The Pharma Innovation Journal 2022; SP-11(7): 408-412

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(7): 408-412

www.thepharmajournal.com
Received: 13-04-2022
Accepted: 16-05-2022

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Development and performance evaluation of 3-Jaw manual vegetable transplanter

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Abstract
Vegetables are parts of plants that are consumed by humans or other animal as food. A more precise definition is "any plant part consumed for food that is not a fruit or seed, but including mature fruits that are eaten as part of a main meal". Vegetables refer to all edible plant matter, including the flower, fruits, stems, leaves, roots and seeds. The field capacity of developed transplanter is 0.15-hectare per day which is equals to almost 4 person's capacity. The payback uses in terms of number of seedlings of transplanting was found to be 21679 seedlings in 0.78 ha area seedling transplanting. The payback period was found to be 30.83 hours or 3.85 days of operation of the vegetable transplanter. The payback period was found to be 30.83 hours or 3.85 days of operation of the vegetable transplanter.

Keywords: Transplanter, vegetable, field capacity and payback

1. Introduction
The basic requirements for small scale cropping machines are that they are simple in design and technology, suitable for small farms and versatile for use in different farm operations. Now a day most of the operations in agriculture are being performed by machines. This reduces the human efforts which have been the principal motivating force in mechanization. Small scale farmers cannot afford to purchase such costly machines. Vegetable transplanting machine is a device which helps in planting of vegetable seedlings in a desired position which helps farmers to save time, money and tedious job. The cotton stalks bio-chars can be effectively used as a raw material for the preparation of activated carbon. Bio-chars obtained at high pyrolysis 500 °C (Makavana *et al.* 2020) [4]. India is the second largest producer of vegetables. About 175 types of vegetables are grown in India including 82 field vegetables and 41 root (tuber and bulb) crop. Total vegetable production of India was 184.394 million metric tons in the year 2018-2019. Area under cultivation of vegetable is 10.259 million hectares with an average yield of 17.97 tons/ha (Anon., 2018) [2]. In Gujarat, the total area under vegetable is 36.79% out of total agricultural area and the area under cultivation of vegetable is 613.1 thousand hectares with a production of 12254.3 thousand metric tons and productivity is 19.98 MT/ha. The main vegetables grown in Gujarat include brinjal, chilli, tomato, cabbage, onion etc. where, brinjal, chilli and tomato contribute 11.56, 2.40(Anon., 2015) [1] and 7.60% of the total area under vegetable cultivation respectively. Vegetable cultivation in the state has a spectacular success story and covers about 6.13 lakh hectare in Gujarat. There has been an increase from 80.01 lakh MT in the FY 2013-14 to 89.96 lakh MT in FY 2017-18 and from 370.76 thousand hectares to 422.41 thousand hectares in the area under vegetable cultivation during the same period (Anon., 2018) [2].
Planting of good quality seedlings at appropriate spacing, depth and with sufficient soil cover around the seedlings is one of the most labour-intensive operations in the production of vegetables, particularly brinjal, chilli and tomato. Manual transplanting of seedlings is time consuming, labour-intensive, expensive and often results in non-uniform plant distribution (Kumar and Raheman, 2008; Manes *et al.*, 2010; Parish, 2005) [8, 9, 11]. Therefore, development of such equipment is necessary to solve this problem which is easy to transplant the vegetable seedlings and also labour and time saving.
Gite *et al.* (2009) [5] measured 79 different body dimensions of 12,525 Indian agricultural workers from 12 different states. These data include stature height, weight, etc. for the Gujarat region metacarpal height, elbow height, hand breadth and grip diameter (inside) were measured 762 mm, 1,143 mm, 90 mm and 59mm respectively. Zamani (2014) [13] designed and developed an automatic vegetable transplanter and evaluated where it was found that physical

damage to the stem, leaves and roots of seedling increases by increasing of forward speed of machine and the fast moving of mechanism of tray displacement causes dislocation of tray by needles.

Desai (2017) [3] developed and evaluated a manual vegetable transplanter. Three angles of penetration of jaw 25º, 30º and 35º were selected for study and found that 25º angle was suitable for considering all performance and economic parameters. Effective field capacity was found as 0.015 ha/h which is 3 times more than manual transplanting. Cost saving was 30% over manual transplanting. Cost for hectare was calculated as ₹ 4979/- per ha as against manual transplanting.

Thorat *et al.* (2017) [12] designed a transplanter on the basis of morphological parameters of seedlings, agronomical requirements and ergonomically consideration for transplanting two rows (4 seedlings) at a time. The jaw is main operational part of vegetable transplanter which was fitted at the bottom of hollow delivery tubes (4 numbers) for transplanting. Maximum field efficiency of 86.75% was obtained for 4 weeks age of seedlings on bare bed. In general, effective field capacity was found as 0.014 ha/h for 6 weeks age of seedlings on mulch bed. Minimum cost of operation was considered ₹ 672.74 per ha for 6 weeks age of seedlings on mulch bed. Maximum cost for transplanting 1000 seedlings using the vegetable transplanter was observed to be ₹ 114.43 as against ₹ 156.38 when done manually. Assuming an annual use of transplanter as 250 h, the payback period was found as 926.74 hours or 3.71 years.

Jagvir *et al.* (2018) [6] designed and developed a Single Row Manual Vegetable Transplanter for transplanting of brinjal, chilli and tomato seedlings. In the research they evaluated that the transplanting mean effective field capacity observed from trials was 0.029 ha/h with field efficiency of 91.34%. Significantly lower labour was required with developed prototype over traditional method with an average saving of 52.83 per cent of time and labour. The activity of work load was found as moderate with maximum heart rate (112 beats/min) and energy expenditure (9.1 KJ/min) with developed transplanter. Mean value of overall discomfort rating, usculo-skeletal problem, rating of perceived exertion were also found lesser in comparison with traditional method. The mean cost of transplanting for three different seedlings was calculated to be ₹ 1308.16 per ha for the single row manual vegetable transplanter in comparison to ₹ 2482.2 per ha with the traditional method of transplanting. Khadatkar *et al.* (2020) [7] found that the critical canopy diameter for chilli and tomato seedling was 68.2 mm and 70.4 mm, respectively. These property of vegetable seedlings is useful in designing and selection of different components of vegetable transplanter.

2. Materials and Methods

The following points were considered while development of transplanter

1. Easy to develop with locally available material
2. Economical, light weight, farmer friendly
3. Easy to use, store and transport
4. Suitable for different plants transplanting
5. Minimum efforts required to do operation

3. Development of Transplanter

3.1 Seedling delivery pipe

The seedling delivery pipe was made up of PVC particularly for light weight, the diameter of pipe was 75mm having 4 kg/cm^2 strength, which was calculated as approximately the root media maximum dimension (plug/pot seedlings) when the plant in standing condition i.e., 30 to 40 mm. A hopper of 110 mm to 75 mm was fixed on top of the pipe for reducing damage of larger canopy seedlings. The height of pipe was set as 1000 mm which was lower than 95th percentile value of standing elbow height of Indian farmer (i.e., 1123 mm) for easiness in operation. The effort can be made when the elbow angle of 150° to 170°. A small capacity (5 kg/batch) biomass pyrolyser was designed and developed for making bio-char from the shredded cotton stalk as feed stalk (Makavana et. al. 2020) [10].

3.2 Handle

The handles were mounted at top of the seedling delivery pipe, made of mild steel pipe. They were useful to control, hold and penetrate the jaw in the soil bed. The height of handles from ground can vary on the basis of average standing elbow height of operator i.e., 1000 mm and diameter as 35 mm (including handle grip) was used on the basis of average handgrip of human and length of handle was kept 14 cm.

3.3 Three jaw assembly

It was a soil engaging part of equipment, which makes opening for placing the seedling. The length of jaw was 200 mm with top width of 75 mm. The jaws were fabricated with three sections from mild steel. These three jaws are connected with mid-ring, which is directly connected with lever by means of 3.2 mm diameter wire. When mid-ring pulls up by lever these three jaws opens by stretching in wires and closes when mid-ring gets its original position by spring tension (as shown in Fig..1).

3.4 Lever

The lever was used to operate the jaws, which was made up of mild steel. The length of lever was 155 mm and the diameter of lever was 9.5 mm. A wire of 3.2 mm diameter was provided to give leverage to open the soil by jaws.

3.5 Marker

The marker was used for marking a point for next seedling transplantation at a required distance. Main purpose of marker was to maintain plant to plant distance. A 6.2 mm diameter MS rod was used for making marker attached with 2 arrangements that is 45 cm and 60 cm (as shown in Plate 1).

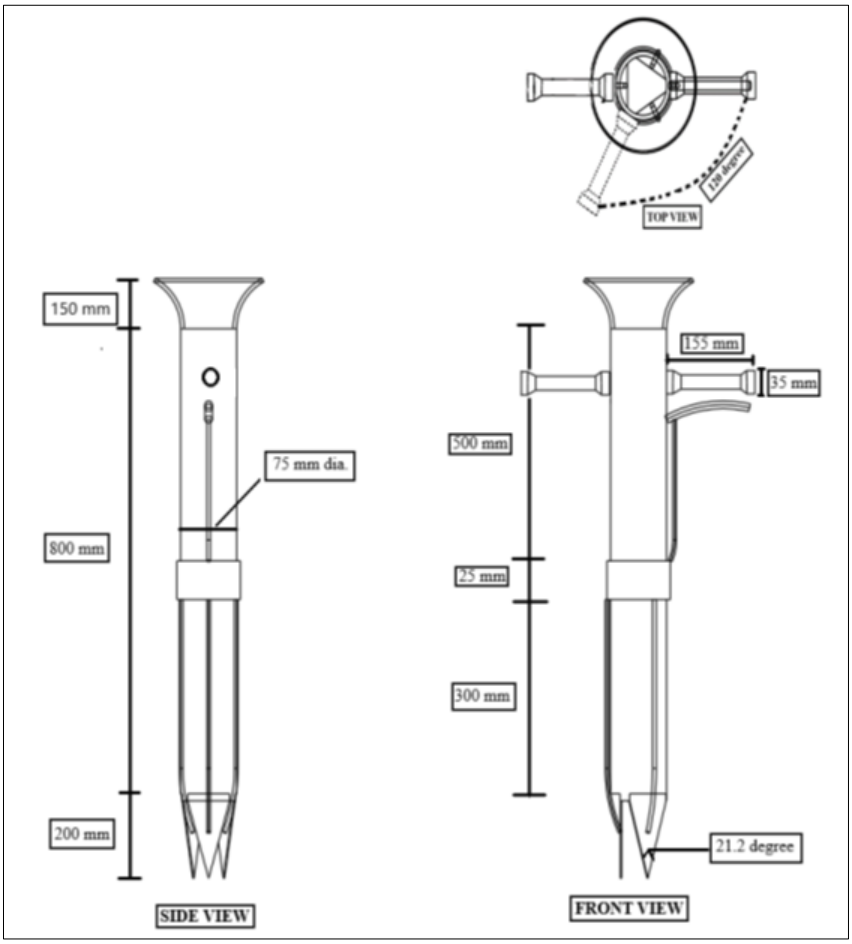

Fig 1: Orthographic views of developed transplanter

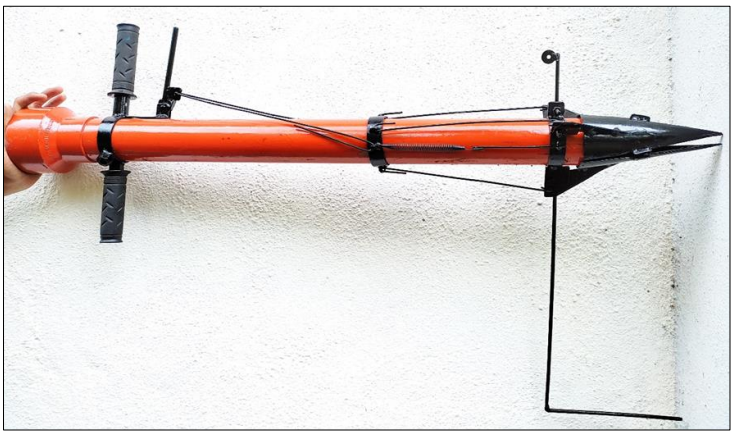

Plate 1: Views of developed transplanter

Table 1: Specifications of developed transplanter

Parameters	Value	Material
Total length of the transplanter, mm	1150	PVC
Diameter of seedling delivery pipe, mm	75	PVC
Diameter of hopper, mm	110 × 75	PVC
Diameter of hole punched in soil, mm	40-50	-
Depth of operation, mm	50-70	-
Height of handle from ground, mm	1000 (Adjustable)	-
Length and diameter (with grip) of handle, mm	155, 35	MS pipe, rubber
Type of clutch used	Lever type	-
Clutch wire, gauge	10	MS wire
Overall weight, kg	2.7	-
Adjustment of plant spacing, mm	45, 60	-
Jaw mouth length, mm	200	MS Sheet
Apex angle, degrees	21.2	-

4. Working principle

Choose a required spacing seedbed for transplanting of seedling. Set marker rod at specific length of 45 cm or 60 cm as per plant description. Put the transplanter in the soil by means of manual force applied on handle by operator. Place a seedling in the hopper and press the lever, action of lever opens the jaws of transplanter inside the soil and creates a space for seedling. Then gently pull up transplanter in jaw open condition. Remaining outside soil will cover the root of the seedling after pull up (as shown in Plate 2).

Plate 2: Performance evaluation in the field

5. Results and discussion

Following parameters were evaluated in developed transplanter

1. Soil parameters of operational field
2. Crop parameters of brinjal, chilli and tomato seedlings
3. Tool performance parameters
4. Effect of different vegetable crops and methods on different parameters
5. Economic of the developed transplanter
6. Comparative field performance evaluation of developed transplanter and manual transplanting.

Table 2: Comparative field performance evaluation of developed transplanter and manual transplanting

Parameters		Developed transplanter	Manual transplanting
Survived plants (%)		98.96	96.12
Damaged plants (%)		1.04	3.88
Effective field capacity (ha/h)		0.018	0.009
Field efficiency (%)		88.21	76.41
Clogging (%)		-	-
Time saving over manual transplanting (%)		47.42	-
Cost of operation	₹/h	75.946	75
	₹/ha	4018.30	7731.95

The survived plant (%) for developed transplanter as 98.96% which was 2.95% higher than manual transplanting i.e., 96.12%. The damaged plant (%) for developed transplanter as 1.04% which was 26.80% of the manual transplanting i.e., 3.88%. The effective field capacity of developed transplanter (0.018 ha/h) was observed approximately two times higher than manual transplanting (0.009 ha/h) because of elimination of bending and digging activities in the operation of the developed transplanter. The average field efficiency of developed transplanter as 88.21% which was 15.44% more than manual transplanting i.e., 76.41% (as shown in Fig. 5.1).

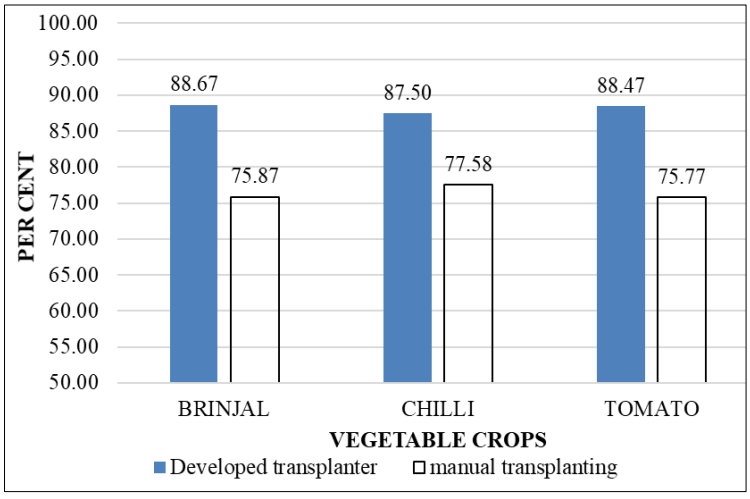

Fig 5.1: Effects of different vegetable crops and methods on field efficiency

The cost of operation per hectare with the developed transplanter worked out as 4018.30 which was 48.03% less than the manual transplanting (7731.95). The hourly cost of developed transplanter was more than manual transplanting because of requirement of two labourer for the long operation. However, the saving in the cost of transplanting with the developed transplanter was observed 37% per hectare as compared to manual transplanting.

6. Conclusions

- The field capacity of developed transplanter is 51.32 per cent more than traditional method of transplanting.
- The time and labour requirement for developed transplanter nearly one half over traditional method.
- The cost of operations of developed transplanter was reduced 33.01 per cent over traditional method.
- The field capacity of developed transplanter is 0.15-hectare per day which is equals to almost 4 person's capacity.
- The payback uses in terms of number of seedlings of transplanting was found to be 21679 seedlings in 0.78 ha area seedling transplanting.
- The payback period was found to be 30.83 hours or 3.85 days of operation of the vegetable transplanter.
- It can be used for transplanting many vegetable crops such as tomato, brinjal, cabbage, chili, cucumber etc.
- Vegetable seedling transplanter machine made transplanting seedling easier, faster and used less manpower.
- It is suitable for small and marginal farmers.
- It is very suitable for some plants which need plastic film mulching.

7. References

1. Anonymous. District wise estimated area & production of horticultural crops for the year 2015-16, 2015. Available at https://doh.gujarat.gov.in/Images/directorofhorticulture /pdf/statistics/Area-Production-2015-16.pdf, accessed on 2nd March, 2021.
2. Anonymous. Horticultural Statistics at a Glance 2018. OUP Catalogue. Ministry of Agriculture and Farmers Welfare, Govt. of India, 2018, 158-194. Available at http://agricoop.nic.in/sites/default/files/Horticulture%20Statistics20at%20a%20 Glance-2018.pdf, accessed on 18th February, 2021.
3. Desai R. Development and performance evaluation of manual vegetable Tran's planter M. Tech. (Agril. Engg.) Unpublished Thesis. CAET, Jau, Junagadh, Gujarat, 2017.
4. Makavana JM, Sarsavadia PN, Chauhan PM. Effect of Pyrolysis Temperature and Residence Time on Bio-char Obtained from Pyrolysis of Shredded Cotton Stalk. International Research Journal of Pure and Applied Chemistry, 2020, 10-28.
5. Gite LP, Majumdar J, Mehta CR, Khadatkar A. Anthropometric and Strength Data of Indian Agricultural Workers for Farm Equipment Design. Central Institute of Agricultural Engineering, Bhopal, 2009.
6. Jagvir D, Kumar V, Mudasir A. Development and evaluation of a single row manual vegetable transplanter. Agricultural Engineering Today. 2018;42(2):58-66.
7. Khadatkar A, Mathur SM, Gaikwad BB, Pandirwar A, Shrinivas DJ. Biometric properties of plug vegetable seedlings relevant to the design of vegetable transplanter. Journal of Agricultural Engineering. 2020;57(1):16-24.
8. Kumar GVP, Raheman H. Vegetable transplanters for use in developing countries. International Journal of Vegetable Science. 2008;14(3):232-255.
9. Manes GS, Dixit AK, Sharda A, Singh S, Singh K. Development and evaluation of tractor operated vegetable transplanter. Agricultural Mechanization in Asia, Africa and Latin America. 2010;41(3):89-92.
10. Makavana JM, Kalaiya SV, Dulawat MS, Sarsavadia PN, Chauhan PM. Development and performance evaluation of batch type biomass pyrolyser for agricultural residue. Biomass Conv. Bioref, 2020. https://doi.org/10.1007/s13399-020-01105-1
11. Parish RL. Current developments in seeders and planters for vegetable crops. Horticulture Technology. 2005;15(2):1-6.
12. Thorat PV, Jhala KB, Jadhav ML. Design, Development and Performance Evaluation of Manually Operated Two Row Trolley Type Vegetable Transplanter. International Journal of Current Microbiology and Applied Sciences. 2017;6(11):3577-3589.
13. Zamani MD. Development and evaluation of a vegetable transplanter. International Journal of Technical Research and Application. 2014;2(6):40-46.