International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 2102-2105

Received: 13-09-2019
Accepted: 16-10-2019

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Development and field evaluation of bullock drawn solar powered high clearance sprayer

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Abstract
The bullock drawn solar powered high clearance sprayer was developed and performance was evaluated in research farm, University of Agricultural Sciences, Raichur. Two Solar pv modules of 250 W capacity were selected to operate the DC motor coupled with pump. The DC motor of 1500 rpm was selected based on the voltage available from the Solarpv modules. The current produced by the panel was 20.88 Ah and the charging time was 9.6 h. To discharge 100 Ah battery time required was 2.6 hr. About 888.46 l of chemical was discharged as the battery was fully discharged from a fully charged state. Field capacity of the bullock drawn solar powered high clearance sprayer was found to be 0.945 ha/h for cotton crop and 1.012 ha/h for red gram crop. For spraying operation, the bullock drawn sprayer is operated at an average travel speed of 2.7 km/h for cotton and 3.0 km/h for redgram crop. The average draft for spraying operation was found to be 802.65 N for cotton and 804.38 N for red gram crop. The average power output and breakeven point was calculated for both cotton and for red gram crop.

Keywords: bullock drawn sprayer, solar sprayer, field capacity, discharge

Introduction
"Energy-demand" is one of the major threats for our country. Finding solutions, to meet the "energy-demand" is the great challenge for social scientist, engineers, entrepreneurs and industrialist of our country. According to them, applications of nonconventional energy are the only alternate solution for meeting out energy demand. Solar energy plays an important role in drying agriculture products and for pumping the well water for irrigation purpose in remote villages without electricity. This technology on solar energy can be extended for spraying pesticides, fungicides fertilizers, nutrients and weedicides using solar sprayers (Joshua *et al*., 2010) [3].

The usage of pesticides to prevent pre-harvest and post-harvest losses has assumed a great significance during the last two decades, in an attempt to provide sufficient nutritive food for the ever growing population. Thus, application of pesticides is one of the most important operations in agricultural production. The most important and common method of applying pesticides in the modern agriculture is to apply with spraying machines. The efficient application of agricultural chemicals is a major social and economic concern in the present agricultural scenario. Inaccurate application of pesticides could result in more contaminated environment and higher farming cost (Khalid, 2010) [5].

More than 55 per cent of the total cultivated area is still being managed by using draught animals as against about 20 per cent by tractors. India possessed the finest breeds of draught animals. Bullocks, buffaloes and camels are the major draught animals for field operations. The small and marginal farmers are generally maintaining a pair of bullock for carrying out the field operations. To increase the utility of the animal power and proper selection of suitable spraying equipment, it is necessary to mechanize the spraying operation (Kalikar, 2012) [4].

Generally, the engine powered sprayers are more oftenly used in India which require fuels like petrol, diesel, kerosine, *etc*. As the fuel prices are increasing day by day, these sprayers have became uneconomic and need to be replaced by solar powered sprayers. Renewable energy source like solar energy is available abundantly so by utilizing solar energy using solar panels sprayer can be powered. This solar sprayer can be drawn by bullocks because of availability of animal power in the villages, cost of operation will be less so it will be economically feasible than the diesel powered sprayers. This sprayer has an advantage that it has a high clearance so that taller field crops can be sprayed. Therefore the present study was carried out to develop

and evaluate the bullock drawn solar powered high clearance sprayer.

Materials and methods

Development work has been carried out at workshop of Department of Farm Machinery and Power Engineering, College of Agricultural Engineering, University of Agricultural Sciences, Raichur. The development has been done by considering crop parameters, machine parameters and meteorological parameters.

A solar powered spraying system has been developed for field crops. Solar power sprayer consists of solar pv module, Battery, Dc motor, pump, tank and spray boom fitted with nozzles. The spraying system consists of 5 hollow cone nozzles. The sprayer is provided with 500 W solar panels, 5 nozzles are provided for spraying five plant rows. The solar sprayer is provided with DC pump of 0.5 hp and operating pressure of pump is 10 kg/cm^2. The pump is coupled with 24 V DC motor having an rpm of 1500. The sprayer is provided with water tank of 275 liters capacity. Diameter of the suction of pipe is 2.54 cm and delivery pipe is used to provide adequate discharge and pressure to the sprayer, having diameter of 2.54 cm. Pressure gauge of 20 kg/cm^2 capacity is installed on the supply line to the sprayer.

The two solar panels of 250 W are mounted on the frame through nut and bolt system. The frame is made up of mild steel angles. The length of the frame is 1.70 m; width of the frame is 2 m. This frame is having 5.08 cm angled mild steel and mild steel flats for supporting the base of the panels. The frame is supported by four angled steel from the tank platform. The length of the angles is 92 cm and size is 2.54 cm. The base of the frame and supporting angles are welded for rigid structure. The pump capacity is designed on the basis of discharge rate and operating pressure. The panel capacity was decided based on the pump capacity requirement. The seat of the operator is placed at the front end of the panels. The solid diagram and specification of the developed bullock drawn solar powered high clearance sprayer is presented in Fig 1. and Table 1. respectively.

Table 1: Specifications of bullock drawn solar powered high clearance sprayer

Sl. No.	Parameters	Value
1	Source of power	Solar pv modules
2	Pump	25 l/min and 50 l/min of 1500 rpm speed and 10 kg/cm^2 operating pressure.
3	Motor	0.5 hp capacity, 1500 rpm speed and 24 V, DC.
4	Power transmission	Panel-motor-pump
5	Number of nozzles	5
6	Pressure control device	Pressure relief valve
7	Boom length, mm	4500
8	Wheel, mm	Diameter 1000, width 100
9	Ground clearance, mm	1200
10	Tank capacity, l	275

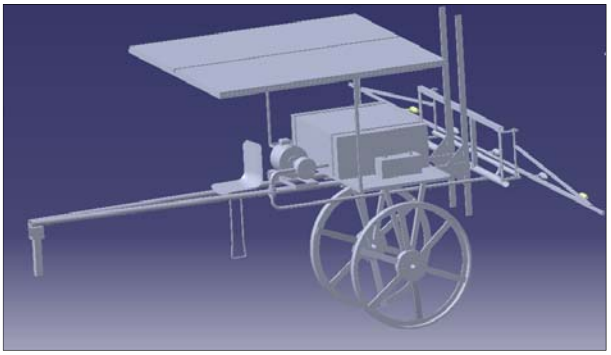

Fig 1: Solid model of bullock drawn solar powered high clearance sprayer developed by CATIA software

Performance evaluation of bullock drawn solar powered high clearance sprayer for field crops

The performance evaluation of bullock drawn solar powered high clearance sprayer on cotton crop and red gram crops have been carried out at research farm of University of Agricultural Sciences, Raichur during the year 2014-15. The data on field capacity, quantity of chemical solution, efficiency, speed of operation, power output and time losses were measured and noted for the cotton crop and red gram crop.

Solar power output

The solar power output is measured in terms of W/m^2 through an instrument called pyranometer. The normal solar radiation intensity is 1353 W/m^2.The solar power output is measured during different time intervals from morning to evening. Since spraying operation can be done any time in a day, the test was conducted from 9 am to 5 pm at 1 hour interval. The solar radiation intensity was normally high in bright sunshine hours. So maximum power can be obtained directly from pv modules in the afternoon.

Analytical calculation of current and discharging time of the battery

a. The current produced by the solar panel (I) was calculated by the knowing the maximum power (P) of the solar panel and the voltage rating (V) of the battery that is given by:

$$I = \frac{P}{V} \text{ Ampere} \qquad \text{.....(1)}$$

$$I = \frac{500}{24}$$

$$I = 20.83 \text{ Ah.}$$

b. Charging time (T) was computed by taking the ratio rating of the battery in ampere hour (Ah) to the total current consumed by the solar panel.

$$T = \frac{\text{Battery rating in ampere hour}}{\text{Total current consumed by the solar panel}} \qquad \text{.....(2)}$$

$$T = \frac{200}{20.83}$$

$$T = 9.6 \text{ h.}$$

To discharge 100 Ah battery, time required was 2.6 h.

$$\text{The capacity of fully charged battery covers an area} = \frac{1640.47\text{l/ha}}{888.46\text{l/h}} = 1.9 ha/h.$$

$$\text{The cpacity of 100 Ah battery at a discharge rate of sprayer was} = \frac{2310\text{l/h}}{2.6\text{h}}$$

$$= 888.46 \text{ liters}$$

Field capacity

Field capacity of the sprayer was calculated using the formula

$$\text{Field capacity (ha/h)} = \frac{\text{Width (m)} \times \text{Speed (km/h)}}{10} \quad (3)$$

Speed of operation

The forward speed of the bullock drawn solar powered high clearance sprayer was noted while spraying in the field for the fixed distance using stop watch. The time was noted for multiple trials and speed was calculated.

Quantity of chemical solution

The quantity of the chemical solution sprayed in the field is calculated using the formula

$$\text{Quantity of chemical solution (l/ha)} = \frac{\text{Discharge (l/h)}}{\text{Field capacity (ha/h)}} \quad (4)$$

Draft

Draft required by the pair of bullocks to pull the sprayer was measured using dynamometer. A hydraulic dynamometer was used to measure the draft. The sprayer is hitched by the bullocks and the draft required to pull the sprayer unit was measured by the dynamometer attached to them. The data pertaining to measurement of draft was noted during the spraying operation.

Power output

Power output is calculated using the formula

$$\text{Power output (hp)} = \frac{\text{Draft (kg)} \times \text{Speed (m/s)}}{75} \quad (5)$$

Results and discussion

The solar power output is measured in terms of W/m^2 through an instrument called Pyranometer. The normal solar radiation intensity is 1353 W/m^2.Since the spraying operation can be done any time in a day, the test was conducted from 9 am to 5 pm at 1 hour interval. The current produced by the panel was 20.88 Ah, and the charging time was 9.6 h. To discharge the 100 Ah battery the time required was 2.6 h. To discharge 100 Ah battery time required was 2.6 h. The capacity of 100 Ah battery at a discharge rate was 888.46 litres. The capacity of fully charged battery covers an area of 1.9 ha/h. Similar results were reported by Varikuti *et al.* (2013).The field performance results of the sprayer on cotton and red gram crop is presented in Table 2.

Table 2: Field performance of bullock drawn solar powered high clearance sprayer on cotton and red gram crop

Sl. No.	Parameters	Values	
		Cotton	Red gram
1	Variety	B*t* Cotton MRC7351	Maruthi ICP 8863
2	Row spacing, mm	900	600
3	Plant to plant, mm	450	200
4	No. of rows covered, No.	5	7
5	Swath width, mm	4500	4500
6	Total boom length, mm	5580	5580
7	Operating pressure, kg/cm^2	7	7
8	Discharge rate, l/min	36.5-44.5	36.5-44.5
9	Speed of travel, km/h	2.7	3.0
10	Draft, N	802.65	804.38
11	Size of field, ha	2	2
12	Field capacity, ha/h	0.945	1.012
13	Power output, kW	0.65	0.68
14	Quantity of chemical solution, l/ha	1840.47	1717.7

Field capacity of the bullock drawn solar powered high clearance sprayer was found to be 0.945 ha/h for cotton crop and 1.012 ha/h for redgram crop. The field efficiency of the sprayer unit was found to be 80 per cent and the results are in agreement with the findings of Hunt (1983) [2]. For spraying operation, the bullock drawn sprayer is operated at an average travel speed of 2.7 km/h for cotton and 3.0 km/h for red gram crop. Similer results were reported by Veerangouda *et al*. (2010) [7]. The average draft for spraying operation was found to be 802.65 N for cotton and 804.38 N for red gram crop. The average power output was found to be 0.65 kW for cotton crop and 0.68 kW for red gram crop. This is the power to operate the sprayer in the field, which was within the range (0.61 to 1.1 kW) of a pair of bullocks as reported by Gupta *et al*. (2003) [1].

Conclusion

The average quantity of chemical solution sprayed for cotton crop has been found to be 1840.47 l/ha and for red gram it was found 1717.7 l/ha. The efficacy was measured by taking the number of insects present before the spraying and number of insects present after the 3 days, 5 days and 10 days.

References

1. Gupta RA, Pund SR, Patel BP. Design and development of bullock drawn traction sprayer. Agric. Mech. Asia. 2003; 34(1):26-30.
2. Hunt D. Farm Power and Mahinery Management 10th Ed., Waveland press Inc, New Delhi, India, 1983, 6.
3. Joshua R, Vasu V, Vincent P. Solar sprayer agriculture implement. Int. J. Sustain. Agric. 2010; 2(1):16-19.

4. Kalikar VK. Development and evaluation of bullock drawn engine operated sprayer. M.Tech. Unpublished Thesis, Univ. Agric. Sci., Raichur (India), 2012.
5. Khalid AA. Effect of nozzle height and type on spray density and distribution for a ground field sprayer.King. Saud. Univ, Riyadh, 2010, 1-19.
6. Varikuti VR, Mathapati S, Amarapur B. Multiple power supplied fertilizer sprayer. Int. J. Sci. and Res. Publications. 2013; 3(8):1-5.
7. Veerangouda M, Prakash KV, Jagjivan R, Neelakantayya G. Performance evaluation of bullock drawn sprayers for cotton crop. Karnataka. J. Agric. Sci. 2010; 23(5):756-761.