Rice Production Manual

Pesticide Safety and Knapsack Sprayer Use

Rationale

Care must be taken when selecting and using agricultural chemicals as any movement of the chemical away from the target reduces the efficacy of the chemical and may cause damage to the environment. For a pesticide to work properly it must be applied correctly at the right stage of development of the pest.

Objectives

At the end of this lesson participants will have a basic understanding of the importance of:

- Pest target selection,
- Water quality for spraying
- Spray application equipment
- Personal protection when spraying and
- Knapsack sprayer calibration:

Pesticide Safety and Knapsack Sprayer Use

1. Introduction

The use of agricultural chemicals in developing countries will continue to grow because of the economic advantages that they bring Agricultural chemicals are used to increase both the level of production and maintain the quality of the final product. Agricultural chemicals include pesticides, fertilizers and other chemical products such as cleaning agents. Care must be taken when selecting and using agricultural chemicals as any movement of the chemical away from the target reduces the efficacy of the chemical and may cause damage to the environment.

For a pesticide to work properly it must be applied correctly at the right stage of development of the pest. Insecticides must be applied to maximize, directly or indirectly, the uptake of the pesticide by the insect. Herbicides are most effective when good spray coverage is obtained on small, unstressed weeds.

To attain effectiveness, care needs to be taken to:

- select the most appropriate target
- choose the best means of application
- use sufficient water volume of an acceptable quality
- spray safely

2. The Target

Both the target and the mode of action of the chemical must be known before application. Depending on the pest the target may be the soil, the leaf, plant shoot, inflorescence or a moving target such as an insect. It may have a flat surface such as a broadleaf weed or be erect as with a grass weed. Most herbicides are taken up through the leaf or the stem. Some kill on contact while other are systemic and must be translocated or moved around inside the plant to cause death. Insects are most often killed by taking up the chemical through either ingestion of plant material or absorption through its skin as it moves over the surface.

3. Application equipment

A range of different equipment is used to apply chemicals in Asian rice fields.

Hand Sprayer

The hand or knapsack sprayer is the most popular means of applying chemicals on smaller field. The advantages of using a hand sprayer are that it is cheap to purchase, easy to operate and versatility of use in both wet and isolated situations. The major disadvantages include its limited field capacity and problems of accuracy of application (overdosing or leaving unsprayed strips). Some knap sack sprayers also have engine driven pumps

Mechanized Boom Sprayer.

The mechanized boom sprayer is most efficient when spraying large areas at lower water volumes and when timeliness is important. It is much more accurate than the hand sprayer. The major disadvantage is the purchase cost, traction problems in the wet and difficulty of use in small or confined areas

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Other means of application

Chemicals can also be applied in irrigation water, as granules either broadcast or incorporated into the soil and as dusts on seed.

4. Water quality

The quality of the water used can adversely affect a pesticide's performance. Ideally water should be clear, colorless, odorless and neutral in pH. When available, rain water is best. If water contains excessive solids, obvious problems such as nozzle blockages will occur. Less obvious will be the binding of the chemical to the suspended materials and subsequent loss in effectiveness. The effectiveness of some chemicals can be

drastically reduced by suspended clay particles. As well, solids accelerate nozzle wear. If a coin at the bottom of a bucket of water cannot be seen, that water it is too dirty to use for spraying.

Water suitability guide.

A quick guide to the suitability of water for mixing agricultural chemicals can be obtained by using the following procedure:

- Make up 500 ml of correctly diluted spray in a clear glass, sealed container according to the manufacturer's instructions
- Mix thoroughly
- Allow to stand for 30 minutes. If, after this time, creaming, sedimentation or separation into layers occurs, the water may be unsuitable for mixing with sprays. If suspected of being unsuitable, a sample of this water should be chemically analyzed for slat and hardness levels.

5. Personal protection

Pesticides are toxic chemicals that should be handled, mixed, applied and stored in a manner that minimizes the risk to all people and the environment. The person who carries out the mixing and application of the pesticides is at most risk because of the proximity to the pesticide. The use of appropriate protective equipment, knowledge of entry points of the chemical to the body and good safety habits reduce the chances of personal contamination and poisoning.

Principles of Protection

The basic principles for protection when using pesticides involve:

- elimination by removing people from the work place that are not involved in the spraying operation.
- substitution of chemicals for a less hazardous chemical.
- use of mechanical chemical handling systems eg chemical induction systems and buffer areas
- protection by using personal protective equipment.

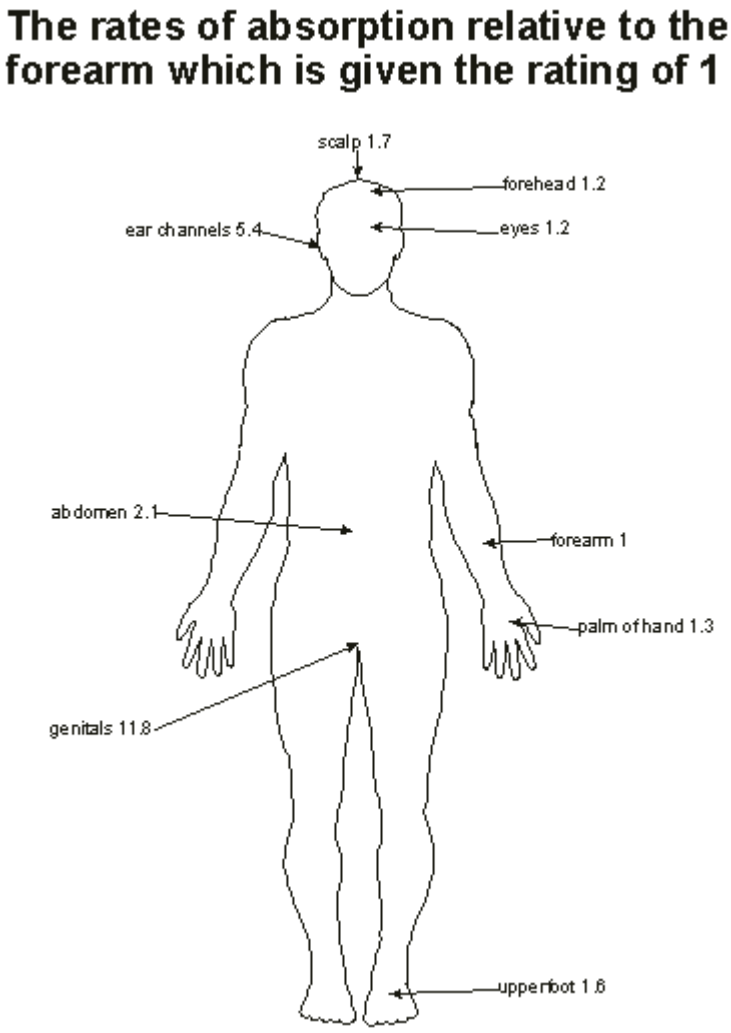
Entry of Pesticides into the Body

Pesticides can enter the body in a number of different ways:

Method of Entry	Causes	Principles of Protection
Oral	Direct by drinking	Store products in original containers only Keep pesticides out of reach of children Keep pesticides in locked store
	splashes	Use face shield Use pouring aids
	direct by eating	When spraying do not eat, or drink
	smoking	do not smoke when spraying
	eating sprayed produce	Minimize residues by following the label – Withholding Period Only use calibrated equipment Ensure people are aware of the spraying status of a paddock
	cleaning nozzles with mouth	Use a brush to clean nozzles Match filter to nozzle Use clean water Use quality products and water
Inhalation	Nose, mouth, but predominately the lungs	Use respirator matched to the product being used
Dermal	Absorption through the skin. Increased when skin is broken or perspiring	Cover skin but avoid perspiration Always position upwind from the spray when mixing and spraying Ensure sprayer does not leak Use clean water to wash any spill Observe Re-entry periods following spraying.

Rate of absorption

Acute poisonings usually result from inhalation or oral intake of the concentrate. Chronic exposure normally results from dermal contact. Pesticides are absorbed and transferred into the bloodstream more completely and quickly when they enter the body either orally or by inhalation. The greater incidence of exposure occurs through skin (dermal) contact. The selection of protective equipment must take into account the relative absorption rate for the different parts of the body.



6. Protective equipment for mixing and spraying

The amount and type of protective equipment required for spray operators is determined by the:

- properties of the chemical to be used
- degree and duration of exposure
- weather conditions and
- application equipment to be used.

Over protection in some cases can be as bad as under protection. Conversely a respirator left hanging around the operators neck is useless. Read the label for the safety directions. Details about general use of the various type of protection equipment given in the table below.

Equipment	Pictogram	Principle	Comments
Clothing		Cover as much of the body as possible, especially the neck, chest and forearms. Use washable fabric overalls, disposable overalls and waterproof clothing if coming in contact with large quantities of pesticides	Under hot conditions beware of perspiration – this can increase the rate of entry into the body
		Use aprons mostly while mixing	An apron worn on the back helps protect from leaks when using knapsacks
Gloves		Never use leather or cloth materials because they absorb pesticides and provide a constant source of contamination. Gloves should be unlined for this reason.	

Boots		Never use leather or cloth materials because they absorb pesticides and provide a constant source of contamination	Wear the trouser leg outside the boots
Head, face and eye protection		Hard hats, washable hats Goggles shields Spray helmets	Important when handling concentrates. Avoid splashes
Respirators		Dust mask for particles and larger droplets Types of filtration available include mechanical, electrostatic and chemical. Choose the correct type and have the correct cartridge fitted.	Use a mask that matches the class of pesticide to be used. Replace cartridges regularly and write the date on each cartridge. Ensure there is an adequate fit on the face.
Clean up		Sprayers, protective equipment must be cleaned after application People exposed should wash immediately.	

7. Using a Knapsack Sprayer

Knapsack sprayers are widely use in all rice growing countries. Knapsack sprayers come in many different forms but the basic components and requirements for use are the same for all. Some units use a pressurized tank system but the majority do not.

Components of a knapsack sprayer

The components of a knapsack sprayer are similar as for a broad acre boom sprayer.
Knapsack sprayers are available in many different configurations they all comprise of the same basic components. These components are:

- Tank to hold chemical
- Hand pump to create pressure
- Filtration system behind the nozzle tip to reduce blockages
- Control Valve to control pressure and turn of the sprayer
- Nozzle tip to control application rate an produce the correct size droplets

Tank. Tanks come in many different shapes and sizes. Most knapsack tanks hold from 10-20lites of fluid must be non corrosive, able to be sealed and very durable.

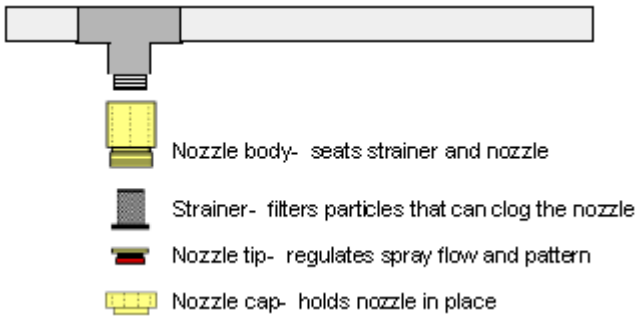
Hand Pumps. Most knapsacks use diaphragm or piston type pump. The hand pump is normally mounted to one side of the tank although some versions have above tank handles. These are more difficult to use and tend to cause greater variation in spray pressure

Control valves and pressure regulation .Most knap sack sprayers have one control valve which is the on off switch. The on/off switch also often acts as the pressure regulator. Pressure tends to fluctuate between the down stroke of the pump and the upstroke- high on the down stroke and low on the upstroke. It will also tend to fluctuate as a person spraying becomes tired and finds it more difficult to maintain the initial pressure. Several companies are now manufacturing regulator valves that are intended specifically for knapsack sprayers. They are durable, accurate and relatively inexpensive. Automatic pressure relief valves attach in a lance or boom line, usually directly before the nozzle. They do not open until their rated pressure is reached. Once the valve does open, excess pressure is managed down to the preset pressure. If pressure should drop below the preset pressure, the valve will shut off flow to the nozzle

Filtration. Small filters or fine mesh screens are inserted into the nozzle body to filter out particles that may clog the spray tip. While filters are needed for all spray solutions, tips will become clogged. The best way to clean a clogged tip is to remove it from the nozzle body and rinse it in water. If necessary, a soft brush can be used to help remove particles. Never use a wire, or any hard tool, to clean a spray tip as this will damage the tip. If blockages are occurring on a regular basis reduce the size if the filter mesh.

Nozzle

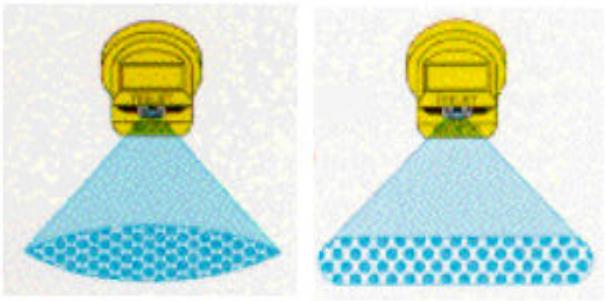
Nozzles are comprised of a spray tip, a filter/strainer, and a nozzle body and cap.



Nozzle tip

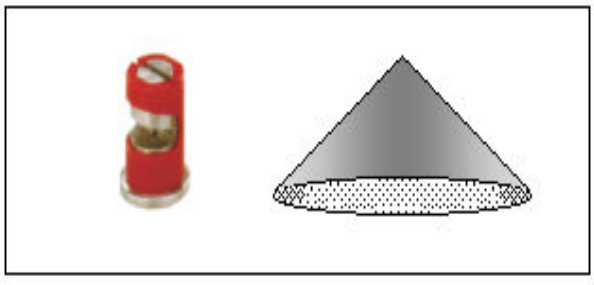
The nozzle tip is the most important nozzle component. It determines the flow and distribution of the spray. There are many different types of tips, each designed for a certain type of spray application.

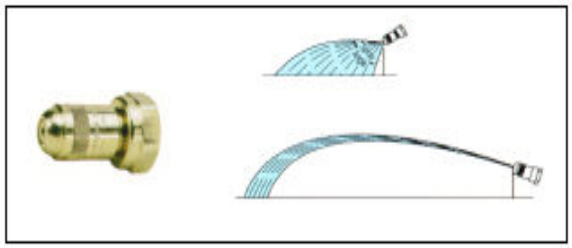
Flat Fan nozzle tips are designed specifically for multiple nozzle booms. The spray pattern is tapered from the center (full flow) to the edges (lighter flow) and is designed to overlap with adjacent nozzles, creating a uniform pattern across a spray boom



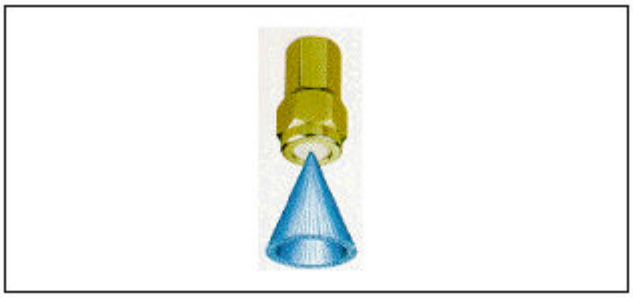
Even Fan nozzle tips are designed for single pass sprays over crop rows or between rows. The spray pattern is uniform (full flow) from edge to edge. Even fan spray tips are not made for use on multiple nozzle booms

Flood nozzle tips are designed to have a wide spray pattern at low pressure making them popular with knapsack sprayer operators. They are best suited for defoliants and herbicides. The spray pattern is tapered from the center to the edge, however is it not as uniformly tapered as that of the flat fan. The spray is heavy toward the very edges and coarse throughout the spray pattern. Using this nozzle in a "swinging" pattern across a field will normally result in poor application results. Overlapping by fifty percent can help eliminate the inherent unevenness in the spray pattern .



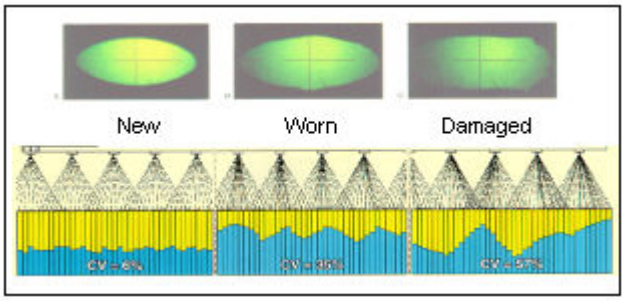


Variable Cone nozzle tips have a cone-shaped spray pattern that is adjustable from a fine mist to a solid stream. The adjustable pattern makes variable cone spray tips versatile tools. Calibrating these nozzles is not easy due to the difficulty of adjusting the tip to the same pattern and flow time after time. While not ideal for most applications, they are useful for many insecticide, fungicide and herbicide sprays.



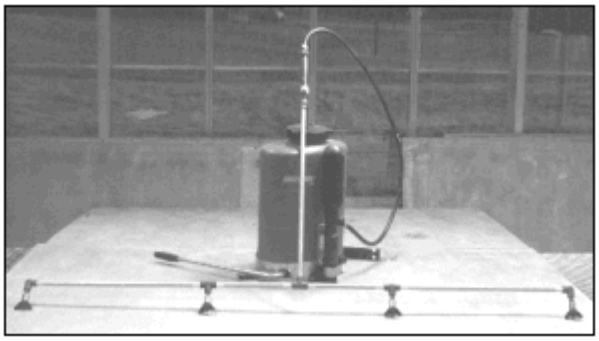
Hollow Cone nozzle tips produce a fine spray that is concentrated on the outside edge of the pattern. The spray approaches the target from different angles increasing coverage. They are designed for fungicide and insecticide applications where excellent coverage is needed. The fine spray pattern increases spray drift potential

Worn tips



Worn and damaged nozzle tips lose the ability to properly regulate the spray pattern and should not be used. Worn tips have a greater output with the spray concentrated beneath the tip. Damaged spray tips have an erratic output, over-applying and under-applying. Spray tips and spray patterns should be checked at regular intervals and be replaced when worn and damaged.

Multiple nozzle booms



Multiple nozzles are used to increase application efficiency and accuracy. Hand booms are constructed from any type of plumbing material suitable in strength and weight. Aluminum, steel, brass, copper and plastic tubing with brass or plastic fittings have all been used to create boom sprayers.

Flat fan nozzles are spaced on the boom so that the spray pattern of adjacent spray tips will overlap by thirty percent. Spacing will depend on boom height and the angle rating of the spray tips. Larger angle tips have a wider spray pattern and may be spaced further apart on the boom when the height remains constant.

Spray Applications

Pesticides applications need to be applied uniformly. Areas of over- or under-application will result in undesired application results. Problems include crop injury, poor pest control and crop injury in the following crop when using residual pesticides.

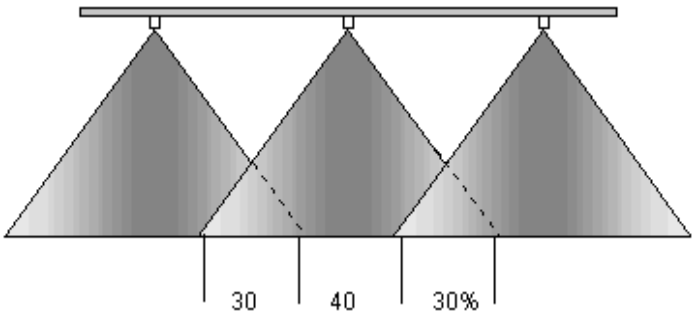
Single Lance

Pesticide applications can be made using a single nozzle lance, however spraying a swath evenly with appropriate overlapping is extremely difficult. If the single nozzle lance is swung from side to side while walking, the resulting application will have large areas of under- and over-application. Multi nozzle booms are much more accurate.

Multi nozzle boom

Using a boom sprayer, compared to swinging a single flood jet nozzle, will increase the uniformity of spray applications. The width of a pass may be smaller using a three or four nozzle boom, but each pass will have very uniform herbicide distribution. Spray swaths of three meters or more can be obtained by fitting a knapsack with the appropriate nozzles and adjusting the spray pressure of the system to provide adequate output.

When a single flat fan nozzle is sprayed, only the middle third of the spray pattern of the nozzle can be considered to have a full rate application. When two or more are spaced to overlap by 30%, the tapered pattern of adjacent nozzles create a uniform spray distribution. On the boom ends, where there is no adjacent nozzle, the outside edge of the spray will still have a light application.



The two most common spray tip angles are 800 and 1100. This refers to the size of the angle of the spray pattern from side to side. Nozzles should be spaced 50 cm apart on the boom and boom height maintained at approximately 50 cm for 1100 and 70cm for 800 Adjacent passes of multiple nozzle booms must overlapped by approximately thirty percent, similar to the way adjacent nozzles on the same boom should overlap. Height is important when using a boom sprayer. If the boom is too low to the ground, the nozzles will not overlap resulting in bands of concentrated spray with little or no spray between.

To determine the spray swath width of multiple nozzle booms, multiply the nozzle spacing by the number of nozzles. When the boom is used at the appropriate height, this will give the spray swath width for that boom when multiple passes are made across a field. For example: 4 nozzles x 50 cm spacing = 200cm swath width.

8. Calibrating a Knapsack Sprayer

Calibration is necessary in order to achieve accurate, uniform applications. Calibration is determined by measuring sprayer output for a known area. Walking speed, swath or boom width, nozzle capacity and spray pressure all influence sprayer outputs.

To calibrate a boom spray:

1. Determine the walking speed.

Walk in the field to be sprayed for 100 meters with the sprayer and equipment that will be used during the time of spraying. This will most nearly simulate the conditions during the time that the chemical is actually being applied. Record the time required to travel the 100 meters.

2. Determine the spray volume

With the sprayer stationary and an operating pressure preferably at 280 kPa or 40 psi, collect the volume of water discharged from the nozzle for the length of time that it took to walk over the 100 meters. Record the volume from the nozzle and calculate how much would have been delivered from all nozzles (multi nozzle boom) using the following formula:

$$\text{Liters applied over 100 meters} = \frac{\text{liters collected x No of sprayer nozzles on}}{\text{No of nozzles sampled}}$$

3. Swath width

This will vary according to the nozzle type and number of nozzles. For a single nozzle on a lance, a good way of judging coverage or swath width is to do multiple sprayings on a

dry concrete surface and observe the collection of the spray and therefore the effective width. A good rule of thumb is 5 meters for a lance and the number of nozzles multiplied by 0.5 meter for a boom.

4. Calculate the amount of water applied per hectare by using the following formula:

$$\text{Liters/hectare} = \frac{\text{Liters applied over 100 meters x100}}{\text{Swath width treated by sprayer in meters}}$$

5. Example:

Swath width in meters, 2
Number of nozzles on sprayer, 4
Number of nozzles caught during test, 1
Total liters of liquid caught during test, 1

Using the formula in step 2, substitute the values found;
L/100m = 1x4/1 liters
= 4 liters

Using the formula in step 4, substitute the values found:
L/ ha = 4x100/2
=200l/ha

The sprayer has been found to have an output of 200 liters / hectare. This is only true for the speed and pressure that were used when it was calibrated.

Determining the Amount of Herbicide to Use
Once the sprayer output per area is known, the applicator can begin to prepare to spray the field. With a sprayer output of 200 liters/hectare and a herbicide rate of 1 liter/hectare the rate of mixing can now be calculated.

If each tank holds 15 liters then

Rate of mixing = 15/200x1x1000mls.
= 75ml/tank

Mix the chemical with the water prior to pouring into the knapsack tank.