Design And Development Of Wheel Spray Pump

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Abstract- *The design and Development of Wheel spray operated pesticide sprayer. This Sprayer consists of back pack sprayer which is mounted on the tank base of the trolley. The piston rod of the tank is connected to the crank, which is mounted on the smaller gear, which in turn is meshed with a larger gear; the larger gear is mounted on the trolley. The pump is connected to the pressure tank, which pressurizes the fluid during operation and stores in the pressure tank. Using a flexible hose, the pressurized pesticide is transferred to the multiple nozzles. According to the need the valve is operated so as to obtain a fine spray throughout. By using manually operated pesticide sprayer, the strain, which is caused to the farmers in conventional backpack sprayer, is reduced and larger area can be covered in a short time.*

Keywords- Multi-Nozzle, Back pack Sprayer, Pesticide

I. INTRODUCTION

Day by day the population of India is increasing and to fulfil the need of food modernization of agricultural sectors is important. Due to chemical fertilizers the fertility of soil is decreasing. Hence farmers are attracted towards organic farming. By mechanization in spraying devices fertilizers and pesticides are distributed equally on the farm and reduce the quantity of waste, which results in prevention of losses and wastage of input applied to farm. It will reduce the cost of production. Mechanization gives higher productivity in minimum input. Farmers are using same traditional methods for spraying fertilizers and pesticides. Equipment is also the same for ages. In India there is a large development in industrial sectors compared to agricultural sectors. Conventionally the spraying is done by labours carrying backpack sprayer and fertilizers are sprayed manually. The efforts required are more and beneficial by farmers having small farming land. Mechanization gives higher productivity in minimum input. Farmers are using same traditional methods for spraying fertilizers and pesticides. Equipment is also the same for ages. In India there is a large development in industrial sectors compared to agricultural sectors. Conventionally the spraying is done by labours carrying backpack sprayer and fertilizers are sprayed manually. Generally, mechanization of small forms are very difficult and non-affordable. Demand for agriculture is rising rapidly with increase in population and per capital income and growing demand from industry sector. There is, thus, an urgent need to identify severity of problem confronting agriculture sector to restore its vitality.

In this agriculture sector there is a lot of field work, such as weeding, reaping, sowing etc. Apart from these operations, spraying is also an important operation to be performed by the farmer to protect the cultivated crops from insects, pests, funguses and diseases for which various insecticides, pesticides, fungicides and nutrients are sprayed on crops for protection. Farming has undergone a great evolution in last 50 years. Out of the various reasons involved for this evolution is control of various diseases on crops. In the modern agriculture, the usage of pesticides is still increasing moreover the 90% of these pesticides are being applied in the form of spraying which will maintain environment friendly approach. One way to overcome this problem is to use the equipment developed for application of the pesticides through the use of mechanical power. In selecting a pump forthe farmers who use these types conventional backpack sprayers face many problems like fatigue, tiredness, pain in spinal cord and muscles etc. Following problems can take place by use of this conventional type of pump.

- Heavy weight of sprayer makes the sprayer to lift manually.
- The operator may feel fatigue and tiredness due to heavy weight which his efficiency reduces.
- Large size of pump causes inconvenience to the operator.

These problems combined with the lack of awareness, technical knowledge and poor maintenance leads to damage to health of the operator and to the environment.The project is a Pesticide/Fertilizer Sprayer mounted on a Cart which is operated mechanicallywithout any external source of energy. The aim of developing such a concept is primarily because of preventing the 3 major drawbacks of the pump being used currently; First, the farmer must carry the entire weight of the pesticide spraying (approx. 20+ kg) pump on his shoulder; second, he must continuously use his one hand to pump using the handle; third, reduction in spraying time. All these factors have been taken care of in this

project along with being cost effective, light in weight and good in strength. The pump already available with the farmer can be directly used in this mechanism. The handle of the sprayer will be mechanically operated through the rotating shaft of the wheels of the cart using an efficient mechanism. This will result into the reciprocating motion of the piston and hence pumping will be done. The user will now just have to push the cart and the whole mechanism will be operated with ease.This will be a case of Pure Mechanical Automation.

II. LITERATUR REVIEW

The Food and Agriculture Organization (FAO) has defined pesticide as: Any substance or mixture of substances intended for preventing, destroying, or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals, causing harm during or otherwise interfering with the production, processing, storage, transport, or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances that may be administered to animals for the control of insects, arachnids, or other pests in or on their bodies. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant, or agent for thinning fruit or preventing the premature fall of fruit. Also used as substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport.

2.1 R.D. Dhete has worked on "Agricultural fertilizer & pesticides sprayers". In his work he emphasizes on different method of spraying devices

Day by day the population of India is increasing and to fulfil the need of food modernization of agricultural sectors are important. Due to chemical fertilizers the fertility of soil is decreasing. Hence farmers are attracted towards organic farming. By mechanization in spraying devices fertilizers and pesticides are distributed equally on the farm and reduce the quantity of waste, which results in prevention of losses and wastage of input applied to farm. It will reduce the cost of production. It will reduce the cost of production. Mechanization gives higher productivity in minimum input.

Farmers are using same traditional methods for spraying fertilizers and pesticides. Equipment is also the same for ages. In India there is a large development in industrial sectors compared to agricultural sectors. Conventionally the spraying is done by labours carrying backpack sprayer and fertilizers are sprayed manually. The efforts required are more and beneficial by farmers having small farming land.

2.2 Pavan B. Wayzode, Sagar R. Umale, Rajat R.Nikam, Amol D. Khadke, Hemant carried out their work in "Design Fabrication of Agricultural sprayers, weed with cutter

Chemicals are widely used for controlling disease, insects and weeds in the crops. They can save a crop from pest attack only when applied in time. The chemicals are costly. Therefore, equipment for uniform and effective application is essential. In this work we have proposed an equipment that is wheel and pedal operated 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 and peddling the equipment. In this equipment using reciprocating pump and there is an accumulator provided for the continuous flows of liquid to create necessary pressure for the spraying action. 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. Weed management is one of the tedious operations in crop production. Because of labour costs, time and fully manual weeding is unfavourable. Hence effort is made to design and develop efficient Farm equipment to perform weeding without using electric power.

2.3 According to literature published on flow control of agricultural spraying machine by massey university New Zealand on different spraying mechanism are studied

New Zealand relies heavily on its agricultural industry. A large portion of this industry is pastoral farming, where livestock are raised to graze on pasture. This includes beef, sheep and dairy farming. An important aspect of this style of farming is maintaining pasture quality. In order to increase growth fertilisers are often applied to the pastures. This increase yields in both meat and milk production.

However, the increased application of fertiliser is linked with diminishing water quality. While the effects of nitrogen leaching and the best ways to manage fertiliser use are still being investigated, it is clear that control over the application will become more and more important. The Tow and Fert is a range of fertiliser machines designed and built in New Zealand by Metalform Dannevirke.

The Tow and Fert range are capable of spraying a wide range of fertilisers including both soluble and non-soluble fertilisers. The Tow and Fert is unique in its ability to spray fertiliser slurries consisting of mixture ratios of up to three-parts fine particle fertiliser to one-part water. This is achieved using a recirculating system. Currently there is next to no control on the flow rate of the machines and the

application rate is determined by the speed the operator maintains. The purpose of this thesis is to design and build a flow control system for the Tow and Fert product range and investigate the effect of the changing flow rate on the spray characteristics.

The ability to spray such a wide range of fluids with drastically different properties presents many challenges. Many flow meters were considered and a low-cost ultrasonic sensor (TUF2000M) was installed and investigated. After limited success of the ultrasonic sensor, a simple turbine flowmeter was installed. A flow controller was developed and tuned. Based off a PID control loop, the controller was able to maintain flowrate well between 10 L/min and 25 L/min depending on the installed nozzle.

2.2 Existing pesticide sprayers

There are many types of pesticide sprayers available in the market. Depending on the crops, area of the farm, type of pesticide and cost of the sprayer, the pesticide sprayers are chosen. Some of the most widely used pesticide sprayers are as follows.

2.2.1 Manually Operated Sprayers

2.2.1.1 Compression Sprayer

Fig. 2.2.1.1. Compression sprayer

Usually considered as the standard equipment for residual spraying. It consists of a tank for holding a liquid insecticide formulation, which can be pressurized by means of a hand pump attached to it. The compressed air forces the liquid from the tank a hose with a cut off valve, a lance and a nozzle. It consists of following main parts.

- **The tank**: It is usually made of stainless steel. Most tanks have four openings on top; a large one for filling, fitted with a removable cover and openings for the air pump, discharge system and pressure gauge.
- **The tank cover**: It consists of a rubber gasket, a handle, a PRV, operated by hand or by giving the handle a quarter turn, a chain to prevent the cover from being lost.
- **An air pressure gauge**: It is used to measure pressure in the tank.
- **The shoulder strap**: It should be wide enough to prevent it from cutting into the shoulder of the person using the sprayer.it is fastened to the tank with steel buckles. On large tanks, it is adjustable.

Advantages:

- Low price.
- Convenient maintenance.
- High efficiency.
- Continuous operation.
- Low price of accessories.

Limitations:

- Low efficiency..
- High labour intensity is not suitable for large area operation.
- Leakage may arise leading to direct contact with the pesticide liquid.
- Repair rate is high.

2.2.1.2HI-TECH Sprayer

Fig. 2.2.1.2. HI-TECH sprayer.

It is recommended as “Most efficient and comfortable sprayer.” It is ergonomically designed and has a capacity up to 16 litres. Its pump is centrally placed outside the tank and has smaller piston diameter, which is easy for operation as balance is perfectly maintained. It has adjustable shoulder straps which helps to operate it to right or left. The overall construction is very strong and easy in operation.

2.2.2Power Operated Sprayers

Various power-operated sprayers are available and range in size from small, hand-carried engine-driven pump units to large self-propelled sprayers. Some of the power operated sprayers are as follows.

2.2.2.1Knapsack Power Sprayer

Fig. 2.2.2.1 Knapsack power sprayer.

Knapsack Power Sprayers [4] are easy to use and highly durable. Designed in sync with the industrial standards, these sprayers are immensely used for garden spraying - weed, pest control, liquid fertilizing and plant leaf polishing. General Technical Specifications are as follows.

- Spraying capacity: 8 litres/min
- Capacity of chemical tank: 25 litres
- Capacity of fuel tank: 1.1 litres
- Net weight: 10.5 kg
- Engine type: 2 stroke
- Petrol displacement: 22 cc

However, there are certain limitations of this sprayer. They are,

- Heavy in weight
- Service life is low
- Initial cost is high
- Complicated maintenance
- Pollutes environment
- Certain parts can get corroded

2.2.2.2Motorized Knapsack Mist-blower cum Duster

Fig. 2.2.2.2. Motorized Knapsack Mist-blower cum Duster

This sprayer cum duster is fitted with a 2-stroke air cooled engine of 35-70 cc capacity, connected to a centrifugal fan by a direct drive. The spray liquid is first pressurized by air generated by the blower. This air current achieves a velocity of over 275 kmph at the nozzle and sprays the chemical in fine particles that can be measured in microns. The nozzle design enables even spraying at maximum efficiency.

When dusting, the air blast enters the tank from an air inlet, which is connected to a tube with several holes on its surface.

2.2.2.3 Hydraulic Sprayer

Fig. 2.2.2.3. Hydraulic sprayer.

Hydraulic sprayers [5] may be engine or electric motor driven and are available with single, double and triple piston pumps. The single piston pump develops a maximum pressure of 150 psi, whereas the double and triple piston pump develops 300-400 psi. Only two discharge lines can be used with the single piston pump, whereas the double and triple piston pumps can accommodate 4 – 6 discharge lines.

The operation is by means of 1 – 2 HP electric motor or 2 – 3 HP petrol, petrol-kerosene or diesel engine. These sprayers can also be driven by a power tiller or tractor.

2.2.2.5 Electrostatic Sprayer

Fig. 2.2.2.5. Electrostatic sprayer.

The sprayer consists of battery-operated motor with a spinning disc, a liquid tank, a handle and a set of batteries.

In this process, a free charge flows to the plant in response to the presence of an electrical field, which is created by a charged cloud. The surface charge is of the opposite polarity to the charged cloud and has a magnitude and distribution that maintains the plant at ground potential in the presence of the charged cloud.

The most commonly used version of this new system is the hand-held Electrostatic Sprayer, which atomises and propels charged droplets by means of electrical forces set up between a high voltage, positively charged nozzle, the droplets and the earthed crop. The formulation is fed by gravity to the nozzle where it picks up a high voltage charge. The formulation then forms a number of uniform ligaments, which in turn are broken up into electrically charged droplets. These droplets are of uniform size and mutually repellent and form a tenacious, even coating all over the crop, including stems and undersides of leaves. No mechanical energy is required at the nozzle to induce droplet formation; neither are compressors or centrifugal energy employed, so the whole system works without moving parts.

III. WORKINGPRINCIPLE

The sprayer machine is pulled manually leaving behind the spraying effect. Here, the driver gear drives the driven gear to rotate. The wheel is of 457.2 mm diameter and the drive gear is of 52 number of teeth which drives the driven gear with 38 number of teeth which gives us the ratio of 1:1.37. The wheel covers 1436.33 mm during which the pumping is done for 1.37 times. Thus, each stroke is effective at 1048 mm travel distance. Next, we have a pump with piston of 50 mm and the stroke length of 100 mm, with cranking provided at 50 mm. The tank is held on the tank holder which is fixed on the frame. The driven gear drives the crank which pushes and pulls the cranking of the tank pump arm which effects in building the pressure generated into the accumulator which dispenses the pressure through the outlet port and through the valve provided which is connected through the four-way splitters to the four jets which are fixed on the adjustable boom. The adjustment is given to adjust the height and for the rows as required. We have provided four number of jets which are fixed to the polyurethane connectors with 8 mm pipe, which are held on the plates welded to the guide bushes held on the rods on the boom as required.

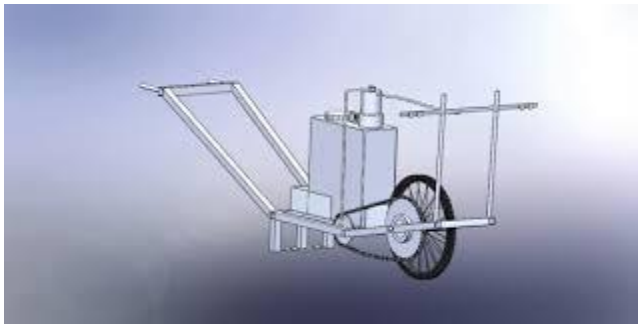

Fig. 3.1. The working model

IV. MODELLINGANDDESIGN

4.1Modelling

19.05 mm diameter mild steel pipe is used for the frame of the structure. HI-TECH tank is mounted on the tank base plate of the main frame. 457.2 mm diameter wheels are used. Standard sprockets being used in bicycle with inner diameter of 34 mm with outer diameter of 75 mm with 14 mm thickness with 16 number of teeth. Gears of 97 mm and 70 mm are used for transmission of motion. Four nozzles are used for spraying purpose.

Fig. 4.1.1. view of the model.

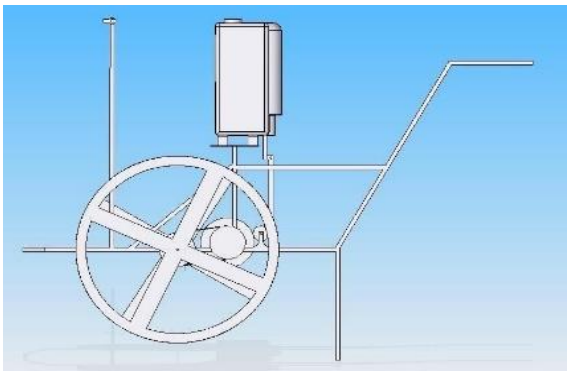

Fig. 4.1.2. Side view of the model

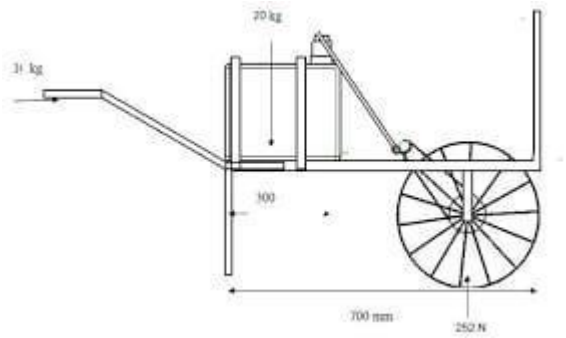

Fig. 4.1.3. Front view of the model.

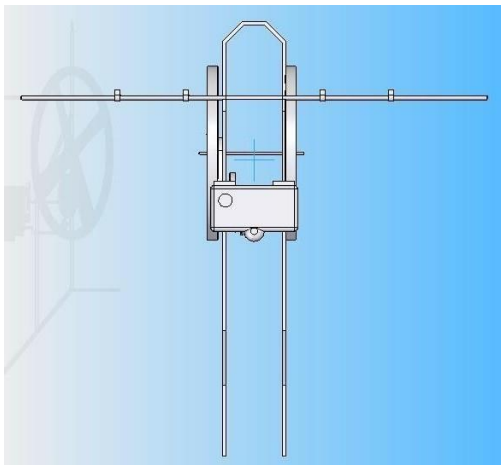

Fig. 4.1.4. Top view of the model

4.2Dimensions of the Model

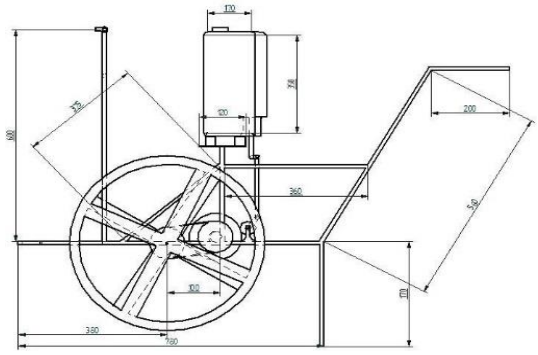

Fig. 4.2.1. Side view dimensions (mm)

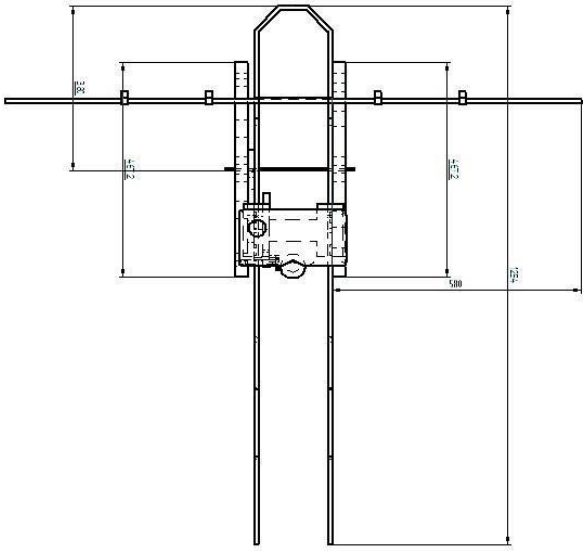

Fig. 4.2.2. Top view dimensions (mm)

Centre distance between gears

CD = (driver)–(driven)/2
= (89.81–63)/2
= 13.405 mm …(5.5)

a)Flow Rate of Pump

Wheel Diameter, Wd = 457.2 mm
Circumference = n×Wd = n×457.2 = 1436.33 mm
Gear Ratio, Gr = N1/N2 …(5.6)
= 52/38 = 1.36
Distance for one cycle = €ircumference /Gr …(5.7)
= (1436.33)/(1.36) = 1056.125 mm
Distance for one stroke = 1056.125/2 = 528.065 mm
Flow Rate of Pump, Q = (G×(Dc^2)×Sc×rpm)/4 …(5.8)
= G×502×50×30/4
= 2.5 litres/min

b) Power required to drive the pump
K = (P×Q×y)/(600) …(5.9)
= (3.1×2.5×0.85)/(600) = 0.011 kW
Where P = Pressure in kg/cm^2
Q = Flow rate in litres/min
y = Efficiency

V. FABRICATION

5.1Parts of Sprayer Pump

Every sprayer pump should have

A cut-off valve
An extension rod (straight or goose-neck)

An appropriate nozzle

5.1.1Cut-off Valve

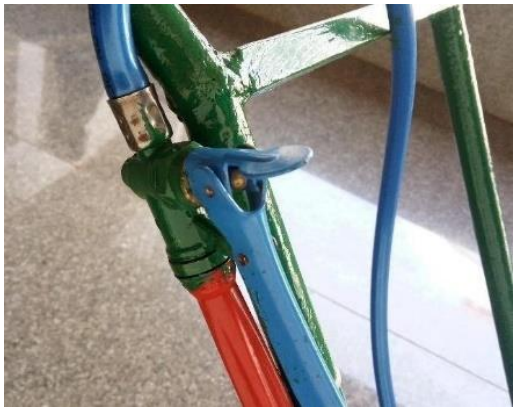

Fig. 5.1.1 Cut-off valve.

These are spring activated or operated by means of a simple knob or trap

5.1.2 Extension Rod

Fig. 5.1.2. Extension rod.

It comes in varying lengths, according to customer requirements but lengths more than 90 cm are difficult to handle

5.1.3 Nozzle

Fig. 5.1.3. Nozzle.

A nozzle is a device designed to control the direction or characteristics of a fluid flow (especially to increase velocity) as it exits (or enters) an enclosed chamber or pipe. A nozzle is often a pipe or tube of varying cross-sectional area, and it can be used to direct or modify the flow of a fluid (liquid or gas). Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. In a nozzle, the velocity of fluid increases at the expense of its pressure energy.

5.2Parts of Our Model

5.2.1Main frame

Fig. 5.2.1. Main frame.

This is made from MS pipe of diameter 19.05 mm, cut to a length of 1760 mm and 160 mm, all are ground to remove the cutting burr and joined by arc welding to make the rectangular frame. This frame is then marked at the centre of the length and drilled to have 10 mm hole to insert the wheel axle into it. Wheels are assembled in this holes with the axle at both the sides as required.

5.2.2 Wheel

Fig. 5.2.2. Wheel

These are standard bicycle tyres of diameter 457.2 mm with rim, spokes, spindle with hard tubeless rubber tyre. Such 2 numbers of wheels have been used

5.2.3Sprocket

Fig. 5.2.3. Sprocket.

These are standard sprockets being used in bicycle with inner diameter of 34 mm, outer diameter of 75 mm, 14 mm thickness and with 16 number of teeth. Such 2 numbers of Sprockets have been used.

5.2.4Chain

Fig. 5.2.4. Chain**.**

This is a standard 8 mm roller chain being used in bicycle.

5.2.5Ball Bearing

Fig. 5.2.5. Ball Bearing

These are standard Ball Bearings with housing. Such 2 numbers of bearings have been used.

5.2.6Intermediate Axle

Fig. 5.2.6. Intermediate Axle

These axles are made from MS, machined to the required dimensions to fit for the bearings and the gears. Such 2 numbers of axles have been used.

5.2.7 Tank Base

Fig 5.2.7 Tank Base

This is made from mild steel flat being cut from the size of 40mm x 6mm of lengths 240mm--2nos, 250mm—1nos, all are hammered for flattening and then right-angle grinding is done and then joined to make the frame as per the sketch to be able to hold the tank on this. This is then marked for the holes to hold the clamps to be able to clamp the tank at four places as per the requirement.

5.2.8Vertical Legs

Fig. 5.2.8. Vertical legs.

This is made from MS pipe, similar to which is used in the rectangular base, being cut to a length of 270 mm and welded onto the rectangular base to support the tank base. Such 2 numbers of vertical legs have been used.

5.2.9Lever

Fig. 5.2.9. Lever

This is made from MS flat being cut to a length of 32 mm then centre drilled at both the ends to make a hole of diameter 6 mm.

5.2.10 Vertical Guide Rod

Fig. 5.2.10. Vertical guide rod.

These are made from MS, being cut to the required dimension and welded together to support the nozzle. Such 2 numbers of vertical guide rods have been used.

5.2.11Cross Support

Fig. 5.2.11. Cross support.

This is made from MS, cut to the required dimension and welded to support the vertical legs.

5.2.12 Rear Rest

Fig. 5.2.12. Rear rest.

These are made from MS pipe, being cut to a length of 200 mm and welded using Arc welding technique. Such 2 numbers of pipes have been used.

5.2.13Handle Support

Fig. 5.2.13. Handle support.

These are made from MS pipe, being cut to a length of 360 mm and welded using Arc welding technique. Such 2 numbers of pipes have been used.

5.2.14 Handle

Fig. 5.2.16. Handle.

This is made from MS pipe cut from the size of length 800 mm and ground to remove the cutting burr and then marked for the cutting at the distance of 600 mm from one end and slightly angle cut and then bent to make the handle as required. Such 2 numbers of pipes have been used.

5.2.15Backpack sprayer with Pump

Fig. 5.2.17. HI-TECH backpack sprayer.

This is a standard HI-TECH sprayer pump with piston attached to it. It is kept over the tank base and welded to place it firmly. It is run through the lever-crank mechanism, which in turn is driven by the gears.

VI. FINAL ASSEMBLY

VII. ADVANTAGES

- Very much useful for insecticides application to control insect pests on crops.
- For the fungicides and bactericides application to control the plant diseases.
- For the herbicides application to kill the weeds.
- For the harmony spray application to increase thefruit set or to prevent the premature dropping of fruits.
- For the application of plant nutrients as foliar spray.
- For applying the powdery formulation of poisonous chemicals on the crops.
- Pesticides sprinkling.
- Eliminates the problem of back pain, since there is no need to carry the tank on back.
- Since it has number of nozzles, which can be set according to the rows of plants, can cover maximum area of spraying in minimum time and at maximum rate.
- This can be used for multiple crops with height and row adjustment boom.
- Maintenance cost is less.

VIII. CONCLUSION

This suggested model has removed the problem of back pain, since there is no need to carry the pesticide tank on the back. Health problems from the pesticide during the spray will be zero. This model has more number of nozzles which will cover maximum area of spraying in minimum time & at maximum rate.

When it comes to time saving i.e. to spray the Pesticides in the given area, there are multi nozzles which cover larger area with less time. All the nozzles spray with the same pressure. The nozzles can be adjusted both vertically and horizontally. This individual sprayer can be used for multiple crops.

The performance of the equipment will increase when it is operates on the smooth surface or less uneven surface and it will be more effective when it is used on the crops having nearly similar height and having the less space between two crops.

For easy handling and comfort of usage some additional mechanisms like cut-off valve and sprockets have been used. It is a low budget sprayer for the low and middle scale farmers which is compact and easier to use also maintenance is very low.

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