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Performance of Four Row Self Propelled Walking Type Paddy Transplanter

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Rice (*Oryza sativa* L.) is one of the leading food crops in the world within the worldwide-cultivated cereals, and is second only to wheat in terms of annual food consumption. Rice is generally grown by transplanting seedlings in flooded field conditions or direct sowing depending upon the availability of water. In many parts of country as well as in Konkan region of Maharashtra eight row self propelled paddy transplanter has been used and it is found useful. The limitations are observed due to smaller plot size and hilly terrain. Four row self propelled walking type transplanter has been developed at Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli. The present study was undertaken on performance testing of four row self propelled walking type paddy transplanter. The result reveals that, average hill to hill spacing, planting depth, seedlings per hill, numbers of hills in one square meter area were 12 cm, 3.85 cm, 3.5, 34 hills m^{-2} respectively. The machine maintained the plant population of 100 to 120 per m^2. Average missing hills m^{-2}, speed of operation, fuel consumption, time required for planting, time loss in turning, time loss in feeding, total time of operation, field capacity were 4, 1.275 km h^{-1}, 1.39 h^{-1}, 8.19 h ha^{-1}, 0.81 h ha^{-1}, 1.11 h ha^{-1}, 10.11 h ha^{-1} and 0.099 h hr^{-1}, respectively. The field efficiency of machine was found to be 71%. As compared to manual transplanting method transplanting with newly developed machine can save Rs. 1856 ha^{-1}. The average operating cost of newly developed transplanter was Rs. 311 h^{-1} and Rs. 3144 ha^{-1}.

*(**Key words:** Paddy transplanter, Mat nursery, Puddled field, Field performance)*

Rice (*Oryza sativa* L.) is one of the leading food crops in the world and is second after wheat in terms of annual food consumption. In Asia more than 90 per cent of the global rice is produced and consumed. Being the staple food for more than 62 per cent of people, our national food security hinges on the growth and stability of its production. India has 42.6 million hectares area under rice and with the production of about 103.4 million tonnes, it ranks second only to China with productivity of about 2240 kg ha^{-1} during the year 2011-2012 (Anonymous, 2012). Maharashtra has 15.14 lakh ha land under rice cultivation with rice production of about 27.12 lakh tonnes and productivity is 1.8 t ha^{-1} during the year 2011-12 (Anonymous, 2012). Rice is staple food of Konkan region of Maharashtra. It is grown on 4.136 lakh hectares with production of 10.42 lakh tonnes and productivity is 2.56 t ha^{-1}. Konkan region is basically a narrow strip of 40 km wide and running 750 km of length from north to south, and is a hilly terrain lying between Sahyadri ranges in the east and Arabian Sea in west. Here terrace farming is followed for paddy crop and the field size is small. In Konkan region, wet land cultivation system is followed. The land is ploughed thoroughly and puddled in 3-5 cm standing water. The puddling is largely done by bullock drawn country plough and wooden planks. In some of the pockets, power tiller is used for puddling, but the extent is very low. Rice is generally grown by transplanting seedlings in flooded field conditions or direct sowing depending upon the availability of water. Transplanting refers to the planting of 20-22 days old seedlings of 12-15 cm height under wet land condition. The seedlings are raised in nursery and uprooted for transplanting. Transplanting has number of advantages over direct sowing viz, transplanting helps the plant to have better start over the weeds hence results in less growth of weeds, more chance for selection of more healthy seedlings for vigorous growth, allow better water management practices, less seed requirement, better weeding and intercultural operations. Rice transplanting is a tedious and very time-consuming job requiring about 250 to 300 man-hour ha^{-1} which is roughly 25% of the total labour requirement of the crop.

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(Chaudhary and Varshney, 2003). This results in increased labour wages and a delayed transplanting operation (Singh *et al*., 1985). Transplanting can be also be done by using transplanters which helps in saving of labour and time. The Yanji Shakti 8 row rice transplanter has been tried in various parts of the country and performance was encouraging. However, its adoption is restricted due to small and fragmented plots of Konkan region. Problems arise while shifting the machine from one plot to the neighboring plot because of bunds, soft patches, leftover debris and stubbles (Baruah *et al*., 2001). Complete coverage of some of the plots was not possible due to the irregular shape of field and bigger size of the transplanter. Considering the limitations of the eight row paddy transplanter as well as two row self propelled transplanter was developed in Dapoli. A four row self propelled walking type transplanter was developed in department of Farm Machinery and Power, CAET, Dapoli. The present study deals with performance of four row self propelled walking type paddy transplanter developed by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.

MATERIALS AND METHODS

Four row self propelled paddy transplanter (Dr. BSKKV Design)

The four row self propelled transplanter developed by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth consists of engine, gear box, transplanting mechanism, tray, tray movement mechanism, float, drive wheel, handle, etc. The transplanter is fitted with 2.8 kW engine. Engine power is supplied through gear box of suitable ratio to reduce speed. From gear box, part of power is transmitted to transplanting mechanism while other is transmitted for the forward motion of machine to drive the wheels. At the time of transplanting operation, the cut mat nursery is placed on the tray. After every stroke of transplanting arm, tray slides and 3-5 seedlings from mat nursery are picked up by needles and planted in the puddled soil at 4-5 cm depth. The tray has the horizontal sliding movement which controls the supply of seedlings to the needle at every stroke. The transplanting arm starts rotating in elliptical path. The power from gear box is transmitted to drive wheels through chain and sprocket arrangement. As the engine is started, power is transmitted from gear box to drive wheel which causes the forward motion of the transplanter. The total weight of machine is 110 kg. The paddy transplanter tested is shown in Fig. 2.

The land was ploughed with the help of mould board plough to a shallow depth (15-20 cm). Two different fields of 10 m x 10 m size were prepared using rotavator or cultivator. The depth of tilling was kept as 10 cm. Puddling of the field at a depth of 15 cm was carried out with the help of power tiller. After that the soil was allowed to settle for 48 hours. After 48 hours land was ready for transplanting.

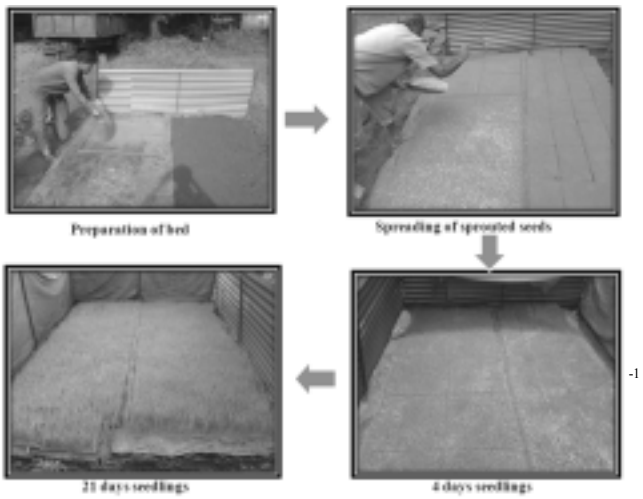

Fig.1. *Method of preparation of mat type nursery*

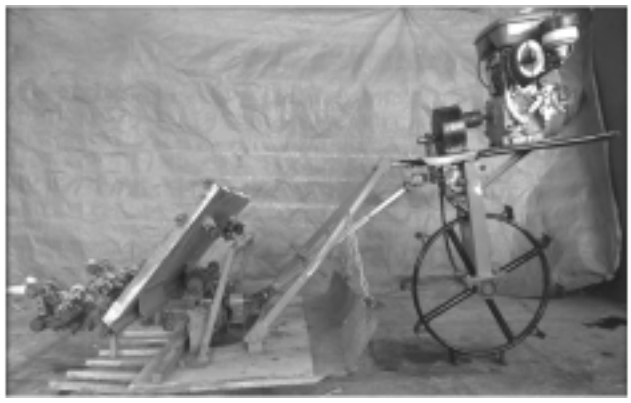

Fig. 2. *Four row self propelled paddy transplanter*

Fig. 3. *Four row self propelled transplanter operating in the field*

Table 1. *Condition of seedlings during field trial*

Sr. No.	Items	Details / Specifications	
		Test 1	Test 2
1	Variety of Paddy	Ratnagiri-24	Ratnagiri-24
2	Type of Nursery	Mat	Mat
3	Soil type of seed bed	Laterite	Laterite
4	Date of sowing in the nursery	24-09-2013	28-10-2013
5	Date of transplanting in the field	19-10-2013	20-11-2013
6	Age of seedlings (days)	25	23
7	Leaf stage (leaves seedling^{-1})	3	4
8	Size of seedlings (thickness at the base of shoot, mm)	1.10	1.07
9	Length of seedling (mm)	170-180	150-160
10	External treatment, if any	Urea application (10 gram in 1 litre water)	Urea application (10 gram in 1 litre water)
11	Growing density of seedling (seedlings cm^{-2})	12 - 14	15 – 17

Table 2. *Operating parameters of the four row self propelled paddy transplanter*

Sr. No.	Items	Transplanting		Average
		Test 1	Test 2	
1.	Depth of water at the time of transplanting (cm)	3.1	2.5	2.8
2.	Puddling index (%)	68	64	66
3.	Operating speed (km h^{-1})	1.3	1.25	1.275
4.	Hill to hill spacing, (cm)	13	11	12
5.	Planting depth, (cm)	3.5	4.2	3.85
6.	No. of seedlings hill^{-1}	3	4	3.5
7.	No. of hills m^{-2}	32	36	34
8.	Missing hills m^{-2}	5	3	4
9.	Time required for planting (h ha^{-1})	7.76	8.62	8.19
10.	Time required for turning (h ha^{-1})	0.78	0.84	0.81
11.	Time required for feeding (h ha^{-1})	1.16	1.06	1.11
12.	Total time of operation (h ha^{-1})	9.7	10.52	10.11
13.	Field capacity (ha h^{-1})	0.103	0.095	0.099
14.	Field efficiency, (%)	72	70	71
15.	Fuel consumption (L h^{-1})	1.4	1.38	1.39
16.	Operating cost (Rs ha^{-1})	3026	3261	3144

Performance testing of newly developed prototype

Before field testing of machine, the land was prepared for the test. The performance test is required to obtain reliable data on operating accuracy, work rate, field efficiency and other parameters in field. The machine was operated in laboratory as well as in field. It was operated in laboratory for observing its forward movement and working of transplanting mechanism using newly developed driving mechanism. After satisfactory working of the machine under laboratory condition, the performance of developed machine in the field was studied. The mat type nursery was prepared for paddy seedlings. The selected seeds were dipped in 15-16% salt solution and floating seeds from the water were removed. Then the seeds were soaked in good quality water of 40^{o} C for 24 hours. Then seeds were removed from water and kept in gunny bag for sprouting. The land was leveled and a raised bed of 6 x 2.5 m size was prepared maintaining the height of bed as 15-20 cm. The thick plastic paper of 6 x 2.5 m size was spread over the raised bed. The frame size of 1 m x1 m was made with angle iron of 25 mm and 2 mm thick placed on the raised bed covered with plastic. The prepared soil mixture was spread uniformly in the frame and compacted well to

from a soil bed of 5 x 2 m (Alam *et al.*, 2002). The sprouted seeds were spread uniformly over the soil mixture (Fig. 1). Soil mixture (soil + dry cow dung) of 5 mm thick was spread over sprouted seeds. It was covered with straw to protect from birds. Water was splashed over it for next 21 days. Method of preparation of nursery is shown in Fig. 1. The four row transplanter was operated in the field. The transplanting mechanism and forward movement was started and it was just guided by the operator. Hence, the operator had walked behind and operated the machine. The performance parameters recorded during the testing are depth of water at the time of transplanting, sinkage, puddling index, operating speed, plant to plant spacing, planting depth, number of plants per hill, number of hills per m^2 area, missing hills, time required for planting, time required for turning, time required for feeding, total time required for operation, field capacity, field efficiency, fuel consumption etc. The working of machine in the field is shown in Fig. 3.

RESULTS AND DISCUSSIONS

The machine was operated for 40 minutes in the field for this short duration test. Before starting the actual tests, various parameters of the paddy crop nursery were collected throughout the study are listed in Table 1.

After 48 hours of pudding, mat type seedlings were used for the transplanting and the field testing of transplanter was carried out. The observations during trial are given in Table 2. The result reveals that, average hill to hill spacing was 12 cm. Average planting depth during testing was 3.85 cm. The average seedlings per hill were 3; the average numbers of hills in one square meter area were found as 34 hills m^{-2}. The machine maintained the plant population of 100 and 120 per square meter. Average missing hills m^{-2} was observed to be 4. Chaudhary and Varshney (2003) observed 0 to 14% missing hills mainly due to non-uniformity of the seedlings in the mat.

Average hill to hill spacing during testing was 12 cm and row to row spacing was 23.5 cm. The labour requirement for transplanting operation with the machine was reduced to two as compared to manual transplanting. The field capacity of the machine was found to be 0.099 ha hr^{-1} (10.1 hr ha^{-1}). This capacity is 73.98 % higher than two row self propelled paddy transplanter (0.0569 ha hr^{-1}). This saved labour requirement to a greater extent. Normally manual transplanting requires 50-60 man days ha^{-1} (400-480 man hr ha^{-1}). The field efficiency of newly developed machine was found to be 71%. As remarkable saving in labour requirement was observed, remarkable saving in cost was also found. The operating cost of machine was Rs. 1856 ha^{-1} only which is 37.12 % when compared with traditional method. Alizadeh *et al.* (2001) reported that total cost of transplanting decreased by 19 - 26% compared to hand transplanting. Chaudhary *et al.* (2005) concluded that rice planting by self-propelled transplanter ensured timely operation, saving of cost and reduction in human drudgery.

The four row self propelled paddy transplanter worked satisfactorily in the fields during its field test. This paddy transplanter is small, low weight (110 kg) and easy to operate. It has a good potential for use in small and fragmented paddy fields for mechanical transplanting with saving in labour requirement and operating cost.

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