Equipment and Application Techniques

Learning Objectives:

After completion of the study of Equipment and Application Techniques, the trainee should be able to:

- Discuss the characteristics, advantages and limitations of various kinds of control equipment.
- Discuss proper maintenance of equipment.

Those involved in pest control should know the characteristics, advantages and limitations of various kinds of control equipment so they can choose the equipment best suited to each job and use it safely and effectively. Proper maintenance of equipment is important to safety and efficiency and also to profitability, in that it prevents costly repairs.

Along with a knowledge of equipment, pesticides and pests, the applicator must be thoroughly familiar with the application techniques suited to a given situation. Many current and all future pesticide product labels will indicate how a pesticide is to be applied. Application techniques vary with the equipment used, type of pesticide applied, target pest involved and size and scope of the application job involved. Proper application techniques ensure effective control, proper use and prevent drift and pesticide loss into the environment.

Equipment Sprayers

Compressed Air Sprayer

The basic piece of spray equipment used in general pest control is a small, hand-operated and hand-carried compressed air sprayer with a capacity in the range of 1/2 to 1 1/2 gallons. Air pressure is supplied by a hand-operated pump or by an electrically or gasoline operated air compressor. The air pressure is contained in the tank above the surface of the liquid to be dispensed. This air, usually compressed to 20 to 50 pounds of pressure, forces the pesticide out through a discharge tube to the nozzle when the discharge valve is opened. The liquid is not mixed with air, but is pushed out as a wet spray without atomization. There are several sprayers of this type made by several different companies. The pest control operator should choose the type best suited to his needs.

To control a variety of insects – cockroach, ant, flea, stored product pests and numerous other types of pests – the general pest control operator uses these sprayers. It is used for applying crack and crevice, spot and general sprays. It is the workhorse of a pest control operation.

A compressed air sprayer consists of:

- a tank for the spray mixture,
- a hand-operated pump for compressing air in the tank,
- a siphon tube to carry the spray mixture to the hose,
- a hose which connects the sprayer tank and siphon tube to the valve,
- a valve to control the spray flow, and
- a nozzle to distribute the spray in the desired application pattern.

Use a wand or short piece of curved tubing to extend the distance between the valve and nozzle. Compressed air forces the spray material out through the nozzle when the valve is open.

Hand-operated compressed air sprayers are designed to operate with 20 to 50 pounds of air pressure. Usually, pressure of less than 20 pounds is desirable when operating indoors, such as when making crack and crevice applications. The reduced pressure results in reduced splashing. Higher pressures of 20 to 50 pounds are necessary when operating outdoors, projecting a spray stream over long distances, spraying large volumes and to develop proper nozzle patterns when using fan or cone nozzles.

The tank is made of stainless steel, brass, galvanized steel or plastic. Stainless steel tanks are generally resistant to the corrosive effects of many pesticides. Some tanks may have an air release valve and/or a pressure gauge.

The air pump is usually mounted in the cover of the head opening. It consists of a handle, cap, sealing ring, plunger rod, piston to force air into the tank through a check valve in the bottom of the pump and a brass, stainless steel or plastic cylinder. The piston has a leather or synthetic rubber cup, which may require maintenance. The check valve at

the bottom of the pump cylinder prevents air and spray material from being forced back into the cylinder. The check valve may also require periodic replacement.

The nozzle is the most important part of the sprayer because it determines whether the insecticide will be sprayed as a solid stream, flat spray, hollow cone or solid cone. It also determines the rate of spray output at a given pressure, the thoroughness of application and the safety with which a spray is applied.

Nozzles are available in many types, each designed for a specific delivery pattern and discharge rate. Base the selection of nozzles on the proper particle size and application rate. Solid stream nozzles are used in crack and crevice treatment. Use fan nozzles in making flat surface applications. Solid and hollow cone nozzles distribute sprays in a circular pattern and are used more often in applications to trees and shrubs. Adjustable nozzles containing a variety of tips are available and useful when varying spray patterns.

If a sprayer is used daily, clean it after each use. When cleaning the tank, use hot water and a good detergent, preferably one containing ammonia. Remove any residue accumulations on the inside of the tank by scrubbing the inside and bottom of the tank with a stiff bristle brush until the surface is perfectly clean. Clean and polish the outside of the tank to preserve the surface and to prevent contamination or damage to other objects. Pressurize the tanks after cleaning to check for small pinhole leaks.

Store upside down when the sprayer is not in use. Remove the pump unit and turn the tank upside down, lay the pump assembly on a clean surface, hang the shutoff valve on a hook and let the hose extend its full length. Open the shutoff valve so that any liquid trapped in the extension can drain out of the hose. Sprayers need to be protected during freezing weather to prevent damage (e.g., valves may freeze and crack).

Inspect the pump unit and maintain the three gaskets. At two- or three-week intervals, lubricate the cup leather of the pump with a few drops of neat's-foot oil. Oiling the cup leather in this manner helps retain its shape and keeps it moist for maximum efficiency when pumping. The sealing ring, in time, becomes worn and needs replacing. When worn out, this gasket can cause severe pressure leaks.

Periodically inspect the lip of the pump cylinder for cracks as this causes pressure loss around the pump cap. Clean and polish the inside of the pump cylinder. Remove the check valve and polish the valve seat with steel wool.

Sprayer malfunction often occurs within the pump assembly. Proper diagnosis will indicate the problem that may require repair or replacement. Frequent replacement of the gaskets is much less costly, in most instances, than solving the problems of accidental pesticide discharge.

Problem

- Failure to develop pressure or no back pressure when plunger is pushed down.
- Liquid or air flows into pump, causing liquid to shoot up out of the cap around the handle, or the handle "creeps" up when not locked down.
- Sprayer loses pressure slowly, even when no spraying is being done.

Cause or Answer

- Worn plunger cup or plunger cup needs oiling.
- Worn check valve.
- Worn sealing ring.

Thoroughly inspect, rinse and clean the sprayer hose once a week. This is most convenient when the tank is rinsed with detergent. After the tank has been washed thoroughly, pressurize the sprayer and spray the detergent through the hose, shutoff valve and nozzle. Never let the sprayer hose stand unused for more than one day with pressure in the sprayer. Even the best sprayer hoses show some deterioration if left standing under pressure when filled with solvents and insecticides. Never leave an unattended sprayer of any kind under pressure. The next person walking by may try the shutoff valve and contaminate himself or the area. Loosen the cap slowly. After the pressure is released, extend the hose upward full length and depress the valve. This allows spray material accumulated in the hose, valve and wand to drain back into the tank.

Occasionally oil the valve plunger and replace the packing around it. When the valve fails to feed or stops up when operating, it may be clogged. The valve may fail to shut off completely, permitting a

continued drip from the nozzle. There may be some dirt lodged in the valve seat, or there may be a scratch on the valve surface. When these problems occur, take the valve apart. The manufacturer can provide the necessary diagrams and instructions to aid in this procedure.

The strainer assembly of any sprayer is a very important part. A properly functioning strainer filters out particles that would clog nozzle tips or interfere with shutoff closure. Remove the assembly once a week and wash thoroughly to remove all sediment and residue from the strainer screen. Otherwise residue builds up on the screen and stops the flow of insecticide. Normally, these sediments can be removed by running hot water over the strainer. If necessary, soak the strainer a few minutes in a suitable solvent and clean with a soft bristle brush.

Nozzle tips occasionally become clogged with extraneous materials that distort the spray pattern or completely prevent liquid passage. There are several remedies for clogged tips. Use compressed air to blow foreign matter out of the tip, and for best results, always force the air through the front of the orifice. Soaking the tip in a suitable solvent and cleaning with a toothbrush usually cleans out the accumulated sediment. Never use anything more rigid than a toothbrush bristle to clean the spray tip, and never insert any metal object such as a pin, wire, etc., into the end of the tip. The orifice is precision machined and can be marred easily, causing a distortion in the spray pattern.

Small Hand Sprayers

There are uses for even small hand sprayers in public health programs. The “flit gun” type sprayer and the pistol sprayer can be used for treating very small areas when extreme portability is important or when only small quantities of pesticide are needed as when treating small mosquito-breeding areas or wasp nests.

Dusters

Equipment for applying dusts varies with the use and the type of practice. Some of the more common types of dusters are:

Hand Shakers

Hand shakers are available in a wide range of sizes or can be homemade. Shakers may be used for applying tracking powders and patches for mice and rats in runs along the base of walls or foundations or on beams. They may be used for insects where careful placement and neatness are not essential. Do not apply too much in one place. If the shaker is fitted with a 16- to 20-mesh screen, over-application is less likely to occur.

Hand Bellows Duster

A hand bellows duster is a rubber cylinder with a metal or plastic top and bottom. The bottom has an extension tube for delivery of the dust. The top contains an opening for filling and a tight stopper.

Inside the rubber cylinder is a large coil spring that resumes its shape after compression. The dust is delivered by squeezing the top and bottom of the bellows together. This duster is used where small quantities are needed, and careful placement and neatness are important. They are used to apply a thin layer of dust or to force dust into small cracks or voids where insects may be hiding. They are sometimes used for cockroach control or treating nests in wall voids.

Bulb Duster

A bulb duster is a rubber bulb with a screw cap cover fitted with a dust nozzle. Dust is distributed by squeezing the bulb. These dusters are used in the same situations as hand bellows dusters.

Hand Plunger Dusters

Hand plunger dusters consist of a plunger-type pump and a metal or glass reservoir into which the airblast goes when the plunger is pushed. The dust is dispersed as a relatively fine cloud or a heavy blast, depending on how the duster is held. They are not suitable for most inside work but are sometimes used for treating large areas, such as crawlspaces or attics, when larger rotary or power dusters are not available. They might be used to apply insecticide dusts for silverfish and spider control in attics or crawlspaces.

Foot Pump

A foot pump is similar to the hand plunger duster but is held down on the ground by placing the foot in a stirrup and pumping with the hands to force the insecticide out through a short, flexible delivery tube. It is useful for applying dusts to rat burrows.

Rotary or Hand Crank Dusters

These dusters have a 5- to 10-pound capacity hopper. Some are designed to be carried on the operator's back. When the crank is turned, a fan blows air through a long delivery tube. Dust is dropped into a mixing chamber or directly into the fan chamber from a hopper, which may or may not contain an agitator to fluff the dust and feed it into the fan for dispersion out the tube. Most have adjustments to regulate the delivery rate of the dust. Usually a fan-shaped tip is supplied with the duster to produce a broad band of dust. With the fan tip removed, it can be used to treat rodent burrows. These dusters are primarily for outdoor use but are also used to treat larger indoor areas, such as crawlspaces and attics and for treating sewers.

Power Dusters

Power dusters vary in size and output. They are similar in principle to the crank dusters but have a larger capacity and power-driven fans and agitators. Small electrically driven dusters produce a very fine layer of dust and are used effectively to treat small cracks or wherever deep penetration is required. Another type of power duster is the compressed air duster. It is similar to a dry-type fire extinguisher and must be pressurized with air before operation. A mixture of dust and air is discharged when the valve handle is depressed. These dusters would also be used to treat attics and crawlspaces to control several kinds of insects that may be a problem in these areas.

Most dust application equipment is maintained easily, but periodic maintenance is essential to keep this equipment in effective working condition. Empty dusters frequently. Clean thoroughly to remove all caked or hardened dust. Insert a piece of stiff wire in the tubes to scrape caked dust from the sides and tip of the tube. Clean screens and all other small openings frequently to ensure they are not clogged. When storing the duster, first remove all dust and then clean thoroughly. Be especially careful to purge the foot pump duster after use of calcium cyanide. Make sure the storage area is dry so that metal parts do not rust.

Space Treating Equipment

Space treatments for quick knockdown and control of flying insects have been used extensively. Any insecticide used to fill a space must first be broken down into fine particles or droplets to allow their suspension in air or to allow the particles to be moved by wind currents. Fine-droplet dispensers-foggers, misters, aerosolizers and ultra-low dose (ULD) applicators were developed for this purpose.

Equipment used in dispensing fine particles comes in a variety of types and sizes, each designed to produce particles within a specific range of sizes. At present, there are no particular field methods for determining droplet size quickly. Equipment can be adjusted within certain limits to produce a wide range of droplet sizes.

It is a common mistake to relate the type of application specifically to the piece of equipment being used. To be effective, safe and efficient, know fogs, mists, aerosols and ULD in terms of droplets size and their characteristics and usages in given control situations; then use the proper equipment for the purpose.

Distribution and effectiveness of insecticides in space treatments are dependent on the production of very small drops in much larger numbers than with conventional application methods. These very fine drops, however, are more subject to drift and tend to deflect around target insects instead of hitting and impinging on them.

The micron (a unit of measurement) is used to measure droplet or particle size. One micron equals 1/25,000 of an inch.

Effectiveness of spray droplets depends on their size, their ability to penetrate or to reach the target area and their ability to impinge on or hit the insect. Research indicates that droplets in the 5- to 15-micron range (most conventional spray droplets are in the range of 100 to 400 microns) are more efficient for controlling cockroaches and other structural pests.

Spray droplet size is affected by the pressure or flow rate, the size of the outlet orifice and the viscosity and physical characteristics of the spray mixture. The higher the air pressure or flow rate or the smaller the orifice outlet, the smaller the droplets produced. Viscosity affects flow rates and evaporation rates; higher viscosities generally reduce both rate of flow and evaporation.

Penetration of droplets into an area not in direct line with the spray outlet is dependent primarily on droplet size, speed or velocity of the droplets, air currents and gravity. Impingement is affected by the same factors affecting penetration plus the size and shape of the target insect.

Factors influencing the effectiveness of conventional sprays also affect fine particle dispensing, including the insecticide used, concentration and rate of application, thoroughness of application, amount of harborage area (hiding places) and the nature of the treated surfaces.

Aerosols

Insecticides in extremely fine mists are aerosols. Aerosols used indoors may be gas propelled or thermally released.

Gas-propelled aerosols are insecticides in special containers in which a liquefied gas is used to force the contents under pressure out through the nozzle in droplets of 0.1 to 50 microns. They are presently available in a variety of sizes from the disposable “soft drink” can size used by the public and industry to the heavier specially developed, reusable containers for use by industry for space, crack and crevice treatments. They are handy and convenient to use and require no special motors, electrical outlets, water or oil, but are more expensive per unit of insecticide. They are sometimes used for “flushing” or inspection to determine the nature of the problem, such as in cockroach control. Some are available with long flexible nozzles for crack and crevice treatments. Other aerosols are used in space treatments for the quick knockdown and control of crawling and flying insects and to increase insect activity to ensure contact with deposits of residual insecticides.

Aerosols may be purchased as timed-release dispensers with a clock-like mechanism that releases the spray on a preset schedule. Total release aerosols are being used increasingly. These dispensers contain residual or non-residual insecticides or both. They are designed so the release valve can be locked in an open position for total release of the contents.

Pressurized spray applicators are used commercially and by the general public. These spray applicators differ from aerosols in that they usually contain a much larger percentage of petroleum and diluent, and the nozzle produces a coarse spray that deposits a thin film of insecticide directly on surfaces.

Pressurized aerosols require some special care. Store them in temperatures between 70 and 120 degrees F. Higher temperatures increase the pressure within the container and can cause it to explode. Lower temperatures cause the pressure to drop, resulting in improper operation and larger droplets. Store and transport aerosols so they will not discharge accidentally.

Fogs

Fogs can be produced thermally or mechanically. A mechanical fog generator is most often a mist machine adjusted to produce fog-sized droplets. Most fogs, however, are produced thermally.

Fogs and aerosols technically are dispersions of droplets ranging from 0.1 to 50 microns with the preferred range of droplets thought to be 5 to 10 microns for greatest efficiency. Many formulations are produced for fogs or aerosol applications. Some specify the range of particles or droplets to use (i.e., none over 50 microns and 80 percent less than 30 microns). Fogs may be used to treat warehouses for stored product pests, cockroaches or other insects.

There are many makes, models and sizes of thermal fog machines available. These machines break the pesticide into fine droplets with hot exhaust gases. The hot exhaust gases vaporize the oil solution of an insecticide. As the vapor is discharged into the cooler outside air, it condenses into very fine droplets producing a fog. Some people believe heat causes some insecticide decomposition. Using less volatile oils may minimize this. Thermal fog generators sometimes produce a flame when started and should be started outdoors or in a safe area. If a fogger ceases to function, take it outside to restart it.

Thermal fogs may be used alone, indoors or along with residual applications for controlling crawling insects. Indoors, fog rarely penetrates into cracks and crevices unless air currents are running into such areas to carry the fog with it. Fogs usually do not move against cold exterior walls.

Thermal fogging can cause explosions. Usually, this is the result of having too high a concentration of fog in the structure and operating near a spark or flame, which ignites the explosive mixture. Turn off

all pilot lights by shutting off the main gas valve rather than individual valves. Wait until the gas in the line has been used and the pilot lights go out.

The concentration of fog can be too high from overdosing or from pockets of accumulated fog material. Good practice and most labels call for using 21 gallons of fogging compound per 50,000 cubic feet, which is well below the explosive limit, but an open flame can ignite the oil and cause a fire. Know the cubic footage of the area being treated and the amount of fogging mixture to put into the space. Then you must know how fast your fogger puts out the mixture. Record the information so you do not have to recalculate if retreatment is required.

Mists

Mist particles or droplets range from 10 to 80 microns in diameter and can be dispersed using oil or water as a base. Since mists are generally larger particles than other types of space treatment, they settle out fairly rapidly. Use mists in conjunction with a residual treatment for long-lasting control of crawling insects, but apply them following the residual application. Mists, like fogs, are used more frequently in warehouses.

Mist-producing applicators break up the insecticide mechanically into fine particles using low pressures and a high volume of air. The smaller units most commonly used inside are electrically driven at high speeds. Some force air and liquid through a hollow shaft and between pairs of disks by centrifugal force. A blower on the same shaft blows across the outer edges of the disks, shearing droplets off and into the outer edges of the disks, shearing droplets off and into the airstream at high speed. Particle size depends generally on rotation speed, delivery rate and viscosity of the insecticide solution or emulsion. Others produce an airblast that sucks the spray mixture from the tank, shears it into a fine insecticidal mist and projects it for several feet.

Mist applicators are available in a wide range of sizes and can be used to apply oil-based sprays or water emulsions. They have low manpower requirements and can apply small amounts of toxicant to a large area in a short time. Oil-based mists can be ignited by an open flame but are generally considered less hazardous than thermal fogs. Water-based mists have no fire or explosion hazards. When used outside, the insecticides may spot cars and windows. The oil may burn shrubbery if the machine is not properly operated.

Ultra Low Dosage (ULD)

ULD uses high concentrations of insecticide (as fine droplets) at reduced application rates. A very high percentage of the droplets are produced in the range of 1 to 30 microns with none exceeding 50 microns in size. The droplet size appears fairly uniform. Distribution and effectiveness depend on the production of very fine drops in much larger numbers than with conventional application methods. These very fine drops, however, are more subject to drift and tend to deflect around target insects instead of hitting and sticking to them.

There are many makes, models and sizes of ULD applicators available. Some have fixed nozzles, while others have remote nozzle hose assemblies. They may be powered by electric motors, gasoline engines or by compressed gases (pressurized aerosols). In the electric- and gas-powered units, the insecticide is drawn into the nozzle and forced out at high speed, producing small droplets. A supercharger usually produces pressure in these units. Follow the manufacturer's directions to obtain the desired range of droplet size. Both oil- and water-based formulations are available for use in this equipment.

ULD treatments provide good flushing action for cockroaches, but should be used after first making a residual treatment. Since ULD involves the use of higher than normal concentrations and lower than normal application rates, this information must appear as a part of the labeling to avoid misuse of the product. At this time, the number of insecticides registered for ULD use is limited.

The disadvantages of ULD in comparison to conventional space sprays are poor residual life, chemical slick if oversprayed, poor results in ventilated areas, the necessity of wearing protective equipment, a certain degree of fire and explosion hazard compared to conventional space sprays and the necessity of applying at a time when the area is unoccupied. If a gasoline-powered spray unit is used, the additional disadvantages of carbon monoxide and noise may be a factor. Because droplet size is critical, maintain the equipment and operate at specific pressures and flow rates.

The advantages of ULD include shorter treatment time and lower fire and explosion hazard

than with foggers. Other more debatable advantages include deeper penetration, more thorough flushing action and more effective use of the insecticide.

Information provided by the manufacturer for care and maintenance of equipment should be consulted. The following general considerations and safety recommendations for using fine droplet-dispensing machines may also be useful.

- Maintain the equipment well. The engine should run evenly at the proper speed. Keep the engine well tuned. The flow rate or pressure must be correct.
- Allow use only by an experienced operator trained in safe and effective use.
- Keep insecticides and solvents at room temperature. Low temperatures (less than 50 degrees F) increase viscosity and cause larger droplets to form, resulting in poorer control and a tendency to create oil slicks on horizontal, hard-finished surfaces.
- Direct the insecticide into harborage areas for maximum penetration and greatest contact with the pests.
- Reduce airflow and air currents in treatment area by closing doors and windows to allow droplets to stay in suspension longer.
- Shut off the ventilation system.
- Turn off smoke alarms.
- Do not use more than one gallon of oil solution to 50,000 cubic feet of space.
- If using gasoline engines: Start engines and generators outside if possible. Keep engine mufflers, exhaust pipes and the hot tip of the generator away from combustible materials and items that might be damaged.
- If using oil-based materials: Extinguish all flames and pilot lights. Use only those diluents approved by the machine manufacturer. Notify local fire authorities. Have a fire extinguisher handy.
- Use only materials and formulations registered for use in your application equipment.
- Keep the treated area closed and secured for as long as specified on the label.
- After the treatment and exposure period has been completed: Open doors and windows. Remove any seals. Ventilate thoroughly (30 minutes or longer) as specified on the label. Inspect and clean up. Remove warning signs. Turn on utilities that were shut off, making sure that all pilots are relit.
- Use after residual treatment for crawling insects.
- Follow label instructions.
- Follow safety precautions: Remove occupants, pets and birds. Cover or remove plants and aquariums. Remove food or place it in tight containers. Cover food preparation surfaces or clean after treatment. Wear an approved respirator and goggles. Applicators should work in pairs and in sight of one another in large buildings if the machine is operated indoors. Post warning signs at all entrances.

Fine droplet-dispensing equipment requires continuous maintenance because the equipment is costly and because it will not dispense correct particle sizes and dosages unless properly maintained.

Keep instructional materials, diagrams and other information supplied by the manufacturer readily available. Consult this literature for instructions when you disassemble equipment during maintenance or repair.

All moving parts of fine droplet-dispensing equipment should be routinely inspected, cleaned and lubricated if necessary. Give particular attention to those parts that regulate calibration or droplet sizes to ensure they are in good working order.

Foggers and heat generators require special attention. The high degree of heat in these machines causes a carbon formation from the insecticide formulation, which must be removed regularly to prevent interference with the normal flow of insecticide through the machine. Remove carbon immediately after each use before it hardens or builds up into a thick layer. Heated carbon particles could dislodge and start a fire. It is especially important not to damage any portion of the heat chambers or any small orifices that may be present.