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Development and performance evaluation of an onion bulblet planter for vertisol

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ABSTRACT

India is the second largest producer of onion in the world next after China. Mechanization of farming is increasing day by day to produce yield of crop for gaining the profit. This study was related to the development of an onion bulblet planter for vertisol. The development and fabrication of different furrow opener for matching to the existing inclined plate metering device for planting of onion bulblet. The performance of onion bulblet planter in term of depth and width of planting, missing index percentage, multiple percentage, seed damage , actual field capacity and field efficiency. The result indicated that the field efficiency was maximum 83.33% with minimum seed damage 10.2%. Multiple index was 5.1%, missing index was 2.2 % and bulb to bulb spacing was 10.66 cm in chisel type furrow opener at 1.8 km/h speed with moisture content 17.2 %.

Key words: Actual field capacity, Field efficiency, Furrow openers, Onion bulblet.

INTRODUCTION

Onion (*Allium cepa* L.) is an important commercial crop grown on a large area for local consumption medicinal and export purpose. In India onion is cultivated in an area of 9.59 lakh hectares with the annual production of 163.09 lakh tonne with an average productivity of 17.01 tonne per hectare.(Agrifarming. in). In Madhya Pradesh onion is cultivated in an area of 1.17 lakh hectare with the production of 28.42 lakh tonne hectares.(Anonymous 2014-15). Onion grows under wide range of conditions but mild season without great extremes of heat or cold or excessive rainfall is best suited. It requires temperature of 12-25°C before bulbing and 15.6-21.1°C for bulb formation. It requires 70% relative humidity. Onion grows well in almost all types of soils from sandy loam to heavy clays. Onion matures early in sandy soils than in heavier ones. The best pH ranges from 6.5-7.8. There are two methods of seed production. Seed to seed and bulbs to seed methods and both the methods are in practice for onion seed production. However, bulb to seed method is the most widely followed method for seed production. In the bulb to seed method the bulbs produced in the previous season then harvested , selected, stored and replanted to produced seeds in the second year. Gajakos *et al.* , (2015) evaluated of manually operated garlic planter with the depth of placement of 4-5 cm. the field efficiency and cost of operation found were 85 per cent and Rs 1214/ ha. Bairwa (2016) developed an inclined plate metering device for manually operated onion planter. It was found that the elevating error was minimum 1.04 %, bulb damage was nil and cell fill was maximum 101.04 per cent at an angle of inclination 50° compared to 60° and 70°. Actual planting distance, mean planting distance and planting error was minimum and feed index was maximum 95.99 % at travel speed of 0.6 km/h. Maheshwari and Varma (2007) .evaluated manually operated garlic planter. Speed of planter was 1.8 km/h The average yield by manually operated garlic planter and manual planting was 60.83 and 64.68 q/ha respectively. Benjaphragairat *et al.* (2010) focused on increasing the planter capacity by reducing the draft of the planter, increasing the field efficiency by increasing the optimum number of rows and increasing the uniformity of the seed.

MATERIALS AND METHODS

The experiment was conducted farm field at the College of Agricultural Engineering, J.N.K.V.V. Jabalpur. The onion bulblet planter was developed and tested in the field to evaluate its overall performance. the onion planter consist of main frame, seed box, seed metering device, seed delivery tube, power transmission system and drive and supporting wheel.

COMPONENTS OF ONION BULBLET PLANTER

Frame: Two rectangular hollow flats 50 x 25 x 2 mm of 1 meter were welded with the help of M.S. flat, holes was provided in the frame with bush to fit the support wheel to prevent lateral movement of the wheels.

Seed box: Overall dimension of seed box was 500 x 552 x 250 mm. The capacity of seed box was 5.6 kg, but it maintain 4-5 kg onion bulb for the experimental purpose. Opening of

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100 x 70 mm was provided to discharge the onion bulb to the delivery passes.

Seed metering device: A circular wooden metering plate of 250 mm diameter was made. The thickness of metering plate was 30 mm. A circular hole of 16 mm diameter was made.

Seed delivery tube: Seeds should fall freely from the metering device through the conical funnel and the tube into the furrow.

Power transmission: Positive drive should be provided to the seed metering device to ensure minimum power loss and to maintain metering accuracy. In this study, chain, sprocket and bevel pinion was used for power transmission. Speed ratio from drive wheel shaft to metering shaft was 0.66.

Length of chain: Length of chain was 502 cm.

Development of furrow opener

As shown in Fig 1, The three different type of furrow opener were developed:-

1. Chisel type: The furrow opener is made of M.S. Flat. The shank of 30 mm wide and 120 mm long was provided. Two flat iron pieces, each of 250 × 50 × 2 mm size, were welded to shank to form channel. Four holes of 6 mm dia. were drilled at an interval of 10 mm for depth adjustment.

2. Shoe type: The furrow opener made up of flat of size 120 × 30 mm was used for fabricating the shank of shoe type of furrow opener .These types of furrow openers are used for forming narrow slit under heavy soils for placement of seeds at medium depths. The angle bar iron was fabricated to shoe type like structure to facilitate an easy cut through the soil. Nut and both were used to fasten the device to the frame through a hole drilled on the frame for adjusting sowing depth according to crop.

3. Shovel type: The furrow opener made up of MS rectangle section for the increasing the strength. Nut and both were used to fasten the device to the frame through a hole drilled on the frame for adjusting sowing depth according to crop.

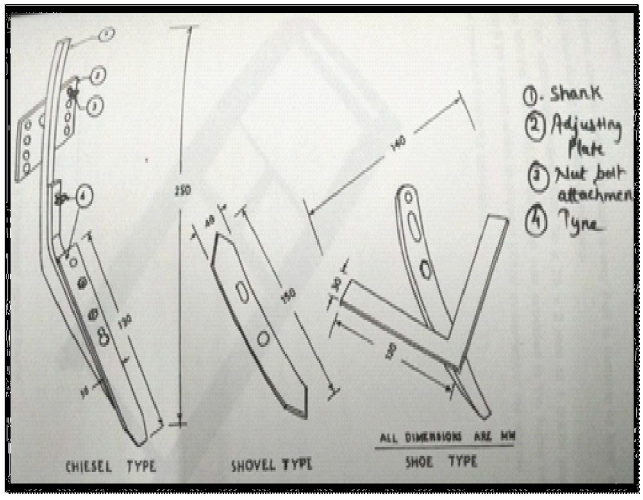

Fig 1: Different types of furrow opener.

Table 1: Specification of developed onion bulbet planter.

Parts name	Dimensions detail
Frame, mm	1000x25x2
Handle, mm	750x900x20x
Seed box, mm	650x252x250
Metering device, mm	Diameter-250 Cell diameter – 40 Number of cell -8
Overall dimension of furrow opener, mm	260x50x5
Drive wheel, mm	390x25x5
Power transmission	Chain sprocket and bevel pinion
Speed ratio	0.66
Overall dimension, mm	1500x900x990
Weight of machine, Kg	35.5

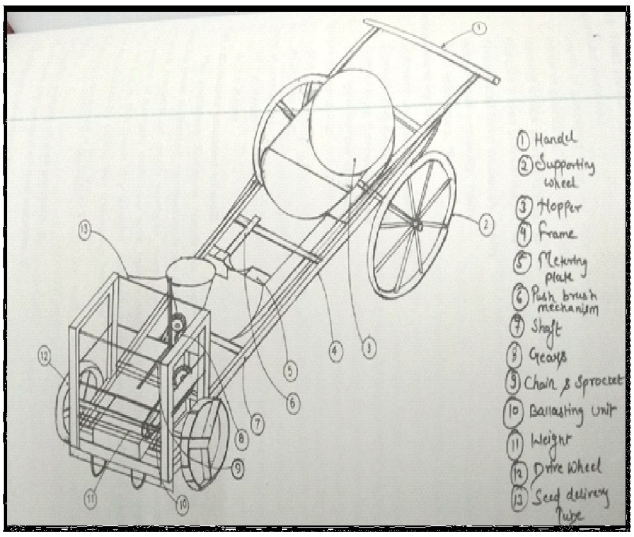

Fig 2: Isometric view of manually operated onion bulbet planter.

PERFORMANCE PARAMETERS MEASURED DURING FIELD EVALUATION

Speed of operation and turning time: During field trial of planter speed of operation was measured by recording the time required to cover 10 m distance by using stop watch.

Speed (Km/h)=

$$\frac{\text{Distance covered (m)}}{\text{Time required to cover the distance (Sec)}} \text{ X } 3.6$$

Depth and placement of onion bulblet: The machine was operated in the field of onion bulb with some setting in depth adjusting mechanism, in order to get average depth of the bulb placement.

Missing hill percentage: The miss index is the ratio of number of spacing greater than 1.5 times of set spacing and total number of measured spacings

$$M = \frac{nt - na}{nt} \text{ X } 100$$

Where, M= missing hills, %
nt= Number of hills present in row for given row length , theoretically
na= Actual number of hills observed in a row for same length

Theoretical field capacity: It depend upon theoretical speed and width of implement. The theoretical field capacity was calculated as:

$$\text{Theoretical field capacity(ha/h)} = \frac{S \times W}{10}$$

Where, S speed of travel Km/h
W = theoretical width of implement, m

Effective field capacity: For calculating effective field capacity, the time taken for actual work and that lost for other activities such as turning, cleaning, refilling of seed box, adjustment of machine and time spent for machine trouble were taken in to consideration. By calculating the area covered per hour, the actual field capacity was calculated.

Field efficiency: Field efficiency is the ratio of the effective field capacity and theoretical field capacity and expressed in percentage. Field efficiency was calculated as:

$$\text{Field efficiency} = \frac{\text{Effective field capacity}}{\text{Theoretical field capacity}} \times 100$$

RESULTS AND DISCUSSION

Performance evaluation of manually operated onion bulblet planter: The field test were conducted on the farm field college of Agricultural Engineering JNKVV Jabalpur. The type of soil was vertisol. The field size was 30 m^2. Performance of manually operated onion bulblet planter with different shape of furrow opener at 17.2% and 20.2% moisture content and 1.8 Km/h and 2.5 Km/h speed.

Depth of planting : In Fig 3 shows that effect of different shapes of furrow opener on depth of planting at 17.2% and 20.2% moisture content and at 1.8 Km/h and 2.5 Km/h.

Effective field capacity: It Fig 4 shows that the maximum effective field capacity was 0.0219 ha/h with shovel tpe furrow opener at 17.2% moisture content. Figure shows that effective field capacity was more for 17.2% MC as compared to 20.2% MC for almost all the three shaped of furrow opener.

Field efficiency: In Fig 5 shows that chisel type furrow opener is more suitable as it provided higher efficiency (83.3%) as compared to shovel (81%) and shoe type (80.3%) for the moisture content 17.2% at the speed of 1.8 Km/h. Almost similar results are obtained when machine operated on the field having 20.2% moisture content. This agreed with the result of an earlier study by Maheswari and Verma (2007), where the speed of planter was 1.8 Km/h, the field efficiency was 78%.

Missing index percentage: In Table 2 shows that the missing hill percentage with this planter was observed to be 2.22 per cent.

Missing index = (4/180) X = 2.22%

The result of an earlier study by A.V. Gajakos *et al.* (2015) where the missing index percentage was 28.00 %. However it is observed that being black cotton soil, the soil

Table 2: Performance of different types of furrow opener at different parameters.

Parameters	Chisel type opener	Shovel type opener	Shoe type opener
Missing hill percentage	2.22	2.90	3.02
Multiple index percentage	4.7	5.1	5.3
Seed damage	0.2	0.5	0.9

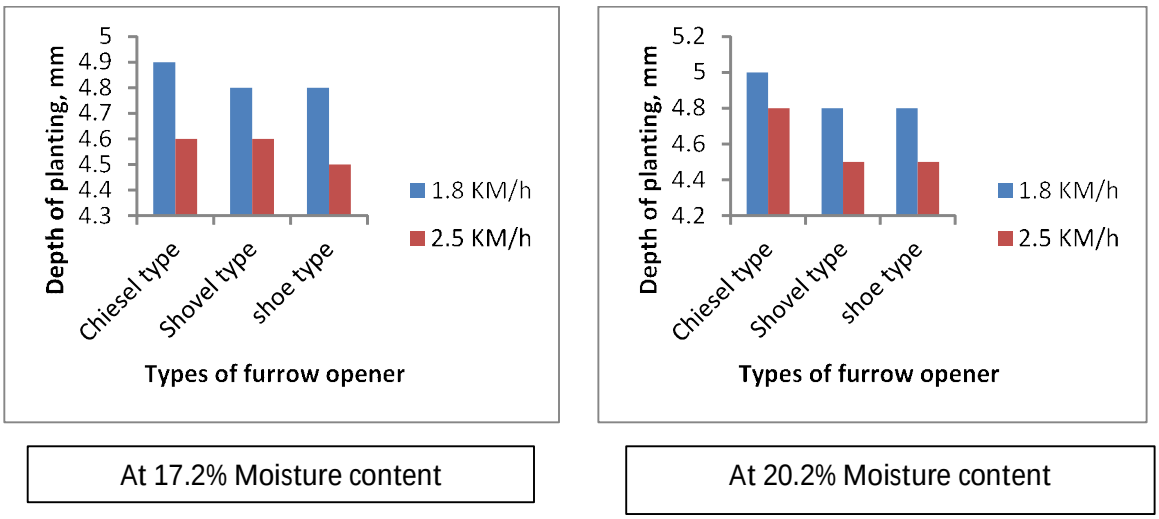

Fig 3: Effect of moisture content and speed of operation on depth of planting.

condition remains cloddy even after harrowing. This caused excessive jerks to be planter while in operations. As a result misplacement of the bulbs were more.

Multiple index percentage: In Table 2 shows that the only 8 bulbs were found to be 5 m, hence the multiple index was only 5.1% of the bulb were viewed as dropped at the same time as the previous bulb.

Seed damage: In Table 2 shows that the number of bulblets that were damaged mechanically including significant bruising, skin removal or crushing were counted. It was observed only 0.2 per cent which is considered to be very low and within acceptable limit.

Seed uniformity: In Table 3 shows that the difference between bulb to bulb spacing along a randomly selected 10 m length of 3 row was calculated. The average spacing bulb to bulb was 10.66 cm respectively .the result in the earlier study by Pitre Ashish madan (2013) , it is found that the

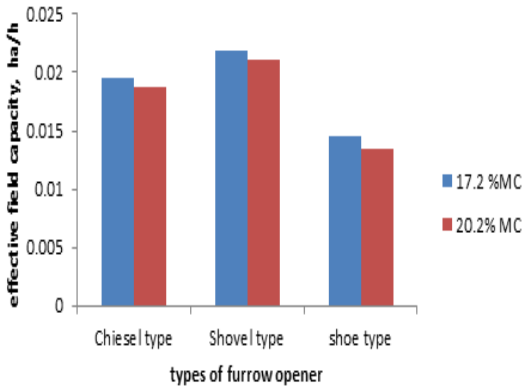

Fig 4: Effect of effective field capacity for different type of furrow opener.

Table 3: Measure plant to plant distance at adjacent row.

S.No	Plant to plant distance, cm			
	Row 1	Row 2	Row3	Average
1	10	12	11	11
2	8	9	12	9.66
3	12	10	10	10.66
4	10	10	10	10
5	12	12	8	10.66

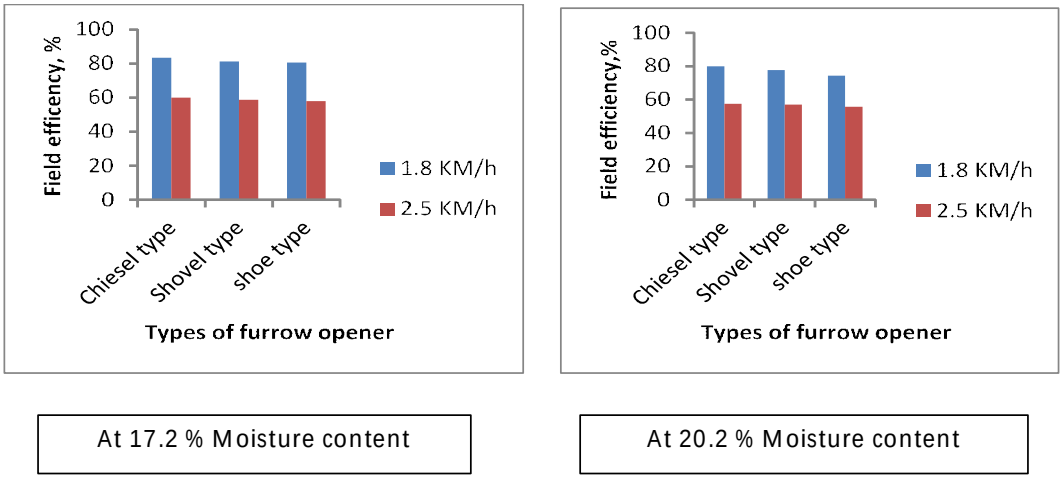

Fig 5: Effect of moisture content and speed of operation on field efficiency



Fig 6: In view of field performance of developed machine.

maximum (13.42 cm) at travel speed of 2.12 km/h and minimum (11.56 cm). Actual planting distance increases with increase in travel speed, as misses and accumulations increases.

CONCLUSION

The developed manually onion bulblet planter with chisel type furrow opener at 17.2 % moisture content and at 1.8 Km/h speed was recommended in view of minimum missing percent and multiple percent. The field efficiency was recorded to be the maximum (83.3%). The seed damage was also minimum (0.2%). The performance of planter with chisel type furrow opener at the speed of 1.8 Km/h and moisture content 17.2% was found to be the best and its operability was satisfactory and may be recommended for onion planter in vertisole.

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