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Development of tractor operated semi-automatic two row turmeric planter

Er. Manoranjan Kumar and Akhilesh Bariha

Abstract
Turmeric can be grown in tropical areas that are hot and humid. If planting is mechanized then the area under turmeric can be increased. The planter will remove human drudgery during planting and also improve the quality of planting. Therefore, two row semi-automatic tractor operated turmeric planter was developed at the department of Farm Machinery and Power Engineering, College of Agricultural Engineering and Technology, RPCAU Pusa. The planter consists of a main frame, seed metering mechanism, seed hopper, ground wheel, furrow opener, ridger, power transmission unit and operator seat. The field performance of the planter carried out at three different speed 0.75 km/h, 1.00 km/h and 1.25 km/h. The spacing between seeds was found 22.00 cm, 22.24 cm and 23.00 cm at the speed of 0.75 km/h, 1.00 km/h and 1.25 km/h respectively. The missing percentage was found 10.35%, 12.02% and 15.43% at the speed of 0.75 km/h, 1.00 km/h and 1.25 km/h respectively. The theoretical field capacity was observed that 0.067 ha/h, 0.09 ha/h and 0.112 ha/h at the speed of 0.75 km/h, 1.00 km/h and 1.25 km/h respectively. The effective field capacity was observed that 0.059 ha/h, 0.077 ha/h and 0.09 ha/h at the speed of 0.75 km/h, 1.00 km/h and 1.25 km/h respectively. The physical properties of turmeric i.e., weight, length, width, thickness and moisture content were 23.81 g, 58.90 mm, 53.97 mm, 25.79 mm and 15.65% respectively.

Keywords: Tractor operated, semi-automatic two row, turmeric planter

1. Introduction
Turmeric (*Curcuma longa*) is a perennial herb, which is used as spice. It's known as Indian saffron, and *Haldi*. Turmeric production is estimated to be over 11 lakh tonnes per year worldwide. India dominates the global production picture, accounting for 80% of total output, followed by China (8%), Myanmar (4%), Nigeria (3%), and Bangladesh (3%). Because turmeric is an important component of many Indian dishes and traditional remedies, India is the largest producer and exporter of turmeric and turmeric-based products. In India, roughly 2.54 lakh hectare of turmeric were planted in 2019-2020 with production of 12.29 lakhs tones. Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Maharashtra, and Assam are the most prominent turmeric-growing states in India.
The total area under turmeric in Bihar is 3384 ha, with an annual production of 8237 tonnes. Turmeric is primarily farmed as a significant spice crop in Bihar's northwestern districts, including Muzaffarpur, Samastipur, Vaishali, East Champaran, Madhubani, Sitamarhi, Bhagalpur, and Begusarai.
Planting turmeric take time and effort. This is tedious task as workers have to manually dig the soil and sow the seed on the ground. In the current economic environment, the shortage of skilled workers makes it very difficult to increase turmeric production. It associated with human drudgery, human energy intensive and back breaking tasks due to regular bending posture at the time of sowing. With the above stated reason there is need of tractor drawn turmeric sowing implements. The objective of this research is to develop a tractor drawn semi-automatic turmeric planter.

2. Materials and Methods
2.1 Development procedure
The following analysis were carried out to develop different parts of implement.

2.1.1 Determination of forces acting on main frame
Draft per tyne = soil resistance × width × depth
Torque produced on frame (T) = draft × ground clearance × no. of tynes

2.1.2 Determination of capacity of hopper

$$\text{Capacity of hopper} = \frac{\text{seed rate}}{\text{n} \times \text{bulk density}}$$

Where n is number of refilling per hectare

2.1.3 Design of metering mechanism

Number of cell/slots on metering disc was determined by

$$\text{Number of cell per metering disc} = \frac{\text{actual distance travelled by ground wheel}}{\text{gear ratio} \times \text{rhizome spacing}}$$

Diameter of metering disc was determined by
Diameter of metering disc

$$= \frac{\text{Number of cell per metering disc} \times \text{Peripheral distance between two cells}}{\pi}$$

2.1.4 Determination of number of revolutions of drive wheel

$$\text{No of revolution per hectare} = \frac{10000}{\pi D \times \text{working width of planter}}$$

Where D is diameter of drive wheel

2.2 Description of the turmeric planter

1. **Main frame:** MS square pipe was used to fabricate rectangular frame. The main frame was strong enough to withstand all types of loads during working condition. All the other parts of the planter were supported by the main frame.
2. **Hopper:** The planter's hopper was fabricated with an angle bar frame and a suitable cover by a 2.2 mm thick mild steel sheet. To avoid frequent feelings during operation, the seed box should be able to store a sufficient quantity of turmeric.
3. **Seed metering mechanism:** The seed metering mechanism was fabricated by mild steel flat and was powered by two wheels attached to both sides of the frame. The metering disc has ten slots which is equally spaced throughout the periphery of the disc. The metering disc was horizontally rotated after being mounted over a set of bevel gears. The horizontal disc type metering unit is a metering device that requires manual feeding.
4. **Seed dropping mechanism:** The seed dropping mechanism was fabricated by a mild steel sheet half-cylindrical form. The turmeric seed will be placed in the cell by the operator then the turmeric will be passed through a half cylindrical tube and dropped in between the two ridger.
5. **Ground wheel:** The ground wheel was fabricated using high carbon steel. The ground wheel was attached to both sides of the frame and connected through the shaft. 22 lugs, 10 mm diameter and 100 mm length were welded at equidistant on the round rim of the ground wheel. The wheel had 12 spokes between the inner rim and hub, made from mild steel rods, and was welded to the hub at the centre and inner rim of the wheel. 7 spoke between the outer rim and inner rim and were welded to the rim.
6. **Ridger bottom:** The ridger bottom was attached to the turmeric planter frame to create uniform sized ridges. As the planter was developed for two rows therefore three ridger were provided. The ridger bottom consists of a shovel, tyne, and wing. The ridger bottom was developed with adjustable curved wings shaped. At the lower end shovel was bolted with the tyne.
7. **Operator Seat:** The seat was fabricated by an angle iron and flat that was attached to the back side of the frame. The dimensions of the operator seat were 640 mm length and 770 mm width. Back support was provided in the seat for back support and safety. MS flats were welded between the two angle iron for sitting and back support. 5 MS flats were welded between angle iron for sitting and 4 MS flats were welded between angle iron for back support. The two operators will get together seated in the operator seat to feed the turmeric into the metering mechanism.
8. **Power transmission system:** The power is transmitted from the ground wheel to the shaft fitted above the main frame. The shaft rested on 3 US bearings, two at the end and one at the middle of the shaft. From the shaft fitted on the main frame, the drive is transmitted to the bevel gears fitted on the shaft of the turmeric metering mechanism with a gear ratio of 1.8:1. The bevel gear fitted on the turmeric metering shaft drives the metering disc.

2.3 Crop parameter

The following crop parameter were considered for the development of turmeric planter. Physical properties of crop i.e., length, width, thickness, weight and moisture content. Moisture content of crop was calculated by oven dry method.

2.4 Field test

The developed planter was tested at Farmer's field of village Kalyanpur district Samastipur, size of the plot was length 80 m and width 8.1 m. Based on speed 3 different treatments perform on the field, each treatment having 3 replications.

Plate 1: field evaluation of planter

2.4.1 Missing percentage

The missing percentage (I_{miss}) indicates how frequently the turmeric seed skips the desired spacing. When the spacing is greater than 1.5 times the recommended spacing (S) it

indicates missing. That is given below,

$$I_{miss} = \frac{n_1}{N} \times 100$$

Where,
n_1 = number of spacing in the region > 1.5 S
N = total number of observations

2.4.2 Theoretical field capacity
The theoretical field capacity was calculated by taking planter's working width and travel speed into account. The theoretical field capacity is expressed in ha/h using the formula,

$$\text{Theoretical field capacity} = \frac{\text{width of operation (m)} \times \text{speed(km/h)}}{10}$$

2.4.3 Effective field capacity
During field tests, time losses for each event, such as turmeric refilling in the planter and turning losses, were recorded. The actual field capacity was expressed in ha/h and measured using the formula,

$$\text{Effective field capacity} = \frac{\text{length of field (m)} \times \text{width of field(m)}}{10000 \times \text{time (h)}}$$

3. Results and Discussion
3.1 Machine evaluation in field
3.1.1 Spacing between seeds
Average spacing between seeds was increases as increased in speed. The spacing between seeds was found 22.00 cm, 22.24 cm and 23.00 cm at the speed of 0.75 km/h, 1.00 km/h and 1.25 km/h respectively.

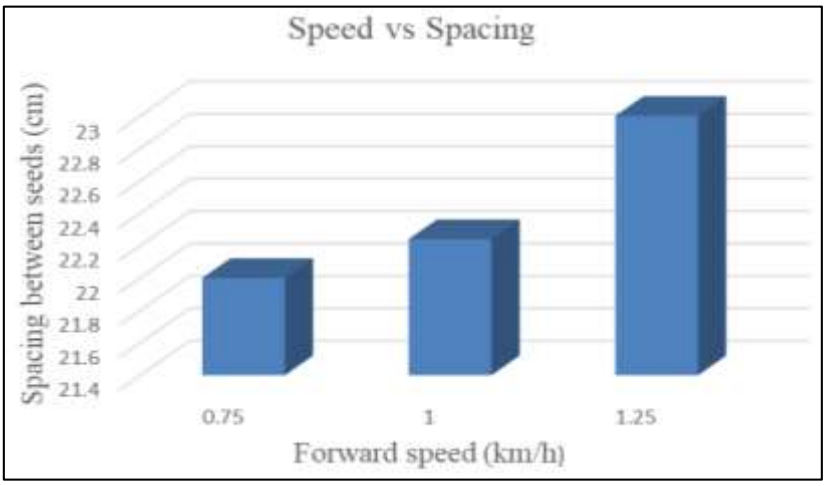

Fig 1: Seeds spacing

3.1.2 Missing Percentage
The missing percentage slightly increased with an increase in speed. The missing percentage also depends on the labour's skill to fill the cell with turmeric seeds. The minimum missing percentage was found at speed of 0.75 km/h. The missing percentage was found 10.35%, 12.02% and 15.43% at the speed of 0.75 km/h, 1.00 km/h and 1.25 km/h respectively.

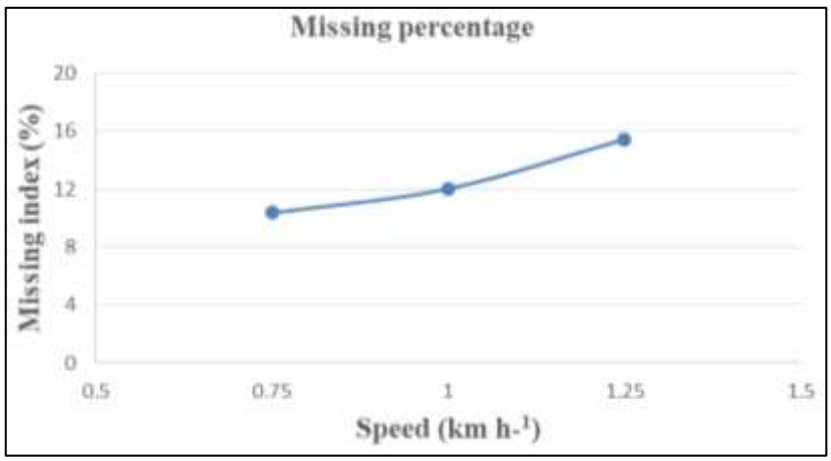

Fig 2: Missing percentage

3.1.3 Theoretical field capacity, effective field capacity and field efficiency
Theoretical field capacity increased with an increase in speed. The theoretical field capacity was 0.067 ha/h, 0.09 ha/h, and 0.112 ha/h at the speed of 0.75 km/h, 1.00 km/h and 1.25 km/h. Effective field capacity increased with an increase in speed. The effective field capacity was 0.059 ha/h, 0.77 ha/h and 0.09 ha/h at the speed of 0.75 km/h, 1.00 km/h and 1.25 km/h respectively.

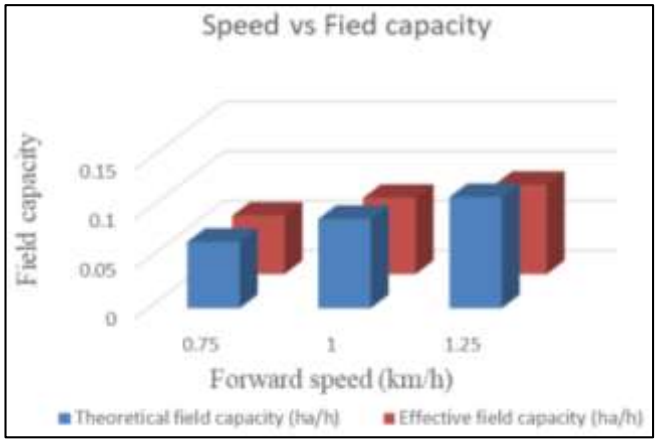

Fig 3: Field capacity

3.2 Crop parameter

The physical properties of turmeric were measured that is average of weight, length, width, thickness and moisture content was 23.81 g, 58.90 mm, 53.97 mm, 25.79 mm and 15.65% respectively.

Table 1: Physical properties of turmeric seeds

S.N.	Particular	Observation	Average
1	Variety	Rajendra Sonia	
2	Weight (g)	26.12	23.81
		23.76	
		21.57	
3	Length (mm)	57.92	58.90
		60.01	
		58.77	
4	Width (mm)	36.07	53.97
		41.25	
		48.59	
5	Thickness (mm)	25.81	25.79
		29.22	
		22.34	
6	Moisture content (mm)	13.57	15.65%
		17.71	
		15.73	

Conclusion

The turmeric planter was fabricated and evaluated in the field. The performance evaluation of planter was carried out at three different speed 0.75 km/h, 1.00 km/h and 1.25 km/h. The spacing between seeds and missing percentage was increased with the increase in speed. The spacing between seeds were found 22.00 cm, 22.24 cm and 23.00 cm at the speed of 0.75 km/h, 1.00 km/h and 1.25 km/h respectively. The maximum missing percentage was found 15.43% at the speed of 1.25 km/h and the minimum missing percentage was found 10.35% at the speed of 0.75 km/h. The theoretical field capacity and effective field capacity increased with the increase in speed. The theoretical field capacity was found 0.067 ha/h, 0.090 ha/h and 0.112 ha/h at the speed of 0.75 km/h, 1.00 km/h and 1.25 km/h respectively. The effective field capacity was found 0.059 ha/h, 0.077 ha/h and 0.09 ha/h at the speed of 0.75 km/h, 1.00 km/h and 1.25 km/h respectively.

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