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**RESEARCH ARTICLE :**

# Performance and evaluation of tractor operated semi-automatic onion bulb planter

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**SUMMARY :** The experiment was carried out at Department of Farm Machinery and Power, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) during September to July in year 2012-13 to check the performance and evaluation of tractor operated semi-automatic onion bulb planter. The field performance of onion bulb planter was tested. Mistubishi (18.5 HP) tractor was used for carrying out the field operation. The test was conducted at an average forward speed 1.3 km.h$^{-1}$. The draft required by the planter was 206.61 kgf. Wheel slippage was found to be 20.85%. The average row to row distance was observed as 600 mm and average plant to plant distance was observed as 181 mm. The actual field capacity was found to be 0.042 ha.h$^{-1}$. The field efficiency of planter was found to be 53.85 per cent. The missing percentage was found to be 8.12 per cent. The seed rate obtained was 2833 kgha$^{-1}$ against recommended 3000 kg.ha$^{-1}$. Total cost required for operation was found to be‘ 166.82 per hour. The total cost of operation obtained per ha was ‘ 3971.90 per hectare. Whereas cost of operation observed in conventional method was ‘ 8880 per hectare.

**KEY WORDS :**
Onion bulb planter, Field efficiency, Cost of operation

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## BACKGROUND AND OBJECTIVES

Onion (*Allium Cepa* L.) is one of the most important vegetable crops grown in India. Onions are one of the oldest vegetables in continuous cultivation dating back to at least 4,000 BC. The ancient Egyptians are known to have cultivated this crop along the Nile River. They have long been valued in China and India for their flavoring. In India only fresh market onions are grown that are mostly red onions, white onion are grown on commercial scale in few states like Maharashtra, Gujarat etc. Major varieties found in India are Agrifound dark red, Agrifound light red, NHRDF red, Agrifound white, Agrifound rose, Agrifound red, Pusa Ratnar, Pusa red and Pusa white round. There are yellow varieties of onion which are suitable for export in European countries such as Tana F1, Arad H, Suprex, Granex 55, HA 60, and Granex 429. In Maharashtra Baswant-780, N-53, N-2-4-1, Arka Niketan, Phule safed, Phule Suwarna, Phule Samarth, AFDR, AFLR varieties are prominent. In Maharashtra onion is much sensitive crop and all varieties of onion are not possible to grow in all areas in

all seasons.

The favourable season for planting onion bulb for seed purpose is from last week of November to first week of January. Onion cannot be grown in alkaline or low lying marshy land. Best soil for onion production is friable loams and alluvium where a free drainage, absence of president weeds and presence of organic matter favour production of excellent crops. Onion is sensitive to high acidity and alkalinity. The optimum pH range is 5.8 to 6.5 (Chaudhari 2004). Major work done on onion seeder and onion transplanter but onion bulb planting for seed production is still manually done in India. Based on literature cited seed production aspect of onion is limitedly mechanized. As area under onion get increased demand for onion seeds also get increased. Therefore, it is necessary to develop technology in onion seed production on commercial basis.

Bulb sizes and planting time are most determining factors for onion seed production. Suitable size of mother bulb coupled with appropriate planting time gives optimum seed yield. Generally 25-30 q of medium size bulbs are required to plant one hectare. Area under onion seed production in India is 598.49 ha (NHRDF 2011-12). Highest seed yield obtained with large size bulbs ranges from 5 to 8 cm and at spacing of 60 × 20 cm (Gaikwad 1996). Planters are those machines which plants seed in such a way that plant to plant and row to row distance is maintained. Planters are either automatic or semi-automatic. The manual plantation is very time consuming and increases the cost of plantation. Also this method does not maintain uniformity in plantation in terms of depth and spacing. Hence there is need to develop mechanical onion bulb planter that will reduce the labour cost, save the time and will keep uniformity in planting onion bulbs. Present research relates with mechanization in onion bulb planting against hand dibbling. Considering present need the project entitled "Development and performance evaluation of tractor operated (18.5 hp) semi-automatic onion bulb planter" was undertaken in the Department of Farm Machinery and Power of Dr. Annasaheb Shinde College of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri.

## RESOURCES AND METHODS

### Basic functional units of semi-automatic onion bulb planter :

The machine was fabricated in the workshop of AICRP on FIM, MPKV, Rahuri. The tractor operated (18.5 hp) semi-automatic onion bulb planter is shown in Fig. The onion bulb planter consists of following functional units. Artenstein (1924) developed similar planter for potato with different spacing.

- Feeding hopper
- Main frame
- Three point linkage
- Operator's seat
- Furrow Opener
- Ridgers
- Power transmission unit
  - Ground wheel
  - Chain and sprocket arrangement
  - Shaft
- Cup-feed conveyor unit.

### Working mechanism:

The attachment of planter was done with three point linkage to the tractor. The ground wheel in contact with soil rotates first. The rotation of ground wheel transmits rotary motion to power transmitting shaft by means of chain and sprocket arrangement. Rear pulley of conveyor unit was fitted on shaft which gives motion to conveyor unit. The conveyor belt fixed tightly on two pulleys. The rotation of pulley causes the rotation of belt on which steel cups were riveted. The operator sits on seat, picks up onion bulbs from feeding hopper and places it in cups. The placement was done in such a way that its root portion remains at top and cut portion at bottom. A guard was given with proper clearance to restrict the movement of onion bulb while dropping. The purpose of guard was to allow onion bulbs to come downside such that bulbs remain in same position as on top of belt. Due to guard the placement of bulb was done in such a way that cut portion remains at top side and root portion remains at bottom side. The bulbs were covered by forming a ridge over it with suitable height of soil by means of ridger. The plant to plant spacing was maintained by optimizing various parameters such as speed of belt, spacing between cups mounted on belt, diameter of ground wheel (Young, 1923).

### Test procedures :

Testing of the semi-automatic onion bulb planter for low hp tractor was done as per the guidelines & procedure suggested by the Regional Network for Agricultural Machinery (RNAM, 1983) and ISI test code IS : 9856 –

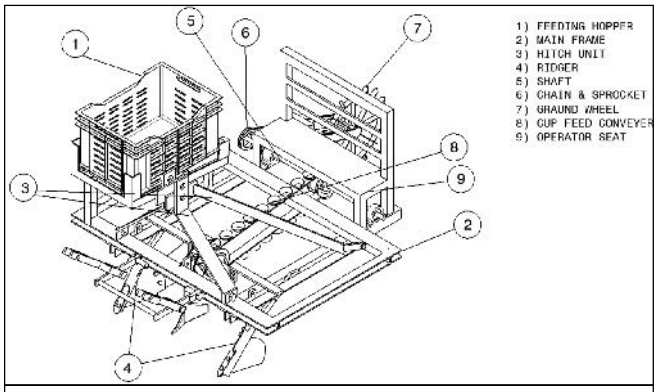


**Fig. A : Isometric view of tractor operated (18.5 hp) semi-automatic onion bulb planter**

1981. General, laboratory and field test are carried out to check the performance of onion bulk planter. Field efficiency was calculated by following formula :

$$\text{Field efficiency, } \% = \frac{\text{Effective field capacity } (\text{ha.h}^{-1})}{\text{Theoretical field capacity } (\text{ha.h}^{-1})} \times 100$$

The germination percentage was calculated by using the following formula:

$$\text{Germination, } \% = \frac{\text{Number of plants germinated}}{\text{Number of seeds own}} \times 100$$

## OBSERVATIONS AND ANALYSIS

The laboratory tests and the field trials of the newly developed tractor operated (18.5 hp) semi-automatic onion bulb planter were conducted to evaluate its performance as per the procedure suggested by the Regional Network for Farm Machinery (RNAM, 1985) and ISI test code IS : 9856 - 1981.

### General tests :

The material used for different components of the implement was of mild steel. The size and specifications of these components conforms to BIS specifications. The visibility from the tractor operator's position was found good. The operator can see most of the working components of the equipment. The depth control adjustments can be done by depth control lever. The cups on conveyor belt were fixed according to bulb spacing requirement.

### Laboratory tests :

Details of Laboratory tests, calibration test of onion bulb for 10 revolutions of ground wheel and test data are presented in Table 1, 2 and 3, respectively.

### Performance evaluation data :

The onion bulb planter was tested for the field crop of onion. The final test results for planting onion bulbs were shown in Table 4.

**Table 1 : Laboratory tests**

| Sr. No. | Particular | Value |
|---|---|---|
| 1. | Date of test | 28/12/2012 |
| 2. | Capacity of seed hopper, (kg) | 20 |
| 3. | Onion bulb characteristics | |
| | – Variety used | Phule Samarth |
| | – Shape of bulb | Oblate |
| | – Avg. diameter of bulb, (mm) | 57.9 |
| | – Avg. length of bulb, (mm) | 30.5 |
| | – Avg. mass of onion bulb, (g) | 52.8 |
| 4. | Machine parameter | |
| | Name of implement | Semi-automatic onion bulb planter |
| | – Length, (mm) | 1080 |
| | – Width, (mm) | 1220 |
| | – Height, (mm) | 915 |
| | – Weight, (kg) | 109 |
| 5. | Diameter of ground wheel, (mm) | 420 |
| 6. | Effective working width, (mm) | 600 |
| 7. | Area covered in 10 revolutions of ground wheel, $m^2$ | 7.92 |
| 8. | Avg. moisture content, (%) | 23.83 |

**Table 2 : Calibration test of onion bulb for 10 revolutions of ground wheel**

| Test No. | Weight of seed, kg | | | | | Avg. | Seed rate (Kg ha$^{-1}$) |
|---|---|---|---|---|---|---|---|
| | No. 1 | No. 2 | No. 3 | No. 4 | No. 5 | | |
| 1. | 2.52 | 2.43 | 2.34 | 2.48 | 2.27 | 2.40 | 3030.30 |
| 2. | 2.36 | 2.34 | 2.44 | 2.39 | 2.38 | 2.38 | 3005.05 |
| 3. | 2.46 | 2.33 | 2.40 | 1.46 | 2.38 | 2.41 | 3042.93 |
| | | | Average | | | 2.39 | 3017.68 |

**Table 3 : Test data**

| Sr. No. | Particular | Specification |
|---|---|---|
| 1. | General | |
| | Date of test | 04/01/2013 |
| | Location of test | 'D' Block MPKV Rahuri |
| | Type of soil | Black cotton |
| 2. | Field parameter | |
| | Plot size, (m$^2$) | 120 |
| | Length, (m) | 20 |
| | Width, (m) | 06 |
| | Last crop grown | Soyabean |
| | Method of land preparation | Ploughing and harrowing |
| 3. | Depth of planting, (mm) | 40.2 |
| 4. | Accumulation | nil |
| 5. | Uncovered bulbs | 216 |
| 6. | Missing | |
| | No. of bulbs missed | 81 |
| | Missing percentage | 8.12 |
| 7. | Row to row spacing, (mm) | 600 |
| 8. | Average bulb to bulb spacing, (mm) | 181 |

**Table 4 : Results of performance evaluation of onion bulb planter**

| Sr. No. | Particular | Value |
|---|---|---|
| 1. | Area covered, (ha) | 0.012 |
| 2. | Duration of test, (h) | 0.46 |
| 3. | Speed of operation, (km.h$^{-1}$) | 1.30 |
| 4. | Draft required, (kgf) | 206.61 |
| 5. | Wheel slippage, (%) | 20.85 |
| 6. | Effective working width, (mm) | 600 |
| 7. | Recommended seed rate, (kg.ha$^{-1}$) | 3000 |
| 8. | Obtained seed rate, (kg.ha$^{-1}$) | 2833 |
| 9. | Planting frequency (no.min$^{-1}$) | 71 |
| 10. | Bulb density (no.ha$^{-1}$) | 92081 |
| 11. | Germination percentage | 79.28 |
| 12. | Theoretical field capacity, (ha.h$^{-1}$) | 0.078 |
| 13. | Effective field capacity, (ha.h$^{-1}$) | 0.042 |
| 14. | Field Efficiency, (%) | 53.85 |
| 15. | Fuel consumption, (lit.h$^{-1}$) | 1.63 |
| 16. | Avg. plant count, (no.m$^{-2}$) | 8.4 |
| 17.. | Obtained plant population, (no.ha$^{-1}$) | 84000 |
| 18. | Recommended plant geometry, (mm) | 600 × 200 |
| 19. | Obtained avg. plant geometry, (mm) | 600 × 181 |
| 20. | Cost of operation, `.h$^{-1}$ | 166.82 |
| 21. | Cost of operation, `.ha$^{-1}$ | 3971.90 |

**Summary :**

The planter was developed and fabricated with care so that the components were free from cracks and visual defects. The welded joints were not porous. The anticorrosive and rust preventive paint was given for each component. The plastic crate was used as hopper. The hopper was fitted on angle frame. Main frame was made strong enough support to all components fixed on it. Three point linkage was used for hitching to tractor. Three point linkage was made to suit special arrangement for 18.5 hp Mitsubishi tractors. The furrow opener was fixed on main frame with nut bolts. The ridgers were fixed with clamp and nut-bolt arrangement. Two half ridgers were provided to form a single ridge. Power transmission unit consists of ground wheel, chain and sprocket, power transmission shaft, respectively. The power was transmitted from ground wheel to conveyor unit. The cup feed conveyor unit was made up of flat canvas belt and steel cups. Operator's seat was close to hopper so that operator can easily pick up onion bulbs and place it onto cups. In laboratory tests onion characteristics, machine dimensions and soil moisture content was determined. The field trial was carried out in well ploughed and harrowed black cotton soil. The performance of developed onion bulb planter was found satisfactory for planting of onion bulb with effective field capacity 0.042 $ha.h^{-1}$ and 53.85 % field efficiency.

**Conclusions:**

The planter can be used for planting onion bulbs on the top of ridge. A skilled person with one unskilled labour can operate the onion bulb planter at an average forward speed of 1.3 $km.h^{-1}$ and can cover an average area 0.042 $ha.h^{-1}$. The power source was 18.5 hp Mitsubishi tractor and draft required by the machine was 206.61 kgf. The depth of seed placement was observed to be 40.2 mm. The seed rate of 2833 $kg.ha^{-1}$ was obtained for onion bulb which is slightly less than recommended seed rate. The average plant geometry was 600 × 181 mm as against the recommended plant geometry of 600 × 200 mm. The field efficiency of the planter was 53.85 %. Cost of operation was less as compared to conventional method. The mechanical planting can save 4980.10 '.$ha^{-1}$

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