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PERFORMANCE EVALUATION OF SINGLE ROW MANUALLY OPERATED VEGETABLE PLANTER CUM HERBICIDE APPLICATOR

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Abstract

The aim of this research was to create an implement that would allow small and marginal farmers to save money and time by simultaneously sowing seeds and applying herbicide. Performance of the developed implement was evaluated through laboratory tests and field trials for two crops namely cowpea and okra. The tests carried out were considering seed rate, nozzle discharge rate, speed of operation, field capacity and field efficiency. Cost of operation was also calculated. Weeding efficiency of five randomly selected spots was found 68.7 per cent. It was found that EFC for okra and cowpea were 0.097 and 0.085 ha/h respectively.The average speed of operation was 1.80 km/h. The average field capacity and mean field efficiency was 0.143 ha/h and 73.8 per cent respectively. The average discharge of nozzle was 0.592 l/min. The cost of sowing okra and cowpea was found to be 515 Rs/ha and 588 Rs/ha, respectively.

Keywords: Vegetable planter, manually operated, sprayer, herbicide, seed rate.

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1. Introduction

In India, vegetables are consumed by people daily in many forms such as raw, cooked, or using in any food items. Vegetables are good source of many nutrients such as carbohydrates, vitamins, dietary fiber and some calories. Growing vegetable is a very good source of earning money for farmers. It is grown across India as well as in the world. Different vegetables are grown in different parts of the country and vegetables are sown according to different climatic conditions of the country.

Planting is one of the most important agricultural operations that has a direct impact on productivity. The uniform placement of seeds at an appropriate depth determines crop yield, cropping reliability, cropping frequency, and other factors. In India, weeds are the most common cause of crop damage. Weeds reduce crop yields by 10% to 80%, degrade product quality, cause health concerns, and harm the environment.

Farmers are currently using various types of implements for sowing, spraying, and performing all activities independently, which increases operating costs and time. Considering these points a single row manually operated

vegetable planter cum herbicide applicator was developed to perform the two agricultural operations planting and pre-emergence herbicide application simultaneously.

2. Review of Literature

Kumar et al. (2018) made manually operated ridge vegetable planter for the sowing of vegetable crops on ridges. The planter's effective field capacity was 0.046 ha/h, with a field efficiency of 86.79 per cent. 4.4 kgf was the planter's draft requirement. The use of an established planter to plant okra seeds resulted in a net saving of Rs. 813 per hectare. In comparison to manual dibbling, the develop planter needed 21.73 man-hours per hectare, saving 51.1 per cent time for planting in a one hectare field.

Shivaraja et al. (2014) developed a wheel and pedal operated sprayer that uses reciprocating pump with an accumulator. In order to generate the required pressure for the spraying operation, the reciprocating pump produced continuous liquid flows. Spraying took less time with the newly built equipment. It also prevented the pesticide from spraying in front of the nozzles, where it would have come into contact with the pesticide sprayer.

3. Materials and Methods

Development of manually operated double row vegetable planter and fertilizer applicators for sowing is design of functional requirement of planter ,agronomical requirement and economical consideration such that agriculture worker can work effectively with maximum efficiency and less drudgery . The various design parameter have consider for developing machine the vegetable planter consist of main frame, holding structure, seed hopper, fertilizer hopper seed metering mechanism ,power transmission system, t type furrow opener with depth adjustment seed rate adjusting lever and spike wheel and transport wheel and leveler.

This study was conducted in the year 2020 at Department of Farm Machinery and Power Engineering, Swami Vivekananda College of Agricultural Engineering & Technology and Research Station, IGKV, Raipur. The different component of the implement were fabricated and assembled in the institute’s workshop. The developed machine was tested in laboratory and in field as per the standard procedure by using IS 6316: 1993 and IS 10134: 1994 test codes.

3.1 Evaluation of the implement

The developed implement was evaluated on the basis of parameters such as seed rate, nozzle discharge rate, speed of operation, field capacity, field efficiency, power requirement and cost of operation.

3.2 Seed rate

Calibration was done to set the developed vegetable planter to achieve approximate seed rate recommended for selected crops. Vertical rotors were selected as per the requirements of the selected crops. The selected vertical rotor were then tested for calibration of selected seeds with 4 seed box exposure scale with hopper of full fill, 3/4 fill and 1/2 fill capacity. Readings were taken for different exposure scales for different hopper capacities and the

value observed were then compared. The values nearest to the recommended seed rate of the crops were selected for further analysis.

3.3 Nozzle discharge rate

Nozzle discharge was calculated for forward speed of 2.5 km/h. The planter cum sprayer was jacked up and 3/4th volume of the sprayer tanks were filled with water. Polythene bags were attached to the sprayer nozzles such that any discharge was collected in the polythene bags. The ground wheel was rotated at 36 rpm speed (equivalent to 2.5 km/h forward speed for 315 mm diameter of ground wheel) the discharge was calculated by measuring the water collected per minute from each nozzle individually.

3.4 Speed of operation

For calculating the speed of operation, two poles were used to mark 20 m length. Time required to cover this distance was recorded using a stopwatch. The time was recorded 5 times to find out the average speed of operation.

3.5 Weeding efficiency

It is the ratio between the numbers of weeds grown after the application of preemergance to the number of weeds present in a unit area and is expressed as a percentage. The samplings were done by quadrant method, by randomly five selected of spots by a square quadrant of 1 square meter (Tajuddin, 2006).

Weeding efficiency (%) = $\frac{w1-w2}{w1}\times 100$ … (1)

Where,

W_1 = Number of weeds counted per unit area before herbicide application; and

W_2 = Number of weeds counted in same unit area after herbicide application.

3.6 Theoretical field capacity

It is the rate of field coverage in hectare per hour when the implement is working at its 100 per cent rated speed and width. It was calculated by measuring the nominal width of the developed implement, taking the rated speed and putting up the values in formula (Bainer *et al.*, 1987)

TFC = $\frac{W\times S}{10}$ … (2)

Where,

TFC = Theoretical field capacity, ha/h;

W = Width of operation, m; and

S = Speed of operation, km/h.

3.7 Actual field capacity

Actual field capacity was measured for an area of 15 x 10 m^2 i.e. 0.015 ha. It was calculated by recording the time to cover the total selected area including the loss of time in turning, filling of hopper, filling of sprayer tanks etc. The actual field capacity or the effective field capacity was calculated using formula (Bainer *et al.*, 1987)

$$AFC = \frac{A}{T} \ldots (3)$$

Where,

AFC = Actual field capacity, ha/h;

A = Area covered, ha; and

T = Time taken, h.

3.8 Field efficiency

It is the ratio of actual field capacity to theoretical field capacity. Field efficiency is calculated in per cent using the given formula (Bainer *et al.*, 1987)

$$\eta = \frac{AFC}{TFC} \times 100 \ldots (4)$$

Where,

AFC = Actual field capacity, ha/h; and

TFC = Theoretical field capacity, ha/h.

3.9 Cost of operation

Cost of operation of the implement was calculated using overhead cost, variable cost and actual field capacity. Per hour overhead cost and variable cost were calculated. Sum of these gave the cost of operation per hour. The ratio of cost of operation per hour and actual field capacity gave the cost of operation per hectare. Cost of operation per hectare was calculated separately for cowpea and okra.

3.10 Overhead cost

Overhead cost included depreciation and interest on investment. For calculating depreciation, straight line method was used.

$$D = \frac{C-S}{L \times H} \ldots (6)$$

Where, D = Depreciation per hour.

C = Capital investment, ₹;

S = Salvage value, 10% of capital;

L = No. of working hour per year; and

H = Life of implement in years.

Interest on investment at 12 per cent per annum

$$I = \frac{C+S}{2} \times \frac{i}{H} \ldots (7)$$

Where, I = interest per hour; and

i = Rate of interest per annum.

3.11 Variable cost

Variable cost included repair and maintenance cost and hiring charges of bullock pair with operator.

$R = \frac{C \times m}{L} \ldots (8)$

Where,

R = Repair and maintenance charge per hour;

m = Repair and maintenance rate, 6 % of capital cost;

C = Capital investment, ₹; and

H = No. of working hour per year.

Local charges were considered as charges of labour with operator.

4. Results and Discussion

The average seed rates for cowpea and okra were found out to be 15.39 kg/h, and 15.5 kg/ha respectively which were close to the recommended seed rates. Metering rotor number 8 with exposure scale number 7 and metering rotor number 4 with exposure scale number 4 were found suitable obtained the seed rates closer to the recommended values for cowpea and okra respectively (Table 1). The average discharge of the boom was 0.592 l/min with an average developed pressure of 215.74 kPa. The average speed of operation was 1.8 km/h. The actual field capacities for cowpea and okra were were 0.059 and 0.062 ha/h respectively and the respective field efficiencies were 69.78 per cent and 72.48 per cent. Cost of operation for cowpea and okra were ₹515/ha and ₹588/ha respectively with an average cost of ₹552/ha (Table 2).

Fig. 1 CAD model of designed vegetable planter cum herbicide applicator in Creo 2.0

Table 1. Optimum seed rates for different crops

Crop	Recommended seed rate (kg/ha)	Rotor number	Exposure scale	Average seed rate obtained (kg/ha)
Cowpea	12-14	8	7	15.39
Okra	15-20	4	4	15.5

Table 2. Field performance results and cost of operation for different crops

Crop	Theoretical field capacity (ha/h)	Actual field capacity (ha/h)	Field efficiency (%)	Cost of operation (₹)
Cowpea	0.090	0.062	72.48	588
Okra	0.091	0.059	69.78	515
Average	0.090	0.060	71.12	552

5. Conclusion

A single row manually operated vegetable planter was created to allow for simultaneous planting and pesticide treatment. Laboratory and field testing were used to evaluate the implement's performance, and the results were good. Based on the findings, the created implement is clearly beneficial to farmers with small and marginal land holdings.

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