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Development of a gravity fed automatic vegetable transplanter

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ABSTRACT : A gravity fed automatic vegetable transplanter was developed and evaluated in the laboratory. The main objective of this work was to drop the seedling by gravity without causing damage to the seedling. To make the feeding pro - tray simple, an open bottom type pro tray seedling was used. To move the tray continuously, a 50 rpm gear motor with finger type moving mechanism was developed and tested. The conventionally practiced growing medium with 20, 30 and 40 days old seedling was used for conducting experiment. Under laboratory condition it was found that it was feasible to drop 28 plants min^{-1}.

KEY WORDS : Pro-tray, Gear motor, Finger wheel, Automatic vegetable transplanter

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India has emerged as a leading horticultural country of the world with a total annual production of 240 million tonnes of horticultural crops during 2010 - 11. Developing countries contribute 72 per cent of the total vegetable production in the world. India is the second largest producer of vegetables after China. Production of vegetables in India stands at 14.0 per cent of the world production in 2010 - 11. India produces nearly 60 leafy, fruity and tuber varieties of vegetables. The area under vegetable is around 8.50 million ha and production 146.55 million tones (Horticulture data base 2011). At present the transplanting of vegetable seedling is carried out by manually all over the country. The vegetable nursery is grown in the field and later transplanted to the main field by manually transferring them but their survivable is usually not good. Now a days, the vegetable growers have moved on to the pro - tray seedling, since the pro - tray seedling has good reestablishment capability after transplanting them manually or mechanically.

Some minor dimensional changes may have to be made to the trays to make mechanical handling easier (Shaw, 1986). The tray grown plants cost more but their survival is better and transplanting shock is much less. The tray grown seedlings have stirred up interest in developing fully automatic transplanters, since the seedlings are in an orderly array that might be handled mechanically (Shaw, 1999). The difficult problem is how to remove the seedlings from the tray.

The imported vegetable transplanters are not suitable for Indian soil condition. Moreover, the existing mechanism of plant removal in these machines complex, hence we are simplify the plant removal mechanism for using appropriate methodology. Automatic dropping of seedling by gravity with continuous movement of pro - tray was hence contemplated.

METHODOLOGY

The seedling instead of being taken from top is planned to be dropped through the bottom. The plug - tray, which is open at the bottom, is not commercially available. So pro - tray cell bottoms were manually cut and used on trial basis. Instead of using the whole pro - trays, pro - tray was segmented into seven linear strips and used, so that each strip with seedling can be fed to the machine rather than the whole tray.

The pro - tray strips were cut manually to uniform size and the bottom was removed manually for which a dye was made and placed on top of the pro - tray and knife was used to cut the bottom of the pro - tray. Fig. A shows the details of the open bottom type pro - tray segments (Tsuga, 2000). It was felt that if this method proved successful, the seven segments could be made attachable to each other to grow the seedling in a whole unit, after which they could be separated and fed into the designed machine. The important difference here is that the pro - tray segment was placed upside down, media filled and seeds sown in bottom-up position. When the seedlings are fully grown the taper available is the cell will allow the seedling to slide down easily by gravity.

Fig. A : Open bottom type pro – tray

A feeding chute for the machine was fabricated which would allow the segmented pro - trays into the machine from waist height. The experimental feeding chute was developed to test the process by feeding the pro - tray strips towards testing whether gravity ejection is really feasible. The details of the chute are shown in Fig. B. A transfer plate was also developed for transferring the pro - tray segments with seedlings into the feeding chute (Fig. B). While transferring the seedlings to the transfer plate the seedlings are loosened slightly by gravity from the pro - tray due to the two round rods provided the inner edge of the transfer plate and the clearance created thus. The transfer plate was then inserted onto the top of the feeding chute, then the seedling tray pushed down by hand, so that it slides downward until it reaches the bottom of the feeding chute. At the bottom end of the parabolic sliding feeding chute, matching hole is provided. When the pro - tray cell bottoms are synchronized in position with the bottom hole of the feeding chute at the end, the seedling could fall down by gravity to the ground. To prevent tipping of the seedling to side while moving down the chute, ribs were provided on both sides of the feeding chute with a height of 1.5 cm.

Fig. B : Test rig for seedling ejection by gravity

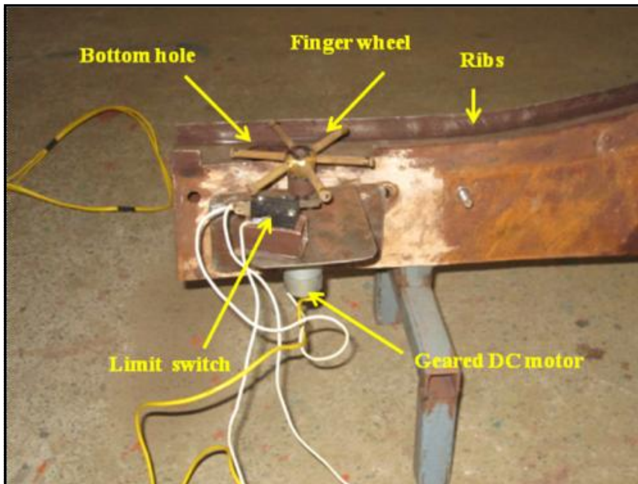

Fig. C : Finger wheel moving mechanism

A 12 V, DC, 50 rpm centre shaft gear motor was used for provide the movement to the seedling segment. A hub with six equally spaced fingers was fitted on the motor shaft. The fingers on the wheel moves a linear distance of 3.6 cm (*i.e.* the centre to centre distance of the tray cells) and the pro - tray with seedlings is pushed forward down the rig such that each cell aligns with the hole sequentially. The fingers were sheathed with rubber to avoid damage to tray wall while pushing it forward (Fig. C). The circuit that allowed the finger wheel to push the tray cells one by one is shown in Fig. D. A limit switch was provided which stops the movement when each of the fingers moves the tray segment through one cell distance. When, the hole is aligned to the seedling bottom, it

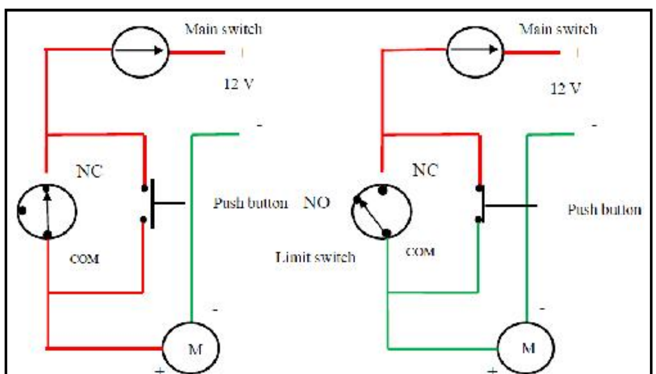

Fig. D : Circuit diagram for imparting movement to the pro-tray segment

is free to fall through it. A push button was connected in parallel to override the limit switch when next movement was required. Thus the tray segment carrying the seedlings was pushed one by one to the hole for making them to fall through.

The motor is connected through the NC terminals of the limit switch to the battery. So when the finger activates the limit switch, the circuit is opened and the motor is stopped and is retained in that position. But when the push button is pressed manually and momentary, the circuit is completed and motor rotates till the next finger hits the limit switch and so on.

RESULTS AND DISCUSSION

The seedlings were grown in open bottom type pro - tray with growing medium of coir pith + vermicompost (4:1) (media 1), coir pith + vermicompost (4:1) + paper cone (media 2), soil + vermicompost (4:1) (media 3), and soil + vermicompost (4:1) + paper cone (media 4), and tested on the developed rig. The agronomical parameters like plant height, stem diameter, number of leaves and root weight was measured to find any influence of the media on the growth when grown in open bottom type pro - tray. It was found that no significant difference existed between them. The results were shown in Fig. 1. It was observed that the (media 4) soil + vermicompost (4:1) + paper cone seedlings fell down successfully due to the weight of the seedling when compared to other media, moreover, the paper cone prevents media stick on to the pro - tray hence, all the seedlings fell down successfully without any damage of root ball.

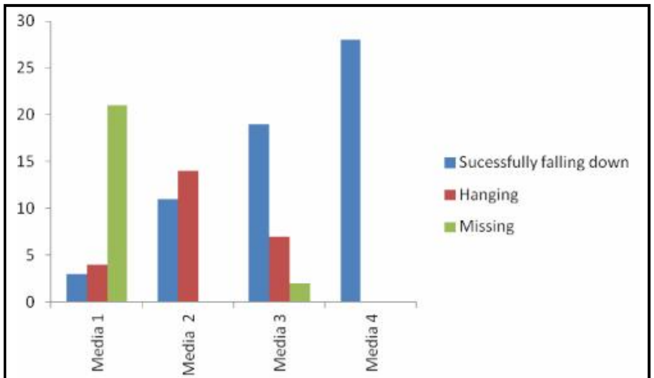

Fig. 1 : Effect of gravity falling with open bottom type pro - tray

Conclusion:

The mechanism was not smoothly moving the pro - tray segment. Since the fingers were pushing the cells tangentially, thus moving of axially along the test rig, they pierced into this plastic wall of the cells causing damage. The successful falling was found to be 28 plants min^{-1}. Using some appropriate mechanism such as walking beam mechanism or four bar mechanism may be avoided this problem.

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