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Development and Testing of Trolley Mounted Solar Operated Low Volume Boom Sprayer

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ABSTRACT

Sprayers are mechanical devices that are specifically designed to spray liquids quickly and easily. A sprayer of this type is a great way to cover large areas such as lawns quickly and easily. The main objective of this paper is to economize the cost of operation by using renewable energy as a source of power and to evaluate the performance of this equipment. Solar operated low volume sprayer was developed with higher operational features.This sprayer typically consists of a tank (20L.) for carrying the liquid to be sprayed, a solar panel (20W), a battery (12V), a control panel, a motor for pumping out liquid, spray nozzle on a boom that automatically disperse the liquid in a downward direction over an appreciable area, ball valve, a chassis with wheels on which the sprayer is mounted, and a hose attachment for spraying. The sprayer runs for complete 90 min after 3 hours continuous charge by exposing in hard sun. The operational features like application rate, swath width, discharge rate and adjustment angle at boom height 43.5 cm was found to be 87.03L/ha, 1.35m, 0.47 L/min and 112.41^{o} respectively on uncultivated land. The field capacity of sprayer was found to be 0.324 ha/h which is very economical for such sprayers.

Key words: Application rate, Adjustment angle, Discharge rate, Field capacity, Swath width.

The solar energy was being used directly for purposes like drying clothes, curing agricultural produce, preserving food articles, etc. Even today, the energy we derive from fuel-wood, petroleum, paraffin, hydroelectricity and even our food originates indirectly from sun. Solar energy is virtually inexhaustible. The total energy we receive from the sun far exceeds our energy demands. It is probably the most reliable form of energy available everywhere and to everyone, unlike other sources. For human development in many countries there is research and trials are going on the Solar energy and the wind energy, but in our country, manpower is available in large proportion, So we make use ofour new concept solar operated mechanical boom sprayer which is used for application of pesticide,fertilizer and herbicides on small plants in lawns and gardens in the form of spraying. The main objectives of the study are

1. To develop solar operated low volume boom sprayer in order to economize the cost of operation by using renewable energy resources.
2. To evaluate the performance/operational features of the equipment by lab and field trials.

MATERIAL AND METHODS

Two cycle wheels of 700 mm inner diameter complete with tire, tube, hub and bearing are filled on the center of the chassis with the help of one center axle. The wheels are fitted at the distance of 480mm apart which can be adjusted broad according to row spacing and which also help the machine for proper balancing.Chassis is a rectangular structure made up of M.S. angle 19mm fitted at a height of 480mm from the ground level and tank and battery are fixed on the chassis. The front end is connected to the pulling handles and a spray boom is hinged at the lower side middle of the chassis. The pesticide tank has a circular support to bear vibration during operation. The boom is made up of cast iron having a length of 1760mm. The spray boom is fitted with 1 spinning disc spray head. The height of spray boom can be adjusted to the heights of 435 mm, 505mm, 575mm, 645mm,715mm and 775mm from the ground level.The adjustable boom is attached to the front of the lower side of the chassis. The boom is able to achieve a maximum spraying height of 775mm and with a minimum of 435 mm .A spinning disc

head is fitted on the boom. The spinning disc made of plastic 78mm diameter is fitted on an electric motor and powered with 12 volt D.C. dry battery. The speed of rotation of spinning discs can vary between 2000-4000 RPM with the help of an electrical regulator

A water pump running with 12V battery having specifications of 3-5 Psi pressure and a flow of 18.5 GPH has been installed to provide a continuous supply of solution at a constant to flow rate to achieve uniform discharge. It is fitted at front of rectangular box having nut and bolt arrangement over the chassis with a wire connection from battery to get operated a battery with a capacity of 12V, 17 Amp with a size of (18x7) cm is installed to provide power for the water pump and nozzle. The battery runs normally 1.30h.Withan A.C charging of 3 hours taking the entire load given for operation of sprayer. Battery is connected to a solar panel through a charging kit to charge it through solar energy. The battery is also covered with iron sheets to avoid unusual electric shocks during operation and a Control Panel is equipped with the charging kit which serves as a media for charging the battery with solar Panel. Solar panel is installed at the top of the frame connecting the chassis. It produces 20W having 72 small cells. It receives solar energy from sun and converts them in to electrical energy in order to charge the battery attached to it. It is clamped and fastened with a ball bearing arrangement to rotate it in the direction where the sun ray falls and a pvc discharge hose coming from the water pump is connected to the inlet of the nozzle to give the appropriate amount of solution to go for disc spinning and also a single on-off valve fitted on the front side of the tank of the sprayer, for opening or closing the delivery of pesticide solution to the spinning discs. A Sprayer Stand is provided at the rear end of the rectangular box on the chassis to keep the sprayer balanced at the spare time. It is made up of M.S iron clamped with nut and bolt to adjust the height and stand the sprayer.

To evaluate the performance or the operational features of the sprayer, the different lab trails were carried out.

The discharged water by the disc head in one minute was collected in a polythene bag and measured with the help of measuring cylinder. Average of three readings was collected and total output of sprayer was worked out. The discharge rate at different boom height was measured as mentioned above.

Another technique was followed to cross check the data obtained. The tank was filled with known amount water and allowed the sprayer to operate for a minute. The remained water after operation was measured to calculate the discharge. The data obtained through both techniques was same.

The measurement of swath width was carried out in laboratory. The swath width assessment is very essential to determine the flow rate and the application rates. Water soluble blue was dissolved in water and was sprayed and the spray droplets were allowed to deposit on piece of white paper placed on the ground. The visible blue spots on the white paper revealed the distance reach of the spray droplets across the swath, considered as the swath width readings were taken at different boom heights

The calibration of the sprayer was done by marking the known area of (4x100) m^2. The spray tank was filled with known quantity of water. Then marked area was sprayed carefully maintaining the swath width and the time required for covering the area was also noted. Thereafter the water left in the tank after spraying was measured. The quantity of water required to cover the area of 400m^2 was thus worked out, based on the average of three such readings the sprayer flow rate (lit/min), application rate (lit/ha) and area covered in ha/h. was also calculated.

RESULTS AND DISCUSSION

The pump and nozzle gives an output of .471 L/min with a power consumption of 12 V

Maximum length of the sprayer((Boom to handle) = 230 cm

Maximum width of the equipment = 112.5 cm

Normal width of the equipment = 85 cm

Total weight of the tank filled with water = 18.7 kg

Boom height adjustment

It facilitates in the sprayer to adjust the boom at different heights so that the sprayer can be used at different crop heights to control the pests. The height adjustment of sprayer shows the utility of the sprayer. The boom can be adjusted to the following heights

Maximum height = 77.50 cm

Minimum height = 43.50 cm

Fig 1. solar operated boom sprayer

Fig 2. collecting of discharge water from nozzle.

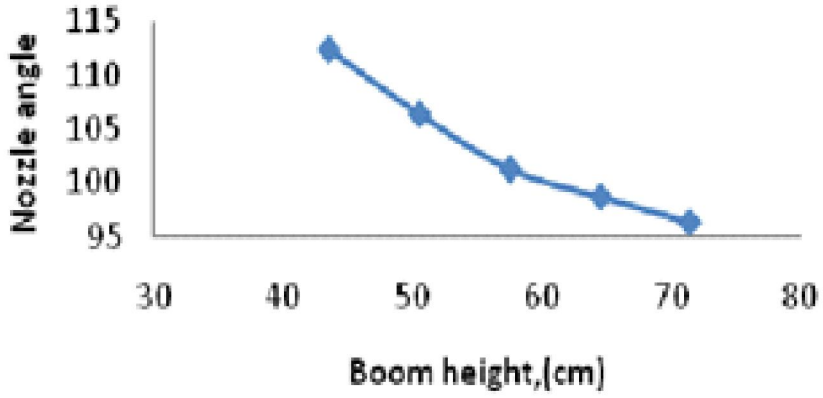

Fig 3. Variation of Nozzle adjustment angle with different Boom height.

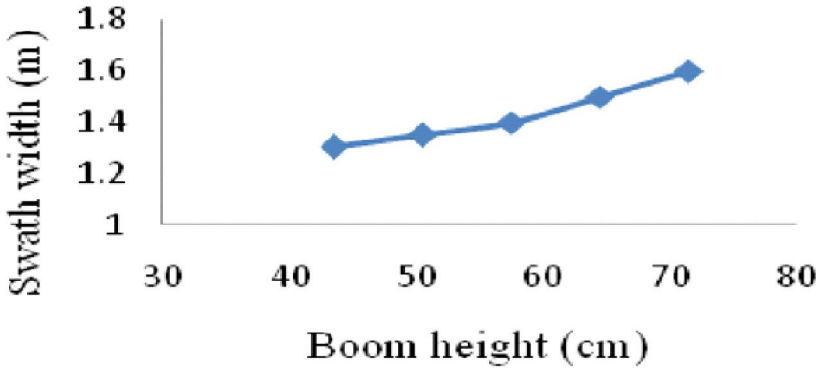

Fig4. Variation of Swath width at constant discharge with different Boom heights

Table 1. Calibration of the sprayer.

S.NO	Area(m^2)	Swath width(m)	Walking speed(m/min)	Flow rate(l/min)	Application (l/ha)
1.	4x100	1.35	40	0.47	87.03
2.	2x100	1.35	35	0.47	87.03
3.	1x100	1.35	30	0.47	87.03
Average	266.6	1.35	35	0.47	87.03

Flow rate = 0.47 L/min Walking speed = 40 m/min
Swath width = 1.35 m Application rate = 87.03 L/ha
Area covered in an hour = 0.324 ha

Nozzle adjustment Angle

The readings are taken at different heights. The boom height of 43.5 cm provides effective spraying with nozzle adjustment angle found to be 112.41^0. Knowing the swath width of Disc Head and height of operation, the nozzle adjustment angle of Disc Head can be calculated by using this formula $\theta = 2 \tan^{-1} b/2h$

h-Height of boom from ground level during operation
b-Swath width of the Disc Head
θ- Nozzle adjustment Angle

Measurement of discharge rate and swath width at different boom heights

The results are shown in table 1. The data revealed that the increase in boom height increases swath width.Fig.4 shows the relationship between boom height and discharge rate/swath width. Basically increase in the height of boom from the ground level automatically increases the swath width because the pesticide flow by water pump from the tank into the disc head is constant.

Calibration of the sprayer

The field capacity of sprayer was evaluated and the results were presented in table1. The field capacity of sprayer was found to be 0.324 ha/h which is very economical preposition for such sprayers.

Conclusions

The sprayer work on low volume spraying technique with 117.5L/ha application rate. It requires a short time period per unit area spraying, the field capacity of the sprayer is 0.324 ha/h which is one of the most prerequisite of a low volume spraying technique. It can be easily operate in the field, both at load and no load conditions because of proper balancing and use of two cycle wheels with tyres, tube and bearing. This sprayer is useful for treating the different crop heights by the adjustment of boom heights. It can be successively used for spraying insecticide, fungicide and also herbicide of water soluble formulations.The contamination of the operator by the pesticide is very less as the operator is always kept at a distance of 1500 cm from the spray heads, with the help of cross bar given in the handles.

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