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RESEARCH ARTICLE

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DEVELOPMENT OF WHEEL DRIVEN SPRAYER

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ABSTRACT

used to kill insects or otherwise control their reproduction. These herbicides, pesticides, and fertilizers are applied to agricultural crops with the help of a special device known as a "Sprayer," sprayer provides optimum performance with minimum efforts. By the invention of sprayers, this enables farmers to obtain the maximum agricultural output.

A pesticide sprayer has to be portable and with an increased tank capacity as well as should result in cost reduction, labour and spraying time. In order to reduce these problems, there are a number of sprayer introduced in the market, but these devices do not meet the above problems or demands of the farmers. The conventional sprayer having the difficulties such as it needs 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

In order to overcome these difficulties, I have proposed equipment that is 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. This wheel operated pesticide spray equipment consumes less time and avoids the pesticide from coming from front of the nozzles which will in contact of the person who sprays pesticides. The mechanism involved in this sprayer is reciprocating pump, which is driven by the wheel

Keywords: Reciprocating pump, Spraying time, Tank capacity, Accumulator, nozzle.

INTRODUCTION

Chemicals are widely used for controlling disease, in sects and weeds in the crops. They are able to save a crop from pest attack only when applied in time. The chemicals are costly. Therefore, equipment for uniform and effective application is essential. Dusters and sprayers are generally used for applying chemicals. Dusting, the simpler method of applying chemical, is best suited to portable machinery and it usually requires simple equipment. But it is less efficient than spraying, because of the low retention of the dust.

The invention of a sprayer brings revolution in the agriculture or horticulture sector, this enables farmers to obtain the maximum agricultural output. They are used for garden spraying, weed and pest control, liquid

fertilizing and plant leaf polishing. There are many advantages of using sprayers such as easy to operate, maintain and handle, it facilitates uniform spread of the chemicals, capable of throwing chemicals at the desired level, precision made nozzle tip for adjustable stream and capable of throwing foggy spray, light or heavy spray, depending on requirement.

The agriculture sector is facing problems with capacity issues, shrinking revenues, and labour shortages and increasing consumer demands. The prevalence of traditional agriculture equipment intensifies these issues. In addition, most formers are desperately seeking different ways to improve the equipment quality while reducing the direct overhead costs (labour) and capital. Thus, a significant opportunity rests with understanding the impact of a pesticide sprayer in an agriculture field. A pesticide sprayer has to be portable and with an increased tank capacity as well as should result in cost reduction, labour and spraying time. In order to reduce these problems, there a number of sprayers introduced in the market, but these devices do not meet the above problems or demands of the farmers.

The conventional sprayer having the difficulties such as it needs 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. In order to overcome these difficulties, I 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 involved in this sprayer is reciprocating pump, and nozzles which were connected at the front end of the spraying equipment.

LITERATURE REVIEW

Objective of Pesticide Application

In an average year, especially during the summer, one or more types of sprayers will be used by the average home gardener. Of the many products available, it is important to select the most efficient and easiest type for your particular need, whether it is for applying insecticides fungicides, weed killers, liquid fertilizers or wetting agents. For example, lawn sprayer is made especially for the application of liquid materials to the lawn area. They are metered to allow quick mixing and coarse spray, so it does not take as long to apply weed killers, insecticides, etc. Also, there is not as much chance of drift of the liquid into nearby flower and shrub beds. The old saying “You get what you pay for” certainly applies to sprayers. Efficiency and accuracy vary considerably, especially with the type that attaches to the garden hose.

Sprayers that are used for weed killing or for applying any type of soil sterility should not be used for any other purpose. In fact, you will find it a good practice to set a sprayer aside just for the lawn area. Use a separate one for flowers and shrubs. It is a good practice to clean out your sprayer immediately after you have used it for any type of spraying. A little soapy water, swished around and through sprayer, then flushed out with warm water, does good job.

Types of sprayers

- **Portable sprayers**

These are small hand held or backpack sprayers can handle small jobs, like spraying weeds in a driveway. They would be used occasionally in residential and rural homes. Common chemicals applied would be Round-up. Some of portable sprayer mentioned is given below:

a) Hose sprayers
b) Tank sprayers
c) Trombone sprayers
d) Hand pump sprayers

- **All terrain vehicles (ATV) sprayers**

a) Two behind sprayers:
b) Skid sprayer

Types of spray guns

a) Spot sprayer gun

b) Broadcast/Boom spray
c) Tree sprayer gun
d) Lawn sprayer gun

Spray Guns (Handgun)

A spray gun is a sprayer which you direct at the desired target. It is attached to the sprayer by a hose (usually ten meters or longer). Spray guns may be used for spot treatments or to treat weeds, crops, or ground in areas inaccessible or a boom sprayer. The spray gun has a shutoff trigger or a rotating shutoff handles and a single nozzle. Precise calibration is very difficult, so spray guns should be used for applications where accurate rates are not required. For example, herbicides are generally applied with a handgun by mixing a very dilute solution and applying to the point of runoff.

Sprayer nozzles have three main purposes:

- Breaking liquid into droplets;
- Spreading the droplets in a specific pattern;
- Helping regulate sprayer output

The older style nozzle has a threaded cap which holds the spray tip and strainer to the nozzle body. The nozzle body is clamped to the boom. Newer nozzles have a quick-release nozzle cap which requires only a quarter turn to attach or remove it. They can be removed by hand without use of a wrench. This makes it easy to remove tips and strainers for changing and cleaning. The quick-release nozzles also correctly align the nozzle tip each time it is replaced.

Nozzle check valves are recommended to stop spray solution leaking out of nozzles after the flow of spray has been shut off. This prevents release of spray when turning at the end of rows or after you leave the treatment area. The check valves also keep the boom full and provide spray immediately when the flow is turned on again. You must increase boom pressure to compensate for valve opening pressure. Pesticide applied over the full width of the boom (not just rows) is known as a broadcast treatment. For broadcast treatment, nozzles are spaced so that spray patterns overlap. This provides uniform spray coverage along the boom.

Application of a pesticide in a strip between or over crop row is called a band treatment. Nozzles are spaced so that spray is directed over or between crop rows are required. The boom may be fitted with nozzles on drop pipes to improve spray coverage of soil or plants in each band.

The speed travelled while applying granules should be slow enough to prevent bouncing of the equipment as this causes uneven application. The application rate can be adjusted by changing the discharge opening. The actual rate of output must be checked during calibration.

a) High pressure sprayer

High pressure sprayers are often called “hydraulic sprayers.” They operate with dilute mixtures and different pressures from two hundred and fifty up to several hundred psi. The design of high pressure sprayers is similar to that of low pressure sprayers, the only difference being that the components have to withstand high pressures.

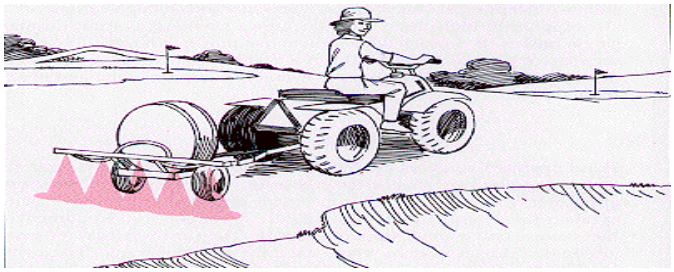

Figure 1: When fitted with booms they can do any work done by a low pressure boom sprayer. They may also be fitted with handguns. The handguns are used for spraying shade trees and ornamentals, livestock, orchards, buildings, unwanted brush, rights-of-way, commercial crops, etc.

Advantages

High pressure sprayers are useful for many different pest control jobs. They have enough pressure to drive spray through heavy brush, thick cow hair, or to the tops of tall shade trees. Because they are strongly built, they are long lasting and dependable. Piston pumps are standard and resist wear from gritty or abrasive materials. Mechanical agitators are also standard and keep wet powders well mixed in the tank. With a long hose, targets in hard-to-get-at places such as trees, shrubs, etc., can be treated. If label directions for mixing are followed the applicator is not likely to overdose.

Disadvantages

High pressure hydraulic sprayers have to be strongly built and can be heavy and costly. They usually use large amounts of water and thus require frequent filling. The pesticide can easily be misdirected, causing drift and off-target contamination.

1. Problem Identification

3.1. Drawbacks in Existing backpack Sprayer Pump

Lever operated backpack sprayer. A backpack sprayer consists of tank 10 -20 liter capacity carried by two adjustable straps, this may causes the back pain to the operator due to constant pumping which result in muscular disorder [1].Also, the backpack sprayer can't maintain sufficient pressure for the spraying action. Results in drifts [9].Developing insufficient pressure is laborious and time consuming.[13].Pumping to operating in the insufficient pressure is also time consuming[6]. Moreover, very small area is covered while spraying. So, more time are required to spray the entire area.

3.2. Uneconomical cost of sprayers.

Presently farmers are using knap-sack sprayer for spraying pesticides on crops in their farms which costs for Rs 1800-4500/-.Pesticides are diverse and omnipresent[5].This sprayer has a wide limitations and thus farmers can use the other sprayer also like power sprayer, boom sprayer and tractor mounted sprayer. Cost of boom sprayer is about Rs 80000/.

DEVELOPMENT OF THE MODEL

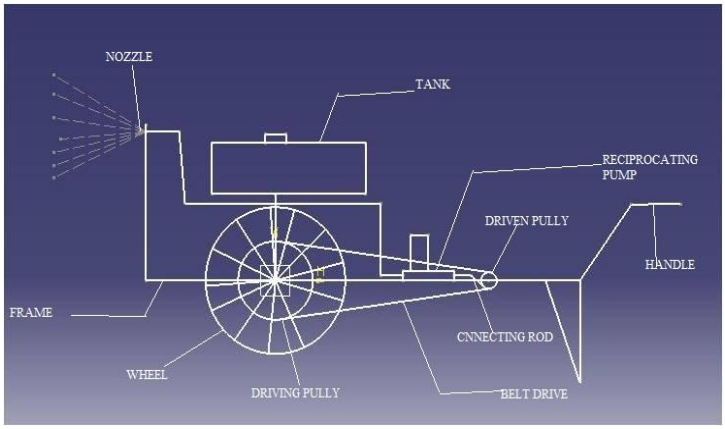

Figure 2: 2D model of the equipment

This is a two wheeled body with cranking mechanism with pump being cranked and pushed and pulled to result in pumping, building the pressure in the tank for pesticide spraying. The wheels are fixed on the main axle and cranking is on the other axle which pushes the piston rod in and out of the cylinder pumping the air pressure into the tank. There is a tank fitted on the frame through there is a main suction tank which consists of pesticide which the sprayer is connected on the protruded rod and jet is set for the required pitch. When the handle is pushed the wheels rotate and move and simultaneously pump the air is affected.

This equipment has an air pump which compresses air into the tank and pressurizes the spray mixture. The pressure slowly drops as the liquid is sprayed. The forward motion of the wheels drives the reciprocating pump

to pump the air into the tank which maintains the pressure for the spraying. In this equipment the reciprocating pump take place reciprocating action by two methods one is by moving the equipment.

Figure 3: Actual model of the equipment

2. Design Considerations

5.1 Design of axel

By normal stress theory

$$D=\left\{\frac{16}{\pi\sigma_{ed}}[k_b M_b + ((k_b M_b)^2 + (k_t M_t)^2)^{\frac{1}{2}}]\right\}^{\frac{1}{3}} \quad (1)$$

Torque transmitted

$$M_t = \frac{9550*N}{n} \quad (2)$$

$$=\frac{9550*95}{55}$$

=16495.45N-mm

Consider the pulley drive

$M_t = (T_1-T_2)*R_P$ (3)

$16495.45 = (T_1-T_2)*150$

$(T_1-T_2) = 109.96$

$T_1=1.5T_2$

$1.5T_2-T_2=109.96$

$T_2=219.93$

$T_1=1.5T_2$

$=1.5*219.93$

$T_1 =329.895$

Horizontal load on the belt=T_1+T_2

=329.89+219.93

=549.82 N

Resultant Force

$$F_r=\sqrt{W_P{}^2 + (T_1 + T_2)^2} \quad (4)$$

$$=\sqrt{(2*9.81)^2 + (549.82)^2}$$

F_r =550.17 N

Bending Moment

$$M_b=\frac{Fr*L}{4} \quad (5)$$

$$=\frac{550.17*1066.45}{4}$$

=146682.1991 N-mm

$\sigma_{ed} = \frac{F_{max}}{FOS}$ (6)

$=\frac{553.0}{5}$

$=110.6\ N/mm^2$

Substituting in (1)

D=27.27mm≈ 28mm

RESULTS AND DISCUSSION

Data Collection for the Sprayer Calculation

Table 1:-Data collection for the sprayer calculation

Time consumed	60 Seconds
Replicate	**Volume of water collected(lts)**
1	1.428
2	1.5
3	1.32
4	1.40

Average volume flow out from the implement

$= \frac{1.428+1.5+1.32+1.40}{4}$

= 1.412 lts

Amount of water flow out from the implement per second

$= \frac{1.412}{60}$

= 0.02lts/ s

Application rate

$F=\frac{SDA}{10000}$ (7)

Where F = Flow rate ltr/min

S = swath width in meter

D = Operator walking speed in M/min

A = Application rate in ltr/ha

$F = \frac{SDA}{10000}$

$F = \frac{2*60*A}{10000}$

$4 = \frac{120*A}{10000}$

` $A = \frac{40000}{120}$

A = 333.33 ltr/ha

CONCLUSION

This wheel driven sprayer is manly low cost and easy to move in the fields and also improves the quality of spraying pesticides. After experimentation of this wheel driven sprayer device, it was observed that the operator can cover two parallel rows simultaneously without any additional energy being used as well as it reduces the fatigue of the operator.

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