

# Guide to safe and effective use of pesticides for crop production in Borno State, Nigeria

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# **Guide to safe and effective use of pesticides for crop production in Borno State, Nigeria**

Promoting Sustainable Agriculture in Borno State

(PROSAB)

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As this guide is also accessible to the public we have taken extra care to ensure that the guide is a well illustrated document that extension agents, contract sprayers, and pesticide dealers can use to assist farmers on learning how to use pesticides effectively and safely. We hope that this guide will also raise awareness about both the benefits and the hazards of pesticide use. It is very important that farmers are properly informed about critical aspects of pesticide use, as presented in this guide.

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# Introduction

This pesticide guide aims to improve the knowledge of extension agents, lead and elite farmers, and other service providers on how to use chemical pesticides responsibly and with care. It is important to stress that the use of chemical pesticides is undesirable and should be completely avoided wherever possible. All options for using alternative, nonchemical methods of crop protection should be explored first. Only if no other options are possible should chemical control be considered as a last resort. Remember that pesticides are poisons, and have a damaging effect on people and the environment.

All over the world the use of pesticides is increasing because of the need to feed the world's ever-expanding population while the amount of land available for food production is diminishing. The increase in the use of pesticides has increased both the hazards to human health and the pollution of the environment. In Borno State, Nigeria, the use of pesticides is a relatively new practice. Many pesticide users do not observe the necessary precautions because they lack awareness and technical training. Increasing population in the state has forced farmers to intensify agricultural production and as a result there has been an increase in the incidence of pest and disease problems. Farmers are responding to these problems by adopting the use of pesticides. Where agricultural labor is scarce or expensive, herbicides can save farmers' time by replacing laborious manual weed control. Herbicides and insecticides have become popular among farmers in Borno State for controlling weeds and insect pests, including storage pests. Unfortunately, many farmers and extension agents lack the technical skills for proper and effective use of pesticides. This has had many unfortunate consequences, including human and livestock exposure to pesticide poisoning, crop injuries, soil degradation, and environmental pollution. Many accidents, and even deaths, have occurred due to improper use of pesticides.

Pesticide use is very technical and it is very difficult for the individual farmer or extension agent to adopt safe and responsible practices without detailed

step-by-step instructions. This guide defines the principles of correct and effective application procedures for pesticide use. It also provides information on proper storage of pesticides at the farm level and on the safe disposal of used pesticide containers. The guide also includes specific pesticide recommendations for Borno State.

### **Why we need to be careful when using pesticides**

Many cases of accidents and deaths due to improper use of pesticides have been reported in Borno State in the last few years. Two families lost key members when they slept in the same room where cowpea treated with fumigants was stored, due to inhalation. Three contract sprayers lost their lives when they sprayed insecticides to control cowpea insect pests without wearing suitable protective clothing. Whole fields of crops have been lost in many cases because the application of herbicides had been carried out wrongly. We hope that this guide, prepared for extension agents and farmers, will help farmers in Borno State adopt good agricultural practice for the safe and effective use of pesticides.

### **Weather and pesticide risks**

The risks of pesticides are greater in warm climates than in temperate climates, for both humans and domestic animals. This is because the effects of poisoning occur more quickly in hot temperatures. In hot weather, the human body tends to absorb toxic substances faster, which means that it is extremely important to wear protective clothing. Farmers often find that protective clothing is uncomfortable to wear and choose not to use it, which adds unnecessary risk. We strongly advise that farmers should always wear protective clothing when working with pesticides of any kind. Farmers can choose to apply pesticides early in the morning or late in the evening, when the temperature is lower than it is during the middle of the day, to minimize the discomfort of protective clothing.

## **What are pesticides?**

Pesticides are agrochemicals that are used for crop protection. A pesticide is a substance intended to prevent, destroy, repel or control any animal pest or disease caused by microorganisms, as well as unwanted weeds. Pesticides are harmful to animals and microorganisms through direct contact, feeding or other kinds of effective exposure during their stages of growth. Plant produce can be protected during conservation stages, storage, transport, and distribution, and processing. Pesticides may be used for crops on the field, harvested produce, agricultural commodities or animal feeds and fish. Different pesticides are used for different products depending on the problem and situation.

Some pesticides are used for killing insects that are harmful to man, such as mosquitoes, or administered to animals for the control of external (ecto-) parasites, such as ticks. These and other agrochemicals that act on life processes such as crop-growth regulators are not covered in this guide.

Bio-pesticides are biologically based active ingredients pesticides and may include beneficial microorganisms or others such as plant extracts that have pesticidal effects.

Pesticides may be used either for prevention or for curative purposes. A preventive pesticide treatment is used to protect crops or stored products against infection by diseases, infestation by insect pests or competition from harmful weeds, while a curative treatment is used to destroy or reduce or limit the development of harmful organisms.

## **Effects of weeds and insects on crop plants**

Weeds and insects can directly damage crops and cause yield losses in many ways. Weeds compete with crops for nutrients, air and space, and may parasitize or contaminate crop seeds. Insects eat plant leaves and make them unattractive; insect larvae and caterpillars eat or make holes in the leaves or the stems of seedlings. Insects also reduce the ability of the plant roots to absorb water or nutrient when they eat parts of the roots. Sometimes, insects inject toxic substances when they feed on the plants or create holes

through which disease-causing bacteria or fungi may enter the plant. The two main methods of controlling or reducing pest damage are chemical and nonchemical methods. Nonchemical methods include physical, cultural, biological, and mechanical methods. Chemical methods, which generally mean the use of pesticides, are discussed in this guide.

## **Pesticide names**

Many pesticides have difficult names that reflect their chemical structure. Therefore, they are often given a shorter name, called common name, to make them easier to identify. These common names are often based on the name of the active ingredient in the pesticide. For example: carbaryl is the common name for 1-naphthyl methyl carbamate, and glyphosate has a chemical structure called N-(phosphono methyl) glycine.

The active ingredient (abbreviated as a.i.) is the compound that is used to control the harmful organism. Its ability to kill, harm or deter a certain pest or disease has been proven and its use for this purpose is authorized through a registration process.

Farmers and extension agents need to remember that different companies produce pesticides that contain the same active ingredient, which are sold under several trade names (see Table 1). Usually, the common or chemical names are printed on the products (labels) to enable users to identify the different products that contain the same active ingredient. For example, cypermethrin 10EC is the active ingredient in the following insecticides: Cyperforce, Balathrin 10EC, Globathrin 10EC, Cymbush 10EC, Delthrin 10EC, Suraksha 10EC, Superthrin 10EC, etc.

## **Types of pesticides**

Pesticides can be classified according to type of pest or disease against which they are effective. See Table 2 for more details. Some pesticides are effective only against one species of pest or disease. Many pesticides are less specific or selective, or even nonspecific. These nonselective pesticides can harm or kill different kinds of insects, microorganisms, animals or plant species when they are used.

**Table 1. Common names of some pesticides and the names in which they are sold in Nigeria**

Common name	Trade names of pesticide, as sold in Nigeria	Uses
Paraquat	Gramoxone, Bret-P, Paraforce, Weedoff, Weedcrusher, Dragon, Dizmaxone, Lasher, Miazone, Weedex, Ravage, etc.	General weed control (by contact) in all crops
Atrazine	Atrazine, Delzine, Atrataf, Atraforce, Xtrazine,	For the control of grass weeds in cereals
Butachlor	Butachlor, Butacrop, Butastar, Butacot, Butaclear, Risene, Teer, Butaforce, Cleweed	For the control of broadleaf and grass weeds in rice, and some legume crops
Propanil	Propanil, Propacare, Propan, Rhonil, Orizo, Propaforce, etc.	For post- emergence weed control in rice
Pendimethalin	Stomp, Pendiin	For preemergence weed control in rice, maize and some legume crops
Oxidiazone	Ronstar, Riceforce, Unicrown	For preemergence weed control in rice
Alachlor	Lasso, Alachlor, etc.	For preemergence weed control in maize and some legume crops
Glyphosate	Roundup, Glycel, Wipeout, Clearweed, Bushfire, Forceup, Sarosate, Rhonasate, Delsate, Glyphosate, Touchdown forte, etc.	Systemic herbicide for general weed control before land preparation
2,4-D Amine	Aminoforce, Delmin-forte, 2,4-D-Amine, Select, etc.	For pre- and postemergence control of broadleaf weeds
Lamdacyhalothrin	Karate, Laraforce, Attack, Karto, Zap, etc.	Systemic insecticide for many crops
Cypermethrin	Cypermethrin, Suraksha, Superthrin, Best, Cymbush, Cypercot, etc.	Contact insecticide for many crops
Dichlovos	Nuvan, Pestoff, Rhonclov, Dash, Smash, Delvap, Wonder, Shooter, Nopest, Clepest, DDforce, VIP, etc.	Contact insecticide for the control of insects in storage and in houses. It is combined with Actellic and used to protect grains in storage.
Mancozeb	Z-force, Hi-shield, Mancozeb, Mycotrin, etc.	Contact fungicide for disease control in many crops

**Table 2. Types of pesticides and their functions**

Type of pesticide	Activity
Algicide	Kills algae, e.g., on wood
Anti-feedant	Prevents animals feeding on a crop or stored product
Attractant	Attracts pest animals
Bactericide (P)	Kills or inhibits bacterial growth
Fungicide (P)	Fungus disinfection
Fumigant (P)	Gas or smoke against pests or fungi in stored products
Herbicide	Kills or inhibits growth of weeds
Insect growth regulator	Modifies insect development stages or growth
Insecticide (e.g., aphicide) (P)	Kills or harms insects (e.g., aphids)
Miticide / acaricide (P)	Kills or harms mites (or spiders)
Molluscicide	Kills snails and slugs
Nematicide (P)	Kills nematodes
Repellent	Keeps away pest animals
Rodenticide	Kills rats, mice, and rodents
Sterilizant	Sterilizes insects in a chemical way
Termiticide (P)	Kills or harms termites

Pesticides may also be classified according to the way they work. This may be by contact or by systemic action. Contact pesticides need to touch the harmful organisms directly to be effective. The finer the spray mist, the better it will penetrate the crop and thus kill the pests by contact.

Systemic pesticides attach to and penetrate the plant surface, and then disperse through the whole plant. Pesticides that persist for some time in the soil and subsequently penetrate through contact with roots are also systemic. It is important that farmers know the nature of the chemicals that are suitable for a given situation so that they can choose the most appropriate pesticide product to use.

### **Pesticide formulations**

Use of chemicals for pest control requires some knowledge of the pest problem at hand, the type of chemical to be used, and the recommendations of researchers and manufacturers. It is also important that farmers know the features of pesticide formulations so they can choose the appropriate sprayer and timing of their spraying operations. There are different types of pesticide formulations which include wet formulations and dry formulations or fumigants (Tables 3 and 4). Wet formulations are used more commonly than dry formulations because of the ease of mixing and measuring out the right amount. There is no danger of powder being blown away by wind during preparation. The containers are small which make it easy to transport and to store. Wet formulations do not easily sink to the bottom of the spray tank.

### **Precautions when buying pesticides**

You should only buy recommended pesticides and you must examine the pack carefully to make sure that tamper-evident seals and original labels have not been broken. Ask the dealer to show you the expiration dates and do not buy or accept any pesticides that have passed their expiry dates. Do not buy pesticides in repackaged bottles which cannot be identified.

**Table 3. Solid formulations and their special symbols**

Physical state	Dilutants	Formulation type	Acronym
Solids	carrier	Dustable powder or dust	DP
		Granule	GR
		Wettable powder	WP
	water	Soluble or dispersible powder	SP
		Soluble or dispersible granule	SG/WG
	bran, grain	Bait concentrate	B
air	Smoke, fumigant, or gas	-	

**Table 4. Liquid formulations and their special symbols**

Physical state	How applied	Diluents	Formulation type	Acronym
Liquids	diluted	water	Suspension concentrate	SC
		water	Emulsifiable concentrate	EC
	undiluted	oil	Low volume	LV
			Ultra low volume	ULV
			Aerosol	A

### Precautions when transporting pesticides

When transporting pesticides, do not load pesticides into a vehicle carrying passengers, animals, foodstuff or animals feeds. Do not place heavy objects or sharp or protruding materials such as nails on or near pesticides. Load and unload pesticides with care and always clean the vehicle before transporting other items.

## **Precautions when storing pesticides**

Do not store pesticides with foodstuff or animal feeds. Never store pesticides in living rooms, kitchen, animal house or toilets. Do not buy pesticides too early in the growing season, to avoid storing pesticides for a long period. Always keep pesticides stored under lock and key. Keep herbicides separate from other types of pesticides. Check any pesticides you are storing regularly for sign of damage or leakages. Always keep pesticides in their original containers that have manufacturers' labels. Keep all pesticides away from children and other members of the family. Keep pesticides away from source of drinking water, wells, and streams. Burn or bury split or unsalvageable material and used packages at designated sites away from people.

## **Herbicide recommendations**

Herbicides are a type of pesticide used for controlling weeds in different crops (see Table 5 for some of the recommended herbicides). There are three groups of weeds: grass weeds, broadleaf weeds, and sedges. Herbicides are classified by the way they act. Some herbicides kill weeds only when the weeds have emerged and others suppress the germination of weed seeds.

Different herbicides contain different active ingredients and so they are applied at different times. Herbicides that are applied before planting or before land preparation are referred to as preplanting herbicides and are mainly aimed at land preparation and killing troublesome weeds that are already growing. Herbicides that are applied after planting but before germination of the seeds planted and before the germination of weed seeds are called preemergence herbicides. Herbicides that are applied after the germination of the seeds planted and after the germination of weed seeds are called postemergence herbicides.

Clay soils require higher herbicide application rates than loamy or sandy soils. You need to adjust the amount of herbicide you apply, according to the type of soil. For example, when researchers or chemical manufacturers indicate a recommended dosage of 3–5 liters per hectare, it means that farmers should apply 5 liters/hectare in clay soils, 4 liters/hectare in loamy soils and 3 liters/hectare in sandy soils.

**Table 5. Some recommended herbicides and application rates for weed control in selected crops in Borno State**

Product trade name	Brand or common name	Liters/hectare	Quantity per sprayer load	Condition of use	Remarks
<b>Paraquat</b> (For total weed control in all crops)	Gramoxone, Paraquat, Proxone, Bret-P, Premium, Weedex, Ravage, Weedof, Slasher, Agroxone, Dizmazone, Paraforce, etc..	3–4 liters	250–350 ml in 15 liters or 350–450 ml in 20-liter sprayer	Apply on non-cultivated land or before planting	Plant the following day. Do not mix Gamoxone with Glyphosate for subsequent use.
<b>Glyphosate</b> (For total weed control in all crops)	Round-up, Kill-off, Touch-down, Delsate, Sarosate, Glycel, Force up, Clearweed, Desensate, Glyphosate, Rhonasate, etc.	4 liters	350 ml in 15 liters or 450 ml in 20-liter sprayer	Apply on emerged weeds before land preparation	Wait for 10 days after application before preparing the land and plant with or without land preparation.
<b>Primextra Gold</b> (For control of most annual grasses and broadleaf weeds in maize)	Primextra	3.5–4 liters	300–350 ml in 15 liters or 400–450 ml in 20-liter sprayer	Apply after planting but before crop and weeds emerge	Apply on moist and clean seed bed within 1–2 days of planting.
<b>Pendimenthalin</b> (Controls emerging annual broadleaf weeds, grasses and sedges in maize, rice, groundnut, cowpea soybean or cotton).	Stomp, Pendelin	2 liters in light sandy soils; 3 liters in sandy clay loam; 4 liters in sandy clay	150–350 ml in 15-liter sprayer or 200–450 ml in 20-liter sprayer	Apply after planting but before crop and weeds emerge	Apply where difficult weeds like Rottboelia are common. Controls Rottboelia. Do not plant or replant any other crop other than those mentioned for one year after application.
		1.5–2 liters			

Product trade name	Brand or common name	Liters/hectare	Quantity per sprayer load	Condition of use	Remarks
<b>Basagran 480</b> (Controls major postemergent broadleaf weeds and sedges in rice, maize, soybean, cowpea, groundnut, or sorghum)	Basagran	3–4 liters	125–150 ml in 15-liter sprayer or 150–200 ml in 20-liter sprayer	Apply in growing crops when majority of the weeds have emerged	Mix the Basagran 480 with Propanil for grass weed control in rice.
<b>Paraquat plus Atrazine</b> (Controls pre-plant and pre-emergent weeds in maize and sorghum)	For Paraquat as above, For Atrazine: Atrax, Atraforce, Delzine, Beltrazine, Atrazine, Xtrazine, etc..	3 liters of Paraquat plus 5–6 liters of liquid or 2.5–3 kg of powder Atrazine	250 ml Paraquat Plus 400–500 ml of liquid Atrazine in 15 liters or 350 ml of Paraquat plus 550–650 ml of Atrazine in 20-liter sprayer	Apply before the crop germinate or within 2-3 days after sowing	If Atrazine powder, dissolve 3 kg in 3 liters of water. Add 250 ml of solution in 15-liter sprayer or 350 ml in 20-liter sprayer.
<b>Paraquat plus Primextra Gold</b> (Controls pre-plant and pre-emergent weeds in maize).	Same as above for each herbicide	3 liters of Paraquat plus 2–3 liters of Primextra Gold	250 ml Paraquat plus 150–250 ml of Primextra Gold in 15-liter sprayer or 350 ml Paraquat plus 250–350 ml Primextra Gold in 20-liter sprayer	Same as above	Controls most grasses and broadleaf weeds where planting is done 1 week after land preparation. Apply within 12 hours after planting.
<b>Paraquat plus Pendimethalin (500EC)</b> (For preplant and preemergent weed control in cowpea or soybean)	Same as above	3 liters of Paraquat plus 3 liters of Pendimethalin	250 ml Paraquat plus 250 ml Pendimethalin in 15-liter sprayer or 350 ml of Paraquat plus 350 ml of Pendimethalin in 20-liter sprayer	Same as above	Apply within 2 days after planting
<b>Paraquat plus Dual Gold</b> (Controls preplant and preemergent weeds in cowpea or soybean)	Paraquat: same as above Dual Gold	3 liters of Paraquat plus 2 liters of Dual Gold	250 ml Paraquat plus 200 ml Dual Gold in 15-liter sprayer or 350 ml Paraquat plus 250 ml Dual Gold in 20-liter sprayer	Same as above	Apply within 2 days after planting
<b>Paraquat plus Butachlor</b> (as above)	Paraquat: same as above Butachlor: Teer, Butaforce, Butaclear, Butacrop, Butarice, Risene, Butacot, etc.	3 liters of Paraquat plus 4 liters of Butachlor	250 ml Paraquat plus 350 ml Butachlor in 15 liters or 350 ml Paraquat plus 450 ml Butachlor in 20-liter sprayer	Same as above	Apply within 2 days after planting

The level of moisture in the soil, the weather conditions, and the type of sprayer used have an effect on the results of using herbicides applied. Preemergence herbicides should be applied to moist soils on the day the crop is planted. If you cannot apply preemergence herbicide on the day of planting, you can spray up to 2 days after planting but not beyond this time so as not to damage the seedlings of the seed planted. Do not apply herbicides on dry soils or when it is about to rain.

Do not apply preemergence herbicides when the weeds can be seen because they may not be effective in controlling the weeds. Also do not apply postemergence herbicides when young seedlings of crops are growing in the field unless it is specifically recommended, as in the case of rice. Do not wait for the weeds to emerge before applying preemergence herbicides.

Farmers sometimes prepare their land for planting but are not able for some reason to plant immediately. When there is a delay of planting after land preparation and some weeds have started to grow on the prepared land, you can mix the recommended preemergence herbicide with Paraquat (postemergence) as a tank mixture and apply within one or two days after planting. Paraquat will help to kill the existing weeds while the preemergence herbicide will suppress the germination of weed seeds that are yet to germinate.

Some herbicides kill only grasses, while others kill only broadleaf weeds. A small number of herbicides can kill both grasses and broadleaf weeds. You can achieve better weed control when you use herbicides that kill both types of weeds. If herbicides that kill both grasses and broad leaf weeds are not available, you can mix and apply the two types of herbicides that kill the different types of weeds.

The estimated quantities per sprayer load of water plus herbicide mixture given in Table 5 are based on a minimum application rate of 180 liters/ hectare. This requires 12 sprayer loads for a 15-liter (CP 15) knapsack sprayer and 9 loads for a 20-liter (CP 3) knapsack sprayer.

You should measure pesticide quantities carefully using a graduated cup, empty standard "Peak" milk tin, or empty small "Tomapep" tin. One measure of a standard size "Peak" milk tin is equivalent to 150 milliliters and one measure of a small "Tomapep" tin is 75 milliliters.

## **Recommended insecticides for insect control**

Insecticides are chemical substances used for killing insects in different crops (See Table 6 for some recommended insecticides). Insecticides are expensive, dangerous and should be used only as recommended. Most insecticides in common use are nerve poisons which act by contact or are systemic, stomach or respiratory poisons. Insecticides are also used in seed dressing chemicals that control seed and soil-borne pests and diseases that may damage young seedlings. Insecticides are also used for controlling insect pests in field crops such as cowpea, cotton, and vegetables, and for cowpea storage. Use appropriate knapsack sprayers such as CP 15 or CP 3 with a suitable hollow conical nozzle for spraying insecticides.

Cowpea requires about two to three sprayings of insecticide for good yield depending on the period of maturity of the cowpea variety used. Early maturing varieties require two sprayings, while the intermediate and late maturing types require up to three sprayings. The first spraying should be carried out 30–40 days after planting in both low and high rainfall areas, whether or not insect attack has been observed, to ensure good flower production. If you see aphid infestation early in the season, you should spray 14–21 days after planting, and in this case the second spraying should take place 10–14 days after the first spraying. This second spraying should coincide with the time the crop is in full flower and podding has started.

Two sprayings are recommended for low rainfall areas around Damboa and Lake Chad shore. In Biu and Shani areas, especially when late-maturing cowpea varieties are grown; three sprayings of insecticides are recommended. Spraying should be conducted when at least 5 plants out of 100 are affected by insects.

Apply the recommended insecticides early in the morning or late in the evening. Do not harvest vegetables sprayed with insecticides for eating or for sale until 7 days after spraying during the rainy season. When insecticides are sprayed on vegetables, the waiting period before harvesting should be longer than in the rainy season but between 10 and 14 days.

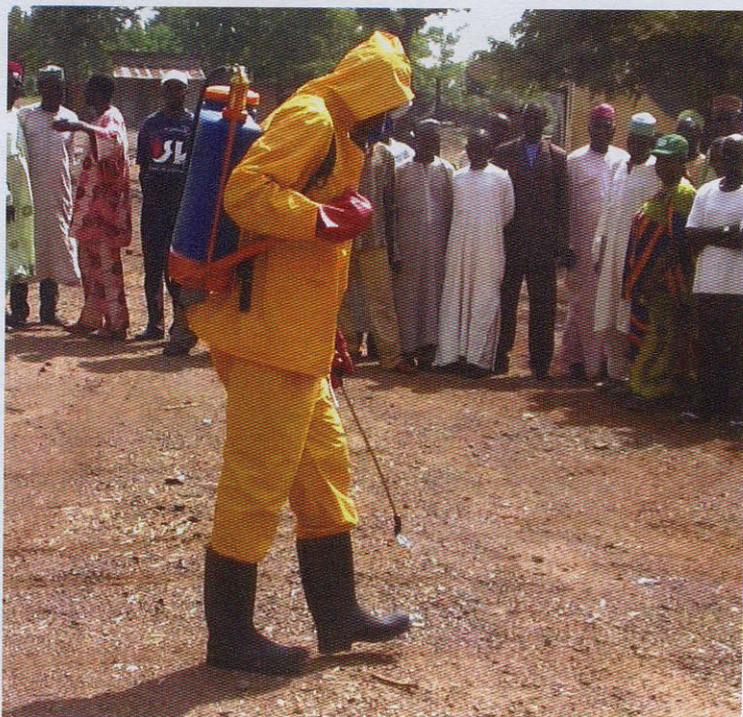
Do not spray insecticides directly on cowpea grains before storage. Instead, use recommended fumigants for grains in bags with an inner lining before stacking them in the store. Ensure proper hygiene in and around the store and inspect your produce store at monthly intervals. Use non-chemical methods for short-term storage and for storing cowpea for immediate consumption.

**Table 6. Some recommended chemicals for control of insect pests and diseases in selected crops in Borno State**

Product trade name	Brand or common name	Application rate	Estimate per one sprayer load	Condition of use	Remarks
Apron Star 42WS (Fungicide/insecticide)	Apron star	One sachet per 4 mudus or (kg) of millet, rice, sorghum or maize; and one sachet per 8 mudus of cowpea or groundnut	Not applicable	Preplant seed coat treatment. Apply as slurry or dust and plant after treatment	Controls downy mildew, damping off diseases, soil and early season foliar insect pests on seeds and seedlings
Lamdacyhalothrine 25 EC (Insecticide).	Karate 2.5 EC, Karto 2.5 EC, Kombat 2.5E C, Lamcot 2.5 EC, etc.	0.4–0.8 liter/ha	35–70 ml in 15-liter sprayer or 100 ml in 20-liter sprayer	Contact and ingestion. Apply at early infestation and against early stages of insects' life cycle.	Controls leaf, fruit- and soil-dwelling insects and migratory insect pests in cowpea, cotton, groundnut, vegetables, maize, rice, and fruit trees.
Perfekthion 2.5 EC (Insecticide)	Dimethoate	0.5–0.8 liter/ha	40–70 ml in 15-liter sprayer or 100 ml in 20-liter sprayer	Contact and systemic action. Apply at early infestation and during early stages of insect life cycle.	Controls plant-sucking insects in cotton, cowpea, groundnut, and cereals.
Cypermertin plus dimethoate (Insecticide)	Best action, Cyperdiforce, Superplus, Sherpaplus, Balalhoate plus, Uppercott, etc.	1 liter/ha	75 ml in 15-liter sprayer or 100 ml in 20-liter sprayer	Contact and systemic action. Apply as above.	As above
Diafuran 3G (Insecticide/Nematicide)	Carbofuran	25–100 kg/ha	3 g/plant or 7–10 g/m <sup>2</sup> of soil during seed bed preparation	Contact, systemic and ingestion. Apply on the soil to control foliar pests through systemic action in plants and controls nematodes.	Controls foliar and soil insects and nematodes in vegetables, maize, sorghum, groundnut, cowpea, soybean, potatoes, and rice.
Actellic 25 EC (Insecticide)	Actellic	100–200 ml mixed in 5 liters of water and spray on 100 square meters of bags or 16–40 ml in 1–2 liters of water mixed with 1000 kg or 10 bags of grains	Double the rate if storage period of more than 3 months is intended.	Dry the grains properly and maintain proper hygiene to ensure protection from storage pests for at least 3 months. Treat the floor, spray each bag stack and finish by spraying tops and sides of the stack in the store.	Do not consume or sell the grains mixed and stored with Actellic until after 3 months for short-term and 6 months for long-term storage.



**Good weed control in cowpea field**



**Calibrate your sprayer before use**



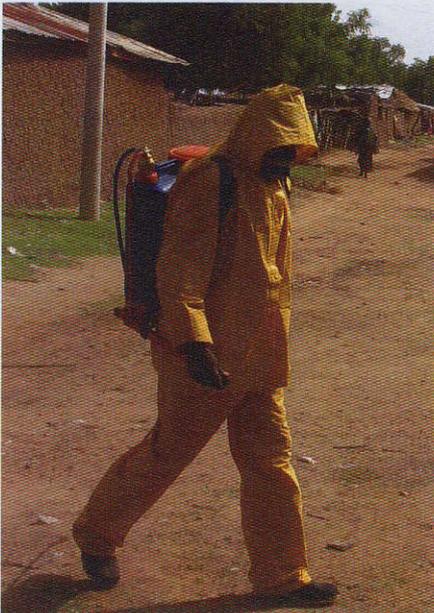
**Do not spray pesticides with leaves**



**Good weed control in soybean field**



**Always read the label before use**



**Correct protective clothing**

### **Measuring and mixing pesticides**

Always read the label and ask for help if you have any doubts before using any pesticide. Check whether the pesticide is suitable for the intended use; check the safety precautions to be observed; select the dose rate, and note the instructions for mixing on the product label. Always follow the recommended dose rates and dilutions. Remember that use of higher or lower doses are a waste of money.

Always wear protective clothing such as overalls, boots, gloves,

respirator, and goggles. Ensure proper ventilation and avoid contamination of skin and splashes. Do not mix or measure herbicides and pesticides at home, but on the farm site where the spraying will be done. Keep children and animals far away from mixing area. Stand opposite to wind direction and handle dusts and wettable powders carefully. Use buckets and sticks for mixing (do not use your hands) and use funnels to pour liquids into sprayers to avoid spillage and splashes.

### **Sprayer calibration**

You should always calibrate your sprayer using ordinary water before mixing and spraying any pesticide. The volume of water required per unit area and consequently the number of tank loads may increase or decrease depending on the person(s) who does the spraying. Do not make arbitrary assumptions about the number of sprayer loads and quantity of the product to be mixed with water during spraying. Calibrate your sprayer before mixing and spraying pesticide as it enables the person spraying to know how much water is required to mix the recommended product to be applied per unit area. This ensures uniform application of the pesticide over a given land area.

Using too much herbicide, by applying above the specified rate, is wasteful, expensive, and injurious to the crop, the operator and the environment. Using too little herbicide, by applying below the specified rate, risks low weed control, which may necessitate reapplication or manual weeding, thus increasing weeding cost.

### **Calibrating a knapsack sprayer**

Check all parts of the sprayer to ensure that they are functioning properly. Clean the knapsack sprayer and set the pressure gauge at low (L) for herbicides or high (H) for insecticides as marked on top of the diaphragm inside the sprayer tank. Use the green, yellow or red flooding polijet nozzle for spraying herbicides and hollow cone nozzle for spraying insecticides. Fill the tank with water and pump to a suitable pressure and check for leaks and drips. Correct any problems before proceeding with the calibration.

Always calibrate the sprayer in the field shortly before actual spraying by following these steps:

- Mark out a rectangular area in your field 50 paces long by 5 paces wide. This is approximately 250 m<sup>2</sup>.
- Pour 5 liters (approximately 1 gallon) of water into the sprayer tank;
- Spray the marked area walking at a normal and comfortable pace and using a constant pumping speed;
- Make sure that the water is finished in the spray area or continue to spray at the normal pace and speed until the water is finished and determine the actual area sprayed;
- If the 5 liters (1 gallon) of water is able to spray 250 m<sup>2</sup>, then the delivery rate for 10,000 m<sup>2</sup> (approximately 2.5 acres) will be 200 liters or 40 gallons of water.
- If the knapsack sprayer tank capacity is 4 gallons (for example a CP 3 sprayer), then you need to fill the sprayer 10 times (10 sprayer loads) to spray 2.5 acres of farm. If you are using a 15-liter capacity sprayer



**Calibrate your sprayer before spraying**

(for example a CP 15 sprayer) you need to fill the sprayer 13 times (13 sprayer loads).

- If the recommended rate is 4 liters per 2.5 acres or hectare, divide the 4 liters (4000 milliliters) by 10 loads which is equivalent to 400 milliliters per sprayer tank. In this example, mix about 2 2/3 "Peak" milk tins or 5 1/3 "Tomapep" tins of the herbicide product with 4 gallons of water to fill one tank load of the sprayer.

## **Spraying pesticides**

Do not apply pesticides without adequate training. Read the manufacturers' labels on the pesticide containers before spraying pesticides. Wear protective clothing such as overalls, boots, gloves, respirator, and goggles before commencement of spraying. Avoid spraying mist and drift as much as possible. Pesticides should not be applied when the wind is blowing towards an adjoining susceptible crop or a crop in a vulnerable stage of growth. The wind should be blowing away from the susceptible crop or the field should not be treated until the wind is still. You can observe the wind direction by raising dust or a piece of cloth, and then spray away from the wind.

Do not eat, drink or smoke while operating a sprayer on the farm. Hold the sprayer nozzle 50 centimeters above ground or at knee height when spraying. Take care not to spray the same area twice and not to leave gaps when spraying. Do not allow children, animals, and nonworkers to enter the sprayed area for at least 24 hours after spraying.

Do not eat, drink or smoke with contaminated hands during or after spraying. Wash your hands thoroughly with soap after handling pesticides and keep all remaining pesticides, baits, and dressed seeds away from foodstuff and children. Close all packages securely after use to prevent leaks or contamination and store safely. Always keep pesticides in their original containers. Wash your equipment three times with soap and water and then rinse with water properly after use. Wash your body and working clothes properly with clean water and soap after spraying. Drink sour lemon or milk or palm oil and sit in an open well-ventilated place for at least 1 hour after spraying to reduce the immediate effect of any pesticide inhaled accidentally. Contract sprayers are advised to have medical check-ups at monthly intervals.

## **Types of sprayers and their maintenance**

Most sprayers have nozzles, a container (tank) to hold the spray, and a pump to force the spray through the nozzles. Other accessories usually found in sprayers are filters or strainers, pressure gauges and regulators, a shut-off valve, and connecting hoses. The nozzle is probably the most important part of the sprayer. Other parts exist only to help the nozzles operate properly. Nozzles determine uniformity of spray application, the rate of application, and the spray drift. Most commonly used nozzles are flooding or polijet nozzles (green, yellow, and red) for spraying herbicides and hollow cone nozzles for spraying insecticides. These are best used for knapsack sprayers.

Some sprayers are hand-operated and others are power-driven models with motors. All hand-operated sprayers are suitable for small plot work and generally have tank capacity of 1 to 20 liters. There are six main types of sprayers that can be used for spraying pesticides. These include: Lancet, Falcon, Knapsack, Motorized mist blower, Ultra Low Volume (ULV), and Electrodyne sprayers. Knapsack sprayers are the most commonly used in the field and they are easy to use as they have an adjustable pressure gauge inside the tank. Turn the pressure gauge to L or low when you intend to spray herbicides or H or high when you intend to spray insecticides or fungicides.

The tank capacity can range from 15 to 20 liters and can be used for spraying fairly large areas. The CP 15 or Dami 16 can hold 15 liters, while CP 3 or Jacto has a 20-liter tank capacity. Note that the tank capacity determines the volume of pesticides that makes up a load.

The inside and exposed parts of the sprayer should be thoroughly cleaned after each use and before storage. As a rule, first wash the tank with soap and water and then rinse with water. Wettable powders and solutions are easily cleaned from sprayers by rinsing thoroughly with water.

Clean the sprayer as follows:

- Fill the tank half full with clean water and shake vigorously. Flush out the cleaning water through the nozzle by operating the sprayer;
- Repeat the procedure above;
- Remove nozzle tips and screens. Clean them in kerosene or detergent solution using a soft brush;
- Do not use a knife, wire, or any hard materials to clean the nozzle tips and never blow into them with your mouth;

- Fill the tank again to about half full with water and add a small amount of household soap;
- Operate the pump to circulate the soap solution through the sprayer, and then flush it out through the sprayer nozzle;
- At the end of the spraying season, follow the cleaning operations listed above and finally rinse the sprayer with a light oil to protect the metal and rubber parts from corrosion;
- Remove nozzle tips, strainers and screens and apply a coating of light oil before storage.

### **Disposal of empty containers**

Empty pesticide containers should be safely disposed off immediately in a way that will not cause hazard to man, animals, and valuable plants. Dispose of containers by burning or burying them. Do not leave empty paper containers lying about as they may be blown away and end up in the wrong location. Burn empty paper packages and cartons unless there is an instruction not to do so on the package. Bury the ashes. Pesticides should not be burnt except in incinerators designed for this purpose. Fumes from burning pesticides could be poisonous, so avoid inhaling them. Punch holes in pesticide containers, flatten them and then bury them deep in the ground in locations where the possibility of contaminating a water supply is minimal. Glass containers should be broken and then buried. It is dangerous to use pesticide containers for other purposes, so you should always destroy them.

### **Signs and symptoms of pesticide poisoning**

Pesticide poisoning can occur in many different ways due to the types of pesticides and different routes of absorption. Other infections or conditions caused by excess heat can mimic pesticide poisoning symptoms. Seek medical attention immediately when you notice any of the following symptoms:

- General: extreme weakness and fatigue;
- Skin: irritation, burning, excessive sweating or discoloration;
- Eyes: itching, burning, watering, difficult or blurred vision, narrowed or widened pupils;

- Digestive system: burning in mouth and throat, extreme salivation, nausea, vomiting, abdominal pain, and diarrhea;
- Nervous system: reaction such as headaches, dizziness, confusion, restlessness, muscle twitching, staggering gait, blurred speech, fits and unconsciousness, sometimes death.

### **First aid for victims of poisoning**

- Remain calm to avoid contamination;
- Maintain the breathing of the patient through artificial respiration if unconscious;
- Remove the patient from the scene of the contamination;
- Remove any contaminated clothing immediately;
- Wash all the affected parts of the body with clean water or wipe with a piece of cloth if available, or even with paper or leaves;
- Convey the patient and the pesticide container to the nearest hospital or clinic for medical attention. (The pesticide container can help medical staff identify the poisoning and the appropriate treatment.)

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