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Determination of Selected Physical Properties of Vegetable Seedlings for Development of Vegetable Transplanter

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ABSTRACT

The physical properties of vegetable seedlings are important for the design or development of vegetable transplanters. The transplanting of vegetable seedlings is generally accomplished through manual, semi-automatic or fully automatic transplanters. The selected physical parameters like,plant height, plant weight, stem diameter and plant canopy of the tomato and chilli seedlings were measured as per the age of the seedlings (4, 5 and 6 weeks). The observed average height of seedlings was 115, 125.4 and 133 mm (Chilli); and 117,122 and 135.60 mm (Tomato) for 4, 5 and 6 weeks old seedlings, respectively. The average weight of seedlings was determined 12.38, 15.34 and 16.64 g (Chilli); and 13.64,16.82 and 19.86 g (Tomato) for 4, 5 and 6 weeks old seedlings, respectively. The average diameters of stems were 1.29, 1.38 and 1.41 mm (Chilli); and 2.22, 2.58 and 3.39 mm (Tomato) for 4, 5 and 6 weeks old seedlings, respectively. The average plant canopies were 97.2, 115.2 and 129.2 mm (Chilli); and 74.60, 88.20 and 119.80 mm (Tomato) for 4, 5 and 6 weeks old seedlings, respectively.

Keywords : Physical properties, Seedlings, Tomato, Chilli, Design, Vegetable transplanter

INTRODUCTION

The importance of vegetables in human nutrition is well known. They are the cheapest natural nutritive food sources and the only source of protective nutrients such as minerals and vitamins. India is the world's second largest vegetable producer, from 2004-2005 to 2018-2019 and the cultivated area for vegetable production increased gradually, rising from 6.74 mha to 10.10 mha (Khadatkaret.al,2020). India produces and consumes the most vegetables, followed by China. Vegetable production covers approximately 8.50 million ha, yielding nearly 188.28 million tonnes and accounting for approximately 15% of global vegetable production (Nage *et al.*, 2022).

Due to increase in labour wages and labour shortage during the peak season, transplanting of vegetables has become more cost intensive unit operation. Another reason is that, seedling grown in nurseries and transplanting them into another field almost done by manually and requires 40% of total cultivation hours (Khadatkar *et.al*, 2018). Mechanization in transplanting means reducing the labour demand during cultivation

with the minimum damage to seedling and attaining the maximum efficiency in unit operations.

The mechanization in vegetable transplanting is important for efficient operation and increased production (Turbatmath *et.al,* 2010). Day by day the demand of the vegetables is increasing due to increasing population and health consciousness, to fulfill the above demand and export the good quality of vegetables in a time bound system the mechanization of the Indian farms is inevitable. For the mechanization in Indian farms the manual and semi-automatic vegetable transplanters are very much economical with respect to operating and servicing cost. The field capacity and accuracy are higher in automatic transplanter but having high initial cost, its complicated mechanism and servicing facility makes it uneconomical in Indian farms (Pandirwaret al., 2015).

MATERIAL AND METHODS

As suggested by Mohsenin (1986) and Thorat *et al* (2017), for easy passage of plug seedlings and its subsequent vertical placement along with the movement from the jaw is influenced by the physical properties seedlings, such as plant height, plant weight, stem thickness and plant canopy. From this point of view following properties was measured as discussed below.

Plant height-The plant height is necessary for the design and development of the seedling carrying tube and dropping jaws. The seedlings were gently pulled from the plug tray and length of the plant (tip of the leaf to the end of stem *i.e.* excluding roots) was measured by scale having least count of 1 mm as shown in figure 3.1, as suggested by Mohsenin (1986). three such observations were recorded for every age (*i.e.* 4, 5 and 6 weeks of seedlings).

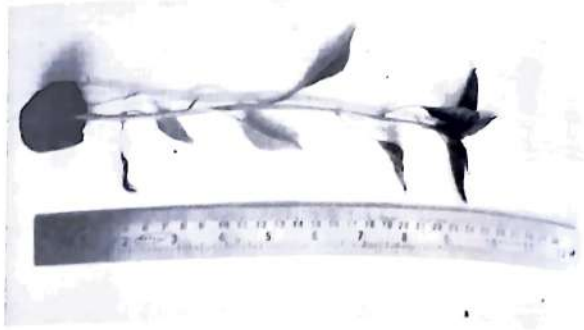

Fig. 3.1 Measuring plant height by steel ruler

Plant weight –Plant weight is very important for the gravitational speed of the seedlings drop from a specific height. Weight of plant was measured using weighing balance having least count 0.5 g as shown in figure 2. as suggested by Mohsenin (1986). Three such observations were recorded for every age (*i.e.* 4, 5 and 6 weeks of seedlings).

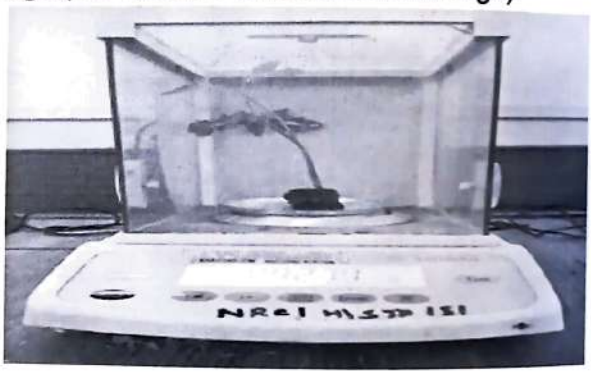

Figure 2 Weighing balance for measuring the plant weight.

Plant stem diameter: Stem diameter that represents the thickness of vegetable seedlings. The measurements were done at

Figure 3 Measuring the plant stem diameter by Vernier Caliper

three positions on the stem *i.e.* Top, middle and bottom measured by vernier caliper having least count of 0.02 mm as shown in figure 3. as suggested by Mohsenin (1986). Three such observations were recorded for every age (*i.e.* 4, 5 and 6 weeks of seedlings) were taken.

Plant Canopy-The size of the canopy of plug seedlings was specified by the critical canopy diameter and is define das the minimum inner diameter of a circular pipe through which a healthy plug seedling dropped (Thor at, 2017). Plant canopy of randomly selected vegetable seedlings (Chilli and tomato) was measured by vernier caliper having least count of 0.02 mm as shown in figure 4 as suggested by Mohsenin (1986). Three such observations were recorded for every age (*i.e.* 4, 5 and 6 weeks of seedlings).

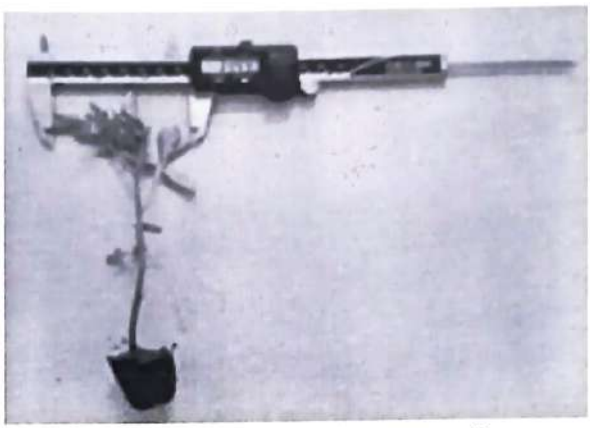

Fig. 4 Measuring the plant canopy by vernier caliper

RESULTS AND DISCUSSION

The physical properties of the vegetable seedlings are required in design and selection of different components of machine. Relevant properties namely weight, height, stem thickness, plant canopy were measured and are summarized in Table 1 to Table 4

Weight of seedlings

The weight of chilli and tomato seedlings is given in Table 1 . The average weight of seedlings was 12.38, 15.34 and 16.64 g (Chilli); and 13.64,16.82 and 19.86 g (Tomato) for 4, 5 and 6 weeks old seedlings, respectively. The weight of seedlings increases with age.

Table 1 Average weight of Chilli and Tomato seedlings

Sr. No.	Age of seedlings	Weight of Chilli seedling	Weight of Tomato seedling
1	4 weeks of seedlings	12.38	13.64
2	5 weeks of seedlings	15.34	16.82
3	6 weeks of seedlings	16.61	19.86

Height of seedlings

The data pertaining to the height of the seedlings (Chilli and Tomato) are given in Table 2. The average height of seedlings was 115, 125.4 and 133 mm (Chilli); and 117,122 and 135.60 mm (Tomato) for 4, 5 and 6 weeks old seedlings, respectively.

Table 2 Average height of Chilli and Tomato seedlings

Sr. No.	Age of seedlings	Height of Chilli seedling	Height of Tomato seedling
1	4 weeks of seedlings	115	117
2	5 weeks of seedlings	125.4	122
3	6 weeks of seedlings	133	135.60

Stem thickness

The stem thicknesses are given in table 3. The average diameters of stems were 1.29, 1.38 and 1.41 mm (Chilli); and 2.22, 2.58 and 3.39 mm (Tomato) for 4, 5 and 6 weeks old seedlings, respectively. The results show that stem thickness of vegetable seedling increases with increase in age of seedlings. The metering mechanism and feeding cups was designed based on seedling dimensions.

Table 3 Average stem thickness of Chilli and Tomato seedlings, mm

Sr. No.	Age of seedlings	Stem thickness of Chilli seedling	Stem thickness of Tomato seedling
1	4 weeks of seedlings	1.29	2.22
2	5 weeks of seedlings	1.38	2.58
3	6 weeks of seedlings	1.41	3.39

Plant canopy

The plant canopies are given in table 4. The average plant canopies were 97.2, 115.2 and 129.2 mm (Chilli); and 74.60, 88.20 and 119.80 mm (Tomato) for 4, 5 and 6 weeks old seedlings, respectively. The results show that plant canopy of vegetable seedling increases with increase in age of seedlings.

Table 4 Average plant canopy of Chilli and Tomato seedlings

Sr. No.	Age of seedlings	Plant canopy of Chilli seedling	Plant canopy of Tomato seedling
1	4 weeks of seedlings	97.2	74.60
2	5 weeks of seedlings	115.2	88.20
3	6 weeks of seedlings	129.2	119.80

CONCLUSION

From the above study it concludes that the physical parameters such as plant weight, plant height, stem thickness and plant canopy of the vegetable seedlings show the vast impact on the design parameters of the vegetable transplanters. As the age of the seedlings increases the above parameters also increases. So, as per the planting suggestions by the horticulturists the above said age of the seedlings which is useful for the sowing of vegetable plants.

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