2. AGRICULTURAL CROP SPRAYERS

Introduction

A sprayer is often used to apply different spray materials, such as pre-emergent and post-emergence herbicides, insecticides and fungicides. A change of nozzles may be required, which can affect spray volume and pressure. The type and size of pump required is determined by the chemical used, recommended pressure and nozzle delivery rate. A pump must have sufficient capacity to operate a hydraulic agitation system, as well as supply the necessary volume of the nozzles.

Pumps must be resistant to corrosion from the chemicals. The materials used in pump housings and seals should be resistant to chemical used, including organic solvents. Other things to consider are initial pump cost, pressure and volume requirements, ease of priming and power source available.

Farm sprayer pumps may be either **positive or nonpositive** displacement pumps and are normally of four general types:

- Diaphragm
- Piston
- Roller
- Gear

Positive Displacement Pump

Piston, roller, and diaphragm pumps are all types of positive displacement pumps. This means that pump output is proportional to speed and virtually independent of pressure. A key component in a positive displacement system is the pressure relief valve. Proper placement and sizing of the pressure relief valve is essential for safe and accurate operation of a positive displacement pump.

Non-positive Displacement Pump

The centrifugal pump is the most common non-positive displacement pump. The output from this type of pump is influenced by pressure. This pump is ideal for delivering large volumes of liquid at low pressures. A key component of the centrifugal pump is the throttling valve. A manual throttling valve on the main output line is essential for the accurate operation of the centrifugal pump.

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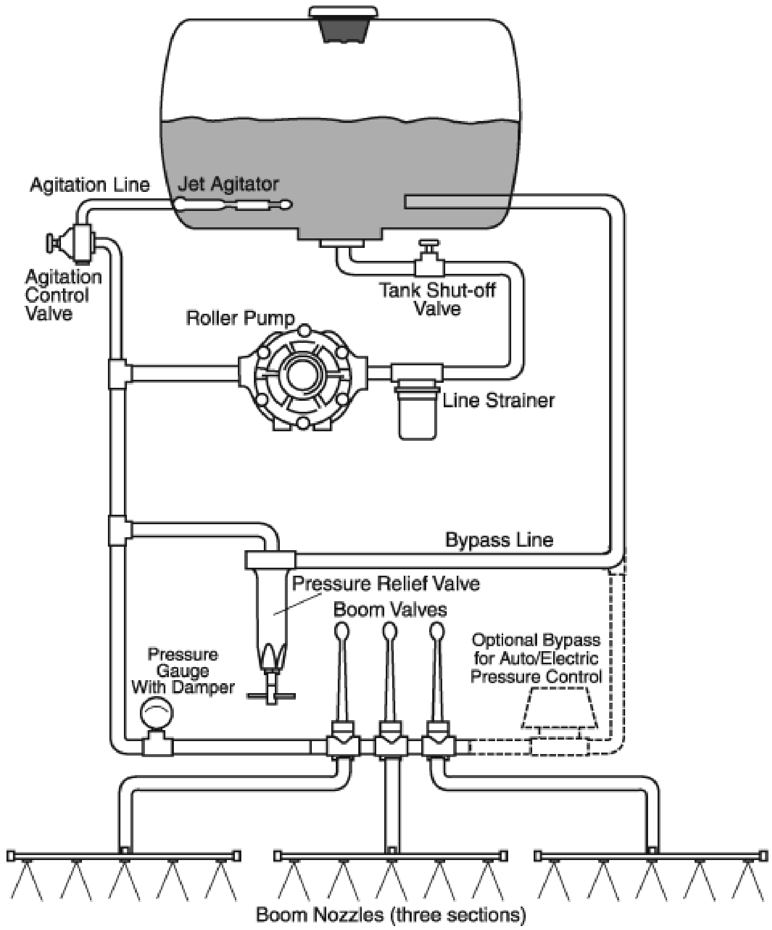

Plate 1: A schematic diagram of a boom sprayer circuit of a roller pump type

The use of herbicides has replaced much of the mechanical tillage done formerly. Chemical application is done with attachments to tillage machines and seeders or with single-purpose chemical application.

Field sprayers are either self-propelled, hand-operated or PTO driven. The necessary components of any sprayer are a tank with strainer and agitator, a pump, a filter, a pressure regulator, valves, piping and nozzles with dirt screens.

Orchard sprayers use high-velocity fans to blow the spray instead of using booms as do sprayers.

Specifications for an all-purpose field sprayer are:-

1. High clearance for row crops
2. Long, light, flexible booms, adjustable in height
3. Hand boom for stationary applications
4. Noncorrosive construction (to allow liquid fertilizer use)
5. Boom selector control valve
6. Accurate ground speed indicator.

The nozzle is an important part of a sprayer system. The type used **(flat fan, hollow cone, solid cone and flooding)** depends on required chemical coverage, penetrating pressure and nature of chemical. The flat fan nozzle is used for uniform coverage applications such as weed spraying. Hollow cone nozzle is used for to give a fine mist for complete coverage of plants being sprayed for insect control. The solid cone is used when a high-pressure penetrating spray is needed, while the flooding nozzle is used for liquid fertilizers, slurries, and liquids with suspended particles.

Determination of amount of chemical to put in the tank

To determine the amount of chemical to add to the spray tank, one needs to know:

- the recommended rate of the chemical
- the capacity of the spray tank
- the calibrated output of the sprayer

The recommended application rate is usually indicated as Kilograms per hectare (kg/ha) for the wettable powders and litres per hectare (ℓ/ha) for liquids. The recommendation can also be given as Kilograms of active ingredient per hectare (Kg. AI)/ha.

1. determination of hectares that can be sprayed with each thankful:- Tank capacity/spray rate = ha/tankful
2. determination of the amount of product needed per ha: (AI/ha)/AI/ℓ = ℓ/ha

Objective

(a) To demonstrate different kinds of chemical application and sprayer calibration.

(b) To demonstrate steps involved in sprayer calibration.

Apparatus/Equipment

- Hand-operated knapsack sprayer
- Tractor mounted Power operated sprayer
- Hand-held Ultra low volume (UVL) sprayer (1 litre bottle with a rotary nozzle)
- Powder chemical applicator
- Tape measure
- Pegs
- Mallet
- stopwatch

Methodology

Identification of the different parts of the sprayer – Tank, pump, intake suction pipe, inlet valve, outlet valve, air chamber (compression) delivery pipe, shutoff , spraying boom, the nozzle. Learn what each part does and know the material it is made of.

i. Look at the different nozzles and note the differences.
ii. Learn how to clean the nozzles and where blockage occurs.
iii. What differences do you note in the droplets emitted by the different nozzles?
iv. Compare and contrast the different types of equipment i.e. hand operated (knapsack), power operated and ULV. Which is more effective and why?

Note some important considerations when choosing the type of equipment application for instance:

- Drift during application – wind direction and droplet sizes
- Clean water availability
- Labour demand and skill
- Cost etc.

Calibration of sprayer

It is very important to crops that the calibration of a farm sprayer is done right and with care. Factors affecting spray concentration per hectare are:-

- Pressure and delivery of the pump
- Speed of forward travel active ingredient to water ratio in the tank
- Height of boom
- Nozzle spacing.

All of these factors determine the effectiveness of spraying. The overlap of adjacent nozzles should produce the same application rate as in the of the nozzle pattern. If overlap rate is low, the boom must be raised relative to the ground surface.

To ensure precise and safe applications of chemicals in the field, effective calibration (checking whether the sprayer is giving out the recommended output as per the manufacturer's recommendations) is essential. Calibration must always be done with clean water and clean sprayer and before the use of any crop protection product.

A standard method of calibration of field crop sprayers:

1. work out the time taken to travel between two markers positioned 100m apart in a field measured with a tractor properly mounted with one spraying gear
2. fill the spray tank in a level position with clean water and mark the level
3. with the tractor stationary and using the tractor operating at the same revolutions per minute (rpm) used when measuring the time for 100m, the sprayer is operated for this period of time. The quantity of water needed to refill the tank to the original level is determined by using a measuring container or flow meter.
4. the volume rate per hectare can be checked by using a calibration chart (given) or calculated as follows:

$$\frac{litres/100m\text{X}100m}{swath(m)} = litres/ha$$

i.e. if 30 lts is sprayed over 10m with a swath of 15m, then the output is 200l/ha. This is the same as saying that, the amount used to cover 100m x 15m = 30lts.

The amount of liquid used to cover 1ha = (100m x 100m) =30/1500 x 10,000 = 200lts.

Calibration of a knapsack sprayer

1. Fill the sprayer with clean water and note the tank capacity
2. Operate the sprayer, clean the nozzle if necessary for an even pattern and identify the patterns.
3. Set the pressure for lowest flow rate. Collect the spray from the nozzle for 30 seconds after a uniform spraying rate has been established. Measure and record the volume of spray collected. Repeat collections until there's negligible difference between volumes collected. Set the pressure for high flow rate and measure the 30 second volume several times until consistency is established.
4. Using the same operator as in (3) measure and mark a spraying distance of 20m on flat open ground. Get the operator to run a spraying operation along the measured length, time the operator (walking at his/her comfortable speed) as he/she operates the pump, measure the spray pattern-width during each run and the nozzle height above the ground from run (3). Compute the volume of spray used up in each run.

5. Repeat (d) with high pressure relief valve setting. Record results on the table below.

Distance sprayed (m)	Low pressure	High pressure
Average time taken (s)		
Volume used (l)		
Average spray width (m)		
Nozzle height above ground (m)		

Computations

a. From 3 above, calculate the average sample volume. What are the low and high volume discharge rates in litres per second?

b. Calculate the theoretical field capacity (at low and high pressure) of the spraying operation based on the calibration data you established above exercise. Give your rates in ha/hr and show your calculations.

c. Calculate the application rate in litres per ha based on your answers to a, and b, above (consider low and high pressure rates).

d. How many tankfuls will you need to spray one ha of closely planted beans at high pressure?

e. If the recommended application rate for pesticide is 2.5 l/ha, calculate the amount of pesticide per thankful in litres.

f. If you were to carry out the above experiment on PTO driven boon-type field sprayer with 12 nozzles, what would be the pertinent experimentation parameters? Consider the flow rate, pattern and uniformity of spray in your answer to this question.