# Performance evaluation of bullock cart mounted engine operated sprayer

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**ABSTRACT :** The bullock drawn engine operated sprayer was tested for cotton crop during the *Kharif* of 2011-12. The diesel engine of 4 HP was used as power source for operating the sprayer and the bullocks were used for hauling purpose. The sprayer unit consisted of 15 hollow cone nozzles adjustable according to row spacing of crop. During performance evaluation, the field capacity of the sprayer was 1.89 ha/h and average speed of bullock cart during the spraying operation in cotton crop was 2.8 kmph. The draft measurement for spraying operation was found to be 804.42 N. The unit cost of sprayer was Rs.70,000 and the cost of operation for spraying was Rs.69.81. The financial and labour savings were found to be of 23.9 per cent and 64.96 per cent, respectively.

**KEY WORDS :** Bullock drawn sprayer, Cart mounted sprayer, Field capacity, Nozzle

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The application of pesticides is one of the most important operations in agricultural production. According to Rao (1980) unless production inputs are matched with protection measures, yield increases are not possible. It has been observed that about one third of reliable global output is estimated to be lost due to insect pests, disease and weeds. In India, the value of crop lost due to pests was estimated at Rs.6,000 crores in 1983 (Atwal, 1986), which reported to have further increased to Rs.29,000 crores in early 1990s (Dhaliwal and Arora, 1996). The agro-chemical policy group- an apex body of 200 crop protection companies has reported that agriculture produce lost in 2007 due to pest was about at Rs.1.40 lakh crores (Kumarswamy, 2008).

Cotton (*Gossypium* spp.) the 'white gold' and 'king of fibers', is cultivated in tropical and subtropical regions of more than seventy countries across the world and enjoys a predominant position amongst all cash crops in India. India occupies first place among cotton growing countries of the world in respect of area (10.33 mha), fourth with respect to production (295 lakh bales) during 2009-10 and in productivity compared to an average yield of 963, 912 and 613 kg/ha in Egypt, USSR and USA, respectively. The cotton average yield of India is only 440 kg lint/ha (Sen, 2003). This clearly stresses the need for further efforts to increase productivity of the most important commercial crop of the country. Cotton crop is infested by various pests. About 10 per cent of insecticides on global basis and 45 per cent in India are used for control of insects in cotton crop alone (Singh, 2004).

Cotton is one of the important crops in Raichur district where the farmers are facing acute labour shortage for spraying operation. Normally, the farmers are using knapsack sprayers and inaccurate application of pesticides may result higher farming cost and causes the environmental problems. Inaccurate application of pesticides could result in more contaminated environment and higher farming cost (Al-Gaadi, 1998).

The use of mechanical power in agriculture has been increased due to use of more tractors. Even though the tractor operated boom sprayer is available for spraying but due to low ground clearance, the crop may damage during spraying. Even though draught animal power is in decreasing trend, Indian farmers still predominantly use the bullocks for agricultural purpose. The small and marginal farmers are maintaining a pair of bullocks for carrying out field operations. In order to cover large area and to avoid labour scarcity the bullock cart mounted diesel engine operated sprayer has been developed for field crops at College of Agricultural Engineering, Raichur. The bullock cart mounted diesel engine operated sprayer has been tested for cotton crop and its performance evaluation has been carried out during the year 2011-12.

## METHODOLOGY

The bullock cart mounted diesel engine operated sprayer basically consists of a steel cart in which the diesel engine and the spray boom are installed and the suitable power transmission system has been made for spraying purpose. A pair of bullock was used for pulling the cart and the diesel engine was used as power source for the operation of sprayer unit. The test was conducted at College of Agricultural Engineering, Raichur.

**Description of bullock cart mounted engine sprayer :**

The bullock cart was made of steel and provided with suitable wheels along with high ground clearance of 1.2 m. The cart wheels are provided with rubber pad along with the periphery of the wheels to avoid any damage. The sprayer unit mainly consists of a spray boom, HTP pump, diesel engine, spray tank and control valves. The spray boom is provided with 15 number hollow cone nozzles which are adjustable according to the row crop. The length of the spray boom is 8120 mm and the spray boom height is also adjustable according to the height of the crop.

The side view of bullock drawn engine operated sprayer is presented in the Fig A. The diesel engine of 4 hp capacity is connected to HTP pump through v-belt. The engine can be started by cranking the handle. The spray tank is made of plastic material and is capable to store 500 litres of chemical solution and is rigidly fixed on the cart. The spray tank acts as a reservoir for supply of chemical solution during spraying operation. The power produced by the engine is transferred to the HTP pump which creates the pressure and the chemical solution is sucked by the pump and delivers it to the nozzles through the outlet hose pipes. The control valves were operated to adjust the discharge and the pressure operated during spraying is displayed by pressure guage. The bullock cart mounted engine operated sprayer was tested for cotton crop during the *Kharif* season of 2011-12. The data pertaining to the machine parameters and field parameters and the agronomical aspects of the crops were noted and analysed.

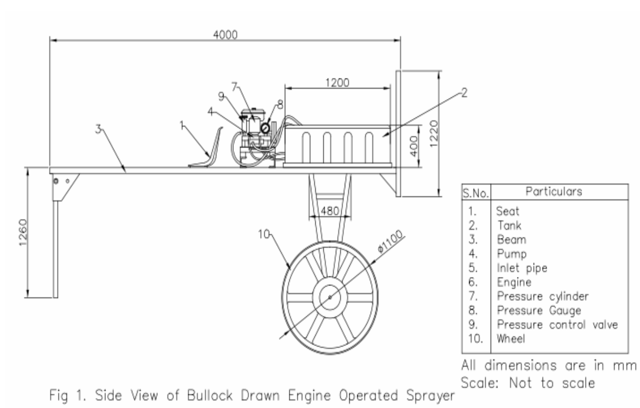


**Fig. A: Side view of bullock drown engine operated sprayer**

## ■ RESULTS AND DISCUSSION

The bullock drawn engine operated sprayer was developed by fabricating a suitable spray boom along with the facility for nozzle adjustment. All the nozzles can be adjusted according to the row spacing and height of the crop. The general specifications of the bullock drawn engine operated sprayer are presented in Table 1.

**Table 1: General specification of bullock drawn engine operated sprayer**

| Sr. No. | Particulars | Details |
|---|---|---|
| 1. | Name of equipment | Bullock drawn sprayer |
| 2. | Make of machine | Samson Industries, Mumbai |
| 3. | Model | SAM D |
| 4. | Power source | |
| | Pull | A pair of bullock |
| | Spraying | Engine |
| 5. | Fuel required | Diesel |
| 6. | No. of nozzles | 15 |
| 7. | Tank capacity (litres) | 500 |
| 8. | Type of nozzles | Hollow cone |
| 9. | Nozzles spacing (mm) | Adjustable |
| 10. | Ground clearance (mm) | 1200 |
| 11. | Adjustable boom height range (mm) | 800-2000 |
| 12. | Boom length (mm) | 8120 |
| 13. | Wheel tread (mm) | 1250 |
| 14. | Cost (Rs) | 70,000 |

The performance of the bullock drawn engine operated sprayer was evaluated by conducting experiments with different levels of operating pressure to find the discharge, distribution, spray angle and droplet size. The discharge was measured at 5 different levels of operating pressure of 10, 20, 30, 40 and 50 kg/cm$^2$. The discharge rate of all 15 nozzles operating at different pressure levels (10 to 50 kg/cm$^2$) were noted and presented in Table 2. It can be observed that the average nozzle discharge varied from 1413 ml/min to 2282 ml/min with increase in pressure from 10 kg/cm$^2$ to 50 kg/cm$^2$. The desired discharge rate of 1000 l/ha for cotton crop which was obtained at 40 kg/cm$^2$ among other operating levels. Thus, the operating pressure of 40 kg/cm$^2$ was fixed for field trials of cotton crop. It can be observed that the variations among the nozzles were calculated and the co-efficients of variation for all the pressures were around 2 per cent which is similar to the findings of Mathew *et al.* (1992).

In order to find the spray uniformity, spray patternator was used. The nozzle is kept at the height of 500 mm (Padmanabhan and Kathirvel, 2007) from the patternator and spray liquid at the collecting pipes of the patternator was collected and the quantity of liquid from each channel is measured. The spray patternator is shown in the Fig 1. Among all the operating pressure levels the spray uniformity was almost uniform at an operating pressure of 40 kg/cm$^2$ and 50 kg/cm$^2$ as shown in the Fig 1. This result may be due to the discharge rate affected the distribution of spray over the channels.

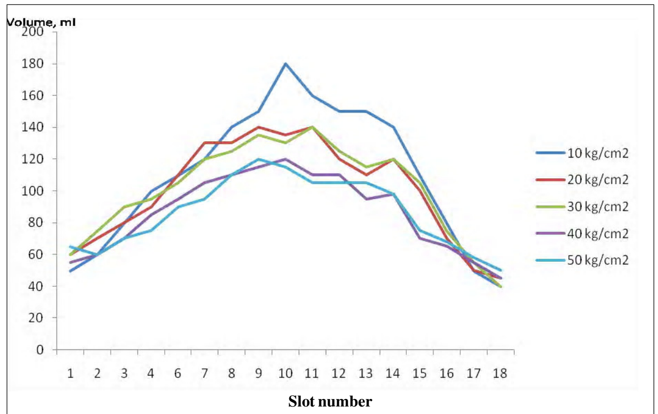


**Fig. 1: Spray pattern distribution using spray patternator**

The spray angle at the operating pressure of 10-50 kg/cm$^2$ was calculated during the laboratory test and presented in the Table 3. The spray angle was found to be increasing

**Table 2 : Individual nozzle discharge for different pressures**

| Pressure (kg/cm$^2$) | Discharge from each nozzle ml/min | | | | | | | | | | | | | | | Average discharge (ml) | Total discharge of boom (l/hr) | C.V (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | | | |
| 10 | 1450 | 1400 | 1350 | 1450 | 1400 | 1400 | 1450 | 1350 | 1450 | 1400 | 1450 | 1400 | 1400 | 1400 | 1450 | 1413 | 1272 | 2.42 |
| 20 | 1750 | 1700 | 1700 | 1780 | 1750 | 1700 | 1750 | 1800 | 1750 | 1700 | 1700 | 1760 | 1700 | 1750 | 1750 | 1736 | 1562 | 1.85 |
| 30 | 1900 | 1850 | 1850 | 1900 | 1950 | 1950 | 1900 | 1850 | 1880 | 1900 | 1950 | 1950 | 1900 | 1900 | 1920 | 1903 | 1713 | 1.82 |
| 40 | 2100 | 2200 | 2150 | 2120 | 2180 | 2200 | 2150 | 2100 | 2050 | 2100 | 2200 | 2150 | 2100 | 2100 | 2200 | 2140 | 1926 | 2.18 |
| 50 | 2300 | 2300 | 2350 | 2250 | 2200 | 2250 | 2200 | 2250 | 2250 | 2300 | 2350 | 2250 | 2300 | 2350 | 2300 | 2280 | 2052 | 2.11 |

**Table 3: Spray angle for different pressures**

| Sr. No. | Pressure (kg/cm$^2$) | Spray angle |
|---|---|---|
| 1. | 10 | 48 |
| 2. | 20 | 52 |
| 3. | 30 | 58 |
| 4. | 40 | 60 |
| 5. | 50 | 63 |

**Table 4 : Droplet size analysis of nozzle at different pressures**

| Operating pressure (kg/cm$^2$) | VMD (µM) | NMD (µM) | UC |
|---|---|---|---|
| 10 | 280 | 135 | 2.07 |
| 20 | 265 | 125 | 2.12 |
| 30 | 250 | 110 | 2.27 |
| 40 | 235 | 105 | 2.23 |
| 50 | 225 | 95 | 2.36 |

**Table 5: Field performance results of bullock drawn engine operated sprayer for cotton crop**

| Sr. No. | Parameters | Values |
|---|---|---|
| 1. | Variety | Bt Cotton |
| 2. | Row spacing (mm) | 900 |
| 3. | Plant to plant (mm) | 450 |
| 4. | No. of rows covered | 7 |
| 5. | Swath width (mm) | 6750 |
| 6. | Total boom length (mm) | 8120 |
| 7. | Operating pressure (kg/cm$^2$) | 40 |
| 8. | Discharge rate (l/h) | 1926 |
| 9. | Speed of travel (km/h) | 2.8 |
| 10. | Draft (N) | 804.42 |
| 12. | Field capacity (ha/h) | 1.89 |
| 13. | Power output (kW) | 0.63 |
| 14. | Quantity of chemical solution (l/ha) | 1019 |
| 15. | Fuel consumption (l/h) | 0.52 |
| 16. | Fuel consumption (l/ha) | 0.23 |

with increase in operating pressure. The droplet diameters were computed for volume median diameter (VMD) and number median diameter (NMD) as suggested by Reghupathi and Dhamu (1999) and uniformity co-efficient was also calculated. The droplet size at different operating pressures was analysed and presented in Table 4 and it is observed that as the pressure increased the particle size decreased. The values of the VMD decreases with increase in the pressure, the minimum VMD is 225 µM attained at operating pressure of 50 kg/cm$^2$ and maximum of 280 µM at operating pressure of 10 kg/cm$^2$. The same trend is being followed by the NMD. The uniformity co-efficient is within the range of 2-2.5.

The performance evaluation of bullock cart mounted engine operated sprayer has been carried out for cotton crop in the research farm during the *Kharif* season of 2011-12. The performance results of sprayer such as average field capacity, draft, speed of operation, discharge rate, fuel consumption and power output were noted and measured. The performance results of sprayer are presented in Table 5. From which, it is observed that the average field capacity of sprayer was found to be 1.89 ha/h. the draft measurement was found to be 804.42 N with power output of 0.63 kW (Table 5). The fuel consumption observed for cotton crop for sprayer was 0.52 l/h. the financial saving of 64.96 per cent were found for the sprayer. The bullock drawn engine operated sprayer for cotton crop worked satisfactory.

## Conclusion :

The average field capacity of the bullock drawn engine operated sprayer was 1.89 ha/h as compared to 0.65 ha/h for bullock drawn traction sprayer. Draft was found to be 804.42 N with power output of 0.63 kW and the fuel consumption during spraying has been measured as 0.515 l/h. The financial saving of Rs. 23.9 per cent has been observed and the per cent of labour saving was found to be 64.96 when compared with the bullock drawn traction sprayer.

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