations).

From the statistical analysis, it was observed that F - calculated value is more than F - tabulated value for the treatments at 5 per cent level of significance. Hence, null hypothesis was rejected and alternate hypothesis was accepted. Further, this analysis concluded that there is significance difference between the treatments. Further, it was noted that the treatment 2 (P_1G_2), is significantly superior over all other treatments. There is no significance difference between treatment 4 (P_2G_1) and treatment 5 (P_2G_2) both are on par with each other and superior over treatment1 (P_1G_1), treatment 3 (P_1G_3) and treatment 6 (P_2G_3). From the results, the optimum hill spacing was obtained by the treatment 2 (P_1G_2) with the spacing of 15.33 cm by transplanted with 4WD tractor mounted paddy transplanter.

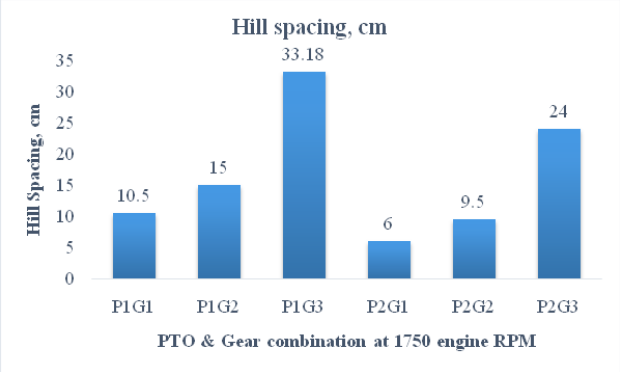

Fig 2. Hill spacing's obtained different PTO & gear combinations during field operation

CONCLUSION

The 4 WD tractor mounted transplanter was evaluated in the field. During the field evaluation, it was observed that the optimum hill spacing was obtained by P_1G_2 combination with the spacing of 15.33 cm. During the evaluation, the average number of seedlings per hill was obtained as 3.33, for P_1G_2 of PTO gear combination. The highest average missing hills, floating hills, buried hills and damaged hills were obtained as 24.3 and 29.3 per cent, 6.1 and 6.5 per cent, 10.1 and 7.5 per cent respectively for P_1G_3 and P_2G_3 PTO and gear combinations due to high rotation speed of transplanting fingers in 3rd forward gear due to transplanting fingers were unable to pick paddy seedlings properly. The advantage of tractor mounted paddy transplanter is it can be used both paddy transplanter in paddy transplanting season and other time it can used for other agricultural operations.

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