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Development and Performance Evaluation of Paddy Seeding Device for Mat Nursery

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ABSTRACT

Rice transplanting is accomplished mainly by the manual method. Manual transplanting is a labour intensive operation comprising of nursery rising, uprooting of the seedlings, transporting and transplanting them in the main field, with a total labour requirement of about 280 to 350 man-h/ha. High labour demand during peak transplanting period adversely affects the timeliness of this operation, thereby reducing the crop yield. To correct the problem, mechanical transplanting could be considered as the most promising option. The major constraint in the adoption of mechanical transplanters is the complex and labour intensive technique of raising mat type nursery in perforated plastic trays. Another constraint is unevenness of plant population in the mat. With a view to reduce the drudgery in raising mat type nursery, a paddy seeding device was developed and tested. The developed device performed satisfactorily and gave desired density of 100 to 120 g seed per mat with two passes (one forward and one backward) of the device over soil filled plastic tray of size 280 X 580 mm at 1.02 mm sprout length. Uniformity of seed obtained was as recommended 50-75 seed per 25 cm^2 area in the mat. No mechanical damage to the seed was observed.

Key words : Mat type nursery, Paddy seeding device ,Seed density, Seed uniformity per cm^2.

The method mostly being practiced to grow rice is by transplanting the seedlings manually in the puddled field. The manual method of rice transplanting gives the desired result but involves enormous drudgery, more human stress and also high labour requirement. It also combined with labour intensive operations like nursery rising, uprooting of the seedlings, transporting and transplanting in the main field requiring about 250-300 man-h ha^{-1} which is approximately 25% of the total labour requirement of crop (Singh and Hussain, 1983). Timeliness of rice transplanting is essential for optimizing the yield and this can be achieved only through mechanical rice transplanting. Mechanical transplanting has been considered as the most promising option because it reduces the labour requirement to 50 man-h/ha (Anoop Dixit, 2007). Apart from saving in time and cost of transplanting which is very high in manual transplanting, it removes human drudgery and can give uniform and desired plant density, good crop stand and productivity.

The mechanical transplanting of rice using self-propelled rice transplanter requires mat type nursery instead of conventionally grown wash root type. The major constraint encountered in the adoption of mechanical transplanting is complex and labour intensive technique of rising mat type nursery. Unevenness of plant population in the mat is another problem leading to the more number of missing hills in the field. It was found that, the transplanter gives better performance with proper mat density (110 g of seed per mat) and uniformity of seed (2 to 3 no.s per cm^2) in terms of less missing hills during transplanting (Behera 2007). Therefore some mechanical means is required for spreading of the pre-germinated paddy seed in the plastic tray with better uniformity compared to manual spreading. This not only saves the time, labour and provides good uniformity of seedling on the mat but will also help in getting desired plant population while transplanting the crop with rice transplanter.

In the context of the above knowledge, a suitable device was developed that can be used for spreading of the pre germinated paddy seed in the soil filled plastic tray of size 280 × 580 mm instead of by manual labour for raising the mat nursery.

MATERIAL AND METHODS

A pre-germinated paddy seeding device was developed in the Dept. of Farm Machinery and

Power, College of Agricultural Engineering, Bapatla. A paddy variety, Swarnamukhi (NLR 145) was selected for the experiment. Sufficient quantity of seed initially soaked in a water for 24 h and then incubated in a gunny bag for 24h. The average sprout length obtained was 1.02 mm.

Details of seed spreading device

The various components of developed device are frame, ground wheel, hopper, agitator, wooden groove roller, power transmitting unit and platform (Fig. 1 and 2).

Frame

The frame of the paddy seeding device is made up of mild steel flat of size 12 mm width and 7 mm thickness. The overall length, width and height of the frame were kept as 380, 305 and 237 mm respectively. All other components of the device were fixed on the frame.

Ground wheel

The ground wheel was provided to support the weight of various components of the device along with the weight of seed in the hopper and also provides power to rotate the wooden groove roller and agitator in the hopper. Four wheels made up of mild steel shaft were provided, each having the diameter of 38 mm with 12 mm hole at the centre to insert the shaft.

Hopper

It was designed by taking into consideration the capacity required, bulk density and angle of repose of pre-germinated paddy seed. The seed spreading device is provided with a hopper made of mild steel sheet 1 mm (22 gauge) thickness to place the sprouted seed and to get the flow of seeds into the wooden groove roller. The hopper is trapezoidal in cross section with length 280mm, width 200 mm and height 145 mm. The side wall of the hopper is kept inclined for easy flow of the sprouted seeds. The inclination is kept as per the angle of repose of sprouted seed which ranges from 40 to 45^0. In order to get the flow of seed from hopper to the wooden roller, an opening of 6 mm width has been provided at bottom of the hopper.

Agitator

An agitator is arranged inside the seed hopper nearer to bottom for preventing the strucking of seed when in operation, so that the sprouted seed flow towards the bottom continuously resulting in uniform distribution of seed over soil filled tray through wooden groove roller. It is made of 5 mm diameter mild steel shaft of length 370 mm with 6 small washers welded at equal spacing. Power is given to the agitator through a rope drive by the arrangement of two small pullies arranged each one on one end of agitator shaft and another one on one end of driving shaft. It rotates at equal speed of driving shaft.

Wooden groove roller

Wooden groove roller is provided under the seed hopper to get even distribution of sprouted seeds over the soil filled tray. It is made from teak wood, having a length and diameter of 330 mm and 40 mm respectively. Along its length, 10 grooves of each depth 3 mm are cut for 280 mm length at left side and leaving 50 mm in plane at other side.

Power transmission unit

The power to operate the wooden groove roller and agitator is transmitted from ground wheel through chain sprocket drive and rope drive respectively. The power from the ground wheel is transmitted to the shaft which is about 19 mm in diameter and 488 mm in length. Two ground wheels are rigidly fixed on this shaft one each on either end of the shaft. The shaft is fitted through two bush bearings to the frame of the device. A sprocket with 44 numbers teeth is fitted on this shaft. Another sprocket having 14 numbers of teeth is fitted on another shaft of diameter 5 mm and 60 mm in length attached to the wooden groove roller. The power from ground wheel shaft is transmitted to wooden groove roller through a chain having pitch 12.5 mm and 600 mm in length. The speed ratio between these shafts was kept as 1:3.

Wooden platform

A separate wooden platform was made to help as a track for moving of the seed spreading device over the soil filled plastic tray. This is having two square wooden pieces of length 1500 mm, width 60 mm and height 110 mm joined together rigidly by three iron rods with bolts. Distance between them was kept as 312 mm and provided with 27 iron rods each of length 336 mm covered with the 16 mm PVC pipes for easy movement of trays. This wooden platform can be used either on leveled surface or on unleveled surface.

In order to test the performance of the device in the laboratory, the following methodology was adopted to determine the following related parameters.

Fig. 1. Schematic diagrams of paddy seeding device for mat nursery.

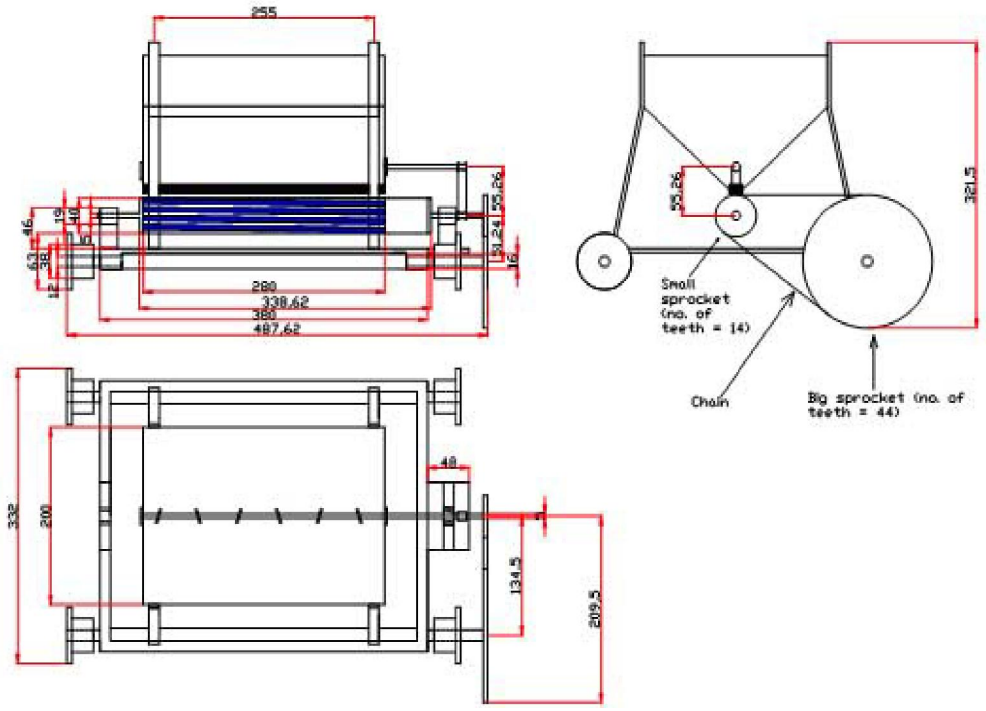

Fig. 2. Developed paddy seeding device for mat nursery.

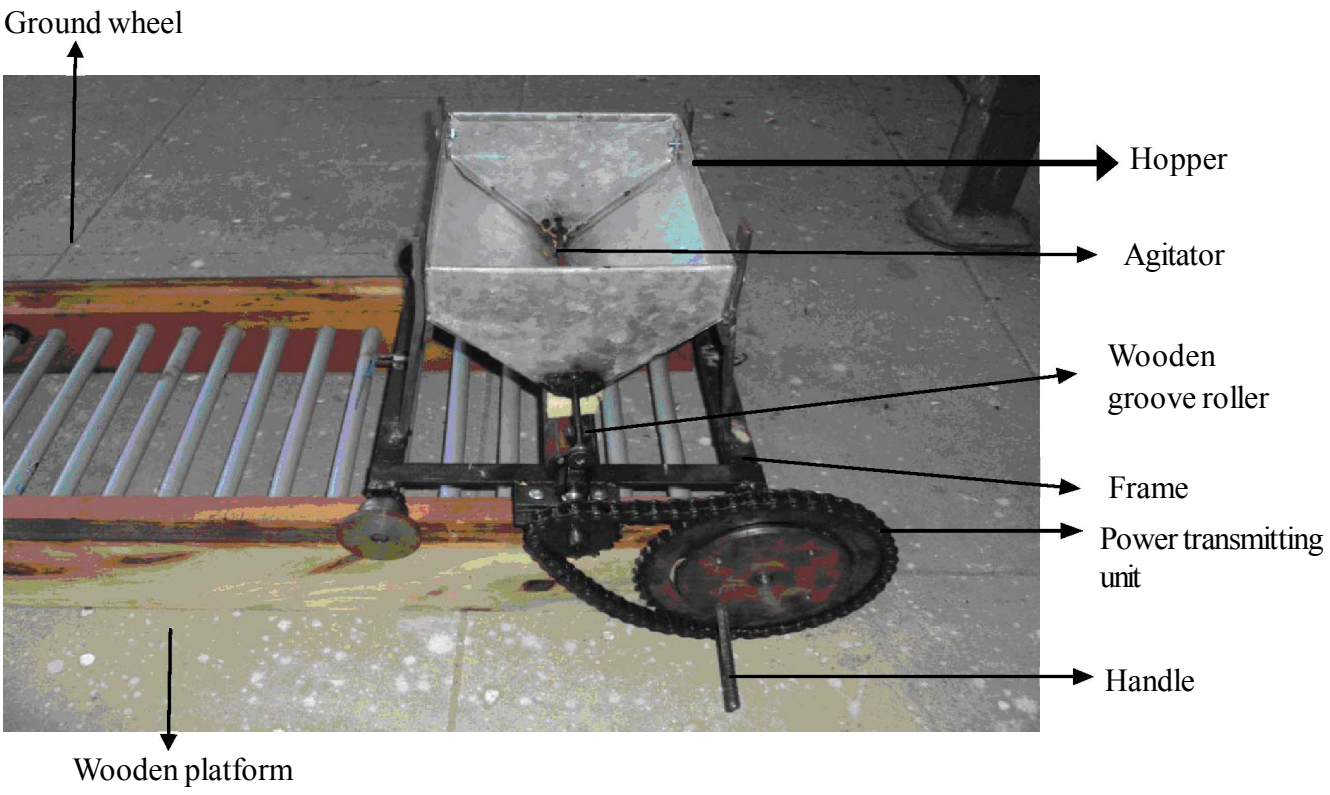

Table 1. Amount of seed dropped per tray in two passes of the device at 1.02 mm sprout length.

S. No.	Number of passes	Replications	Amount of seed dropped per mat, g
1	1	1	55.2
		2	60.1
		3	57.5
Average			57.6
2	2	1	112.0
		2	114.3
		3	110.9
Average			112.3

Table 2. Amount of seed dropped per 50X50 mm in one and two passes of device.

Segment No.	Replications	Amount of seed dropped in 50X50 mm			
		1 pass		2 passes	
		Number of seeds	Weight of seeds, g	Number of seeds	Weight of seeds
One	1	31	0.85	65	2.49
	2	29	0.80	62	2.60
	3	33	0.91	64	2.51
	Average	31.00	0.85	63.60	2.53
Two	1	30	0.83	61	2.54
	2	32	0.88	63	2.60
	3	30	0.82	62	2.56
	Average	30.66	0.84	62.00	2.56
Three	1	34	0.94	60	2.45
	2	31	0.85	64	2.51
	3	28	0.77	62	2.60
	Average	31.00	0.85	62.00	2.52
		30.88	0.84	62.53	2.53

1. Weight of seed per tray

In order to determine the weight of seed per tray or mat, initially the sprouted seed was filled in the hopper and the device was moved on the soil filled plastic tray. When the device was moved over the tray, the sprouted seed was dropped. Thereafter, the seed dropped in a tray was collected and weighed. The weight of the seed dropped in a tray gives the amount of seed dropped per mat. The above procedure was repeated three times to determine average amount of seed dropped per mat.

2. Uniformity of seed

To determine uniformity of seed distribution per 25 cm^2 area in the mat, the device was operated to move over the soil filled plastic tray for spreading of seed. The tray was divided into three equal segments along the length. Five square rings of size 50 × 50 mm were placed randomly in each segment along the length of tray. The seed dropped in each ring was collected, averaged out for each segment, counted and weighed. The above procedure was repeated three times to determine average uniformity of seed.

Table 3. Seedling characteristics of mat nursery raised by both the methods.

S. No.	Parameter	Nursery raising method	
		Manual	Mechanical
1.	Variety	NLR 145	NLR 145
2.	Seed rate, g/tray	100	112.3
3.	Number of seedlings/cm^2	22 - 90	52 - 69
4.	Height of seedling, mm	80.2	79.0
5.	Leaf stage (no. of leaves on 7th day)	2	2
6.	Stem thickness, mm	1.0	1.0
7.	Mat thickness, mm	2.0	2.0

3. Seedling characteristics

For comparative performance of the developed paddy seeding device with manual spreading, seperate nursery was raised in a plastic tray of same size by spreading of sprouted seed (100 g/tray) manually. Number of seedlings per 25 cm^2 area, height of seedling, leaf stage and stem thickness were noted in both the methods of spreading.

RESULTS AND DISCUSSION

The performance of the seed spreading device was evaluated in the laboratory. The results are discussed below.

1. Weight of seed per mat

The results of weight of seed dropped per mat are presented in Table 1. The average weight of seed dropped per mat was 57.6 g for first pass (forward) and 112.3 g for second pass (backward). Therefore, the recommended quantity of seed per mat (100 to 120 g) was achieved in two passes (one forward and one backward). It was found that two passes (one forward and one back ward) of developed device were enough to get the recommended quantity of seed over the soil filled plastic tray.

2. Uniformity of seed

The results of uniformity of seed are presented in Table 2. It is clear that for one pass of the device, the average number of seed dropped in each segment was found to be 30.88 seeds per 25 cm^2 area and when the number of passes was increased from 1 to 2, the average number of seed dropped in each segment was found to be 62.53 seeds per 25 cm^2 area. This shows that, the developed device is able to drop the recommended uniformity of seed (50 to 75 seed/ 25cm^2) or (2 to 3 seed/cm^2) in two passes. Therefore, it can be inferred that two passes (one forward one backward) were enough over the soil filled plastic tray to get the recommended uniformity of seed.

3. Seedling characteristics

The number of seedlings per 25 cm^2 area was found to vary in between 22 to 90 in case of manually raised nursery, whereas, it was 46 to 69 for the developed device. The average number seedlings per cm^2 was found nearly same in both the methods of nursery raising. However, it was absorbed that more number of gaps were found in case of manually raised nursery tray, this may be due to less uniformity in seed spreading. The plant height (80 mm), leaf stage (2), stem thickness (1 mm) were found equal for both the methods of nursery raising. Thus, it is clear from the data, the results of seedling characteristics raised by the developed device are at par with manually raised type nursery.

The major constraint encountered in the adoption of mechanical transplanting is complex and labour intensive technique of rising mat type nursery. Unevenness of plant population in the mat is another problem leading to the more number of missing hills in the field. It was found that, the transplanter gives better performance with proper mat density (110 g of seed per mat) and uniformity of seed (2 to 3 no.s per cm^2) in terms of less missing hills during transplanting. To get recommended density and uniformity of seed on the mat, developed pre-germinated paddy seeding device could be used successfully for raising mat nursery with two passes of (one forward and one backward) device over soil filled plastic tray of size 280 × 580 mm provided the length of sprout nearly 1mm.

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