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Effect of selected parameters on funnel side slope angle for smooth dropping of seedlings in semi-automatic vegetable transplanter

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■ **ABSTRACT :** Studies were conducted on a two row semi-automatic vegetable transplanter to determine the optimum funnel side slope angle in the feeding and metering mechanism at different seedling ages and different types of seedlings. The optimum side slope of the funnel has been decided by laboratory experimentation so that not a single seedling sticks to the funnel side after being dropped from the finger tray of the feeding mechanism. The experiments have been designed as a three Factors Complete Randomized Design with four replications. It was found that, at funnel side slope angle of less than 75° with the horizontal, the per cent of seedlings slipped into the drop tube decreased as the length of seedlings increased. At side angle of funnel of 75° and more, 100 per cent seedlings were slipped into the drop tube irrespective of crop and size of seedlings. Behaviours of different crops were found to be different below 75°. The crop with less foliar development such as chilli slipped more easily than other crops having more foliar development such as brinjal. So a funnel side slope angle of 75° has been taken as optimum to ensure cent per cent slippage of seedling from side of the funnel to the dropping tube for all crops under study.

■ **KEY WORDS :** Furrow opener, Funnel, Finger trays, Dropping tube, Slope angle

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India is the second largest producers of vegetable with 2.8 per cent of total cropped area under vegetables after China. The vegetable production of our country before independence was merely less than 20 mt and now according to National Horticulture Database-2011, total vegetable production in India in the year 2010-2011 was 146.55 million metric tons grown over an area of 8.49 million hectares with an average yield of 17.26 metric tons/ha (Anonymous, 2011a). Vegetable production in India stands at 7 per cent of the world production. Manual transplanting of seedlings, weeding and harvesting are the most labour consuming operations in vegetable cultivation. Transplanting of vegetable seedlings in developed countries like U.S.A., China, Holland, Japan and Canada is being mechanically done with either fully automatic or semi-automatic vegetable transplanters. However, in India, transplanting of vegetable seedlings is done manually allover the country, as very few work has been made to develop vegetable transplanters. Some attempts have been made in recent years on semi-automatic vegetable transplanters for adoption under our conditions. In automatic type vegetable transplanters both feeding and metering of seedlings are automatic where as in semi-automatic type feeding is done manually and metering is done mechanically. Generally, semi-automatic transplanters use bare root seedlings. Metering systems must be designed to maintain desired plant to plant distance in a row. Garg and Dixit (2002) reported the development and evaluation of a single row semi-automatic transplanter with single cone type metering mechanism with a drop chute for placing seedlings into a furrow by gravity. Two operators alternatively place a single seedling at one time. The rotating plate strikes the cone opening it, and the seedling moves in the drop chute pipe. Bare root chilly seedlings transplanted with the machine had missing of 14.47 per cent and the machine had a low capacity. Semi-automatic potato planter and sugarcane planter with revolving magazine type metering mechanism can plant 90 tubers of potato and 60 sets of sugar cane per minute by chilli transplanter with finger type metering mechanism (Satpathy, 2003). Tale *et al.* (2004) developed a manually operated semi-automatic vegetable transplanter and reported that the inclination of the cups become around 50 to 55° with the horizontal, so that the seedling slides along the cup and its roots dropped into the furrow opened by the furrow opener. Craciun and Balan (2005) developed a rotary cup type planting unit with open cup bottoms and supported on a horizontal stationary plate with an opening through which the seedling was discharged. This type of planting device allows the operator to rapidly place several seedlings and then have a brief time to untangle or remove seedlings from cells rather than having to maintain exact timing for each seedling (Parish, 2005). Transplanter with such type of metering unit can plant 50-80 seedling/min/row, depending on the required plant spacing. But this type of planting unit was used for planting pot seedlings in semi-automatic vegetable transplanter. Satpathy and Garg (2008) reported that in two row tractor operated vegetable transplanter with finger type metering mechanism; plant missing was within acceptable limit of 3-4 per cent at 1 to 1.2 km/h with two operators feeding seedlings per row. Mahapatra (2010) reported that slope angle of 75° was considered as optimum for designing the funnel of the dropping tube in power tiller operated single row vegetable transplanter for 100 per cent dropping of vegetable seedling. Narang *et al.* (2011) tested semi-automatic vegetable transplanter with revolving magazine type metering mechanism and reported that average plant missing in case of brinjal was 2.22 to 4.44 per cent and the quality of feeding decreased with increase in plant missing and ranged between 95.57 to 97.78 per cent.

In this study small trays called finger trays have been designed in semi-automatic vegetable transplanter on whom the seedlings are to be kept manually. The seedling feeding and metering mechanism consists of a feeding chain carrying five finger trays on each row, a bevel assembly and a chain and sprocket assembly. The seedlings were dropped in the funnel. A laboratory test was conducted to ascertain the optimum angle with horizontal the side of the funnel need for proper guiding of the seedling into the tube.

METHODOLOGY

The following considerations have been made while designing the dropping tube and funnel.

The height of fall of seedlings has been kept as low as possible to avoid any mechanical injury to the young seedling prior to transplantation.

There is a cut at the rear side of the seedling dropping tube (Fig. A) at its lower end to allow the dropped seedlings to be undisturbed after being placed in the furrow opener when the transplanter moves in forward direction.

Finger trays were fitted in a chain which carrying seedlings. Seedlings were kept manually one by one either by the operator himself or by an extra person on each tray. The seedlings were dropped automatically in the funnel when the transplanter moved. Aluminum sheet was selected as funnel material for better slippage. The details of the seedling tube and funnel are shown in Fig. A.

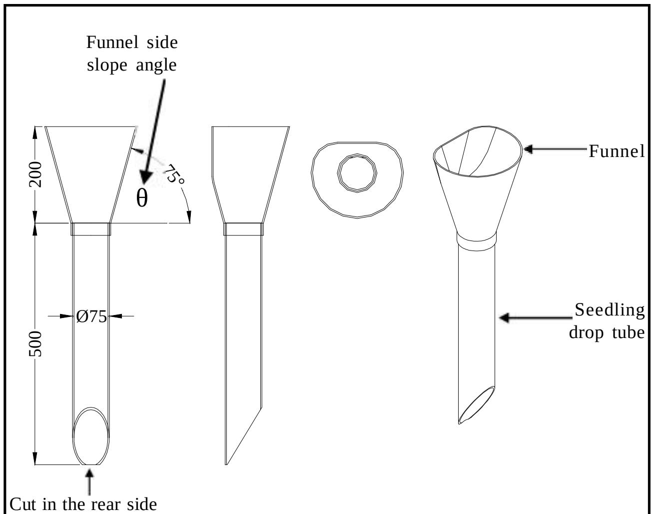

Fig. A : The seedling drop tube with funnel

Laboratory test was conducted to study the optimum angle (θ) that the side of seedling funnel makes with horizontal as shown in Fig A. This angle is important to ensure downward movement of the seedling dropped from the finger tray into the funnel. Any seedling, if not slipped into the dropping tube will cause missing plant and clogging of seedling inside the funnel. Therefore, angle of funnel slope is vital for design point of view. This angle 'θ' helps the seedlings to slip on the side wall of the funnel into the vertical tube. If 'θ' is less than optimum, then the seedlings do not slip into the vertical tube causing both clogging in the tube and missing plant in a row. Therefore, tests were conducted to find out the optimum angle for different crop seedlings with different length.

The experiment was planned as a three Factor Completely Randomized Design with four replications as follows in Table A. The levels of the factors were decided after observing the preliminary tests. The first factor has been taken as the side

Table A: Design of experiment for laboratory test

Sr. No.	Factor number	Factor description	Levels
1.	Factor-1	Angle, 'θ'	θ_1=65°, θ_2=70°, θ_3=75°, θ_4= 80°
2.	Factor-2	Crop, C	C_1=Brinjal, C_2 = Chilli, C_3 = Tomato, C_4 = Cabbage
3.	Factor-3	Length of seedling, L	L_1 = 100-150 mm, L_2 =150-200 mm, L_3 = 200-250 mm, L_4 = 250-300 mm.

angle (Level = 4) and the second factor as four crops (Level = 4) and the third factor as size of seedlings (Level = 4). The diameter of the seedling dropping pipe has been chosen as 75 mm so that the largest possible seedling passes through it without damage as the canopy of all the seedlings are within 75 mm during transplanting.

RESULTS AND DISCUSSION

The purpose of finding the side angle of funnel of dropping pipe was to drop the seedlings in such a way that all the seedlings were guided towards the dropping tube and the missing should be as minimum as possible. The mean of the replications of the experiment has been shown in Table 1.

The ANOVA for the effect of different side slope angles of funnel with respect to horizontal, type of crop and seedling length on the percentage of seedlings slipped into dropping tube (PSSD) has been presented in Table 2.

Effect of funnel side slope and type of crop :

It was evident from the ANOVA table that the individual effects of all the factors were highly significant (probability = 0.0000). Effects of funnel side slope angle and type of crop on percentage of seedlings slipped easily into the dropping tube (PSSD) was found significant at both 1 per cent and 5 per cent

Table 1 : Mean of seedlings slipped into the dropping tube after being dropped on the side of the funnel from finger tray

Funnel side angle	Crop	Seedlings slipped into the dropping			
		L =100-150	L =150-200	L =200-250	L =250-300
65°	Chilli	9.218 (85)	9.351 (88)	9.218 (85)	7.937 (64)
	Brinjal	7.891 (63)	8.658 (75)	7.848 (63)	7.780 (61)
	Tomato	8.942 (80)	8.653 (75)	9.007 (81)	7.354 (55)
	Cabbage	8.580 (74)	8.944 (80)	7.904 (63)	6.794 (46)
70°	Chilli	10.0 (100)	9.872 (98)	10.0 (100)	9.145 (84)
	Brinjal	9.218 (85)	9.281 (86)	9.145 (84)	7.723 (60)
	Tomato	9.414 (89)	9.274 (86)	9.281 (86)	8.006 (65)
	Cabbage	9.809 (96)	9.809 (96)	8.873 (80)	8.536 (75)
75°	Chilli	10.0 (100)	10.0 (100)	10.0 (100)	10.0 (100)
	Brinjal	10.0 (100)	10.0 (100)	10.0 (100)	10.0 (100)
	Tomato	10.0 (100)	10.0 (100)	10.0 (100)	10.0 (100)
	Cabbage	10.0 (100)	10.0 (100)	10.0 (100)	9.872 (98)
80°	Chilli	9.872 (98)	10.0 (100)	10.0 (100)	10.0 (100)
	Brinjal	10.0 (100)	10.0 (100)	10.0 (100)	9.873 (98)
	Tomato	10.0 (100)	10.0 (100)	10.0 (100)	9.872 (98)
	Cabbage	10.0 (100)	10.0 (100)	9.937 (99)	9.541 (91)

* Data in the parentheses are actual data in percentages (rounded to integer)
** Data out side the parentheses have been transformed for analysis of variance.

Table 2 : Analysis of variance for the effect of seedling length, crop and funnel side slope angle on percentage of seedlings slipped into dropping tube (CRD)

Source	DF	Sum of squares	Mean square	F Value	Prob.	SEM	C.D.	
							1%	5%
Factor A	3	110.122	36.707	170.0326	0.0000	0.0581	0.2138	0.1621
Factor B	3	7.476	2.492	11.5426	0.0000	0.0581	0.2138	0.1621
AB	9	8.879	0.987	4.5699	0.0000	0.1162	0.4276	0.3241
Factor C	3	20.532	6.844	31.7022	0.0000	0.0581	0.2138	0.1621
AC	9	15.455	1.717	7.9546	0.0000	0.1162	0.4276	0.3241
BC	9	2.980	0.331	1.5337	0.1385	0.1162	NS	NS
ABC	27	6.138	0.227	1.0531	0.4007	0.2323	NS	NS
Error	192	41.450	0.216					
Total	255	213.032						
Co-efficient of variation: 4.95%								

Factor A: Funnel side slope angle (Level= 4) Factor B: Seedlings of five different crops (Level= 4)
Factor C: Length of seedlings (Level= 4) No. of replication: 4
Dependant variable: Seedlings slipped into the drop pipe without problem, per cent NS=Non-significant

level. The interaction effects of AB and AC were also found significant at 1 per cent and 5 per cent level. However, combined effect of BC and ABC were non-significant at 5 per cent level.

The percentage of seedlings slipped easily into the dropping tube (PSSD) with different types of crop at different side slope angle and length of seedlings have been presented in Fig. 1.

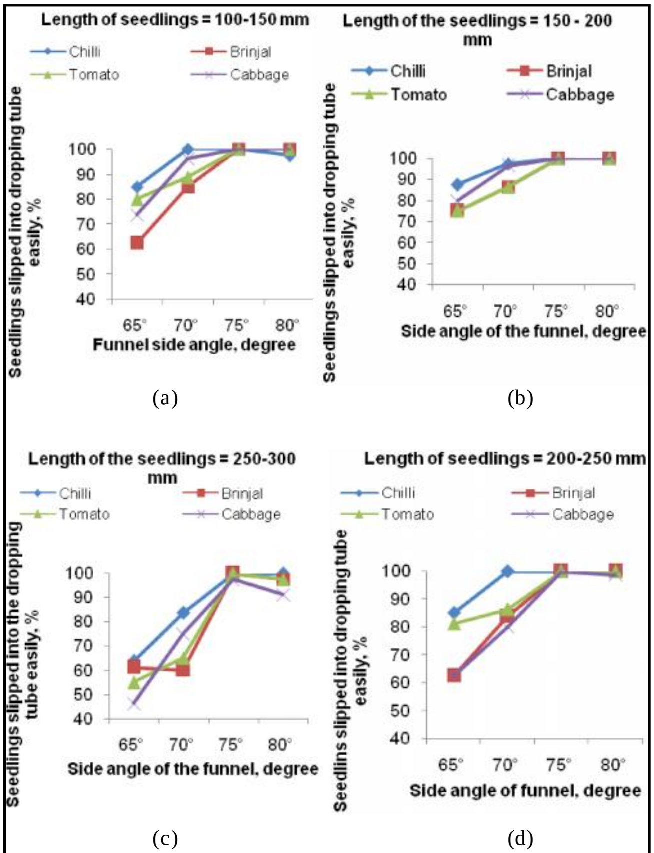

Fig. 1 : Effect of funnel slope with respect to horizontal and length of different types of crop seedlings on percentage of slippage into the dropping tube

It was found that the percentage of seedlings slipped into the dropping tube increased with the increase of funnel slope with respect to horizontal from 65° to 75°. At funnel slope angle of 75°, cent per cent seedlings of all crops were slipped easily into the dropping tube. At values of funnel slope angle more than 75°, the same result has been achieved except in case of cabbage when its length exceeds 250mm. It may be due to softness and more foliar development of cabbage seedlings. Behaviours of different crops were found to be different below 75°. The crop with less foliar development such as chilli slipped more easily than other crops having more foliar development such as brinjal. When the length of crop exceeds 250 mm, percentage of seedlings slipped easily into the dropping tube (PSSD) for all the crops decreased to 80 per cent at 65° and 70° funnel side slope angle. So a funnel side slope angle of 75° has been taken as optimum to ensure cent per cent slippage of seedling from side of the funnel to the dropping tube for all crops under study.

Effect of length of seedling at different funnel slope :

Effects of funnel side slope angle and crop length on percentage of seedlings slipped easily into the dropping tube (PSSD) was found significant at both 1 per cent and 5 per cent level. The effect of length of seedlings at different funnel slope with all crops has been shown in Fig. 2. It was found that at funnel side slope angle of less than 75°, the percentage of seedlings slipped into drop pipe decreased as the length of seedlings increased. But in case of side slope angle of 75° percentage of seedlings slipped into drop pipe achieved 100 per cent irrespective of type and length of crops. The results are in close conformity with the findings of Mahapatra (2010). When side slope angle was 80°, percentage of seedlings slipped into drop pipe decreased as the length of seedlings was of 250-300 mm size.

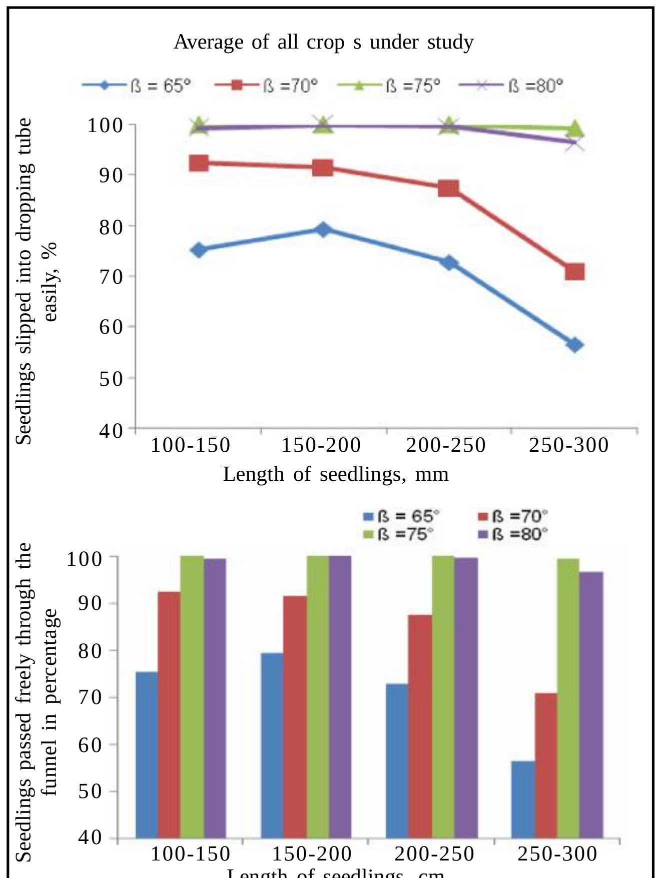

Fig. 2 : Effect of seedling length and funnel slope on percentage of seedlings slipped into the dropping tube

Conclusion :

It was found that, at funnel side slope angle of less than 75° with the horizontal, the per cent of seedlings slipped into the drop tube decreased as the length of seedlings increased. At side angle of funnel of 75° and more, 100 per cent seedlings were slipped into the drop tube irrespective of crop and size of seedlings. Therefore, a slope angle of 75° was considered as optimum for designing the funnel of the dropping tube.

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REFERENCES

Anonymous (2011a). Indian Horticultural Database-2011. National Horticultural Board, Ministry of Agriculture, Government of India, NEW DELHI, INDIA.

Craciun, V. and Balan, O. (2005). Technological design of a new transplanting machine for seedlings. *J. Central Eur. Agric.*, **7**(1): 164.

Garg, I.K. and Dixit, A. (2002). Design, development and evaluation of vegetable transplanter. Paper presented during 24th Workshop of AICRP on FIM (ICAR) held at TNAU, Coimbatore on 18-21, April.

Mahapatra, M. (2010). Design, development and evaluation of a power tiller operated vegetable transplanter. Ph.D. Thesis, Bidhan Chandra Krishi Vishavidhyalaya, Mohanpur, WEST BENGAL (INDIA).

Narang, M.K., Dhaliwal, I.S. and Manes, G.S. (2011). Development and evaluation of a two row revolving magazine type vegetable transplanter. *J. Agric. Engg.*, **48**(3) : 1-7.

Parish, R.L. (2005). Current developments in seeders and planters for vegetable crops. *Hort. Technol.*, **15**(2) : 1-6.

Satpathy, S.K. (2003). Effect of selected parameters on the performance of vegetable transplanters. M. Tech. Thesis, Punjab Agricultural University, Ludhiana, PUNJAB (INDIA).

Satpathy, S.K. and Garg, I.K. (2008). Effect of selected parameters on the performance of a semi-automatic vegetable transplanters. *AMA*, **39**(2): 47-51.

Tale, V.P., Taley, S.S., Revaskar, V.A. and Bhende, S.M. (2004). Testing, calibration and costing of semi-automatic vegetable transplanter. Paper presented in the proceedings of 38th ISAE conevention held at the College of Agricultural Engineering and Technology, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli on January 16-18, India. pp: 92-98.