Fabrication and experimental setup of manually operated sprayer trolley

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ABSTRACT

The population of India is increasing rapidly in order to fulfill their diet and needs, the production of foods must be increased. But this must come at affordable to everyone. In India farming is done by traditional ways besides that there has been larger development of industry and service sector as compared to that of the agriculture sector. To mechanization of agriculture in India, some equipment has been developed. The pesticide sprayer is one among them and it is done by traditional farm workers by carrying backpack type sprayer, which requires human effort or by using an electric pump. To improve the agriculture system and to reduce the human effort and problems associated with the backpack sprayer new equipment is fabricated which will be beneficial to farmers. Mechanically operated sprayer trolley simply uses the kinematic link to convert the kinetic energy to oscillating energy for reciprocating motion of pump. In this system no use of any external energy such as the electrical, engine, any renewal energy etc. Also, minimize the wastage pesticide and time.

Keywords — Kinematics principle, Pressure gauge, Sprayer nozzles

1. INTRODUCTION

Generally, the farmer uses the traditional way that is spray carried on a backpack and spraying crop this becomes time consuming, costly and human fatigue is a major concern. Present day in agriculture the sprayers play an important role in spraying pesticide. Although sprayers vary as motorized, hand operated. Spraying pesticide is an important process in farming. Nowadays, there are many types of pesticide sprayer already in the market. For the different types of pesticide sprayer, there are have different shapes, sizes, a method to carry it but the function is the same. The current idea on sprayer in our project is to utilize effectively for reducing the time of spraying, human efforts and cost of spraying.

The conventional sprayer having some difficulties such as it needs a lot of effort to push the liver up and down in order to create the pressure to spray. Another difficulty of petrol sprayer is to need to purchase the fuel which increases the running cost of the sprayer; it produces more vibrations and noise that irritates the farmer and he refuses to do such work repeatedly. In order to overcome these difficulties, we have proposed a wheel driven sprayer, it is a portable device and no need of any fuel to operate, which is easy to move and sprays the pesticide by moving the wheel.

The mechanism involves in this sprayer is a reciprocating pump and nozzles which were connected at the front end of the spraying equipment. A special arrangement is implemented for adjusting the pressure as low and high with the help of adjusting the nut. Also, the weeding is done by this equipment. In the Agricultural sector use of cheap and beneficial equipment for effective weeding and spraying for increase productivity which is very important for better contribution to India’s GDP.

2. PROBLEM STATEMENT

For the backpack type pesticide sprayer, the user needs to carry the heavy tank at the back and oscillate the lever that required more efforts. As we know, this is the most type of pesticide pump sprayer that user use in farming. User needs to hold the nozzle...
when spraying out the pesticide. The second type of spray pump used is fuel operated spray pump, which is heavier than hand-operated backpack pump. This type of pump is running on the petrol engine. We know that petrol is one of the costly fuel. Also, the pump produces more vibrations which are hazardous to users back muscles, this pump makes unwanted noise.

3. SCOPE
Nowadays the spraying of the crop is done by the operator taking pump on back, but we were developing this conventional spraying for reducing efforts and time by using crank mechanism and motion transmission by chain and sprocket arrangement principles.

4. CONSTRUCTION
The main components of the agricultural reciprocating multi sprayer are as follows:

4.1 Sprockets
The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth. We use freewheel and chain wheel for chain and sprocket arrangement.

4.2 Chain
The chain is made of steel which is used to transmit power from gear sprocket to pinion sprocket, and it has no sleep.

4.3 Crank
The function of the crank is to transfer motion from prime mover to the connecting rod for further operation. Here the circular disc having eccentricity and variable distance at which rotary motion of crank is converted into reciprocating motion of the connecting rod.

4.4 Connecting rod
The main function of connecting rod is to convert rotary motion into reciprocating motion. Here connecting rod converts rotary motion of crank to reciprocating motion of lever and pump.

4.5 Pump
It consists of a piston and cylinder arrangement, it has a lever to operate the motion of the piston in reciprocating direction. The pump generates the pressure of 3 bar and discharge of 2.4 lpm.

4.6 Nozzle
It is a device which converts the pressure energy of fluid into kinetic energy, the spray nozzle is a precision device that facilitates dispersion of liquid into a spray. The nozzle is used for the purpose to distribute a liquid over an area.

4.7 Wheel
The wheel is used to carry the whole assembly and move the machine from one place to another by the rotary motion of it. A bicycle wheel is a wheel, most commonly a wire wheel, designed for a bicycle. A bicycle wheel is designed to fit into the frame and fork via drop outs, and hold bicycle tyre. A typical modern wheel has a metal hub, wire tension spokes and a metal or carbon fiber rim which holds a pneumatic rubber tire. We use a tube tire wheel.

4.8 Frame
The main function of the frame is to carry the whole assembly on it so it has to be strong enough to hold it. The frame is made of square pipe and it is formed out of mild steel.

4.9 Tank
We want our tank to carry as much fluid as it can be along with its self-weight as less as possible. We have taken a tank which is almost 16-liter capacity. A material for the tank used is plastic fiber. Plastic fiber is very low in weight as compared to other materials. It also has a very low cost.

5. WORKING PRINCIPLE AND WORKING
5.1 Working Principle
• Motion transmission by chain and sprockets arrangement.
• Crank mechanism.
• Rotary motion converted into reciprocating motion.

The chain drive transfers the motion of gear sprocket to pinion sprocket. The pinion sprocket and crank is mounted on either side of the same shaft, the rotary motion of the shaft is converted into the reciprocating motion with the help of crank and connecting rod mechanism. The connecting rod is also connected with lever and then the lever oscillates at the fulcrum. The piston connected at fulcrum produce reciprocating motion in the cylinder and the required pressure is achieved. The pesticide from tank sucks in cylinder and piston forced the pesticide to the nozzle through the pipe; the numbers of nozzles are connected to spray the pesticide. We can adjust the pressure, which is required for spraying with the help of special arrangement is to change the length of the crank by providing a slot on the crank. By providing some adjustment at joint of connecting rod and lever free rotation of crank or neutral position can be achieved. Using these adjustments pumping is stopped and the wheel rotates freely when you need not spray pesticide. Height, position and angle of the nozzle can be adjustable.
6. PART DESIGN AND CALCULATION OF ASSEMBLY

6.1 Selection of wheel

Distance between two plants = 1.25 feet = 38 cm.
Line covered by one rotation of wheel = 5

\[ 38 \times 5 = 190 \text{ cm} \]
\[ 190 = 2\pi r \]
\[ r = \frac{190}{2\pi} \]
\[ r = 30.48 \text{ cm} \]
The diameter of wheel = 60.96 cm

6.2 The calculation of power transmission

Driven Sprocket Gear \( (T_1) = 44 \)
Driven Sprocket Pinion \( (T_2) = 18 \)
Compound Sprocket \( (T_3) = 44 \)
Driven Sprocket Pinion \( (T_4) = 18 \)

Driven sprocket gear is compounded with wheel.

\[ \frac{T_1}{T_2} = \frac{N_2}{N_1} \]
\[ N_2 = \frac{T_1}{T_2} \times N_1 \]

Now \( T_2 \) and \( T_3 \) is compounded, then \( N_2 \) and \( N_3 \) is equal
Next from \( T_3 \) to \( T_4 \)

\[ \frac{N_4}{N_3} = \frac{T_3}{T_4} \]
\[ N_4 = \frac{T_3}{T_4} \times N_3 \]
\[ N_4 = \frac{T_3}{T_4} \times \frac{T_1}{T_2} \times N_1 \]
\[ N_4 = \frac{44}{18} \times \frac{44}{18} \times N_1 \]
\[ N_4 = 5.97N_1 \sim 6.0N_1 \]

So the transmission ratio is 1:6
Then one rotation of wheel gives 6 strokes to the reciprocating pump.

6.3 Selection of chain

Chain type roller chain.
ISO Chain no. 05B
Pitch = 0.25 mm

6.4 Selection of pump

We are going to join 4 nozzles then pump required to produce the discharge is,

\[ 4 \times 0.6 = 2.4 \text{ lpm}. \]

Total discharge of pump is 2.4 lpm.
For the above discharge, which pumps give pressure above 2 bar is to be selected.

**Table 1**: comparison between conventional method and Automatic pesticides spraying machine

<table>
<thead>
<tr>
<th>Description</th>
<th>Conventional method (10 Acre)</th>
<th>Automatic pesticides spraying machine (10 Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticides</td>
<td>5Litre</td>
<td>4Litre</td>
</tr>
<tr>
<td>Pesticides cost</td>
<td>5*2000=10000 Rs</td>
<td>4*2000=8000 Rs</td>
</tr>
<tr>
<td>Labor Charge</td>
<td>Rs. 300 / Day</td>
<td>Rs. 300 / Day</td>
</tr>
<tr>
<td>Nos. of labors</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Nos. of working days</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>No of cycle</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
7. RESULT AND CONCLUSION
As the vehicle moves in forwarding direction crank mechanism come in the act and due to it, the pressure will be generated in the tank and pesticide will be sprayed out from the nozzle. This machine will be operated by pushing the vehicle in a forward direction; therefore no harm effect will occur to human health. Also, it covers a larger area in less time so lots of time will be saved with this and also labor cost will reduce and money saved. Based on the present work the followings are some important conclusions have been drawn.

(a) It is found that the existing pesticide spraying machine will be on person's shoulder. That portable backpack sprayer type machine may cause health problems for a person as he directly comes in contact with the pesticide. Also, the human who is spraying the pesticides faces the problem of lumber pain.

(b) In the advent of avoiding such problems enlisted in the first point, an automatic agriculture pesticide spraying machine seems an alternative concept.

(c) Comparison between the existing machine and the present machine shows that the single wheel operated machine can work very efficiently with respect to covering the area, time and cost of the spraying process. Also, it seems economical.

(d) It is economical than conventional type pesticide sprayer.

7.1 For the traditional apparatus
Let us consider Cost of pesticide as Rs. 2000
Labour cost = 500

\[ \text{Total cost per day} = 3 \text{ acres} \times 2000 + 500 \]
\[ = \text{Rs. 6500 per day} \]  
(1)

\[ \text{For 6 acres land} = 6500 \times 2 \]
\[ = \text{Rs. 13000} \]  
(2)

7.2 For our designed apparatus
The cost for pesticide remains same= Rs. 2000
Labour cost= 300

\[ \text{Total cost per day} = 6 \text{ acres} \times 2000 + 300 \]
\[ = \text{Rs. 12300 per day} \]  
(3)

\[ \text{Total saving is 13000 – 12300} = 700 \]

8. REFERENCES