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Study on Planting Performance of Power Operated Paddy Transplanter Suitable for Root Washed Seedlings

S. B. PATIL, P. U. SHAHARE and V. V. AWARE

Department of Farm Machinery and Power
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth
Dapoli - 415 712, Maharashtra

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A four row power operated paddy transplanter suitable for root washed seedlings was developed at College of Agricultural Engineering and Technology, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, situated in the District Ratnagiri (Maharashtra), India. The length of seedling, shoot diameter, number of leaves and weight of seedling varies with the age of seedling. Similarly, the hardness of soil, seedling anchoring power and draft requirement varies with the period of soil settlement after the puddling. Therefore, study of planting performance of the newly developed power operated paddy transplanter was undertaken. Field trials were conducted in February, 2017. Three experimental plots each of size 30 x 15 m were selected for the trials. The depth of tilling and puddling was kept as 150 mm. The transplanting was done in the puddled soil after the settlement period of 24, 48 and 72 h and the seedlings with an age of 28 days, 35 days and 42 days were used for transplanting. The required number of hills per m^2 area was found at 48 h settlement period and number of seedlings per hill required were found with 35 and 42 days old seedlings. The highest planting efficiency (90.24%) was recorded with 35 days old seedlings transplanted at 48 h of soil settlement period.

***(Key words:** Paddy transplanter, Planting efficiency, Root washed seedlings, Soil settlement period)*

Manual rice transplanting is a tedious and very time-consuming job requiring 50 to 60 man-days per hectare area. The cost of puddling and transplanting shares 50% of total production cost (Shahare and Bhat, 2011). At the time of transplanting, there is an acute shortage of labour which results in increased wages and delayed operation. In spite of huge labour requirement, plant to plant and row to row spacing are not achieved. Hence mechanical weeding is not possible. Optimizing plant density and timeliness of operation in paddy is considered essential for optimizing paddy yield which may be possible if dependence on hired labour is minimized (Chaudhary *et al.*, 2005). The acceptability of commercial available eight row self-propelled rice transplanter in the country is very low because it requires mat type seedlings and bigger plot size. It is also difficult to transport to field plots on hill bench terracing. The cost of machine is also high. The farmers find difficulty in preparation of mat type nursery because of precision and special material requirement *viz.* screened clay soil, FYM, use of frame, sprouted seeds, *etc*. Hence transplanters using mat type nursery seedlings are not gaining popularity among farmers. Manual transplanters consume more time in transplanting and involves a lot of human drudgery. Considering the above facts, power operated paddy transplanter suitable for root washed seedlings was developed at College of Agricultural Engineering and Technology, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, District Ratnagiri (Maharashtra), India. The length of seedling, shoot diameter, number of leaves and weight of seedling varies with the age of seedling and the hardness of soil, seedling anchoring power and draft requirement varies with the period of soil settlement after the puddling. Therefore, study on planting performance of transplanter was undertaken.

MATERIALS AND METHODS

The developed paddy transplanter (Fig. 1) consisted of mainly power source (engine), transplanting mechanism, seedling holding trays, and forward movement mechanism. The power transmission system transmits power from engine to transplanting mechanism and to the drive wheel. Field planting performance of the developed transplanter was carried out at the experimental farm of Department of Agronomy, Dr. B.S.K.K.V., Dapoli in February, 2017. Three experimental plots each of size 30 x 15 m were selected for the trials. Before each experiment the field was tilled and puddled using power tiller. The depth of tilling and puddling was kept as 150 mm. As per the experimental plan the transplanting was done in the puddled soil after

**Corresponding Author :* E-mail: sbpatil.patil@rediffmail.com

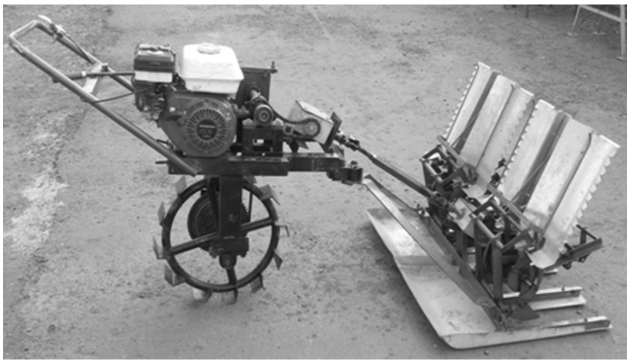

Fig. 1. Power operated paddy transplanter

the settlement period of 24, 48 and 72 hrs and the seedlings having age of 28 days, 35 days and 42 days were used for transplanting. The various parameters of seedlings were measured for each age group and data obtained is presented in Table 1.

A hill without seedlings was taken as missing hill, a hill (bunch of seedlings) in spite of properly placing in the puddled soil, just lying on the surface was termed as floating hill (Singh *et al.,* 1985) and hills which were completely buried under soil after transplanting were considered as buried hills (Mori, 1975). The number of seedlings planted per hill was recorded by counting the number of seedlings at the individual hill from randomly selected hills, at five different locations. The hill to hill distance was recorded by measuring the distance between two hills. A square quadrat (1 m x 1 m) was used to record total number of hills, missing hills and floating hills per square meter area. Percentage of missing hills, floating hills and buried hills was calculated as the ratio of total number of hills without seedlings to total number of hills, ratio of total number of floating hills after transplanting to total number of hills and total number of buried hills after transplanting to total number of hills expressed in percentage respectively. Also, the ratio of number of hills with seedlings to the total number of hill expressed in percentage was taken as planting efficiency.

RESULTS AND DISCUSSION

Effect of three levels of age of seedling *viz.* 28 days, 35 days and 42 days and three levels of soil settlement period *viz.* 24 h, 48 h and 72 h was observed on various performance parameters. The analysis of variance (ANOVA) of the observed data at 5% level of significance is shown in Table 2.

Effect of age of seedling and soil settlement period on number of seedlings planted per hill

The statistical analysis of the data (Table 2) revealed that age of seedling had significant effect on the number of seedlings planted per hill but the effect of settlement

Table 1. *Seedling parameters measured before field testing*

Particulars	Age of seedling		
	28 days	35 days	42 days
Variety	Ratnagiri-1	Ratnagiri-1	Ratnagiri-1
Height of seedlings, mm	206	252	290
Seedling shoot dia, mm	3.28	4.10	4.65
Number of leaves	4	5	6

Table 2. *ANOVA of the dependent parameters*

Source	df	F_{cal}						
		No. of seedlings per hill	Hill to hill distance (mm)	Total no. of hills m^{-2}	Missing hills (%)	Floating hills (%)	Burried hills (%)	Planting efficiency (%)
Model	8	29.932^{**}	2142.685	37.873	22.066^{**}	13.785^{**}	12.983^{**}	29.967^{**}
Settlement Period	2	0.364	8567.796^{**}	150.564^{**}	2.054	16.148^{**}	11.825^{**}	11.426^{**}
Age of Seedlings	2	118.909^{**}	1.130	0.345	82.979^{**}	38.346^{**}	39.658	105.479^{**}
Settlement Period x Age of Seedlings	4	0.227	0.907	0.291	1.616	0.323	0.226	1.482
Error	18							

** significant at 1% level of significance period and combined effect of age of seedling and settlement period on number of seedlings planted per hill was found non-significant. The mean values observed for effect of age of seedling and soil settlement period on number of seedlings planted per hill is presented in Fig. 2. It was observed that almost equal number of seedlings were planted per hill for all settlement periods selected whereas decrease in number of seedlings planted per hill was found with increase in age of seedling. The required number of seedlings per hill *i.e.* 3 seedlings per hill was obtained with 42 days old seedlings at all settlement periods selected. The number of seedlings that can be easily accommodated in the width of opening of the seedling picker depends on the shoot diameter of seedling. With increase of age of seedling, shoot diameter was found to increase (Table1) that reduced the number of seedlings picked by seedling picker thus reducing the number of seedlings planted per hill. Similar kind of observation was recorded by Kavitkar (2016).

Effect of age of seedling and soil settlement period on number of hills per m^2 area

Soil settlement period had significant effect on the on the number of hill per m^2 area but the effect of age of seedling and combined effect of age of seedling and settlement period on number of hills per m^2 area was found nonsignificant (Table 2). The effect age of seedling and settlement period on the number of hills per m^2 area is presented in Fig. 3. It can be seen from the graph that, as the settlement period increased from 24 h to 72 h number of hills per m^2 area decreased from 38 to 32. Number of hills per m^2 area depends on the row width and hill spacing. In this study row spacing of transplanter was fixed, only the hill to hill distance influenced the number of hills per m^2 area. An increase in the hill to hill distance with an increase in the soil settlement period was found and the reason for the same is explained above. The required number of hills (33 hills m^{-2}) was observed with 48 h settlement period.

Effect of age of seedling and soil settlement period on percentage of missing hills

The statistical analysis of the data (Table 2) revealed that, age of seedling had significant effect, but the effect of settlement period and combined effect of age of seedling and settlement period was found non-significant. The significant effect of seedling age on missing hills was reported by Goel *et al.* (2009). The effect of age of seedling and settlement period on percentage of missing hills is presented in Fig. 4. It can be seen from the graph that the least percentage of missing hills was obtained with 35 days age of seedlings (5.654 per cent *i.e.* 1.944 seedlings m^{-2} area) followed by 28 days (8.840 per cent *i.e.* 3.028 seedlings m^{-2} area) and 42 days (9.082 per cent *i.e.* 3.111 seedlings m^{-2} area) old seedlings. Tenderness of shoot and low height of seedlings in case of 28 days old seedlings might be the reason for failure of picking finger to pick up and transplant the seedlings in every pass causing missing of hills. In case of 42 days old seedlings more growth of roots causing interlocking prevented the seedling to get separated and released from the tray. This caused bridging and prevented flow of seedlings towards the opening in tray to get picked up by picking fingers and in turn caused more number of missing hills.

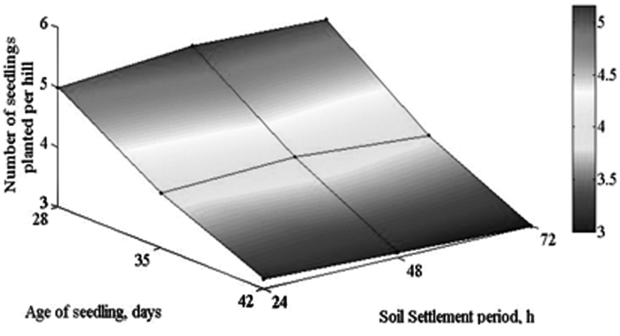

Fig. 2. *Effect of age of seedling and soil settlement period on number of seedlings planted per hill*

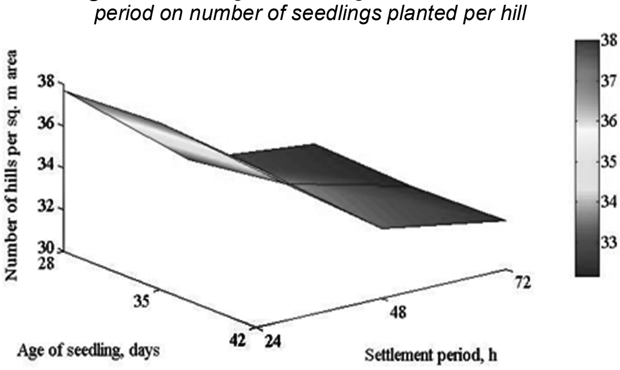

Fig. 3. *Effect of age of seedling and soil settlement period on the number of hills per m^2 area*

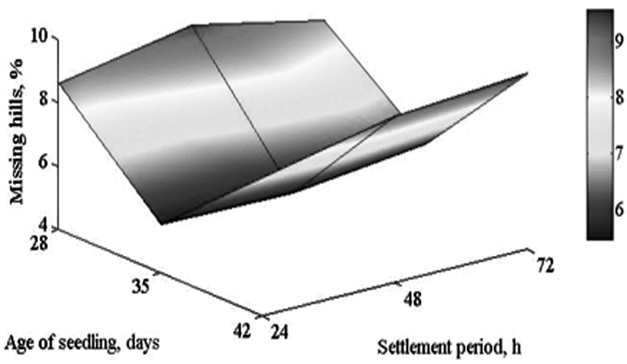

Fig. 4. *Effect age of seedlings and settlement period on percentage of missing hills*

Effect of age of seedling and soil settlement period on percentage of floating hills

Age of seedling and settlement period both had significant effect at 1% level of significance but the combined effect of age of seedling and settlement period on number of floating hills per m^2 was found non-significant (Table 2). The effect age of seedling and settlement period is presented in Fig. 5. It can be seen that with increase in the age of seedling from 28 days to 42 days, the percentage of floating hills reduced from 5.084 per cent to 2.608 per cent. At the same time with increase in the settlement period, the percentage of floating hills reduced. The significant effect of seedling age and soil settlement period on floating hills was reported by Goel *et al.* (2009) and Behera *et al.* (2009). An increase in sturdiness of shoot, increase in height, number of leaves and weight of seedlings with an increase of age of seedlings improved proper picking and transplanting of seedlings in every pass which caused less number of floating of hills. Higher percentage of floating hills at lower levels of soil settlement period might be due to poor anchorage of seedlings in soft soil and movement of puddled mass along with the float due to higher sinkage. A study conducted at G. B. Pant University of Agriculture and Technology, Pantnagar reported similar results (Behera *et al.*, 2007). Besides the above reasons, water level at low sedimentation created a wave action thereby washing away the seedlings. As the soil settlement period increased from 24 h to 48 h soil gained strength and flow of soil along with the float reduced. This was the reason for least percentage of floating hills at 48 h of soil settlement period. At 72 h of soil settlement period an increase in percentage of floating hills was might be due to increased soil hardness that could not provide proper anchorage and gripping force to seedlings. This finding was in agreement with that of Goel *et al.* (2008).

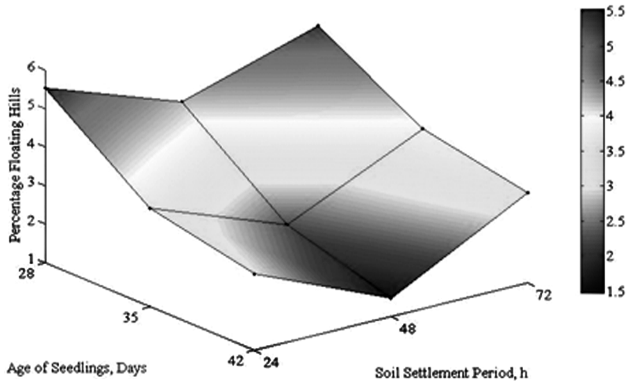

Fig. 5. *Effect of age of seedling and soil settlement period on percentage of floating hills*

Effect of age of seedling and soil settlement period on percentage of buried hills

The statistical analysis of the data (Table 2) revealed that, both age of seedling and settlement period had significant effect on the number of buried hills per m^2 at 1% level of significance. Combined effect of age of seedling and settlement period was found non-significant at 5% level of significance. The effect age of seedling and settlement period on percentage of buried hills is presented in Fig. 6 and it can be seen from the graph that as the age of seedlings increases from 28 days to 42 days the percentage of buried hills found to be decreased from 4.418 per cent (1.528 hills m^{-2}) to 1.587 per cent. (0.556 hills m^{-2}). At the same time, as the settlement period increased from 24 h to 72 h the percentage of buried hills reduced from 3.644 per cent (1.361 hills m^{-2}) to 2.064 per cent (0.667 hills m^{-2}). The significant effect of seedling age and soil settlement period on buried hills was reported by Behera *et al.* (2009). The reasons for decrease in percentage of buried hills with an increase in the age of seedlings were the same as postulated in above section. As the soil settlement period increased from 24 h to 72 h, soil gained strength and flow of soil along with the float was reduced. This may be the reasons for decrease in percentage of buried hills with an increase in the

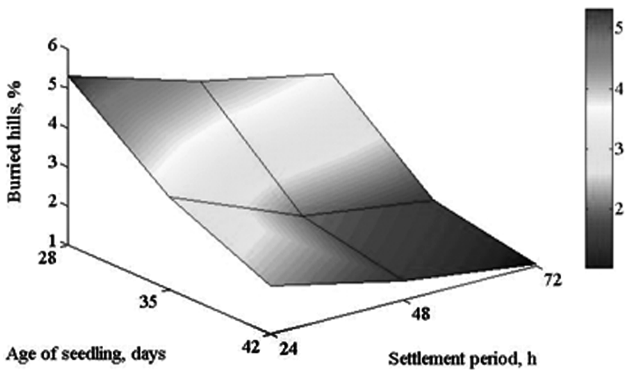

Fig. 6. *Effect age seedling and soil settlement period on percentage of buried hills*

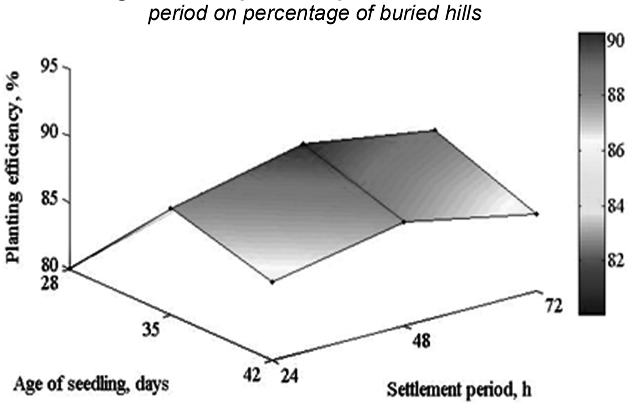

Fig. 7. *Effect age of seedlings and soil settlement period on planting efficiency*

settlement period. Similar findings have been reported by Goel *et al.* (2008).

Effect of age of seedling and soil settlement period on planting efficiency

The statistical analysis of the data presented in table 2 revealed that, the effect of age of seedling and settlement period had significant effect on the planting efficiency at 1% level of significance. Combined effect of age of seedling and soil settlement period was found non-significant. The effect age of seedling and settlement period on planting efficiency is presented in Fig. 7. It can be seen from the graph that the highest planting efficiency (90.247%) was observed with 35 days age of seedlings followed by 42 days and 28 days old seedlings, when planted at 48 h of soil settlement period due to least number of missing and floating hill with 35 days old seedlings.

CONCLUSIONS

The number of seedlings planted per hill significantly decreased as the age of seedling increased from 28 days to 42 days and required number of seedlings (3-4) were found with 35 and 42 days old seedlings. Number of hills per m^2 area significantly decreased with increase in soil settlement period from 24 hrs to 72 hrs and required number of hills (33 hills per m^2) were found with 48 h of settlement period. Least percentage of missing hills was found with 35 days old seedlings at all the levels of settlement period. Age of seedling and soil settlement period had significant effect on the percentage of floating hills and the least percentage of floating hills (1.48%) was recorded with 42 days old seedlings transplanted at 48 h settlement period. The percentage of buried hills significantly decreased with increase in age of seedling and soil settlement period. The least percentage of buried hills (1.04%) was recorded with 42 days old seedlings transplanted at 72 h settlement period. The highest planting efficiency (90.24%) was recorded with 35 days old seedlings transplanted at 48 h soil settlement period.

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