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"Performance Evaluation of Tractor Operated Two-Row Vegetable Transplanter."

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Abstract: *India is the second largest producer of vegetable in the world (ranks next to China only). India share 12 percent of world production of vegetable with a productivity of about 15 tons per ha which is quite low as compared to many countries. In India transplanting of vegetable seedling is done manually all over the country, as no machine is yet available commercially for this work. High labour requirement and shortage of labour during peak transplanting season causes delay in transplanting and affects timely operation. To meet the requirements of a vegetable transplanter a semi-automatic two-row tractor drawn vegetable transplanter developed at PAU, Ludhiana. Therefore by keeping above points in view research was conducted to study the machine performance of semi-automatic vegetable transplanter and compared with the traditional system of manual transplanting; the two-row vegetable transplanter was evaluated in the field for brinjal and chillies and compared with the manual transplanting of bare root seedling. Results of study for field performance evaluation of tranplanter revealed that filed capacity of transplanter was 0.09-0.12 ha/h and field efficiency was found 64 to 75 per cent. The average plant height, number of branches per plant, plant mortality, yield/m^2 , seedling missing, and leaf area index was found more by machine transplanting while plant population, planting depth was found less by machine transplanting. Time saving, labour saving, less cost of operation were achieved in machine transplanting as compare to manual transplanting.*

Key Words: *Two Row Vegetable Transplanter, Performance Evaluation, Chilli, & Brinjal crops.*

I. Introduction

India provides larger quantities of vegetables. During recent years, the production and productivity of vegetable recorded impressive growth. The present vegetable production in India is 113.5 million tons in an area of 7.2 million hectares with an average productivity of 15.7t/ha (Singh,2007). Vegetable play an important role in improving the economic condition of vegetable growing farmers. One of the constraints to increase production and productivity of vegetable crops is low level of mechanization. Mechanization hells in timely compaction of operation. There is lot of scope for increasing yield in most of the vegetables by growing high yielding varieties and adopting improved production technologies. However, in India transplanting of vegetable seedling is done manually (Manes et al., 2008). Manual transplanting is labour & time consuming, costly and more fatigue as transplanting in season causes delay in transplanting which results in poor yield. The transplanting operations represent a significant portion of the transplant seedling cost. Most of the cost is attributable to the labour involved in handling seedling. Maximum vegetable crops like Brinjal, tomato, onion, chilli, cauliflower, cabbage etc. are transplanted manually. Timely transplanting of crops is essential for good yield which may be possible by mechanization. In conventional transplanting practice development of semi-automatic vegetable transplanter is very important. Features of transplanter influenced the performance, plat growth and productivity. Therefore an effort was taken to meet the above requirements and conducted a study of field performance evaluation of semi-automatic vegetable transplanter. A semi-automatic two-row vegetable transplanter was evaluated in the field for brinjal and chillies and compared with the manual transplanting of bare root seedling.

II. Materials & Methods

Physio-Chemical Properties of Soil

The relative proportions of sand, silt and clay in a soil mass determined the texture of soil and to determine it samples were taken from upper layer of 15 cm soil depth from all the experiment sites (S_1= SHIATS field soil, S_2= Village farmer fields soil1 S_3= Village farmer field1soil2). To determine the bulk density and moisture content of soil core cutter method and Infrared moisture meter were used respectively. Cone index was measured with the help of a cone penetrometer. A circular cone (base area= 322m^2) was pushed into the soil at a constant speed. The cone index was calculated as.

$$CI = \frac{Force\ on\ cone}{Base\ area\ of\ the\ cone}\ ,KPa$$

The field selected for the study was uniform in fertility, composite soil samples were subjected to mechanical and chemical analysis to obtained the physio- chemical properties of the soil.

Features of vegetable transplanter

The machine consisted of a frame, two lugged wheels, seedling tray, operator's seat, furrow opener, compaction wheels, finger guide tunnel finger type metering mechanism and a water tank. Picking fingers had spring mounted rubber flapper, which opened before passing through the tunnel and closed during passage. Power from the ground wheel shaft was supplied to the planting mechanism through chain and sprockets. The plant spacingt provision was there to change the plant spacing by chaining the sprockets or number of fingers. A furrow shaper was provided to maintain the shape of the channel between the two transplanting beds.

Measurement of draft

Draft were measured with the help of dynamometer.

Raising bare root type of seedlings

Seeds of brinjal and chilies were sown on the recommended dates on the beds in which seeds were broadcasted and dibbled in lines. Five to seven weeks old seedling were uprooted manually and transplanting in fields

III. Results And Discussion

The performance of two row vegetable transplanter was conducted and it was compared with conventional method. The performance parameters were recorded as per procedure given earlier. The experiment was conducted at S_1= Mohobbatganj village farmer field soil, S_2= Manouka village farmer field soil, $S_{3=}$ SHIATS farm field soil. Physio- chemical analysis showed that the soil of the field was sandy loam texture, medium in organic carbon medium in phosphorus and rich in potash content at location S_1 and S_2. The soil of the field S_3 was sandy texture, low in organic carbon, potash and phosphorus.

Machine performance parameter

The transplanter was operated at an average speed of 1.0 to 1.2 kmph in sandy loam soil at moisture content of 8 to 9.50 per cent. The cone index of the soil was 126-140 kpa. The average draft of the machine was 351 kgf. The field performance results of the vegetable transplanter for brinjal and chilies crop are presented in Table 1. Table 1 & 2 illustrates that the average time requirement for transplanter of brinjal crop was 8.6 h/ha and for chilies crop it was found to be 11.17 h/ha. The average fuel consumption was 3.15 l/h and 3.52 l/h in brinjal and chilies respectively. The average field capacity of the machine was 0.13 ha/h for brinjal and 0.09 ha/h for chills crop. The field efficiency was 75 per cent and 64.3 percent for brinjal and chilies crop respectively. Plant population was 1.49 plants/m^2 by machine transplanting and 2.15 plants/m^2 by manual transplanting at Village farmer field1, whereas at farmers fields it was 1.47 plants/m^2 by machine transplanting and 2.02 plants/m^2 by manual transplanting after 20 days of transplanting.

Plant height

The average data of plant height of brinjal crop at different days after 20 days of transplanting at regular interval of thirty days are presented in Table 2. Table 2 data revealed that at Village farmer field1average plant height was 30.32 cm by machine transplanting and 30.77 cm by manual transplanting at 20 days after transplanting maximum plant height was 58.38 cm and 54 cm by machine and manual transplanting respectively. At farmers fields plant height was 30.32 cm and 28.66 cm by machine and manual method at 20 DAT. Maximum plant height 59.77 cm after 100 DAT respectively.

Number of branches per plant

The average values of data on number of branches per plant for brinjal at different locations are presented in Table 2. Minimum number of branches (5.11) after 20 DAT and maximum (19.87) in machine transplanting, whereas in manual transplanting it was minimum, 4.31 at 20 DAT and maximum 20.21 at 100 DAT. At farmers field minimum was 4.55 and maximum was 21.11 by machine transplanting, whereas by manual transplanting, minimum was 3.87 and maximum 20.16. Analysis of various shows the effect of method of transplanting on number of branches per plant was found non-significant at 5 per cent for Village farmer field1and significant at farmer field.

Leaf area index

The average value of leaf area index are presented in Table 2. Table 2 data revealed that at Village farmer field1, average leaf area index 4.30 by machine transplanting and 3.91 by manual transplanting at 20 days after transplanting. Maximum leaf area index was 15.38 and 15.32 by machine and manual transplanting respectively. At farmers field leaf area index was 3.80 and 3.68 by machine and manual method at 20 DAT. Maximum leaf area index was observed after 100 DAT was 14.38 and 14.08 by machine and manual transplanting respectively. Analysis of variance shows the effect of method of transplanting on leaf index is significant at 5 per cent for both the locations. Above Results revealed that the average field capacity of the tractor operated semi-automatic two row vegetable transplanter was 0.9-0.12 ha/h whereas the field efficiency was 65 to 75 per cent. It is evident from Figure 1 that the seedling missing was 2 per cent higher over control. It was because of improper placement of seedling by figure in the soil and human error in placing seedling in the figure. Same was observed by Craciun et al (2005).

It is indicated from the Figure 3 that the 4 to 6 per cent plant mortality was more in machine transplanting in comparison to manual transplanting. It may be due to improper placement lesser depth of planting and less availability of water to the plant. The furrower provided with the machine was smaller in size with the result the furrow made for applying irrigation was also smaller in size. The seedling transplanting by the machine were at a distant and the availability of the water was less in comparison to manual method. The plant population as revealed from Figure 2 that plant/m^2 was less by machine transplanted over control. The reasons were higher plant to plant and row to row spacing higher mortality by machine transplanting over control. The average plant height, number of branches per plant and leaf area index was more by machine transplanting over control as indicated in Table 2. It was because of height row to row and plant to plant spacing. Same was observed by Mandhar *et al*. (2008).

Figure 1 revealed that the seedling missing was 4-5 per cent higher over control. It was due to the small seedling and difficulty faced by operated in separating individual seedling while feeding. The method of transplanting also controlled toward the missing percentage as in manual method the chilies seedling are transplanting on ridge which reduces the human error in missing the seedling while transplanting whereas in manual transplanting it was done on flat beds there was no effect on the upright/lying down seedling transplanted by machine or manual method. It is evident from the Figure 3 that the 4 to 8 per cent plant mortality was more in machine transplanting in comparison to manual transplanting. It may be due to the seedling transplanting on flat beds having lesser depth and availability of water to the plant.

The plant population found less by machine transplanted over control. The reason was higher plant to plant and row to row spacing higher mortality by machine transplanting over control. The yield per plant was more after first fruit harvesting by machine transiting over control. It was because of higher row to row and plant to plant spacing. On the other hand the yield/m^2 was higher in manual as compare to machine transplanting. It was because of higher plant population per square meter less plant mortality of plants. The results revealed that the higher yield per plant obtained by machine transplanting could not compensate the yield obtained by the higher plant population by the manual transplanting. The average plant height number of branches per plant and leaf area index was more by machine transplanting over control as indicated in Table 1. It was because of higher row to row and plant to plant spacing. But the analysis of variance showed that the different was non- significant.

IV. Conclusions

The average plant height, number of branches per plant, plant mortality, yield/m^2 , seedling missing, and leaf area index was found more by machine transplanting while plant population was found less by machine transplanting. Time saving, labour saving, less cost of operation were achieved in machine transplanting as compare to manual transplanting.

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Table 1. Machine performance parameter for brinjal and chilies

Parameter	Brinjal	Chili
Draft (kgf)	351	351
Speed of operation (km/h)	1.2	1.0
Actual time taken (h/ha)	8.6	11.17
Fuel consumption (l/h)	3.15	3.52
Field capacity (ha/h)	0.13	0.09
Field efficiency (%)	75	64.3

Table 2 Effect of transplanting methods on plant height, number of branches & leaf area index in brinjal

Location	Method of transplanting	Effect of transplanting methods on plant height in brinjal						Performance parameters 1
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	Mean	
Village farmer field1	Manual	30.77	39.71	48.21	55.00	56.55	46.04	
	Transplanter	30.32	40.71	51.32	58.38	59.77	48.10	
	Mean	30.54	40.21	49.76	56.69	58.16		
Village farmer field2	Manual	28.66	37.93	47.71	54.55	56.77		
	Transplanter	30.31	40.71	51.32	58.38	59.77		
	Mean	29.48	39.32	49.51	56.46	58.27		
Location	Method of transplanting	Effect of transplanting methods on number of branches per plant in brinjal						Performance parameters 2
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	Mean	
Village farmer field1	Manual	4.31	10.27	14.60	19.16	20.21	13.71	
	Transplanter	5.11	10.82	15.21	19.87	20.43	14.28	
	Mean	4.70	10.54	14.90	19.52	20.32		
Village farmer field2	Manual	3.87	8.60	13.87	18.93	20.16	13.9	
	Transplanter	4.55	9.49	15.32	20.10	21.11	14.11	
	Mean	4.21	9.04	14.60	19.51	20.63		
Location	Method of transplanting	Effect of transplanting methods on leaf area index in brinjal.						
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	Mean	Performance parameters 3
Village farmer field1	Manual	3.91	8.02	12.02	14.20	15.32	10.69	
	Transplanter	4.30	8.52	12.92	15.12	15.38	11.45	
	Mean	4.11	8.27	12.47	14.66	15.84		
Village farmer field2	Manual	3.68	7.83	10.45	12.31	14.08	9.67	
	Transplanter	3.80	7.76	11.09	13.13	14.38	10.03	
	Mean	3.74	7.79	10.77	12.72	14.23		

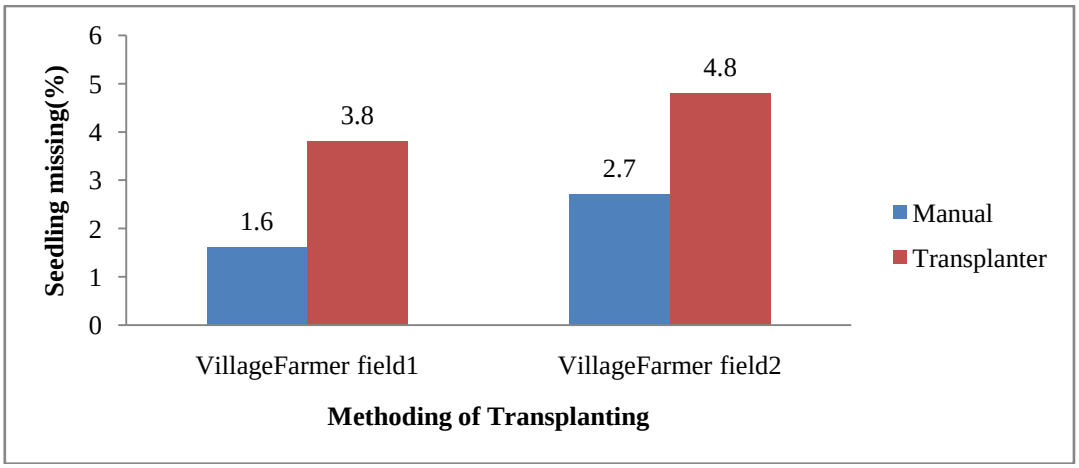

Figure 1. Effect of transplanting methods on seedling missing per cent in brinjal & chilli

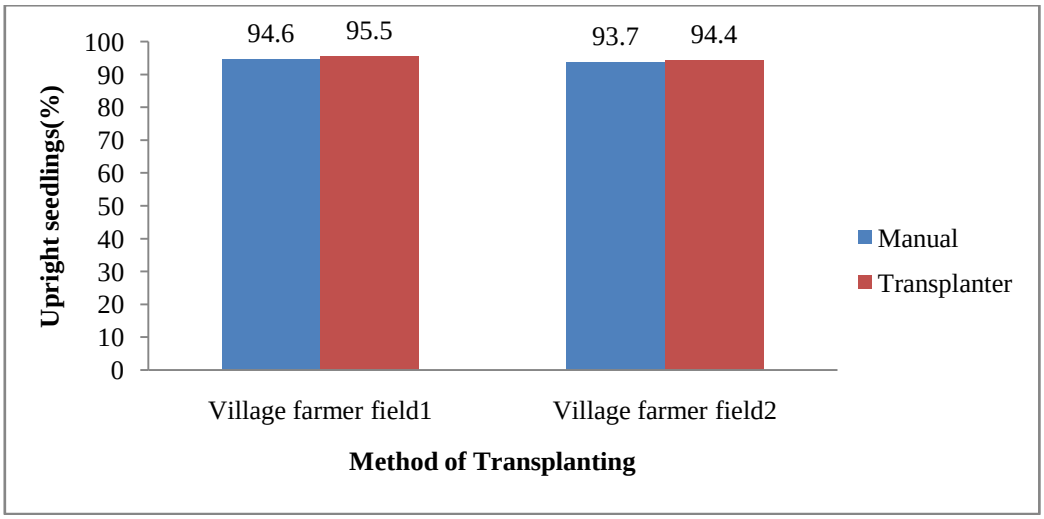

Figure 2. Effect of transplanting methods on upright seedling per cent in brinjal & chilli

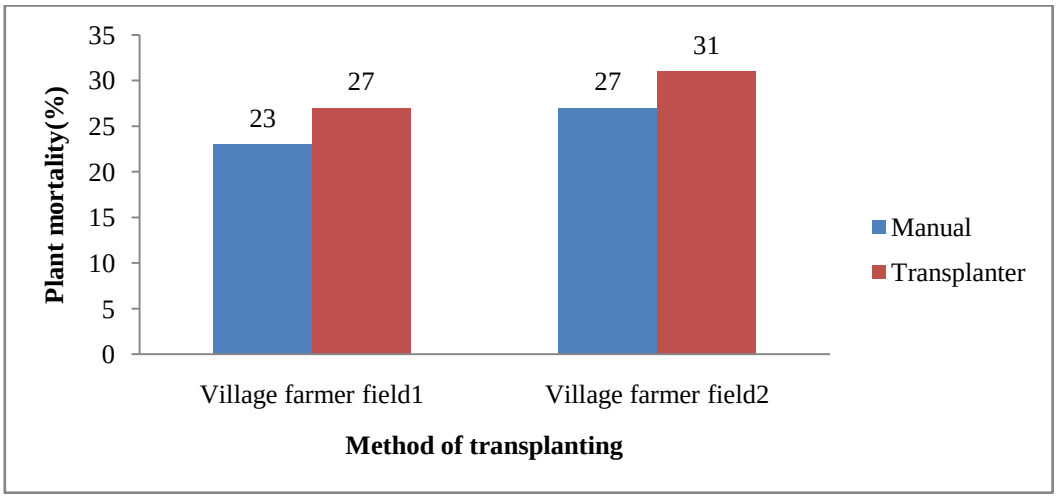

Figure 3. Effect of transplanting methods on plant mortality after in brinjal & chilli