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Fabrication of manual operated two row tomato transplanter

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Abstract
In India, transplanting of vegetable seedling of different crops depends mainly on human labour. In changing scenario of agricultural mechanization, ergonomics plays crucial role for effective operation. Therefore the study was undertaken to fabricate two row manual operated vegetable transplanter for tomato. A low cost manual operated vegetable transplanter is developed for transplanting for seedling of by raising beds. It consists of dropping structure, main frame, furrow opener, handle and seeding plate. Operating system of this developed transplanter involves raising of beds by serrated furrow opener and then by dropping of seedling through dropping structure, and then by moving forward the press wheels compresses the soil in the bed.It was tested by taking seedling of 3 speeds (0.083 m/sec, 0.079 m/sec 0.076m/sec). As per specification which has been designed, tomato transplanter was fabricated and performance evaluation is done by taking 45 days old tomato seedling various forward speed and three observation were taken to find out various parameters like missing percentage, width of operation, row spacing, no of seedling per hill, field capacity, plant spacing, moisture content, lenth of seeding, field efficiency and planting depth. The average field efficiency, theoretical field capacity, effective field capacity was found 72.9%, 0.0343ha/hr and 0.024ha/hr with planting depth of 5.8 cm .The missing percentage and no of seedling per hill was found to be 5.33% and 1.07. Results observed that with increasing speed of the transplanter, missing percentage, plant spacing, planting depth, row spacing, length of seedling increased and effective field capacity, theoretical field capacity and field efficiency decreased.

Keywords: Trans planter, tomato, missing percentage, field capacity

1. Introduction
India is the second largest producer of vegetables after China with a total vegetable production of 146.55 million tons in the year 2010-2011. Area under cultivation of vegetable is 8.49 million hectares with an average yield of 17.26 tons/ha. Among the various cultivation practices followed for raising vegetable crops, transplanting of good quality vegetables seedlings at appropriate depth, spacing and sufficient soil cover around the seedlings is one of the most important operations. Manual transplanting of seedlings is labour intensive, expensive time consuming and often results in non-uniformity in plant distribution. To overcome these problems, use of transplanter is essential. Developed machine provided the combination of operation at a time such as formation of hole, placing of seedling, covering the soil, marking for transplanting, carrying the ability of portray having provision of placing the seedling on the developed prototype.
With the view of above aspects a tomato transplanter was fabricated and performance evaluation is done by taking 45 days old tomato seedling at various forward speed, three observation were taken to find out various parameters like missing percentage, width of operation, row spacing, no of seedling per hill, field capacity, plant spacing, moisture content, length of seeding, field efficiency and planting depth.

2. Material and Methods
The developed manually operated two row vegetable transplanter is made up from locally available material. The manual transplanter is developed by the combination of furrow opener, dropping funnel, main frame, handle, press wheel, seed plate.

2.1 Parts of Vegetable transplanter
2.1.1 Main Frame
It is made up of 1'×1'square pipes. It is made by square pipes to reduce the weight of the transplanter. All the structure is to be aligned on this frame. It's having length of 750 mm and 600 mm width. The structure is made of rectangular frame of 25 mm*25 mm mild steel flat structure. All structure are attached to main frame for core alignment.

2.1.2 Furrow opener
A chisel type of furrow opener is provided in front of dropping funnel to open a continuous furrow which requires low draft. A triangular shape of soil working tool attached to standard made of MS flat of 10 mm thickness having length of 120mm.

2.1.3 Dropping funnel
A conical shape long structure made up of plastic provided just after furrow opener from dropping of seeds etc. The funnel having diameter of 10mm at bottom and 60mm at top.

2.1.4 Press wheels
Furrow covering compaction device should cover roots and bulbs of the seedlings with soil completely, and compact the soil around the seedling without damaging collar and roots.

2.1.5 Seed plates
These are basically made up of plastic of MS flat. These are to be mounted on the top of the frame.

2.1.6 Dropping structure
Funnel is mounted from handle to downward position with a conical shaped structure at top for which dropping of seedlings. Diameter of funnel is 110mm at top and 30mm at bottom. A dropping pipe of 25mm diameter and 650mm length.

Fig 1: Photograph of press wheels

Fig 2: Photograph of funnel

2.1.7 Furrow opener
A chisel type furrow opener is provide at the front of the dropping funnel. The height of triangular structure is 120mm.

a. b.

Fig 3.a): Photograph of tomato transplanter frame equipped with opener and wheels **b).** Photograph of furrow opener

The following table shows different parts of transplanter and specifications are given below.

Table 1: Specification of different parts

S no.	Name of component	Dimension (mm)
1	Main frame	450×900×750
2	Furrow opener	120×80
3	Dropping funnel	650×25
4	Press wheel	260
5	Seed plate	450×300
6	Handle	700×120

2.2 Row spacing
The spacing between two consecutive rows of tomato seedling transplanter was measured with the help of steel tape. The row to row spacing was measured in the field at three different locations randomly and average value of spacing was found out.

2.3 Width of operation
The width of operation of transplanter was measured with the help of metallic tape. It was measured in the field at three different locations randomly.

2.4 Field efficiency
$FET= (Ttr/Tt_{otal})\times 100$

$T_{total} = T_{tr}+T_{tu}+T_o$

Where, FET=Field efficiency of transplanter, %

T_{tr}= Time required to transplant the seedlings, min Ttu= Time required to take turns at headland, min

T_o= Time required for initial adjustments, loading of seedlings on machine, min.

T_{total}= Total time required to complete the transplanting operation in field, min.

2.5 Missing percentage
The seedling feed tubes that were missed by the operator, results in wide spacing between the consecutive transplanted tomato seedlings and expressed as the percentage missing transplanting. percent miss in transplanting was calculated as given below-

Missing percentage$=S_m/(S_m+S_f)\times 100$

Where, S_m =no. of seedlings missed by operator to feed in seedling feed tubes

S_f = no. of seedlings fed by operator in seedling feed tubes

2.6 No. of seedlings per hill
The no. of seedlings per hill was counted randomly at five different locations and average no. of seedling per hill was computed.

2.7 Theoretical field capacity
The theoretical field capacity (ha/h) of the machine was computed by measuring the width of operations and the walking speed of operator.
Theoretical field capacity(ha/h) = Width of operation(m) ×Travel speed(km/h)

2.8 Work quality
Developed machine always plant the seedling in the centre of punch. Working principle of the machine is one has to hold the prototype in vertical position with handle and as the jaw in a closed position to the height of 15-30cm and allow to fall or press it to penetrate into soil bed, one seedling has to be picked up from tray and put it in to the, it will be dropped and held into the jaw from inside. Then, pulling the lever towards handle to open the jaw inside the soil and the moment the jaw is opened the seedling resting inside the jaw will drop by gravity into the pit/hole made by jaw. Lift the transplanter lever in pressed position (jaw open) and the soil accumulated at periphery of jaw roll back towards the root zone of seedling thus stabilizing the seedling in the pit/hole and covering the seedling root zone by soil. The different components were designed based on the seedling characteristics (viz., Dimension of seedlings, soil root containment), human subject strength, reach, clearance limits (viz. Operating force requirement, diameter and clearance between handle and lever, height of equipment),working environment (soil cone index, raised bed /ridge/ mulch).

3. Results and Discussion
The present study was conducted in two stages. In first stage, two row manual operated tomato transplanter was designed and fabricated. During the second stage, evaluation of field performance of manual transplanter was done. The field size taken for performance evaluation of transplanter was 10x20m2 .The testing was conducted three times and dependent parameters like missing percentage, width of operation, row spacing, no of seedling per hill, field capacity, plant spacing, moisture content, length of seeding, field efficiency and planting depth were taken and the average observation table was prepared.

3.1 Length of tomato seedlings
The average Length of tomato seedlings at age of 45days were observed as 17.83cm.

3.2 Moisture content of seedlings
The moisture content (wb%) of tomato seedlings was found to be 93.52%.

3.3 Planting depth
The observed depth of planting for different forward sped presented. The average planting depth at forward speed 0.079m/sec and at 75cm dropping height was 5.8cm for 45 days.

3.4 Effective fieldcapacity
The average effective field capacity was found to be 0.024ha/hr.

3.5 Theoretical field capacity
The average theoretical field capacity was found out by taking 3 forward speeds at 0.083m/sec,0.076m/sec, 0.079m/sec. The verage theoretical field capacity was found 0.0343ha/hr

3.6 Field efficiency
The average field efficiency was found out by the mathematical formula and was found to be 72.9 percent.
The relation between forward speed and seedling per hill concluded that by increasing the forward speed, seedling per hill increases. From the relation between forward speed and missing hill percentage it was observed that with increase in speed, missing percentage increased.

4. Conclusion
The relationship between forward speed and effective field capacity showed that with increase in forward speed, effective field capacity increases. The relation between forward speed and theoretical field capacity showed that with increase in forward speed theoretical field capacity increases. From the experiment it was found that by increasing forward speed of the transplanter missing percentage, plant spacing, planting depth, row spacing and no. of seedling per hill increases and effective field capacity, theoretical field capacity and field efficiency decreases. The manual transplanter which has been developed is suitable for the women in agricultural field which will have low cost, higher working efficiency, less work loadetc.

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