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Performance Evaluation of Intra Row Weeder in Soil Bin

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A B S T R A C T

Weed management is a tedious task, especially in organic crop production, as synthetic herbicides are prohibited and manual weeding is relatively expensive or unavailable. However, mechanical weed control is one of the options that can be implemented by growers to control weeds but the main challenge to both practical farmers and researchers is the selective control of the intra-row weeds. Based on this challenge the objective of the study was to evaluate the minimum plant to plant distance required to operate the developed automated intra row weeder with minimum plant damage.Main components of the automated weeder was ultrasonic sensor, D.C. motor, microcontroller, battery, frame, tine, inter and intra row blade. Ultrasonic sensor was used for the differentiate crop plant from weed. Intra row weeder was detecting the crop plant by sensor and removes the weed. The performance of automated intra row weeder unit was evaluated in the soil bin by determining percentage of plant damage. This parameter is mainly affected by the plant to plant distance and various forward speed of weeder. Various plant to plant distance was selected 15, 25, 35, 45 and 55 cm. where, three different forward speed 0.5, 1.0 and 1.5 km/h was selected. Results of automated intra row weeder showed that without damaging the crop plant minimum plant to plant distance is 35 cm required. For minimum plant damage, forward speed of intra row weeder is found 1.0 km/h.

Introduction

In India, weeds are one of the major biological constraints that limit crop productivity. A weed can be thought of as any plant growing in the wrong place at the wrong time and doing more harm than good (Parish, 1990). Weeds in crop field compete for soil nutrients, soil moisture, sunlight (Tollenaar and Wu, 1999), space, water and other ecological factors throughout the whole growing season (Maxwell and O'Donovan, 2007). Some weed species are dangerous to livestock and release toxins through the soil which endanger other plants (Marer, 2000). Without a proper weed management program, weeds will affect crop yield and quality, resulting in reduced revenue for the grower.

Bhan *et al*., (1999) estimated that weeds in India reduce crop yields by 31.5% (22.7% in winter and 36.5% in summer and kharif

seasons). In other studies, weeds were reported to cause up to one-third of the total losses in yield, besides impairing quality of produce and causing health and environmental hazards. In a survey, Indian weed scientists estimated losses due to weeds from 10% to 100% (Table 1). Even a conservative estimate of about 10% loss would amount to a loss of food grains valued at approximately US$ 13 billion (Yaduraju, 2012).

The majority of the work that has been done in the last decades concerns weed control between the crop rows with implements such as hoe, row cultivator, rotary tiller, brush and rolling cultivator (Pullen and Cowell, 1997).There are also a wide range of mechanical intra row weeders available. Cloutier *et al*., (2007) and Weide *et al*., (2008) reported the usage of finger weeders and torsion weeders. Melander and Rasmussen (2001) report that mechanical intra row weed control is practically impossible; so computers, sensor and electronics are require to involve in intra row weeding machines.Based on this challenge the objective of the study was to evaluate the minimum plant to plant distance required to operate the developed automated intra row weeder with minimum plant damage.

Materials and Methods

The developed automated intra row weeder unit was evaluated in the laboratory for the plant damage at different operating conditions. The evaluation was done in soil bin unit at Farm Machinery and Power Engineering department of CAET, JAU. The evaluation was conducted after creating an appropriate field condition. The soil bin unit was prepared in such a way that it could assist in computing the performance of developed automated intra row weeder.

Soil bin utilized for testing was rectangular in cross section having the dimension of 16 m length, 1.5 m width and 1 m height with soil fill. The soil bin module consists of a tool carrier, trail, variable speed motor, rope drum unit and speed controller.

The soil fill was perfectly levelled and seed bed condition was created by removing soil clods and stones. Tool carrier was held over a trail and was driven by rope drum unit through variable speed motor. The already existed tool carrier was attached with a frame to carry unit of developed automated intra row weeder as shown in the Figure 1.

A 20 horse power variable speed motor with speed control system was used to drive the tool carrier through rope drum unit over the trail. Speed of the tool carrier was varied by varying the speed of the motor using speed control knob on the control panel.

Research plan for performance evaluation

The Research plan for performance evaluation of developed automated intra row weeder in laboratory was done by selecting one independent variables and one dependent variable as shown in Table 1.

Various experiments were conducted as per research plan previously indicated in Table 1. Observations of the total number of plant damage was calculated and discussed. From the various observations, minimum plant to plant distance was selected under consideration of plant damage for operating the developed automated intra row weeder in the field.

Experimental procedure of laboratory testing

Developed automated intra row weeder unit was attached on tool carrier of the soil bin.

Then after, Fresh and healthy brinjal plants were manually picked up with soil strata without disturbing their roots from the nursery of vegetable farm and transported to the laboratory. In laboratory, brinjal plants were re-planted at uniform depth (5-6 cm) on test tract of 10 m length and 55 cm plant to plant spacing. Weed was also re-planted in brinjal row at randomly distance.

After the re-planted brinjal plants and weed, the optimum forward speed of tool carrier for intra row weeder was selected as 1.0 km/h through speed selector knob on the control panel and measured the number of plant damage by intra row blade (Yadav *et al.*, 2018).

For different treatment, brinjal plants were re-planted at 45, 35, 25 and 15 cm plant to plant distance and follow the same procedure. From the various laboratory testing, minimum plant to plant distance was selected for operating the developed automated inter and intra row weeder in the field.

Results and Discussion

The performance evaluation of automated intra row weeder unit is conducted as per research plan indicated in Table 1. There was controlled condition in the soil bin, hence it was possible to re-plant the mature brinjal plant manually at a uniform depth and to maintain moisture content within the range of 15-21 %.

The depth of cut was fixed as 2 cm whereas the width of cut was 20 cm for laboratory testing. As the soil bin filled with the medium black soil, the soil resistance of 0.40 kg/cm^2 was considered.

The performance of automated intra row weeder unit was evaluated in the soil bin by determining percentage of plant damage. This parameter is mainly affected by the plant to plant distance. The results viz. percentage of plant damage at various plant to plant distance are depicted in Table 1.2. The view of re-planted brinjal plants in the test track of soil bin are displayed in Figure 2.

Table.1 Research plan for performance evaluation of automated intra row weeder in laboratory

Sr. No.	Variables	No of level	Levels
1	**Independent Variables**		
	Plant to plant distance, (cm)	5	15, 25, 35, 45, 55
2.	**Dependent Variables**		
	Plant damage (%)		

Table.2 Observation of automated intra row weeder unit during laboratory testing

Sr. No.	Plant to plant distance (cm)	Plant damage (%)
1.	15	100
2.	25	70
3.	35	0
4.	45	0
5.	55	0

Fig.1 Laboratory experimental setup in soil bin module

Fig.2 Re-planted brinjal plants in the test track of soil bin

From the Table 2, it is clear that the percentage of plant damage was zero or constant up to 35 cm plant to plant distance. Below 35 cm plant to plant distance the percentage of plant damage was increased from 0 to 100 %.

In conclusion, weed control is one of the most difficult tasks in agriculture that accounts for a considerable share of the cost involved in agriculture production. Farmers generally expressed their concern for the effective weed control measures to arrest the growth and propagation of weeds. Minimum plant to plant distance was required 35 cm for the operation of automated intra row weeder with 0% plant damage.

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