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Performance evaluation of self propelled boom sprayer

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■ **ABSTRACT :** Spraying of pesticides is done to control pest and diseases for that purpose sprayer are used. Sprayer must break liquid in to droplet of effective size, also distribute them uniformly over the plants and regulate the amount of liquid to avoid excessive application controlling pest, diseases is one serious problem facing the farmers everywhere. In the view of these problems field performance evaluation trials of self propelled boom sprayer were carried out in cotton and chilli field. The average effective field capacity of self propelled boom sprayer in the field of cotton and chilli was found to be 1.28 ha/hr and 1.69 ha/hr, respectively. The average field efficiency of cotton and chilli crop was 62.74% and 81.02%, respectively. As far as concern of spraying cost by using self propelled sprayer was found to be Rs. 359.27 /ha and Rs. 283.87/ha for cotton and chilli crop, respectively.

■ **KEY WORDS :** Cotton, Chilli, Self propelled sprayer

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Crop yield is reduced by mainly due to attack of pests, diseases and weed. Chemical control is the popular method adopted for controlling most insects, weed and diseases. The chemicals are applied either by spraying or dusting. Spraying is one of the most effective and efficient techniques for applying small volume of spray liquid to protect crops. In conventional methods, manually operated low and high volume hydraulic sprayer and power operated hydraulic sprayer with long boom, long lances or spray gun are used to carry fluid at different targets. In this method, the time and labour required is more. It is difficult to spray the pesticide uniformly and effectively throughout the tree by conventional method of spraying. Though this method gives good pest control, it consumes large volume of liquid per plant, great amount of time and labour are required. Also drip losses are more. Owing to concern towards protecting environment from pollution by excessive use of pesticide and to economies the spraying method suitable alternative should be identified. In India, diverse farm mechanization scenario in country due to varied size of the farm holdings and socio-economic disparities. Most of farmer in India are small and marginal land holder. The spraying operation done by Knapsack sprayer which consumes more time and energy. Tractor operated sprayers are difficult for adaption by the farmer due to existing cropping patterns, available field size, field condition during the rainy season. To overcome these problem requirements for better adaptability. In the view self propelled small engine operated sprayer is batter option due to its medium cost and small size implying better manoeuvrability in the small land holding. Self propelled walking type sprayers can full fill the mechanization gap to do spraying operation at the faster rate. This shows there is an urgent need to introduce mechanical sprayer in Indian farm. The engine operated self propelled sprayer should be small for easily manoeuvrable and less expensive for farmers or best source of power mechanical spraying operation. Present pattern of row cropping concept widely adopted by Indian farmer and development of self propelled walking type sprayer is the need of today. Keeping the above point of view, the present investigation was under taken to evaluate field performance of self propelled boom sprayer in the field crops and workout the cost of spraying operation.

Mathew *et al*. (1992) studied test of power tiller operated boom sprayer. In this study the experiment was conducted for varying pressure on the power tiller operated boom sprayer provided with hollow cone nozzle. Also they illustrated the relationship between pressure and cone angle, where cone angle is the angle subtended at the orifice by the edge of spray pattern. The result observed that at higher pressure of 3 kg/cm^2 it shows more even distribution than that of 2 kg/cm^2 pressure. It was also observed that the cost of operating the boom sprayer reduced 29% as compared with the hand

compression Knapsack sprayer. Padmananthan and Kathirvel (2007) evaluated the power tiller operated rear mounted boom sprayer for cotton crop. The performance of power tiller operated boom sprayer was satisfactory at a pressure of 3 kg/ cm^2 and could be adopted by the farmers for spraying cotton crop and other row crops. it saves the cost and time of operation per ha by 51% power operated Knapsack sprayer.

Veerangouda *et al*. (2010) evaluated the performance of bullock drawn sprayers for cotton crop. They reported that the bullock drawn traction sprayer was capable to cover 6 rows at a stretch with an average field capacity of 0.66 ha/h with a power output of 0.68 kW. Also in this study average quantity of chemical solution sprayed per ha was 441.80 l/ha. The field capacity of bullock drawn engine sprayer was 1.19 ha/h with a power output of 0.60 kW. Gimenes *et al*. (2012) evaluated the performance of air-assistance in spray booms which have different spray volumes and nozzle types. Two spray nozzles (flat fan nozzle and hollow cone nozzle) were tested, combined with two air assistance levels in the spray boom (with and without air assistance) and a treatment control. They showed that hollow cone nozzle increased the spray deposit level on the corn plants compared with the flat fan nozzle, at growth stage V4.

METHODOLOGY

The self propelled boom sprayer was developed at Department of Farm Power and Machinery, Dr. PDKV, Akola. The specifications of self propelled boom sprayer are presented in Table A. The self propelled boom sprayer was fabricated by standard techniques. CAD view prototype self propelled boom sprayer are shown in Fig. A. The prototype self propelled boom sprayer is shown in Plate A.

In laboratory, test was carried out for the discharge rate of each nozzles which are on left side and right side of boom at pressure 40-60 Pascal and 100 degree spray angle.

Field test:

Field trials were carried out at CRS Farm at Dr. PDKV, Akola. Test were conducted in different crop for evaluating the performance of prototype self propelled boom sprayers. RNAM test code followed for field testing.

Plate A : Self propelled sprayer in operation in cotton field

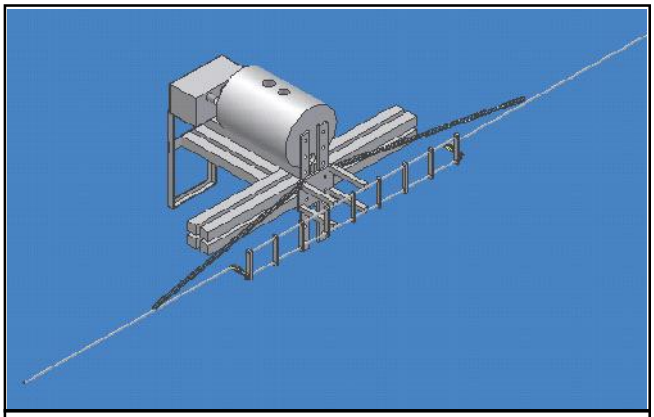

Fig. A : CAD view of self propelled boom sprayer

Following different parameters were noted at the time of testing a self propelled boom sprayer in the field.

Table A : Specification of self propelled boom sprayer

Sr. No.	Particulars	Specification
1.	Source of power	6.5 HP Self Propelled Toolbar (1570 L× 600W×1290 H in mm)
2.	PTO rpm	425
3.	Pump	Piston pump (ASPEE HDS pump)
		3.5 Hp, 900-950 rpm, discharge 24 lpm, maximum pressure 800PSI.
4	Hollow cone spray nozzles	Discharge 0.9 l/m, cone angle 40°
5	Boom	6 m long boom was fabricated by using 20 mm square and 2 mm thick hollow pipe.
6	Boom slider	A boom slider is fabricated by using C shape channels of 60×30×15 mm of 2mm thick size of 1.25 ft height attached to the centre of the boom.
7.	Tank capacity, l	100 l
8.	Machine weight, kg	
	– Toolbar	170 kg
	– Sprayer attachment	145kg

Travelling speed:

For calculating travelling speed, two poles 30 meters apart were placed. On the opposite side also two poles were placed to form the corner of the rectangle, parallel to at least one long side of the test plot. The speed was calculated from the time required to machine to travel the distance (30 m). The average of such 5 readings were taken to calculate the travelling speed of machine in km/hr.

Width of operation:

Width of spraying operation was taken randomly in the field at the different locations.

Actual field capacity :

For calculating actual field capacity the time consumed for real work and that lost for other activities such as turning, filling of tank were taken into consideration. The time required for actual operation and time lost measured by stopwatch. The time lost for refueling was deleted because usually filling up before starting test can make refueling unnecessary for specially large field, also time for rectifying machine trouble and nozzle was not taken onto consideration as it varies widely to varies factors and its inclusion in time factor sometime unreasonably lower the actual field capacity.

$$\text{Actual field capacity was given by} = \frac{\text{Actual area covered (ha)}}{\text{Total time required to covered area (hr)}}$$

Theoretical field capacity :

Theoretical field capacity was calculated by following formula (Sahay, 2008).

$$\text{Theoretical field capacity} = \frac{\text{Theoretical width (m) x Speed (km/h)}}{10}$$

Field efficiency:

Field efficiency is the ratio of actual field capacity to the theoretical field capacity; field efficiency is expressed in %, (Sahay, 2008).

$$\text{Field efficiency} = \frac{\text{Actual field capacity}}{\text{Theoretical field capacity}} \text{ x } 100$$

Fuel consumption:

The method was used for measuring of fuel consumption as follows. The tank was filled to full capacity before the operation with petrol. Amount of refuelling after the test was the fuel consumption for the test. When filling of the tank, care was taken to keep the tank horizontal and did not to leave empty space in the tank.

Economics of spraying operation by using self propelled boom sprayers:

The operational cost of self propelled sprayers was determined as per specification of BIS. The cost of operation of self propelled sprayers was calculated by using standard procedure.

■ RESULTS AND DISCUSSION

In Laboratory, test was carried out for the discharge rate of each nozzle which are mounted on left and right side of boom at pressure 40-60 Pascal and 100 degree angle. Result on discharge rate of nozzles at 40-60 Pascal pressure and 100 degree spray angle. The discharge rate was observed in case of orange colour nozzles of ASPEE at 80 degree angle at pressure 40-60 Pa pressure. Discharge rate of from nozzles was increased as an angle 100 degree at a same operating speed.

Performance evaluation of self propelled boom sprayer:

The developed self propelled boom sprayer was tested in laboratory as well as in actual field.

Field test:

The prototype self propelled boom sprayer was evaluated in cotton and chilli crop for actual field capacity, theoretical field capacity, fuel consummation, etc. RNAM test code and test procedure was followed for field testing. The spraying operation by using prototype self propelled boom sprayer in cotton shown in Plate 1. Result of performance evaluation trial of self propelled sprayer in cotton and chilli crop are shown in Table 2 and 3.

During the test various parameter were recorded as given below:

Speed of operation:

The self propelled sprayer was tested at average speed of 3.27 km/hr in cotton crop while 3.12 km/hr in Chilli crop because increase speed decreases the uniformity of coverage at faster rate reported by Muhammad *et al* (2006). Width of operation of self propelled sprayer was measured randomly at different locations in the field and it was in the range of in 6-6.8 m in both fields.

Actual field capacity:

Average actual field capacity of self propelled boom sprayer was 1.28 ha/hr and 1.69 ha/hr in cotton and chilli crop, respectively. Average actual field capacity was observed higher in chilli field due to higher length of filed.

Field efficiency:

Average field efficiency of self propelled boom sprayer was 62.74% and 81.02% in cotton and chilli crop, respectively.

Fuel consumption:

The average fuel consumption of self propelled boom sprayer was 0.84 l/ha and 0.80 l/ha in cotton and chilli crop, respectively.

Economic of spraying operation:

As for as cost operation is concerned, the self propelled sprayer required reasonable cost. It was observed that operational cost of self propelled boom sprayer was Rs. 359.27/ha for cotton and Rs. 283.87/ha for chilli crop.

Conclusion:

Based on the field test result following conclusions were drawn

- The average theoretical field capacity in cotton and chill crop was 2.04 ha/hr and 2.09 ha/hr, respectively.
- The average effective field capacity was found to be 1.28 ha/hr and 1.69 ha/hr in cotton and chill crop resp. and field efficiency of cotton and chilli crop was 62.74% and 81.02%, respectively.
- The average fuel computation of self propelled boom

Table 1 : Result of performance evaluation of self propelled boom sprayer in cotton

Sr. No.	Particulars	Observation			
1.	Pesticide used	Doxagan insecticide			
2.	Crop variety	Bt Cotton			
3.	Average crop height (cm)	45			
4.	Row spacing (cm)	60			
	Replications	Test 1	Test 2	Test3	Avg.
5.	Effective width of sprayer, m	6.3	6.5	6.4	6.4
6.	Width of field (m)	45	45.5	44	..
7.	Length of field (m)	106	107	106.50	..
8.	Area, m²	4770	4868.5	4686	...
9.	No. of plants	176	179	177	177
10.	Travelling speed, km/hr	3.15	3.19	3.27	3.27
11.	Theoretical field capacity, ha/hr	1.98	2.07	2.09	2.04
12.	Actual field capacity, ha/hr	1.3	1.27	1.29	1.28
13.	Total time require to ha, hr	0.76	0.78	0.77	0.77
14.	Field efficiency,%	65.65	61.35	61.76	62.74
15.	Fuel consumption, l/h	0.86	0.84	0.82	0.84

Table 2 : Result of performance evaluation of self propelled boom sprayer in chilli

Sr. No.	Particulars	Observations			
1.	Insecticide used	Sulphax and acephate (75%) insecticide			
2.	Crop variety	Jayanti			
3.	Average crop height (cm)	41			
4.	Row spacing (cm)	60			
5.	Plant to plant spacing (cm)	60			
	Replications	Test 1	Test 2	Test3	Avg.
6.	Effective width of sprayer	6.8	6.7	6.6	6.7
7.	Width of field (m)	55.7	61	56.5	--
8.	Length of field (m)	94.2	103.50	89	..
9.	Area of field, m²	5246.94	6313.5	5028	...
10.	No. of plants	78	85	81	81
11.	Travelling speed, km/hr	3.09	3.13	3.15	3.12
12.	Theoretical field capacity, ha/hr	2.10	2.09	2.07	2.09
13.	Actual field capacity, ha/hr	1.69	1.72	1.67	1.69
14.	Total time required to ha, hr	0.59	0.58	0.59	0.58
15.	Field efficiency,%	80.47	82.29	80.67	81.02
16.	Fuel consumption, l/h	0.81	0.79	0.80	0.80

sprayer in cotton and chilli crop was 0.84 l/h and 0.80 l/h, respectively.

– The cost of operation of self propelled boom sprayer was Rs. 359.27/ha and 283.87/ha in cotton and chilli crop respectively.

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REFERENCES

Gimenes Marcelo Jonior, Raetano Carlos Gilberto (2012). Air-assistance in spray boom which have different spray volumes and nozzle types for chemically controlling *Spodoptera frugiperda* on corn. *J. Plant Protec. Res.,* **52**(2):247-253.

Mathew, V.J., Desh, S.K., Das, D.K. and Pradhan, S.C. (1992). Development and testing of a power tiller-operated boom sprayer. *AMA*, **23**(4):25-27.

Muhammad Iqbal, Hussain Altaf and Munir Anjum (2006). Evaluation of spray uniformity distribution by environment friendly University boom sprayer test bench. *Pak. J. Agri. Sci.,* **43** (2) : 93-96.

Padmanathan, P.K. and Kathirvel, K. (2007). Performance evaluation of power tiller-operated rear mounted boom sprayer for cotton crop. *Res. J. Agric. & Biol. Sci.,* **3**(4):224-227.

Sahay, Jagdishwar (2008). *Text book of elements of agricultural Engineering*. pp. 233-235.