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Performance evaluation of manually operated garlic planter

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■ **ABSTRACT :** The garlic planter comprises, main frame, seed box, metering mechanism, ground wheel with lugs, adjustable furrow opener and seed tube, covering bracket and marker. The field evaluation of manually operated garlic planter was undertaken with objectives *i.e.* to evaluate the field performance, to modify manually operated garlic planter and to study the economics of manually operated garlic planter. The weight of unit without cloves is 12 kg. Two persons are required for operating the planter. One person require for pulling the implement in forward direction and another for direction control. The laboratory and field test was conducted for the evaluation of the planter. The field test was done for calculating the field performance in terms of field efficiency and missing hills percentages. This planter was also tested for cost of operation, and depth of placement of cloves, missed hill percentage and ground wheel slippage. Result shows that the field efficiency was 84.79 per cent. The cost of operation was found to be Rs.1214 /ha, depth of placement of cloves was 4-5 cm. Time required and cost of sowing by planter was effectively less than manual sowing. Yield and returns of planter were found to be more than manual sowing.

■ **KEY WORDS :** Transmission for seed metering device, Missing hills, Field efficiency

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Garlic (*Allium sativum*) belongs to Alliaceae family. Garlic is a semi perishable vegetable cash crop. It is an annual herb, cultivated mainly for bulbs. Garlic is a frost tolerant crop. It requires cool and moist climate during growth period and warm dry weather during maturity. Bulbing takes longer day at high temperature, exposure to low temperature. Garlic can be cultivated in various types of soils, but well drained fertile loamy soil is suitable for this crop. Clay soil and sandy soil doesn't use for sowing garlic. Land should be brought to fine tilth by shallow ploughing 4-5 times, giving sufficient interval between two ploughings. Land should be levelled and divided into small plots and channels to facilitate proper irrigation and intercultural operations. Critical day length for bulbing is 120 hours. The pH of soil between 6 to7 is suitable for good crop. Highly alkaline and saline soil is not suitable for garlic.

The main states producing garlic in India are Madhya Pradesh, Gujarat, Orissa, Rajasthan, Karnataka, Tamil Nadu, Maharashtra and Bihar. Among these, Madhya Pradesh, Gujarat and Maharashtra are major growing states. Sowing of garlic means the placement of cloves in soil at proper depth, with proper moisture and soil temperature. The cloves sown should be in proper quantity to achieve the desired plant population. Precision and timeliness are important aspects of modern agriculture. Garlic is propagated by cloves. Well-grown compact bulbs of uniform shape and size are selected. The cloves having 2-3 cm size (Lallan *et al.*, 1992) is used for planting. Due to the lack of appropriate planting, cultivation and harvesting machinery for mechanizing its production, it is still grown in relatively small fields using

traditional methods.

At present the sowing of garlic done by dibbling by manual labour. This method has time and labour consuming. Keeping the above constraints in view, a study on performance evaluation of manually operated garlic planter was undertaken. This machine was developed to work in light soil of Punjab region. The major soil of Vidharbha region is black cotton soil hence, it is proposed to undertake the field performance evaluation of this garlic planter in heavy and medium soil.

METHODOLOGY

The methodology and experimental techniques adopted in studying performance evaluation of manually operated garlic planter. The strength, durability, working and economy of farm machinery depends largely upon the selection and quality of material used in its manufacturing and its fabrication. The garlic planter was tested in the laboratory as well as in the field to evaluate its overall performance. The laboratory tests were conducted in workshop of Department of Farm Power and Machinery, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The field trials of planter were carried out at the field of Chili and Vegetable Research Station.

Constructional details :

The manually operated garlic planter consists frame, ground wheel, transmission for seed metering device, seed box, seed metering mechanism, seed tube, furrow opener and handle. Before taking the field test of the planter, the filler trials of the available garlic planter was conducted and observed that, there was a ground wheel slippage due to which clove to clove distance was not maintained. Marker was required to maintain row to row distance of 10 cm and covering device was required to cover the cloves placed in the soil.

Main frame :

Main frame consists of flat section which was made by welding two M.S. flat having length 410 mm and size of 30 × 3 mm.

Ground wheel :

The garlic planter consisted of one ground wheel which was used for transmitting the drive to metering shaft. The diameter of ground wheel is 390 mm and rim width is 80 mm. During field trials, the modification was necessary and shown in Fig. A.

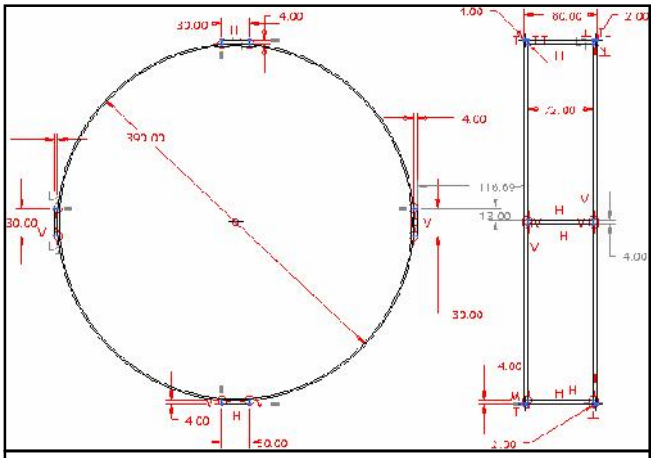

Fig. A : Modified ground wheel

Transmission system :

The power transmission unit consisted of transmission of power from ground wheel drive to metering plate by means of chain and sprocket set arrangement. The drive from ground wheel to the clove metering shaft was transmitted by means of chain and sprockets. Power was transmitted from sprocket on ground wheel shaft to respective sprocket on counter shaft by means of roller chain of length 1300 mm.

Seed box :

To carry the cloves, trapezoidal in shape seed box is selected. It was made from 2 mm thick M.S. sheet. The box was 300 mm long, 195 mm deep and having top width of 300 mm and bottom width of 120 mm. One M.S. flat of 30 × 3 mm size and 410 mm length are used to attach seed box with main frame.

Seed metering mechanism :

The metering mechanism for planter consisted of a vertical disc with spoon on its face (Benjaphragairat *et al.*, 2010). On the hub of this vertical disc sprocket was mounted which was connected to sprocket of ground wheel by chain for power transmission. As the disc rotate in the seed box, the spoon picks the cloves from the seed box and releases it in the seed release funnel. The single cloves picked by spoons and dropped in seed release funnel was totally depended upon spoon size. Spoon size design depends on average size and shape of cloves.

The metering plate is made of acrylic material having diameter 200 mm. The cross section of spoons on periphery of the plate is elliptical. Plate have 12 spoons are placed uniformly on its periphery.

Seed tube :

Seed tube is used for carry cloves, metered by vertical disc, up to boot portion of furrow opener with shortest route of clove travel and minimum obstacles in flow path for easy flow of cloves. A metallic seed tube of 40 mm diameter and 340 mm in length is used.

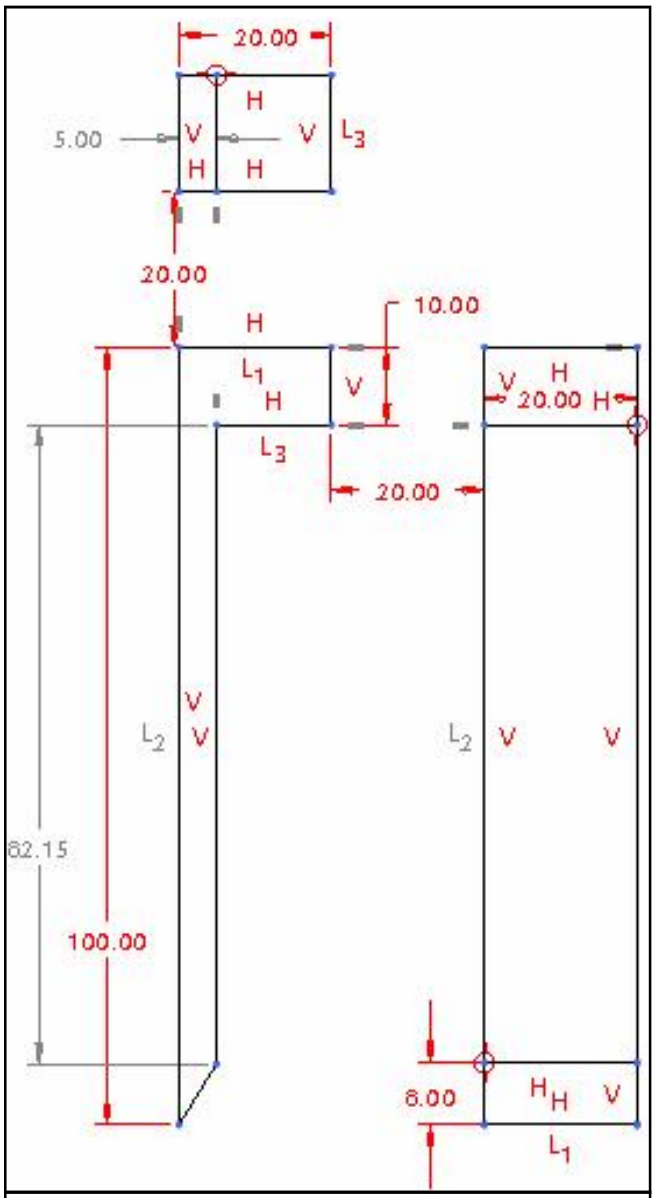

Fig. B : Marker

Furrow opener :

The shovel type furrow opener which is best suited for Vidharbha region was employed in this planter. These furrow openers are suitable for light medium soil free of excessive trash and it has good soil penetration. The furrow opener is made of flat 25 x 2 mm and 330 mm length converging at lower end.

Marker :

As the manually operated garlic planter is worked for single row, it is essential to maintain proper distance between two rows on the bed. Two "L" shape markers were placed at distance of 100 mm from furrow opener at both side of planter with lifting arrangement. The marker is made up of iron bar which is bent into 'L' shape and its one end is lowered so that it will get enough point to insert into soil during working (Fig. B).

Covering device :

After placing the clove at proper depth, covering device is used to cover the cloves. Covering device is attached to rear end of planter by means of nut and bolt. A "U" shape covering device made up of iron flat is provided to planter and diameter of covering device is 255 mm (Fig. C).

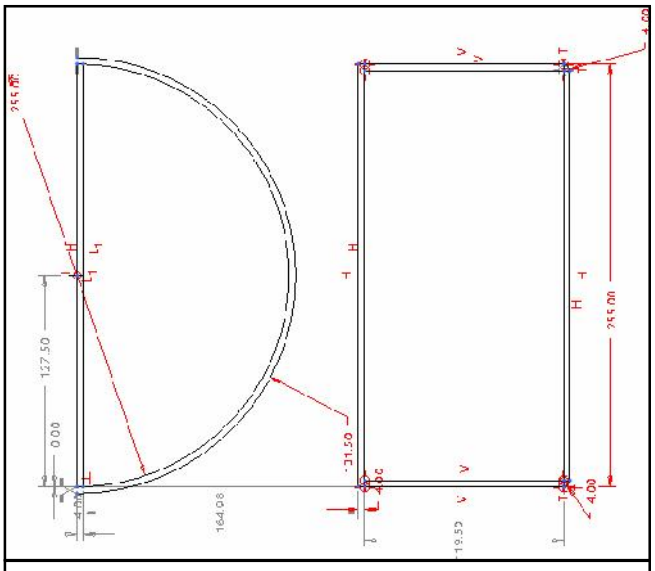

Fig. C : Covering device

Handle :

Handle is provided to control the direction of planter during working, taking turn in the field and also operator

exerts push on handle, if required by which proper depth of operation is controlled. Handle is made up of M.S. pipes.

Working principle of manually operated garlic planter :

The planter was provided with a ground wheel. A ground wheel shaft was provided to transmit the power of ground wheel shaft to seed metering shaft. A positive chain drive mechanism was used to transmit power from ground wheel shaft to seed metering shaft. Single furrow opener was provided to planter with a seed box. A spoon feed vertical disc type seed metering mechanism was used. The vertical disc rotate and spoon on its periphery picks the single clove. When the spoon reach to the top, the clove is dropped into release funnel further it is released into the furrow open by furrow opener. At the headland planter is lifted and placed on the line mark by the marker. During operation of planter, seed metering plate rotates in the same direction, as that of the rotation of ground wheel. Cloves dropped from the spoons to metallic seed tube provided at bottom of seed box to the furrow which was created by furrow opener at specified intervals.

Instrumentation :

Different parameters like speed of operation, time required to cover the field, weight of cloves, row to row spacing, width and depth of furrow, top and bottom width of bed, depth of placement of cloves, moisture content of the soil were measured during the laboratory and field tests. The following instruments were used during field evaluation testing of garlic planter.

Stop watch :

Stopwatch was used to record the travel time required to cover the measured area during the test.

Metallic and steel tape :

A metallic tape of 30 m was used for measuring and marking the layout of test plot. A steel tape was also used for measuring the dimensions of beds and furrows, measuring the depth of placement of cloves and measuring row to row spacing.

Weighing balance :

An electronic weight balance was used to measure the weight of wet and dry soil for determination of moisture content of the soil. It was also used for measuring the weight of cloves.

Electric oven :

Electric oven was used for drying the soil samples, for determination of the moisture content of the soil.

Sample boxes :

The sample boxes were used for keeping the soil samples in oven.

Performance evaluation of manually operated garlic planter :

The performance of manually operated garlic planter was evaluated by taking the laboratory tests and field tests. The laboratory tests and field tests were taken according to procedure described under following sections.

Laboratory testing of manually operated garlic planter :

Laboratory testing of planter was carried out in the workshop of Department of Farm Power and Machinery, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, in order to study the flow rate of cloves in the garlic planter.

- Circumference of ground wheel was calculated.
- Number of revolutions required to cover $1/25^{th}$ area of one hectare was calculated. This was calculated by dividing 10,000 m^2 by area covered in one revolution by the ground wheel.
- The ground wheel was made free to rotate by rising planter. Mark was put on the wheel so that revolution may be counted easily. Hopper was filled with garlic cloves. The size of spoon on the metering plate was calculated from which only one garlic cloves is dropped.
- Then for fixed number of revolutions determined in step 2, the weight of cloves collected was measured which was collected below each furrow opener.
- Area covered by garlic planter was calculated by following formula :

$$\mathbf{A = (\pi DN) \times (W)}$$

where,

A = Area covered by planter,

D = Diameter of ground wheel,

N = Number of revolutions of ground wheel,

W = Width of operation.

Field testing :

The garlic planter was tested on the Chilli and Vegetable Research Center, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola on an area of 0.018 hectare. The size of furrow was 18 m × 1 m. Field performance tests were carried out to obtain actual data about overall performance of planter and working capacity in field condition. The performance evaluation of manually operated garlic planter was evaluated in the experimental field with following parameters.

Moisture content of soil :

The moisture content readings were taken just after sowing. Five samples were collected randomly from field at 4-5 cm depth of sowing. The moisture content of each sample was calculated by oven drying method. The weight of sample with box was taken and placed in the oven for drying. After 24 hours the oven dry weight was taken and that the moisture content was calculated by using the following formula :

$$\text{Moisture content} = \frac{W_1 - W_2}{W_2 - W_3} \times 100$$

where,

W_1 =Initial weight of soil sample, g.

W_2 =Oven dry weight of soil sample, g.

W_3 = Weight of empty box, g.

Speed of operation and turning time :

Speed of operation was calculated to determine other performance characteristics like field capacity and field efficiency. During field trial of planter, speed of operation was measured by recording the time required to cover 18 meter distance by using stop watch. Time required for turning the planter was also recorded by using same stop watch. The speed of operation of machine was calculated by using following formula :

$$\text{Speed (km/h)} = \frac{\text{Distance covered (m)}}{\text{Time required to cover that distance (sec)}} \times 3.6$$

Theoretical field capacity :

It depends upon speed and theoretical 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 spend for machine trouble were taken in to consideration. The length and width of plot was measured and area covered in that time was calculated. 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 :

$$\text{Field efficiency (\%)} = \frac{\text{Effective field capacity (ha/h)}}{\text{Theoretical field capacity (ha/h)}} \times 100$$

Ground wheel slip of planter :

Actual numbers of revolution of ground wheel for a given distance (20 m) were recorded. Theoretical number of revolutions made by ground wheel for given distance (20 m row length) was calculated using formula: :

$$N_t = \frac{L}{\pi \times D} = \frac{\text{Distance to be traveled}}{\text{Circumference of ground wheel}}$$

where,

N_t = Theoretical number of revolutions made by ground wheel for given distance.

L = Given distance traveled by ground wheel for which actual revolution of ground wheel were counted.

D = Diameter of ground wheel in m.

Finally per cent ground wheel slip was calculated by using formula :

$$S = \frac{N_t - Na}{N_t} \times 100$$

where,

S = Ground wheel slip in per cent.

N_t = Theoretical number of revolutions made by ground wheel for given distance.

N_a = Actual number or revolutions made by ground wheel for the same distance (20 m row length).

Depth of placement of cloves :

The machine was operated in the field of garlic crop with some setting in depth adjusting mechanism, in order to get average depth of cloves placement. The loose soil on observed hill drop randomly selected in a row, was removed till garlic were observed in the furrow. The depth of cloves was measured with meter rule.

Determination of missing hill percentage :

Missing hill percentage is useful to know the precision of metering unit of the planter. To find out missing hill percentage of garlic crops, the observations of number of hills were taken in randomly selected 5 rows in the field. In this method first, theoretical number of hills or plants that should present in given row length (which depends upon plant spacing applied) was calculated and then actual number of hills observed in each row for same row length were counted and recorded. The missing hill percentage was calculated by using following formula :

$$M = \frac{n_t - n_a}{n_t} \times 100$$

where,

M = Missing hills, per cent.

n_t = Number of hills present in a row for given row length, theoretically.

n_a = Actual number of hills observed in a row for same length.

Fig. D : Manually operated garlic planter

Determination of cost of operation per hour of manually operated garlic planter :

The cost of sowing operation of garlic crops was calculated using the standard procedure described by RNAM test codes.

Fig. E : Sowing of garlic cloves manually

Fig. F : Garlic planter in operation

■ RESULTS AND DISCUSSION

The garlic planter was tested in the laboratory as well as in the field to assess its accuracy in seed metering, hill dropping, mechanical damage, and germination percentage. General variety of garlic was used for a test which is presented through the following paragraph.

The different parameters of performance are discussed in this paper.

Effective width of planting :

Width of planting of garlic planter was found to be 10 cm (Kilgori *et al.*, 2007).

Speed of operation and turning losses :

The average time required to cover eight row of length 18m was found to be 6 min for 8 observations. The speed was found to be 2.75 km/h and turning time loss was found to be 40 sec. to maximum 45 sec.

Depth of placement of cloves in the soil :

Depth of placement of cloves was measured with the help of steel tape and observations were taken under the five replications at three different places (Table 1).

Theoretical field capacity :

The average theoretical field capacity of garlic planter was calculated as 0.0275 ha/h.

Effective field capacity :

The average effective field capacity of garlic planter was found to be 0.032 ha/h.

Field efficiency :

The ratio of actual field capacity to the theoretical field capacity was found to be 84.79 per cent.

Cost of operation :

The cost of operation of garlic planter per hectare was calculated considering prevailing rates and it was found to be 1214 Rs./ha.

Missing hill percentage :

The observations of number of hills were taken in randomly selected 5 rows in the field. The missing hill percentage was calculated.

The missing hill percentage for this planter was observed to be 28.33 per cent which is on higher side (Bakhtiari *et al.*, 2009). However, it is observed that being black cotton soil, the soil condition remains as cloddy even after harrowing. This causes excessive jerks to the planter while in operation. As a result of this the picked clove in the spoon bounces off the spoon. If very fine seed bed is prepared the jerks to the planter and ultimately bouncing of clove from spoon can be reduced which will finally help to reduce the missing hill percentage.

Ground wheel slippage :

The average ground wheel slip before modification it was 14.68 and after modification was 10.2 per cent at same soil moisture content.

Conclusion :

In conventional method, sowing of garlic *i.e.* by human labour is quite costly and time consuming. It takes about 65 man-days /ha and Rs. 7800/- per ha for sowing

Table 1 : Depth of placement of cloves in the soil

Sr. No.	Observed depth (cm)				
	1st row	2nd row	3rd row	4th row	5th row
1.	3.5	4.1	3.5	3.8	4.1
2.	3.8	3.8	3.7	3.6	3.8
3.	4.0	4.0	3.8	3.9	3.7

Table 2 : Missing hill percentage

Sr. No.	Clove dropped	Missed cloves	Spacing between cloves (cm)	Average missing percentage
To cover 3 meter length in two revolutions of ground wheel				
1.	21	9	9, 10, 11, 12	
2.	22	7	11, 12, 14	28.00 %
3.	20	10	11, 12, 14, 15	
To cover 1.5 meter length in one revolutions of ground wheel				
1.	9	4	9, 10, 11, 15	
2.	9	4	10,11,9, 15	28.33 %
3.	8	5	9, 10, 11, 9	

of garlic cloves by manually. The average ground wheel slip after modification was found to be 10.2 per cent, which was reduced by 4.48 per cent due to provision of lugs on the periphery of ground wheel. Missing hill was found to be 28.33 per cent. The average field efficiency was found to be 84.79 per cent. Cost of planting by planter was found to be Rs.1214/- per hectare as compared to Rs.7800/- per hectare for manual planting. Cost of saving in operation by garlic planter was found to be 84.35 per cent. A manually operated garlic planter can be easily transported and operated because of its light weight and small size. The missing hill percentage for this planter was observed to be 28.33 per cent which is on higher side. However, it is observed that being black cotton soil, the soil condition remains as cloddy even after harrowing. This causes excessive jerks to the planter while in operation. As a result of this the picked clove in the spoon bounces off the spoon. If very fine seed bed is prepared, the jerks to the planter and ultimately bouncing of clove from spoon can be reduced which will finally help to reduce the missing hill percentage.

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REFERENCES

Anantacher, M., Narvani, N.B. and Murthy, B.K.S. (2001). Development and evaluation of planter for rainfed cotton. 35 Annual Conversion, ISAE, Orissa University of Agriculture and Technology, Bhubaneswar (ORISSA) INDIA.

Bakhtiari, M. (2009). Studied and describe the performance parameters measured in terms of planting depth, seeding rate, seed spacing, miss index and clove damage, **11**: 125-136.

Benjaphragairat, J. and Nobutaka, I. (2010). Design and control of metering system and furrow openers for garlic planter. *Internat. Agric. Engg. J.*, **19** (2) : 39-47.

Chauhan, Lallan S. and Singh, L. (1992). Effect and method of planting and size of cloves on yield and quality of garlic. *Newsletter Assoc. Agric. Found.*, **12** (2): 7-8.

Garg, I.K., Dixit, A.K., Chhina, R.S. and Singh, A. (2001). Development and evaluation of ridger planter for maize crop. Souvenir,35 Annual Convention, ISAE, Orissa University of Agriculture and Technology, Bhubaneshwar (ORISHA) INDIA.

Kilgori, M.J., Magaji, M.D. and Yakubu, A.I. (2007). Effect of plant spacing and date of planting on yield of two garlic (*Allium sativum* L.) cultivars in Sokoto, Nigeria. *American-Eurasian J. Agric. Environ. Sci.*, **2** (2) : 153-157.

Punmia, B.C. and Jain, Arun Kumar (2005). *Soil mechanics and foundation*. 16th Ed. NEW DELHI, INDIA.