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Pesticides and Pesticide Formulations

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A pesticide is any chemical which is used by man to control pests. The pests may be insects, plant diseases, fungi, weeds, nematodes, snails, slugs, etc. Therefore, insecticides, fungicides, herbicides, etc., are all types of pesticides.

A pesticide chemical can rarely be used as originally manufactured. Typically, the pesticide must be diluted with water, oil, air or a chemically inactive (inert) solid so that it can be handled by application equipment and spread evenly over the area to be treated.

In addition, in most cases the basic active ingredient cannot be added directly to water or mixed in the field with solids, so the manufacturer must further modify his product by combining it with other materials such as solvents, wetting agents, stickers, powders, or granules. The final product is called a pesticide formulation and is ready for use either as packaged or diluted with water or other carriers.

Goals of This Module

- Learn the different types of labeled pesticides.
- Be able to determine what type of pesticide should be used to control different pests.
- Understand that different pesticides attack pests in different ways and that these differences require that pesticides are used according to label directions.
- Learn the definitions and abbreviations for types of formulations.
- Determine what to consider in choosing the best formulation and when to use it.
- Understand the dangers of these formulations and the steps taken to protect yourself.

Choosing the right formulation can make the difference between a successful control job or a failed application that does more harm than good.

If you must use a pesticide, be sure you know which type of pesticide you need to use, as well as how and when to apply it effectively.

Some pesticides must only contact (touch) the pest to be deadly. Others must be swallowed to be effective. The way that each pesticide attacks a pest suggests the best way to apply it; to reach and expose all the pests. For example, a pesticide may be more effective and less costly as a bait, rather than as a surface spray.

Insecticides

Insecticides are chemicals used to control insects. Often the word "insecticide" is often used synonymously. with the word "pesticide." An insecticide, however, is just one of many different types of pesticides. An insecticide may kill the insect by touching it or it may have to be swallowed to be effective. Some insecticides kill both by touch and by swallowing. Systemic insecticides may be absorbed, injected, or fed into the plant or animal to be protected. When the insect feeds on this plant or animal, it ingests the systemic chemical and is killed.

Spectrum of activity

Insecticides vary in the numbers of different kinds of insects they kill. Some insecticides kill only a few kinds of insects. Sometimes you can choose these insecticides when you wish to kill only one insect pest and not harm other beneficial insects in the area. Many insecticides are general purpose or wide range killers. These "broad spectrum" insecticides target a wide range of insects and are used when several different kinds of insects are a problem. One chemical can kill them all. No broad spectrum insecticide will kill all insects; each varies as to the kinds of insects it controls.

Narrow Spectrum. While many insecticides are broad spectrum, killing a wide variety of insects by attacking a system common to all, such as the nervous system, many newer insecticides are much more selective. The chitin inhibitors only affect animals with chitin in their exoskeleton (i.e. insects). Growth regulators are even more specific. They affect certain groups of species that have a particular hormone. Finally, pheromones are the most restrictive because they react with only one species or one sex of a single species.

Chitin synthesis inhibitors interfere with the development and molting of immature insects causing their death. Chitin is the primary structural chemical in an insect's body wall. An immature insect treated with a chitin inhibitor dies the next time it attempts to molt.

Insect growth regulators or IGRs mimic the action of an insect's naturally occurring juvenile hormone. They interfere with certain normal processes and prevent immature insects from completing development into normal reproductive adults. The effects of IGRs on insects include abnormal molting, twisted wings, loss of mating behavior, and sometimes death to embryos in eggs. Since IGRs attack a growth process found only in insects, there is a great margin of safety for humans and other vertebrates. However, one disadvantage is that growth regulators act slowly, since they do not kill the insect until it molts into an adult.

Pheromones are naturally produced chemicals used by insects to communicate to each other. There are three basic types of pheromones. Aggregation pheromones attract many individuals together, for example, a site where food may be plentiful. Sex pheromones are used by one sex of a species to attract a mate. Trail pheromones are deposited by walking insects, such as ants, so that others can follow. Synthetic pheromones produced in laboratories mimic these natural chemicals. They are used to attract pest insects into traps, disrupt mating, and monitor populations of insects. Because they do not kill insects, they are often not considered to be pesticides.

Short Term vs. Residual

Insecticides also vary in how long they remain active in the environment. Some break down almost immediately into nontoxic by -products. These "short term" chemicals are very good in situations where the insects do not return or where long-term exposure could injure non-target plants or animals. For example, short-term insecticides are often used in homes and dwellings where people and domestic animals might be exposed. Other insecticides remain active killers for a fairly long period of time. These "residual" pesticides are useful when the insects are a constant problem and where they will not be an environmental and/ or health hazard. For example, residuals are often used for fly control in livestock buildings or for termite control in wooden structures.

Miticides and Acaricides

Miticides (or Acaricides) are chemicals used to control mites (tiny spider-like animals) and ticks. The chemicals usually must contact the mites or ticks to be effective. These animals are so numerous and small, that great care must be used to completely cover the area on which the mites live. Miticides are very similar in action to insecticides and often the same pesticide kills both insects and mites. The terms "broad spectrum," "short term," and "residual" are also used to describe miticides.

Fungicides

Fungicides are chemicals used to control the fungi which cause molds, rots, and plant diseases. All fungicides work by coming in contact with the fungus, because fungi do not "swallow" in the normal sense. Therefore, most fungicides are applied over a large surface area to try to directly hit every fungus. Some fungicides may be systemic in that the plant to be protected may be treated or injected with the chemical. The chemical then moves throughout the plant, killing the fungi.

Protectant vs. Eradicant. There are two basic approaches in the use of fungicides. One is designed to prevent the plant from being infected by the disease. These fungicides are used as "protectants" and provide a barrier around the plant. They must be applied before the disease gets a start. This type of fungicide is very useful when a particular disease or group of diseases are likely to attack a plant or crop, year after year. Protectants, for example, are often used as a routine precaution on fruit and vegetable crops when conditions are conducive for disease development.

Most protectant fungicides are fungistatic. This means they prevent or inhibit fungal growth. Once the fungistatic action ceases, the controlled fungus may grow again or produce spores. Thus, protectant fungicides must be applied at regular intervals before infection occurs to continue to protect the plant from fungal diseases. In addition, any new growth which occurs after the application of the protectant fungicide will also not be protected.

The other type of fungicide kills the disease after it appears on (or in) the plant. These fungicides, called "eradicants," and have the ability to cure diseases after infection occurs. Unfortunately, eradicants are less common than protectants because once the fungus is established in a plant, it is often difficult to destroy. Eradicants are often used when protectants aren't available, aren't applied in time, or are too expensive. Eradicants are also applied when the disease appears unexpectedly on a plant or in an area. Eradicants typically must be applied within a short time after infection occurs during early stages of disease development to be most effective.

For example, a common use is on fruit and vegetables when the protectant spray wasn't applied on time to prevent infection. Eradicants are also used by orchardists in combatting certain diseases of fruit trees, such as apple scab.

Herbicides

Herbicides are chemicals used to control unwanted plants. These chemicals are a bit different from other pesticides because they are used to kill or slow the growth of some plants, rather than to protect them. Some herbicides kill every plant they contact, while others kill only certain plants.

Nonselective herbicides are toxic to all plants. These are often used when no plants are wanted in an area. For example, nonselective herbicides could be used for clearing under guardrails or for total control of weeds in industrial areas.

Selective herbicides kill some plants with little or no injury to other plants. Usually selective types will kill either broadleaved plants or grassy plants. These are useful for lawns, golf courses or in areas with desirable trees. Some very selective herbicides may kill only certain plants in a group; for example, crabgrass killers on lawns.

Preplant vs. Preemergence vs. Postemergence.

The timing of an herbicide application is important. Care must be used to get the job done effectively without injuring desirable plants. The directions on the label tell you when to apply the herbicide for best results. Preplant treatments are made before the crop is planted. These chemicals may be used in seed beds or incorporated into the soil before planting.

Any treatment made before the crop and weed appears is called preemergence. The application may be made before both the crop and weeds appear, or after the crop appears but before the weeds appear. The label or directions will state "preemergence to the crop," "preemergence to the weeds," or "preemergence to both crop and weeds."

When the herbicide treatment is made after the crop or weeds appear, it is called postemergence. Postemergence applications must be very selective. They must control the weeds but leave the crop unharmed. Sometimes, the chemical will be applied postemergent to the crop but preemergent to the weeds.

Growth Regulators and Harvest Aids

A plant growth regulator (or plant regulator) increases, decreases or changes normal growth or reproduction in a plant. Fertilizers and other nutrients are not included. Some growth regulators are used to move up or move back the normal harvest date for the crop. Others are used to obtain better quality and/or yield of the crop. Electric power utilities use growth regulators to slow the growth of a tree threatening power lines, thus reducing pruning costs.

Defoliants and desiccants are pesticide materials generally referred to as harvest aids. A defoliant causes the leaves of a plant to drop off early, but does not kill the plant. A desiccant draws moisture from a plant, killing the plant foliage.

While these chemicals not strictly pesticides in the truest sense of the word as they are not toxic and do not kill their target, under Florida Pesticide Law, growth regulators, defoliants and desiccants are treated as pesticides.

Rodenticides

Rodenticides are chemicals used to control rats, mice and other rodents. Chemicals which control other mammals, birds, and fish are also grouped in this category by regulatory agencies. Most rodenticides are stomach poisons and are often applied as baits. Even rodenticides which act by contacting the pest are usually not applied over large surfaces because of the hazard to domestic animals or desirable wildlife. They are usually applied in limited areas such as runways, known feeding places, or as baits.

Nematicides

Nematicides are chemicals used to control nematodes. Nematodes are tiny microscopic round worms, many of which live in the soil and feed on plant roots. Very few of these worms live above ground. Usually, soil fumigants are used to control nematodes in the soil. However, a few contact insecticides and fungicides are also effective against these tiny worms.

Molluscicides

Molluscicides are chemicals used to control snails and slugs. Usually the chemicals must be eaten by the pest to work. Baits are often used to attract and kill snails or slugs in an area.

Repellents

A repellent is a pesticide that makes a site or food unattractive to a target pest. They are registered in the same way other pesticides are and must be used according to the label. Insect repellents are available as aerosols and lotions and can be applied to skin, clothing, or plants to repel biting and nuisance insects. Vertebrate repellents are available as concentrates to be mixed with water, powders, and granules. They can be sprayed or painted on nursery crops, ornamental plantings, orchards, vineyards, vegetables, and seeds. Repelling deer, dogs, birds, raccoons, and others animals can protect sites from damage.

Types of Formulations

Pesticide chemicals in their "raw" or unformulated state are not usually suitable for pest control. These concentrated chemicals and active ingredients may not mix well with water, may be chemically unstable, and may be difficult to handle and transport. For these reasons, manufacturers add inert substances, such as clays and solvents, to improve application effectiveness, safety, handling, and storage. Inert ingredients do not possess pesticidal activity and are added to serve as a carrier for the active ingredient. Manufacturers will list the percentage of inert ingredients in the formulation or designate them as "other ingredients" on their labels. There are several inert substances, such as petroleum distillates and xylene, which will have a specific statement identifying their presence in the formulation. The mixture of active and inert ingredients is called a pesticide formulation. This formulation may consist of:

- The pesticide active ingredient that controls the target pest
- The carrier, such as an organic solvent or mineral clay
- Adjuvants, such as stickers and spreaders

Other ingredients, such as stabilizers, safeners, dyes, and chemicals that improve or enhance pesticidal activity

A single pesticide active ingredient may be sold in several different formulations. The applicator should choose the formulation that will best meet his requirements for a particular job. Considerations in making a choice include effectiveness against the pest, habits of the pest, the plant, animal or surface to be protected, application equipment, danger of drift and runoff, and possible injury to the protected surface.

Usually a formulated product is mixed with water or oil for final application. Most baits, granules, gels, and dusts, however, are ready for use without additional dilution. Manufacturers package many specialized pesticides, such as products for households, in ready-to-use formulations (Figure 2).

A single active ingredient often is sold in several kinds of formulations. Abbreviations are frequently used to describe the formulation (e.g., WP for wettable powders); how the pesticide is used (e.g., TC for termiticide concentrate); or the characteristics of the formulation (e.g., ULV for an ultralow-volume formulation). Common abbreviations and their interpretations are listed in Table 1. The amount of active ingredient (a.i.) and the kind of formulation are listed on the product label. For example, an 80% SP contains 80 percent by weight of active ingredient and is a "soluble powder." If it is in a 10-pound bag, it contains 8 pounds of a.i. and 2 pounds of inert ingredient. Liquid formulations indicate the amount of a.i. in pounds per gallon. For example, 1E means 1 pound, and 4E means 4 pounds of the a.i. per gallon in an emulsifiable concentrate formulation.

If you find that more than one formulation is available for your pest control situation, you should choose the best one for the job. Before you make the choice, ask several questions about each formulation. For example:

- Do I have the necessary application equipment?
- Can the formulation be applied appropriately under the conditions in the application area?
- Will the formulation reach the target and stay in place long enough to control the pest?
- Is the formulation likely to damage the surface to which you will apply it?
- Could I choose a less hazardous formulation that would still be as effective?

To answer these kinds of questions, you need to know something about the characteristics of different types of formulations and the general advantages and disadvantages of each type.

Abbreviations are often used to describe the type of formulation involved. These abbreviations are used on labels and in recommendations. Some of the common ones are: WP for wettable powder; F for flowable; G for granules or granular; D for dusts; SP for soluble powder; EC for emulsifiable concentrate; and SC for spray concentrate.

Aerosols (A)

Aerosols are typically sold in pressurized cans which contain a small amount of pesticide, or a combination of pesticides that are driven through a fine opening by a chemically inert gas under pressure, when the nozzle is triggered. Usually they are small, weighing about one pound.

Advantages. Aerosols are very convenient in that they are always ready to use. They are also a convenient way to buy small quantities of a pesticide. They are easily stored and the pesticides do not degrade or lose potency while in the can during their normal period of use.

Disadvantages. Aerosols are only practical for use in small areas. There is not much active ingredient in any one can. Because of this, it is an expensive way to buy pesticides. Unfortunately, they are also attractive playthings for small children and, if left within reach, can be a hazard. Aerosols can also be dangerous if punctured or overheated. They may explode and injure someone. Don't ever try to burn aerosol cans.

Aerosols are most often used in households, backyards, tents and other small areas. They are typically used either as space sprays for flying insects or as residual sprays

Dusts (D)

A dust is a finely ground, dry mixture combining a low concentration of the pesticide with an inert carrier such as talc, clay, or volcanic ash. There is a wide range in size of the dust particles in any one formulation. Advantages. Dusts are ready to use as purchased and require no mixing. They can be applied with simple, lightweight equipment even in commercial use.

Disadvantages. Because dust particles are finely ground, they may drift long distances from the treated area and may contaminate off target areas. While drifting they are highly visible and may cause public criticism. When used outside, they are easily dislodged from the treated surface by wind and rain and soon become inactive. Dust formulations should never be applied on a windy day.

Principal Uses. Because of drift, dusts are not recommended for large scale outside use. Outside they are used principally for spot treatments and home gardens. They work best when applied to dewy surfaces in the early morning. Inside, they are used in cracks and crevices for roaches and other domestic insects. Dusts are also used to control lice, fleas, and other external parasites on pets and livestock.

Baits

A bait is a food or other substance mixed with a pesticide that will attract and be eaten by pests and eventually cause their death.

Advantages. Baits are useful for controlling pests such as flies, rats, etc., that range over a large area. Often the whole area need not be covered, just those spots where the pests gather. Baits may be carefully placed in homes, gardens, granaries, and other agricultural buildings so that they do not contaminate food or feed, and can be removed after use. Usually only small amounts of pesticide are used in comparison to the total area treated, so potential environmental pollution is minimized.

Disadvantages. Within the home, baits are often attractive and dangerous to children or pets and therefore must be used with care. Outside, they may kill domestic animals and wildlife as well as the pest. Often the pest will prefer the protected crop or food rather than the bait, so the bait may be ineffective. When larger pests are killed by baits, the bodies must be disposed of. If not, they may cause an odor and/or sanitation problem. Unfortunately, other animals feeding on the poisoned pests can also be poisoned.

Principal Uses. Baits are used inside buildings for pests such as ants, roaches, flies, rats, and mice. They may be used outside in gardens for control of slugs, in dumps and similar areas for rat control, and in fields to control slugs and insects.

Granules (G)

Like dusts, pesticide granules are dry, ready-to-use, low concentrate mixtures of pesticide(s) and inert carriers. However, unlike dusts, almost all of the particles in a granular formulation are about the same size and are larger than those making up a dust. A fine granular pesticide pours like ordinary salt or sugar.

Advantages. Granules are ready to use as purchased, with no further mixing necessary. Because the particles are large, relatively heavy, and more or less the same size, granular products drift less than most other formulations. There is little toxic dust to drift up to the operator's face and be inhaled by him. They can be applied with simple, often multi -purpose equipment such as seeders or fertilizer spreaders. They also will work their way through dense foliage to a target underneath.

Disadvantages. With a few exceptions, granular products are not suitable for treating foliage because they will not stick to foliage. In addition, some granular products require rain of moist soil to activate the pesticide.

Principal Uses. Granular pesticides are often used for soil treatments to control pests living at ground level or underground. Some may be systemic in nature, that is, they are absorbed into the plant through the roots and carried throughout the plant. Granular herbicides and/ or insecticides are frequently applied in combination with fertilizers on turf, thereby saving labor. Granular formulations may be the choice when applied by agricultural aircraft where drift is a problem, or when treating water for mosquitoes where there is a heavy foliage cover over the water.

Ready-To-Use (RTU)

These preparations are usually solutions in highly refined oils that contain low concentrations of the pesticide. They are generally used as purchased.

Advantages. Low concentration solutions are designed to be sprayed as purchased. Because of this, no mixing is necessary and this lessens the chances for making mistakes. Household formulations have no unpleasant odors and usually the liquid carrier evaporates quickly and does not stain fabrics, furniture, etc.

Disadvantages. Low concentration ready-to-use formulations are usually fairly expensive for the amount of actual pesticide bought and the uses for such materials are few and specialized. Ready-to-use formulations are most often sold over the counter for residential use.

Principal Uses. Low concentrate solutions may be used in the household for flying or crawling insects and for mothproofing clothes. In barns they are used as space sprays and fly sprays for livestock. They are also used as prepared sprays for mosquito control and shade tree insect control.

Emulsifiable Concentrates (EC)

These preparations are usually solutions containing a high concentration of the pesticide. Most of them are designed to be mixed with water or oil and contain wetting agents, stickers, and other additives. They may contain as much as eight or more pounds of a pesticide per gallon of concentrate.

Advantages. These formulations contain a high concentration of pesticide, so the price per pound of active ingredient is rather low. Only moderate agitation is required in the tank, so they are especially suitable for low -pressure, low-volume weed sprayers, mist blowers, and small home ground sprayers. They are not abrasive and do not settle out when the sprayer is not running. There is little visible residue, which generally allows their use in populated areas. Because of the high pesticide content, the applicator is not required to store, transport, or handle a large bulk of chemical for a particular job.

Disadvantages. It is easy to underdose or overdose because of the high concentration of pesticide, if directions for mixing are not carefully followed. Mixtures of emulsifiable concentrates may be phytotoxic. Also, because of the high concentration and liquid form, which is usually easily absorbed through the skin, there may be hazard to the applicator. The hazard of improperly stored concentrates can also be high. Because of their solvents, most liquid concentrates cause rubber hoses, gaskets, and pump parts to deteriorate rapidly unless they are made of neoprene rubber. Some formulations cause pitting of vehicle finishes.

Principal Uses. High concentrate liquids can be diluted and used in many ways on fruit, vegetables, ornamentals, for residual sprays on farm animals, for structural pests. They are adaptable to many types of application equipment ranging from household sprayers to dilute hydraulic sprayers, low-volume ground sprayers, mist blowers, low volume agricultural aircraft sprayers, and ultra-low volume sprayers.

Flowables (F)

Some pesticides can be manufactured only as solid materials, not as liquids. Often these pesticides are formulated as flowables. Flowables are made from very finely ground solid materials, which are suspended in a liquid. In this form, they can be mixed with water and applied. Flowables are similar to emulsifiable concentrates and are used in the same way. Flowables do not usually clog nozzles and require only moderate agitation.

Wettable or Soluble Powders (WP or SP)

Wettable powders and soluble powders are dry preparations containing a relatively high concentration of pesticides. Wettable powders are mixed with water to form suspensions. Soluble powders dissolve in water to form solutions. The amount of pesticide in these powders varies from 15% to 95%.

Advantages. As is true with liquid concentrates, the pesticides in wettable powders are relatively low in cost and easy to store, transport, and handle. They are safer to use on tender foliage and usually do not absorb through the skin as rapidly as liquid concentrates. They are easily measured and mixed when preparing spray suspensions. Soluble powders dissolve in water forming a true solution and do not require agitation.

Disadvantages. Wettable powders may be hazardous to the applicator if he inhales their concentrated dust while mixing. They require good agitation (usually mechanical) in the sprayer tank and will settle quickly if the sprayer is turned off. They cause some pumps to wear out quickly. Their residues are more subject to weathering than liquid concentrates, and being more visible may soil cars, windows, and other finished surfaces. Unfortunately, since most pesticides are petroleum based, very few pesticide active ingredients are soluble in water and hence there is only a limited number of soluble powder formulations available.

Principal Uses. Liquid concentrates and wettable powders are the formulations most widely used by commercial applicators. Like liquid concentrates, wettable powders can be used for most pest problems and in most spray machinery. Where toxicity to the plant or absorption through the skin of an animal is a problem, use a wettable powder suspension rather than a liquid emulsion or solution of the pesticide.

Fumigants

Fumigants are pesticides in the form of poisonous gases that kill when absorbed or inhaled.

Advantages. A single fumigant may be toxic to many different forms and types of pests. Therefore, a single treatment with one fumigant may kill insects, weed seeds, nematodes, and fungi. Fumigants penetrate into cracks, crevices, burrows, partitions, soil, and other areas that are not gas tight and expose hidden pests to the killing action of the pesticide.

Disadvantages. The area to be fumigated almost always must be enclosed. Even in outdoor treatments the area must be covered by a tarp or the fumigant incorporated into the soil, so that it doesn't escape. Frequently, fumigants are highly toxic. Proper techniques and all recommended protective gear must be used when applying them. Most fumigants burn the skin.

Principal Uses. Fumigants are used inside dwellings or other buildings to control vermin that cannot easily be reached by other pesticide formulations. They are used in ports of entry and at state borders for treatment of plants and other materials to prevent the introduction of new pests into an area. Stored grain pests are often controlled by fumigants. In vegetable production, soil is often fumigated to control a wide range of weeds, pests and diseases before planting.

Growers and pesticide users should familiarize themselves with the different types of pesticides and formulations that are available as well as the advantages and disadvantages of each. The pesticide user must consider several factors when selecting a pesticide formulation, such as the risks associated with the formulation type, the practicality of using the formulation on the target site or pest, and whether it will provide effective control. Having a basic understanding of formulation types before using pesticides helps the user avoid mistakes and accidents in choosing, mixing, loading, and applying the product.

Choosing the right pesticide and the right formulation can make the difference between a successful control job or a failed application that does more harm than good.

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