# SINGLE WHEEL PESTICIDES SPRAY PUMP WITH METERING

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***Abstract*-** In agricultural sector usually, farmer uses ancient manner that's spray carried on backpack and spraying crop. In order to meet the food requirements of the growing population, modernization of agriculture is inescapable. Mechanization do the conservation of inputs through precision in metering satsfying better distribution, reducing quantity needed for pesticide and prevention of input applied or losses. Farmers are using the same traditional methods and equipment.This becomes timeconsuming, expensive and human backpain problem is major concern, these issues may be overcome by producing agricultural multi sprayer. It gives uniform spread of the pesticide, throw the pesticide in controlled amount, precision made nozzle tip for adjustable stream and throw the foggy spray in required amount. In our project we must use slider crank mechanism to convert rotary motion into reciprocating motion to control the pump, therefore the chemical is come through the nozzle. This work provides flow of pesticide at needed pressure and height. A special arrangement is provided during this project to regulate the pressure as high or low. By using agricultural sprayer, spraying time, human efforts reduce and results in cost reduction.

***Keywords*-Metering, Sprayer, Ergonomics, Single wheel, Multi nozzle, cost.**

## I. INTRODUCTION

India's economic security continues to predicate upon the agriculture sector, and the situation is not likely to change in the future. In India about 73% of population is directly or indirectly depends upon the farming. Hence it is said that India is an agriculturally based country. But till now our farmers are doing farming in same traditional ways. They are doing seed sowing, fertilizers and pesticides spraying, cultivating by conventional methods[1] [4]. For agriculture the pesticide and water are mostly required after some interval of time to remove the insect from the agriculture land. In old equipment only one work has been performed at a time due to which the time as well as effort required is more [2].The agriculture sector is facing problems with capacity issues, shrinking revenues, and labour shortages and increasing consumer demands [3].The conventional sprayer having some difficulties such as it needs lot of effort to push the liver up and down in order to create the pressure to spray. Another problem of fuel sprayer is to want to get the fuel that will increase the running price of the sprayer; it produces a lot of vibrations and noise that irritates the farmer and he refuse to try and do such work repeatedly. In order to beat 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 chemical by moving the wheel. The mechanism involve in this sprayer is reciprocating pump, and nozzles which were connected at the front end of the spraying equipment. A special arrangement is enforced for adjusting the pressure as low and high with the assistance of adjusting the nut. In Agricultural sector use of low cost and helpful instrumentality for effective spraying for increase productivity that is extremely necessary for higher contribution for India's GDP[5]. Insects are largely responsible for the crop destruction. Sprayer provides optimum performance with minimum efforts[6].It is generally said that mechanization of small farms is difficult. In order to attenuate the plodding of little farmers, to extend potency and save farmer's time for usurping furthersupplementary generating activities, the employment of contemporary time saving machines/implements of appropriate size needed to be suitably promoted [7].The Indian farmers (small, marginal, little and marginal, semi-medium) area unit presently victimization lever operated backpack sprayer. A backpack sprayer consists of tank ten -20 cubic decimetre unit capacity carried by 2 adjustable straps. Constant pumping is required to operate this which result in muscular disorder [8]. Also, the backpack sprayer can't maintain pressure, results in drifts/dribbling [10]. Developing adequate pressure is laborious and time consuming [9]. Pumping to operating pressure is also time consuming [11]. Moreover, very small area is covered while spraying. So, longer area unit needed to spray the whole land. Back pain problems may arise during middle age due to carrying of 10-20 litter tank on back. Now a day's the spraying in farm is done by operator taking pump on back, however we tend to be developing this typical spraying mechanism for reducing efforts, time & excessive pesticides by using slider crank mechanism and motion transmission by chain and sprocket arrangement principles.We are use metering mechanism with the help of Synthesis Mechanism.

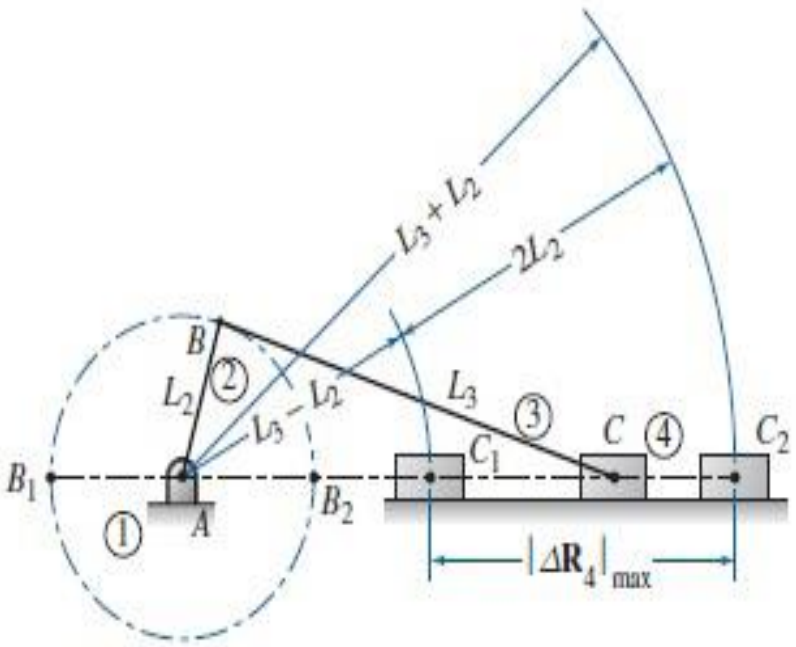


Fig .1 Synthesis Mechanism [14]

## II. WORKING PRINCIPLE

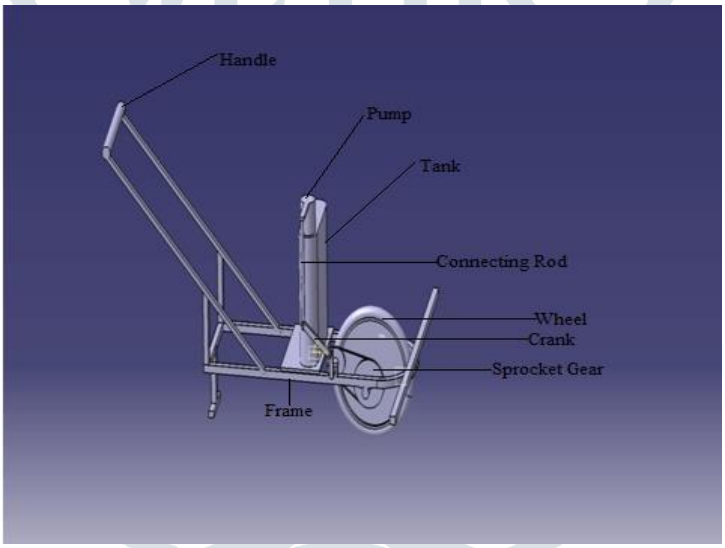


Fig. 2Single wheel pesticide spray pump with metering

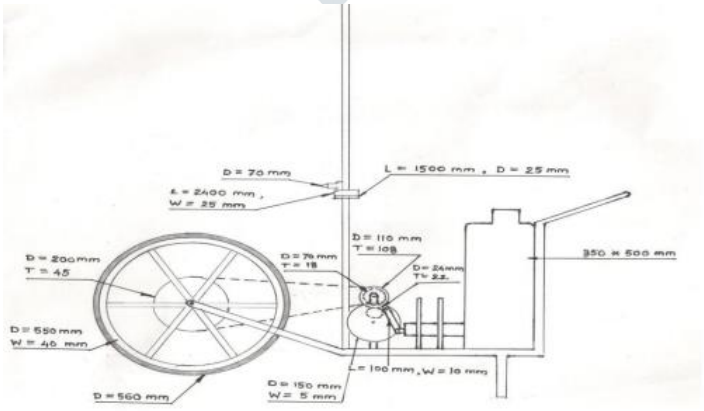

Fig. 3Side view of manually operated multi-nozzle pesticides sprayer pump [13]

The assembly of the agricultural reciprocating multi sprayer. The operator holds the handle and pushes the cycle forward as cycle moves forward, the wheel rotate. When the wheel rotates then the gear sprocket mounted on wheel is also rotate at same speed. The chain drive transfers the motion of gear sprocket to pinion sprocket. The pinion sprocket and crank are mounted on either side of same shaft, the rotary motion of 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 fulcrum. The three positions are providing on the crankso we can adjust the stroke length of the connecting rod.The piston connected at fulcrum produce reciprocating motion in cylinder and the required pressure is achieved. The pesticide from tank sucks in cylinder and piston forced the pesticide to nozzle through the pipe; the 4 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 crank by providing slot on crank. By providing some adjustment at joint of rod and lever free rotation of crank or neutral position will be achieved. Using these adjustments pumping is stop and the wheel rotate freely when you need not spray pesticide [5]. Height, position and angle of the nozzle can be adjustable[12]. The name 'sprocket' applies usually to any wheel upon that radial projections have interaction a series passing over it. It is distinguished from a gear therein sprockets square measure ne'er meshed along directly and differs from a pulley-block therein sprockets have teeth and pulleys square measure sleek. The chain is made of steel which is used to transmit power from gear sprocket to pinion sprocket, and it has a no sleep. The operate of crank is to transfer motion from causal agent to the rod for additional operation. Here the circular disc having eccentricity at which rotary motion of crank is converted into reciprocating/linear motion of connecting rod. The main function of connecting rod is to convert rotary motion into reciprocating/linear motion. Here connecting rod convert rotary motion of crank to reciprocating motion of pump and extension rod. It includes piston and cylinder arrangement, it's a lever to control the motion of piston in mutual direction. The pump generates the pressure of two bar and discharge of 2 lpm. Nozzle is a device which converts the pressure energy of fluid into kinetic energy, spray nozzle is a precision device that facilitates dispersion of liquid into a spray. Nozzle is employed for purpose to distribute a liquid over a section. Wheel is employed to hold the full assembly and move machine from one place to a different by motion of it. A wheel could be a wheel, most typically a foam wheel, designed for a bicycle. Bicycle wheel is designed to fit into the frame and fork via drop outs and hold bicycle tyre. We use a tubeless tire wheel. The main function of frame is to carry whole assembly on it, so it must be strong enough to hold it. The frame is of sq. pipe and it's formed out mild steel [2]. We want our tank to carry more fluid as it with self-weight. We have taken a tank that is nearly 15 litter capacity. A material for tank used is plastic fibre. Plastic fibre is extremely low in weight as compared to alternative materials. It also has very low cost.

Fig 4. Single wheel pesticide spray pump with metering

## III. DISTANCE AND HEIGHT OF THE CROP

The distance and height of the crop have been decided after discussing with the farmer and agricultural expertise. We have taken average distance and height of the crop.

Table -1 Distance and height of the crop

| Sr. no. | Name of the Crop | Distance Between Plant (feet) | Height of the Plant (feet) |
|---|---|---|---|
| 1 | Sorghum | 0.70 | 3.5-4.5 |
| 2 | Sugarcane | 1 | 3.5-4.5 |
| 3 | Corn | 0.35 | 3-4 |
| 4 | Millet | 0.75 | 3.5-4.5 |
| 5 | Soybean | 0.5 | 1-2 |
| 6 | Cotton | 2-2.25 | 3-4 |

## IV. PART DESIGN

### i. Selection of Wheel

Wheel is employed to hold the full assembly and move machine from one place to a different by motion of it. We use a tubeless tire wheel.

Distance between two plants = 1.25 feet = 38 cm.

Line covered by one rotation of wheel = 4

$$38 * 4 = 152 \text{ cm}$$

$$152 = 2\pi r$$

$$r = 152/2\pi$$

$$r = 25 \text{ cm}$$

The diameter of wheel = 50 cm

### ii. Selection of Pinion

When the wheel rotates then the pinion sprocket mounted on wheel is also rotate at same speed. The chain drive transfers the motion of gear sprocket to pinion sprocket. The pinion sprocket and crank are mounted on either side of same shaft.

Minimum no. of teeth available on pinion = 18

Outer diameter of pinion = 8 cm = 80 mm

Inner diameter of pinion = 6.5 cm = 65 mm

Pitch circle dia. (Dp) = ((Do-Di)/2) + (Di)

= ((90-65)/2) + (65)

Dp = 72.5 mm

Gear Ratio = 1:3

On rotation of substances sprocket offers 2 rotation of pinion sprocket, we tend to need 3 strokes to get adequate quantity of pressure.

### iii. Selection of Gear Sprocket

When the wheel rotates then the gear sprocket mounted on wheel is also rotate at same speed. The chain drive transfers the motion of gear sprocket to pinion sprocket.

(1/2) = (tp/tg)

(1/2) = (18/tg)

tg = 36

(tp/tg) = (Dg/Dp)

(2/1) = (Dg/72.5)

Dg = 145

Pitch = (Number of teeth on Pinion / Pitch circle diameter of Pinion)

Pitch = (18/72.5) = 0.25 mm

### iv. Selection of Chain

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

Chain type roller chain.

ISO Chain no. 05B

Pitch = 0.25 mm

Length of chain, L = K.P

No. of chain,

K= ((t1+t2)/2) + ((2X)/p) + ((t2-t1)/ (2*3.142)) *(p/X)

K= ((18+36)/2) + ((2*150)/0.25) + ((36-18)/ (2*3.142)) *(0.25/150)

K= 27 + 1200 + 0.00477

K = 1227 mm

L = K * P

L = 1227 * 0.25

L = 306.751 mm

L = 30.7 cm

### v. Design of Crank and Connecting Rod by Using Synthesis of Mechanism (Three Position Method)

Mechanism synthesis is the procedure by which upon identification of the desired motion a specific mechanism (synthesis type), and appropriate dimensions of the linkages are identified (dimensional synthesis).[14]

Crank, AB = 10 cm

Connecting Rod, BC1 = 50 cm

### vi. Nozzle Selection

Nozzle is a device which converts the pressure energy of fluid into kinetic energy, spray nozzle is a precision device that facilitates dispersion of liquid into a spray. Nozzle is employed for purpose to distribute a liquid over a section.

Diameter of wheel =50 cm

Let's consider farm of 1 Acre,

Therefore, 1 acre = 4046.86 m^2

L =4046.86root

L=64m

Number of plants in 64 meters, Np = (64/0.38) = 168

From survey earlier when backpack spray pump hand used then 60 litters. of pesticide are used for 1-acre farm. Consider 60 litter of pesticide is required for 1-acre farm so how much amount of pesticide is required for one plant.

Total number of plants in 1 acre, 168*168=28224

60 litters. for 1 acre,

(60/28224) = 2.1258*10^-3 litter/plant

Consider time needed for 1-acre farm to spray a chemical is three hrs.
= 180 minutes =180/28224 =6.3775*10^-3 min/plant
=1/ (6.3775*10^-3) = 156.8 plant/min.
Discharge = (2.1258*10^-3) *(156.8)
Discharge=0.3333 litter/min
Find the pressure drop,
((Q2/Q1) ^2) =(P2/P1)
(P2) =(P1) *((Q2/Q1) ^2)
(P2) = 2*((0.3333/0.4166) ^2)
P2= 1.279 bar
Pressure drop = 0.72 bar

**vii. Selection of Pump**

It includes piston and cylinder arrangement, it's a lever to control the motion of piston in mutual direction. The pump generates the pressure of two bar and discharge of 2 lpm.
We are going to join four nozzles then pump required to produce the discharge is,
(4) *(0.3333) = 2 lpm
Total discharge of pump is 2 lpm

**viii. Design of Frame**

The main function of frame is to carry whole assembly on it, so it must be strong enough to hold it. The frame is of sq. pipe and it's formed out mild steel
Length of frame = (Radius of wheel) + (centre distance between two sprockets) + (Distance between rear sprocket to pivot) + (width of tank) +Excess
= 250 + 150+ 180+130+290
L = 1000 mm
Height of Frame = 776 mm
Width of Frame = 500 mm
Total length of pipe = (850*2) +200+(600*2) +1000+(775*2) +100
= 5750 mm
cross section area of square pipe = 25.2*2
= 51*4 sides = 204 mm^2
Volume of frame = 204*5750
= 1173000 mm^3
Density of m.s. material = 7.7*10^-6 kg/mm^3
Density = (mass/volume)

Mass = density * volume

= (7.7*10^-6) *(1173000)

=9.03 Kg

Total weight of assembly = 15+2+1+9

= 27 kg *9.81

= 264.87 N

Yield stress of material = 247 N/mm^2

Area = 5750 * 25.4

= 146050 mm^2

Stress = (load/ area)

= (264.97/146050)

= 0.0181 N/mm^2

Therefore, 0.0181 < 247 N/mm2, therefore the look is safe.

## V. RESULT AND DISCUSSIONS

Table- 1 shows the height of the different crops available in the farming. When we develop our project, we consider height of the plant, distance between the two plant, time required to spray, quantity of the pesticides required to each plant. So, considering all these aspects we develop our project.
When we fix the position 1 then we get 0.0166 L/min flow rate and based on these flow rate we can spray up to 5 feet height. So, this flow rate is enough for sugarcane, sorghum, millet.
When we fix the position 2 then we get 0.0216 L/min flow rate and based on these flow rate we can spray up to 3 feet height. So, this flow rate is enough for cotton, corn.

When we fix the position 3 then we get 0.0241 L/min flow rate and based on these flow rate we can spray up to 2.5 feet height. So, this flow rate is enough for soybean.

Table- 2 Result

| Position of crank pin | Amount of pesticide Sprayed per minute (L) | Flow Rate(L/min) |
|---|---|---|
| 1 | 1 | 0.0166 |
| 2 | 1.3 | 0.0216 |
| 3 | 1.45 | 0.0241 |

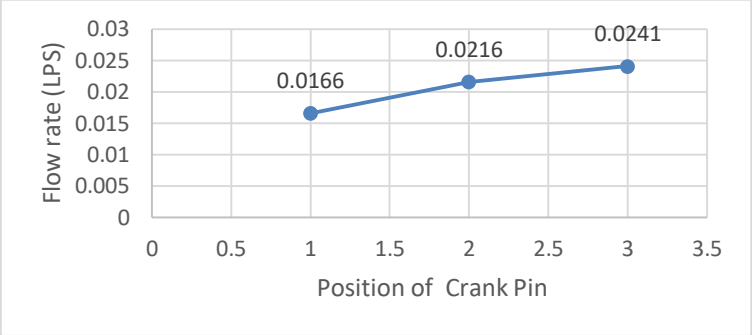


Fig. 5Position crank vs flow rate graph

1st position: In 1st position radial distance between crank pin and crank is less. So, Stroke length of piston get decreased hence we get minimum flow rate as compare to 2nd and 3rd position.2nd position:In 2st position radial distance between crank pin and crank is more than 1st position. Stroke length of piston get increased than 1st position hence we got maximum flow rate as compare to 1st position.3rd position:In 3rd position radial distance between crank pin and crank is more than 1st and 2nd position. Stroke length of piston get maximum hence we got maximum flow rate.Follow these steps to calibrate working model Measure the sprayer width of the nozzle. Measure the nozzle output in litters over one minute.The Sprayer volume can be calculated by following formula:

$$\frac{\text{Nozzle output (L/min) X 10, 000}}{\text{Sprayer width (m) X Walking Speed (m/min)}}$$

Nozzle Output in 1min = 1000 ml
Sprayer width = 2 ft
Walking speed = 84 metre/min
Application rate (L/hr) = 59976 L/hr
Based on synthesis mechanism, we can get three types of flow rate and we can also provide flow control valve. With the help of flow control valve, we can adjust the flow rate between the adjacent position of synthesis mechanism.

## VI. CONCLUSION

It is upgraded design of manually operated sprayer which will be helpful for small land farmers. It consumes less time and saves money as compared with conventional spraying. This machine doesn't need any fuel or power thus maintenance is a smaller amount. This model removes problem of back pain, vibrations and noise. This alone pump can used for multiple crops. The model has provided multiple nozzles, which has continuous spray over crop and this process takes less time than other sprayers for spaying and avoid the wastage of pesticides.

## VII. ACKNOWLEDGMENT

We would wish to specific our feeling and appreciation to any or all people who gave United States of America the likelihood to complete this report. A special thanks to our Guide Prof. K. R. MORE whose help, stimulating suggestions and encouragement, helped us to coordinate our paper especially in writing this paper. We would to understand the steerage given by different supervisor further because the panels particularly in our paper that has improved our presentation skills by their comment and tips.

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