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Field Testing of Power Operated Paddy Transplanter Suitable for Root Washed Seedlings

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ABSTRACT

Power operated transplanter suitable for traditional root washed seedlings was developed at Department of Farm Machinery and Power, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist: Ratnagiri (MS). Field testing for operating performance of the developed transplanter was carried out at 48 h soil settlement period with 35 days and 22 days old seedlings, having 245 to 260 mm height and 4 to 4.30 mm shoot diameter, in two seasons viz. summer and kharif in February 2017 and July 2017 respectively. Field testing was carried out on the basis of total time required for operation, unproductive time, speed of operation, field efficiency, field capacity, fuel consumption, paddy seedlings planted per hill, hill to hill distance, paddy hills planted, missing hills, floating hills, burried hills and planting efficiency. The plant population was obtained 106.42/m^2 and 101.32/m^2 in summer and kharif season respectively. The average speed of operation and fuel consumption of the transplanter were recorded as 0.98 km/h and 1.135 l/h respectively. The average field capacity and field efficiency of the transplanter were found as 0.0445 ha/h and 43.29 % respectively. Average seedling planted per hill, hill to hill distance, paddy hills planted, missing hills, floating hills, buried hills and planting efficiency were found to be 3, 117 mm, 34, 6.97 per cent, 4.35 per cent, 1.65 percent and 93.03 per cent respectively. The operating cost of newly developed paddy transplanter for one hectare of paddy was found to be Rs. 5,415/- which is Rs. 3385/- less (38.47%) than traditional method.

Key words: *Transplanter, Root washed seedlings and Soil settlement period.*

INTRODUCTION

Transplanting of rice is the most common method in India. In most of the region transplanting is done manually. Manual rice transplanting is a tedious and very time consuming job requiring 50 to 60 man days per ha. The cost of puddling and transplanting shares 50 % of total production cost[5]. At the time of transplanting, there is acute shortage of labours 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 and hence mechanical weeding is not possible.

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Optimizing plant density and timeliness of operation in paddy is considered to be essential for optimizing paddy yield which may be possible if dependence on hired labour is minimized[3]. Mechanical transplanting of paddy could be a solution to the prevailing situation to reduce the labours, delay in transplanting and reducing the cost of paddy cultivation. 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 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. Hence transplanters using mat type nursery seedlings are not getting popularity among farmers. Manual transplanters consume more time in transplanting and involves a lot of human drudgery. Hence power operated transplanter suitable for traditional root washed seedlings and easy to transport from one field to another field was developed at Department of Farm Machinery and Power, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist: Ratnagiri (MS). In order to study its field performance testing of power operated paddy transplanter was undertaken.

MATERIALS AND METHODS

Working of Newly Developed Paddy Transplanter

The newly developed paddy transplanter can plant seedlings in four rows at a time. A petrol engine (2.9 kW rated power) is used as a power source for the transplanter. The engine power is provided to the drive wheel for forward motion and to the transplanting mechanism for transplanting of seedlings in a puddled soil. The float of the transplanter ensures the floating of transplanting assembly on the puddled soil and also avoids the sinking of machine. At the time of transplanting operation, the root washed seedlings are needed to keep on the tray in four rows of stalked seedlings placed across the tray with roots at inner side. The tray is kept in vertically sliding to facilitate the sliding of nursery seedlings. Transplanting operation carried out with two mechanisms working simultaneously *viz.* seedling picking mechanism and pushing mechanism. After every stroke of transplanting arm, each arm picks 3-5 seedlings from seedling tray and carries them towards the downward side (near puddled soil). These picked seedlings are placed properly in the puddled soil at 4-5 cm depth by seedling transplanting forks. The seedling stopper operated by a cam opens when the picking finger picks up the seedlings from the tray and immediately closes to prevent the seedlings rolling down. The seedling pusher pushes the seedlings while picking forks reaches to the tray to facilitate easy picking of seedlings. A lever operated cone clutch connects and disconnects the engine power as and when required. An accelerator control provided at the handle is be used to control the engine speed. Fig. 1 shows view of power operated paddy transplanter.

Field Testing

Final field testing for operating performance of the developed transplanter, was carried out at 48 h soil settlement period with 35 days and 22 days old seedlings, having 245 to 260 mm height and 4 to 4.30 mm shoot diameter, in two seasons *viz.* summer and kharif in February 2017 and July 2017 respectively.

Field testing in summer season

In summer season, testing was carried at Agril. Research Station, Repoli, Dist: Raigad (M.S.) on 23/02/2017. Three fields each with 45 x 15 m size were selected for the trials. The fields were prepared and puddled using power tiller. The depth of tilling and puddling was kept as 150 mm. Testing was carried out in the settled puddled soil after settlement period of 48 hrs using 35 days old seedlings (Fig. 2). The seedling parameters recorded before the field testing are presented in the Table 1.

Field testing in kharif season

Kharif season is the most important and main season of paddy growing in Konkan region. Hence, the testing was carried out at experimental farm of Dept. of Agronomy.

DBSKKV, Dapoli on 09/07/2017 to 10/07/2017. Three fields each of size 40 x 3.25 m and one field of 43 x 20 m size were selected for the trials. The field was prepared and puddled using cage wheel tractor with rotavator. The depth of tilling and puddling was kept as 150 mm. The seedling parameters in case of 22 days old seedlings (Table 2) were found matching with 35 days old seedlings grown in summer season hence, 22 days old seedlings were used. Testing was carried out in the settled puddled soil using 22 days old seedlings after 48 h settlement period (Fig. 3).

Performance parameters studied

Speed of operation

The transplanting speed was obtained by recording the time required for the rice transplanter to travel a 20 m distance in the field. The speed of transplanting was computed using the following equation

$$S = \frac{D}{t} \times 3.6 \quad \text{... (1)}$$

where,

S = Transplanting speed, km/h;

D = Distance, m; and

t = Time required to cover the distance D, sec.

Actual field capacity

It is the tactual area covered per unit time including the time loss in turning, feeding the seedlings on tray, repair and adjustment. It was calculated as

$$AFC = \frac{A}{T_t} \quad \text{.... (2)}$$

where,

AFC = Actual field capacity, ha/h;

A = Total transplanted area, ha; and

T_t = Total operating time required for transplanting, h.

Theoretical field capacity

It is the theoretical area covered per unit time eliminating the time loss in turning, feeding the seedlings on tray, repair and adjustment. It is the function of speed of transplanter and the width of operation expressed in ha/hr and it was calculated by the following equation

$$TFC = \frac{W \times S}{10} \quad \text{.... (3)}$$

where,

TFC = Theoretical field capacity, ha/h;

W = Operating width of the transplanter, m; and

S = Transplanting speed, km/h.

Field efficiency

It is the ratio of the actual field capacity and theoretical field capacity expressed in percentage. The field efficiency was calculated using following formula.

$$FE = \frac{AFC}{TFC} \times 100 \quad \text{.... (4)}$$

where,

FE = Field efficiency, %;

AFC = Actual field capacity, ha/h; and

TFC = Theoretical field capacity, ha/h.

Paddy seedlings planted per hill

The number of paddy seedlings planted per hill (bunch of seedlings) was recorded from randomly selected hills, at four different locations in the field in each replication, by counting the number of seedlings at the individual hill. An average of all the readings was taken to calculate the number of paddy seedlings planted per hill.

Hill to hill distance

The hill to hill distance was recorded by measuring the distance between two hills selected randomly at four different locations in the field in each replication. A 300 mm scale will be used to measure the distance between the hills. Hill to hill distance was calculated from an average of all the readings taken.

Paddy hills planted

A square quadrant (1 m x 1 m) was used to record the number of paddy hills planted in a square meter area (hill density). The number of hills, inside the area of square quadrant were counted from randomly selected four locations in the field in each replication. An average of all the readings was taken and number of paddy hills in a square meter area was calculated.

Missing hills

A hill without seedlings was taken as missing hill. A square quadrant (1 m x 1 m) was used to record the total number of hills and missing hills in a square meter area. The observations were taken, inside the area of square quadrant, from randomly selected four different locations in the field in each replication. An average of all the readings of number of hills missing was taken and number of missing hills in a square meter area was calculated. The

percentage of missing hills was calculated by taking the ratio of total number missing hills to the total number of paddy hills planted in square meter area as expressed in following equation

$$\text{Missing hills, \%} = \frac{H_m}{H_t} \times 100 \quad \text{.... (5)}$$

where,

H_m= Number of missing hills in the sampling area; and

H_t = Total number of hills planted in the sampling area.

Floating hills

Floating hills are those hills where all seedlings in a hill are either floating on the surface or just placed on the surface of the mud. A square quadrant (1 m x 1 m) was used to record the number of floating hills in a square meter area. The observations were taken from randomly selected four different locations in the field in each replication. Number of floating hills in a square meter area was calculated from an average of all the readings. The Percentage of floating hills was calculated by following equation

$$\text{Floating hills, \%} = \frac{H_f}{H_t} \times 100 \quad \text{... (6)}$$

where,

H_f = Number of floating hills in the sampling area; and

H_t= Total number of hills in the sampling area.

Burried hills

Hills which are completely burried under the soil after the transplanting are called burried hills. A square quadrant (1 m x 1 m) was used to record the number of burried hills in a square meter area. The observations were taken from randomly selected four different locations in the field in each replication. Number of burried hills in a square meter area was calculated from an average of all the readings. The percentage of burried hills was calculated by following equation:

$$\text{Burried hills, \%} = \frac{H_b}{H_t} \times 100 \quad \text{... (7)}$$

where,

H_b = Number of burried hills in the sampling area; and

H_t= Total number of hills in the sampling area.

Planting efficiency

It is the ratio of number of hills with seedlings (planted + floating + burried) to the total number of hills expressed in percentage[1]. It was calculated by following equation:

$$\text{Planting efficiency, \%} = [1 - \frac{H_m}{H_t}] \times 100 \quad \text{.... (8)}$$

where,

H_m = Number of missing hills in the sampling area; and

H_t= Total number of hills in the sampling area.

Cost Economics of Newly Developed Transplanter

The cost required for manufacturing of newly developed paddy transplanter includes material cost and fabrication cost. The material and fabrication cost for machine was Rs. 55448/-. The operating cost of newly developed paddy transplanter was determined using IS-9164-1979 test code[4].

RESULTS AND DISCUSSION

Field testing in summer season

The result revealed that, average number of seedlings per hill and hill to hill distance were 3.13 and 116.53 mm respectively. The average paddy hills planted were 34.0 hills/m^2. The newly developed transplanter maintained the required row spacing and hill spacing. The plant population was obtained as 106.42/m^2 which is quite satisfactory with the desired plant population of 100 seedlings/m^2 and the planting efficiency of the transplanter was observed 92.66 per cent. The performance parameters recorded and determined are given in Table 3. It shows the average speed of operation of transplanter was 0.97 km/h and fuel consumption of the machine were recorded to be 1.14 l/h. Total time of operation of the transplanter was observed to be 22.08 h/ha and the time lost in turning, loading, adjustments was 12.47 h/ha. The field capacity of the machine was found to be 0.045 ha/h. The field efficiency of newly developed machine was found to be 44.43 %.

Field testing in kharif season

The result (Table 4) revealed that, average number of seedlings per hill and hill to hill distance were 2.98 and 117.65 mm respectively. The average paddy hills planted

were 34.0 hills/m^2. The newly developed transplanter maintained the required row spacing and hill spacing. The plant population obtained was 101.32/m^2 which is quite satisfactory with the desired plant population of 100 seedlings/m^2 and the planting efficiency of the transplanter was observed 93.40 per cent. The performance parameters recorded and determined are given in Table 4.44. It can be seen that the average speed of operation of transplanter was 1.0 km/h and fuel consumption of the machine to be 1.13 l/h. Total time of operation of the transplanter was observed to be 22.67 h/ha and the time lost in turning, loading, adjustments was 12.94 h/ha. The field capacity of the machine was found to be 0.044 ha/h. The field efficiency of newly developed machine was found to be 42.15 %.

Cost Economics of Newly Developed Transplanter

The operating cost of the machine was calculated as Rs. 241/h. The operating cost of newly developed paddy transplanter for one hectare of paddy was Rs. 5,415/-. The cost of transplanting by traditional method was Rs. 8800/ha^2. Hence, there was saving of Rs.3385/- (38.47%) in transplanting expenditure by the use of newly developed paddy transplanter.

Table 1: Parameters of paddy seedling grown in summer season

Sr. No.	Parameter	Observations
1	Variety of seedling	Ratnagiri -1
2	Age of seedling, days	35
3	Number of leaves	5
4	Height of seedling, mm	245-260
5	Shoot diameter, mm	4 - 4.30 mm

Table 2: Parameters of paddy seedling grown in kharif season

Sr. No.	Parameter	Observations
1	Variety of seedling	Karjat-2
2	Age of seedling, days	22
3	Number of leaves	5
4	Height of seedling, mm	240 – 260
5	Shoot diameter, mm	4 mm

Table 3: Results of field testing of newly developed transplanter in summer season

Sr. No.	Parameter	Test-1	Test-2	Test-3	Average
1	Area covered, m^2	675	675	675	675
2	Paddy seedlings planted per hill	3.0	3.1	3.3	3.13
3	Hill to hill distance, mm	116.40	117.20	116.00	116.53
4	Paddy hills planted/m^2	34.40	33.60	34	34
5	Missing hills, %	6.91	7.74	7.36	7.34
6	Floating hills, %	4.65	4.48	5.07	4.73
7	Burried hills, %	1.77	2.08	1.42	1.76
8	Planting efficiency, %	93.09	92.26	92.64	92.66
9	Total operating time, h/ha	21.47	22.37	22.41	22.08
10	Time lost in turning, loading, adjustments etc., h/ha	11.72	12.98	12.73	12.47
11	Speed of operation, km/h	0.96	0.99	0.97	0.97
12	Fuel consumption, l/h	1.14	1.15	1.12	1.14
13	EFC, ha/h	0.0466	0.0446	0.0447	0.045
14	TFC, ha/h	0.101	0.104	0.102	0.102
15	Field efficiency , %	46.33	42.97	43.99	44.43
16	No. of persons required for operating machine	1	1	1	1
17	No. of persons required for seedling feeding	1	1	1	1

Table 4: Results of field testing of newly developed transplanter in kharif season

Sr. No	Parameter	Test-1	Test-2	Test-3	Test-4	Average
1	Area covered, m^2	130	130	130	860	312.5
2	Paddy seedlings planted per hill	3.1	2.7	3.2	2.9	2.98
3	Hill to hill distance, mm	118	118	116.7	117.9	117.65
4	Paddy hills planted/m^2	34.4	34	33.6	34	34.00
5	Missing hills, %	6.49	7.36	6.25	6.28	6.60
6	Floating hills, %	4.06	3.89	4.17	3.78	3.98
7	Burried hills, %	1.42	1.77	1.53	1.49	1.55
8	Planting efficiency, %	93.51	92.64	93.75	93.72	93.40
9	Total operating time, h/ha	22.50	23.46	22.95	21.78	22.67
10	Time lost in turning, loading, adjustments etc., h/ha	12.50	13.24	13.17	12.85	12.94
11	Speed of operation, km/h	1.00	0.98	1.02	0.99	1.00
12	Fuel consumption, l/h	1.19	1.08	1.14	1.10	1.13
13	EFC, ha/h	0.044	0.043	0.044	0.046	0.044
14	TFC, ha/h	0.105	0.103	0.107	0.104	0.10
15	Field efficiency , %	42.33	41.49	40.58	44.20	42.15
16	No. of persons required for operating machine	1	1	1	1	1
17	No. of persons required for seedling feeding	1	1	1	1	1

Fig. 1: View of power operated paddy transplanter

Fig. 2: A view of machine performing in field in summer season

Fig. 3: A view of machine performing in field in kharif season

CONCLUSIONS

1. The average speed of operation of transplanter, fuel consumption, field capacity and field efficiency of newly developed machine were found to be 0.98 km/h, 1.135 l/h, 0.0445 ha/h and 43.29 %, respectively.
2. Average seedling planted per hill, hill to hill distance, paddy hills planted, missing hills, floating hills, buried hills and planting efficiency were found to be 3, 117 mm, 34, 6.97 per cent, 4.35 per cent, 1.65 percent and 93.03 per cent respectively.

3. The operating cost of newly developed paddy transplanter for one hectare of paddy was found to be Rs. 5,415/- which is Rs. 3385/- less (38.47%) than traditional method.

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