UK COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY — COLLEGE OF AGRICULTURE

Pesticide Applicator Training Manual

Pesticide Sales Agent

Category 12

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INTRODUCTION

This publication, along with the manual Applying Pesticides Correctly, provides the information needed to meet the minimum standards for certification in Category 12, Pesticide Dealer. Individuals certified in this category not only provide recommendations and disseminate information on pesticides and pest control but also must be very knowledgeable on regulations that affect pesticide applicators. A broad knowledge of pesticide issues and topics is vital.

PESTICIDE LAWS AND REGULATIONS

Laws governing the use and users of pesticides are designed to protect humans and the environment. Early pesticide regulations were of two types:

1. Those concerned with residues or adulteration of food by use of pesticides
2. Those concerned with registration of pesticides to protect the purchaser from substandard and fraudulent products.

These early laws were replaced in 1947 by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which was administered by the US Department of Agriculture until 1971. This Act required proper labeling of all pesticides, including herbicides. It did not cover products that were manufactured and sold within only one state.

The Environmental Protection Agency (EPA) was established in 1970 to deal with environmental issues; most pesticide regulatory responsibilities were transferred to them. FIFRA was amended in 1972 by the Federal Environmental Pesticide Control Act (FEPCA). Some of the important provisions of the "amended FIFRA" were:

- All pesticides, including those sold in only one state, had to be registered with the Federal government.
- The pesticide label was established as a legal document.
- Established pesticide use classifications.

Restricted Use Pesticides (RUP) are materials that can cause adverse effects on the applicator or the environment, even when used according to label directions.

Restricted Use Pesticides legally can be purchased and applied only by persons who have had special training as certified applicators, or those who work under their direct supervision.

General Use Pesticides (GUP) are materials that have a low potential to harm the applicator or the environment when used according to label instructions. Persons who purchase and use these products do not need to be certified applicators.

The Pesticide Applicator Training and certification program was established and types of applicators were defined as follows:

A Certified Applicator is anyone who is authorized to use Restricted Use pesticides. Certified applicators can provide pest control services but neither sell nor distribute pesticides.

There are two types of certified applicators:

1. **Private applicators** are those who use or supervise the use of any Restricted Use pesticide to produce any agricultural commodity on owned or rented property or on that of an employer. The applicator may apply Restricted Use products on the property of someone else only by trading personal services. No other compensation may be received.

2. **Commercial applicators** are those who use or supervise the use of Restricted Use pesticides for any purpose or on any property other than as defined for private applicators.

Kentucky Division of Pesticides
Chapter 217, 217B
Pesticides Use and Application

The main responsibility of the Kentucky Division of Pesticides is to regulate pesticides and their use in the Commonwealth. The Division is the prime pesticide enforcement agency under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA0). FIFRA sets standards of regulation for the marketing and use of pesticides and requires the certification of commercial

applicators and dealers. Under FIFRA the pesticide label is law. Therefore, once ground water or any other restrictions are placed on the label of a pesticide, then enforcement from the State Division of Pesticides is required. The Division of Pesticides has the authority to ensure that pesticide applicators follow EPA approved label instructions.

In addition, the Pesticide Use and Application Act Kentucky Revised Statute Chapter 217B empowers the Kentucky Department of Agriculture to regulate and control pesticides to ensure their intended and beneficial use. The Department has the authority to prohibit or restrict the application for a pesticide. Violations of the pesticide use act and regulations are stopped by issuing a written Stop Sales, Use, or Removal on the pesticide, involved in accordance with Kentucky Revised Statute 217.610

Kentucky Pesticide Control – Pesticides Control KRS 217.542 - 217.670 addresses prohibitions relating to the distribution of pesticides and their registration. Pesticides must be registered before they can be sold or used in the state. The regulations require that pesticide product labels are to be registered, provided that such regulations shall not impose any requirements for federally registered labels in addition to, or different from those required pursuant to FIFRA. Also, the department may inspect pesticides wherever found.

It may sample and analyze to determine compliance with the KRS 217.542 - 217.670 and any regulations adopted under those sections.

Also any lot of pesticides not in compliance and subject to seizure on complaint by court consent can be condemned and disposed of if found in violation as stated in KRS 217.620

Kentucky Pesticide Use and Application Act – This act regulates the distribution, use, and application of pesticides to pests as defined by KRS Chapter 217B. It recognized the importance of pesticides relative to human health and the environment, including farmlands, from insects, rodents, weeds and other life forms that may be detrimental to farming. However, if these pesticides are used improperly, they present a potential danger to human and animal health and the environment. The purpose of KRS Chapter 217B is to regulate in the public interest the use and application of insecticides, fungicides, and any other pesticides designated by the Department by regulation.

KRS 217B.050 empowers the Kentucky Department of Agriculture to prohibit the use of a pesticide in a given area once certain conditions have been met. It states:

- The Department shall administer and enforce the provisions of this chapter and issue regulations to carry out the provisions of this chapter and in such regulations may prescribe methods to be used in the application of pesticides. Where the department finds that such regulations are necessary to carry out the purpose and intent of this chapter, such regulations may relate to the time, place, manner, and method of application of the pesticides, may restrict or prohibit use of pesticides in designated areas during specified periods of time and shall encompass all reasonable factors which the department deems necessary to prevent damage or injury by drift or misapplication to:

  - Plants, including forage plants, on adjacent or nearby lands.
  - Wildlife in the adjoining or nearby areas.
  - Fish and other aquatic life in waters in reasonable proximity to the area to be treated.
  - Pollinating insects, animals, or persons.

- In issuing such regulations, the department shall give consideration to pertinent research findings and recommendations of other agencies of this state and/or of the federal government.

- The department may by regulation adopt a list of "restricted use pesticides" for the state or for designated areas within the state if it finds that the characteristics of such pesticides require restricting their use to prevent injury on lands other than the land to which they are applied or to persons, animals, crops, pests, or vegetation other than the pests or vegetation which they are intended to destroy. For the purpose of uniformity of requirements between the states and the federal government, the department may adopt this list of "restricted use pesticides" as established by the Environmental Protection Agency or other federal or state agencies.

- The department may establish additional

classifications of applicator licenses as required for compliance with the Federal Environmental Pesticide Control Act of 1972. Such classifications may include private farmer applicators, commercial establishments applicators and government employee applicators not specifically mentioned in this chapter. Such regulations may specify licensing conditions, procedures and fees not to exceed those fees specified for other
licensees under this chapter.

In addition, education and dissemination of information is provided for under KRS 217B.210, and is addressed as follows:

Information and Education – Revision of license examinations, training courses and other materials.

1. The department may publish information and conduct short courses of instruction in the safe use and application of pesticides.
2. The department shall, at least once each year, review and update, to incorporate current information, the license examinations given by the department and all training courses approved by the department.
3. The department shall revise the license applications given by the department, all training courses approved by the department, and all educational materials to include information on preventing contamination of ground water.

Selected Highlights of the Kentucky Pesticide Use and Application Act

- Pesticide dealers must be licensed annually with a separate license for each location or outlet where Restricted Use pesticides are distributed. All licenses expire on December 31 of the year of issue.

- Dealers licenses may be renewed annually without examination unless the Department of Agriculture determines that new knowledge requires an examination.

- The Department of Agriculture may suspend a dealers license for up to 10 days. After opportunity for a hearing, it may deny, suspend, revoke, or modify the license.

- Dealer records shall include but are not limited to:

  < Brands and amounts of R U pesticides sold.
  < Name address and certification number of buyers.

Records must be kept for 2 years from the time of sale.

The dealer is responsible for actions of every employee in solicitation, sale and in all claims and recommendations for use or application of Restricted Use pesticides.

Pesticide Registration

As specified by the amended FIFRA, all pesticides must be registered. Before any registration is issued, however, the manufacturer must submit data to EPA showing that the product, when used as directed:

- will not injure humans, animals, crops or damage the environment;
- and will not result in illegal residues on feed and food.

Among the types information required are:

< Chemical specifications including physical-chemical properties.
< Conditions of use.
< Analytical methods to detect residues and residue data.
< Oral exposure data from rats or mice and signs or symptoms of toxicity.
< Dermal exposure, usually from 2 species including eye and inhalation studies.
< Wildlife toxicity data including 8 day feeding exposure to pheasant, Pekin or mallard duck, and quail and data from 96 hour exposure to bluegills, trout and catfish.
< Two year feeding studies, usually on rats and dogs, which include 3 dose levels with clinical and laboratory tests and with gross and microscopic examinations for changes including carcinogenicity.
< A two or three generation reproductive test where rats or mice are fed the material at 3 dose levels with observations for teratogenic, mutagenic, and neurotoxic effects and with microscopic examination of the final litter.

The data submitted to EPA with the application for registration are carefully analyzed. Some of the areas taken into account are: the pesticide's response in the environment including rate and type of decomposition following application; amount of movement and persistence in the soil, air or water; effect of light and rain on the pesticide as well as potential effect they (pesticides) will have on man, animal and plant life.

Registration for a single product requires several years and millions of dollars in developmental costs. Only a fraction of the materials investigated by industry actually make it through the process and enter the market place.

Establishing A Legal Residue Tolerance

A residue is the amount of pesticide present following an application. The potentially detrimental health effects of these residues are a major concern. The EPA establishes a tolerance for each pesticide on each food crop before registration for use. The tolerance, usually expressed in parts per million (ppm), is the maximum amount of a pesticide residue that legally can be present on or in feed or foods.

EPA studies and analyzes the manufacturers data in order to set tolerance levels. EPA attempts to determine whether or not the pesticide residues remaining when the product is used as directed will exceed the level that is considered as safe for human consumption.

A No Observable Effect Level (NOEL) is determined through long term feeding studies with laboratory animals. It is the dosage of a pesticide that results in no distinguishable harm. This value, in parts per million (ppm) is then used to set the Acceptable Daily Intake (ADI).

The ADI is defined as the daily exposure level of a pesticide residue which, during the entire life of a person, appears to have an acceptable risk of causing harm. The ADI is usually set 100 times lower, or 1/100th, of the NOEL. A much greater safety factor is required if there is evidence that the pesticide increases the incidence of tumors in test animals.

If label directions are followed, the pesticide residues on a crop should be below the established tolerances. The chances of residues reaching, let alone exceeding, the ADI are very low. Residues usually are reduced even further by washing, peeling, and cooking. Information on pesticide residues in food is available through programs such as the Food and Drug Administration "market-basket" survey.

"In 1990, under regulatory monitoring, a total of 19,962 samples of domestically produced food from all 50 states and Puerto Rico and imported food from 92 countries were analyzed by the FDA for pesticide residues. Of these, 19,146 were surveillance samples, which are collected when there is no suspicion of a pesticide problem. No residues were found in 60% of domestic surveillance samples and in 64% of import surveillance samples. Of the 19,146 surveillance samples, 2.8% were violative (above acceptable limits). Under the incidence/level aspect of monitoring, 172 samples of fish/shellfish, 330 samples of whole milk, and 3502 samples of processed foods including baby foods were analyzed for pesticide residues. Findings from these projects were consistent with the regulatory monitoring data. The findings of the 1990 Total Diet Study are evidence that actual dietary intakes of pesticides are generally well below the standards established by the Food Agriculture Organization/World Health Organization and by the EPA. The 1990 results are similar to those obtained in earlier years and demonstrate the continuing safety of the food supply relative to pesticide residues." (Summary from Residues in Foods 1990, FDA)

TYPES OF REGISTRATION

State Registration Requirements

Kentucky law requires EPA registered products to be registered also by the state. This state registration regulates the sale or use of a pesticide and is permitted by federal law as long as it does not allow any sale or use prohibited by FIFRA, or impose any requirements for labeling or packaging in addition to or different from those required by FIFRA. State laws can be more restrictive than FIFRA.

Pesticide Labels and Labeling

Pesticide labels and labeling are among the most important documents that pesticide applicators have. The label refers to any information printed on the product container. Labeling includes any information

that is attached to or accompanying the product at the time of purchase. The pesticide user is legally responsible to follow all label directions. Under the "Directions for Use" section of the label there usually is a statement that says: "It is a violation of Federal Law to use this product on a manner inconsistent with its labeling." The user is personally liable if a pesticide application results in damage.

While "the label is the law", some allowances are permitted. Under Section 2ee of amended FIFRA it is legal to:

- Apply a pesticide at any dosage, concentration (rate), or frequency less than that specified on the labeling unless the label prohibits the deviation.

- Apply a pesticide against any target pest not specified on the label if the crop, animal, or site is specified on the label and the label does not prohibit the use. (The Administrator of the EPA may require that the label specifically state that the pesticide may be used only for pests specified on the label. This can happen if he has determined that the use of the pesticide against other pests would cause an unreasonable adverse effect on the environment.)

- Use any method of application that is not prohibited by the labeling (e.g. do not apply in irrigation water or transplant water).

- Mix a pesticide or pesticides with a fertilizer when the mixture is not prohibited by the labeling.

- Apply according to uses authorized by Section 18 or 24-c registrations

- Apply according to uses which the Administrator of EPA determines to be consistent with amended FIFRA.

Registration for Minor or Specialty Crop Uses

The lack of registered pesticides for use on small acreage crops has become a frustrating problem. Many specialty crops cannot be produced economically or with the quality that markets demand without some use of pesticides. However, the registration process is costly. Gathering the additional data needed for registration increases the time required for developing a new product and obtaining the necessary information on tolerances and residues.

The relatively low financial return in proportion to effort and cost usually results in companies seeking registration of the pesticide only for large acreage crops (corn or soybeans), or crops that receive several applications each year (cotton or some fruits).

Before 1972, many minor or specialty crop uses of pesticides were taken care of by state registration of products from small companies that sold only within the state. Changes in FIFRA resulted in the loss of many minor or specialty crop uses. In addition, pesticides that were registered before 1972 now are going through a reregistration process that requires expensive data to keep old labels in effect. Many companies faced with the reregistration process have eliminated many low acreage or minor crops from their labels.

There are a few methods that have been established to help aid the minor or specialty crop use problems. Interregional Research Project No. 4) (IR-4) is a cooperative effort among the USDA, EPA, State Experiment Stations, and the pesticide industry to accumulate the data necessary to obtain minor use labels for currently registered pesticides. This may involve the addition of a new crop to the label or to allow changes in rate, timing, or application method.

For food or feed crops, the major task of the IR-4 project is to obtain a residue tolerance. This can only be done if there is at least one existing tolerance for the pesticide in question. The UK Agricultural Experiment Station cooperates with IR-4 projects. to

obtain pesticide minor uses for Kentucky growers.

State Local Needs (Section 24-c Labels)

Section 24 (c) of FIFRA permits the Kentucky Department of Agriculture to register federally registered pesticides for some uses that are not on the existing label. These 24-c or State Labels, are valid only in the state of issue. The applicator must possess a copy of the state label when the pesticide is applied. In Kentucky, 24-c labels must be renewed annually.

When there is an existing or expected local or minor pest problem, the Kentucky Department of Agriculture will be permitted to register one or more pesticide products if:

- There is no EPA-registered pesticide for the use in question.
- The EPA-registered pesticide is not available or cannot be obtained in sufficient quantity.
- There is an EPA-registered pesticide which, if used in accordance with the label, would not be safe or effective under the local conditions.

States cannot register:

- Pesticides on food crops that do not have an established tolerance on that crop.
- Pesticides containing active or inert ingredients not contained in any EPA-registered products.
- Pesticide products or uses affected by suspension or cancellation based on human health, environmental, or efficacy considerations.
- Pesticide products and/or uses previously denied registration by EPA.

Special local needs registrations may be sought by commodity groups, university, industry or others. The pesticide manufacturer or formulator must, however, be willing to support the effort and to prepare the documentation needed to justify the request. The registration is not effective for more than 90 days if disapproved by the EPA Administrator within that time.

Emergency Registration of Pesticides (Section 18 Labels)

"The Administrator of the EPA may, at is discretion, exempt any Federal or State agency from any provision of FIFRA, if he determines that emergency conditions exist which would require such exemption. The Administrator, in determining whether or not such emergency conditions exist,shall consult with the Secretary of Agriculture and the Governor of any state concerned if they request such determination" (FIFRA)

It is illegal to apply a pesticide unless it has the appropriate label for the use or purpose. Situations can occur for which there are no registered pesticides. For example, a serious outbreak of a new or previously minor pest may occur on a crop for which no registered pesticide is available. If it is a food crop and no tolerance exists for it, a state 24(c) label cannot be granted. FIFRA provides for the emergency use of pesticides in these situations.

A state may obtain permission to use an unregistered pesticide in an emergency situation when:

1. No effective registered pesticides are available to control the pest problem;
2. No feasible alternative control practices are available; and
3. The situation involves the introduction of a new pest or will present significant risks to human health or the environment or will cause significant economic loss.

FIFRA provides for three types of exemptions:

Specific Exemption

If a pest outbreak has occurred or is about to occur and no effective pesticides are registered for that use or purpose, the Kentucky Department of Agriculture may ask for an exemption to use a specific pesticide. Information including the nature, scope, and the frequency of the problem, the pest involved, which pesticide or pesticides will be used and in what amounts, the economic benefits anticipated, and an analysis of possible adverse effects must be supplied to the EPA, wihch grants the exemptions. Reports

must be filed when the treatment is over. A specific exemption is only good for a specified amount of time and for a designated area.

Quarantine or Public Health Exemption

This exemption may be granted to prevent the introduction or spread of a foreign pest into or throughout the US or to prevent a public health problem. No pesticide that has been suspended by EPA may be used.

Crisis Exemption

A crisis exemption may be used if a registered pesticide is not readily available to control or eradicate the pest and if there is not time to obtain a specific exemption. No pesticide that has been suspended or canceled may be used. The Administrator of EPA must be notified within 36 hours. Within 10 days of the use, the state must file information similar to that required for the specific exemption.

CANCELLATION OR RECLASSIFICATION OF REGISTERED PESTICIDES

The EPA can issue a notice of intent to cancel or reclassify (as general or restricted use), or can hold hearings on the proposed changes if:

- The pesticide, its labeling, or supportive data required to be submitted does not comply with FIFRA.
- The pesticide generally causes unreasonable adverse effects on the environment when it is used in accordance with a widespread and commonly recognized practice.
- The pesticide being evaluated can be manufactured, shipped, sold and used until the EPA makes a final decision. If the pesticide is canceled, the EPA usually allows the existing supplies to be used according to the label until they are exhausted.

Suspension

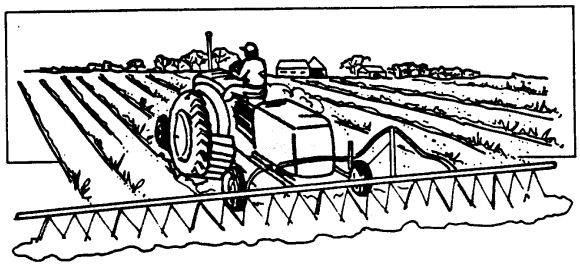
If the Administrator of EPA decides that action is necessary to prevent an imminent hazard during the time required for the cancellation issue to be settled, he may suspend the registrations of the pesticide immediately. A suspension order cannot be issued unless an intent to cancel the pesticide registration is filed at the same time or has been filed previously.

Benefits and Risks Assessment

A benefits and risks assessment is a process which deals with pesticide registration, and/or classification. Extension specialists and Experiment Station researchers have been asked to assist in providing information and data to support the continued registration of pesticides that are going through the review process. If a pesticide shows potentially dangerous characteristics, it is subjected to intensive scientific review and public comment. Then, a decision is made on whether or not to allow continued use or begin the process of cancellation or suspension.

The criteria that trigger a review are: if the pesticide is highly toxic and may pose the threat of immediate poisoning to people or wildlife, if it may cause serious long-term health problems such as tumor formation or mutations in people or "non-target" animals, if the pesticide lacks an emergency first-aid treatment, occurs as excess residues on feeds or food products, or poses a major threat to the environment.

PESTICIDE MODES OF ACTION



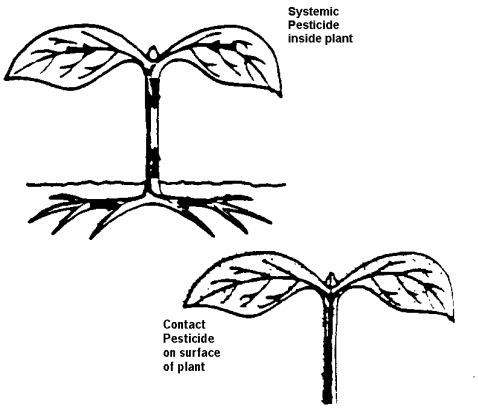
The way a pesticide destroys or controls a target organism is known as its mode of action. An understanding of the modes of action makes it easier to select the right pesticide and to predict which pesticides will work best in a particular situation. If pests develop resistance to one pesticide then selection of one with a different mode of action will often

achieve control.

In general, pesticides within a chemical class have the same mode of action on specific types of pests. They also may have similar characteristics such as chemical structure, persistence in the environment and types of formulations possible.

Herbicides

The mode of action of some herbicides is to destroy weeds by damaging leaf cells and causing them to dry up. Others alter the uptake of nutrients or interfere with the plant's ability to grow normally or to conduct photosynthesis. The mode of action often dictates when and how a herbicide is used. Herbicides must 1) adequately contact plants, 2) be absorbed into the plants, 3) move to the site of action in the plant without being deactivated, and 4) reach toxic levels at the site of action.



Those that inhibit germination or seedling growth are used as preemergent herbicides; they are applied to the soil to control weed seedlings before they break through the soil surface. They rely on rainfall or are incorporated into the soil to place the herbicide in close contact with the germinating weed seed. Some products (e.g. trifluralin) do not move within the plant so injury symptoms are confined to site of uptake. Others (e g. atrazine) are systemic and enter through the roots and move upward. In general, symptoms will be most obvious where the product tends to accumulate.

Other types are used as post emergent herbicides and are applied to the foliage of emerged weeds. Some post emergents have contact activity, meaning they kill the plant by destroying leaf and stem tissues. Other post emergents are translocated (moved within the tissues of the plant) from leaves and other green parts to growing points.

Chemical and physical relationships between the leaf surface and herbicide often determine the rate and amount of uptake. Uptake also can be affected by plant size and age, water stress, air temperature, humidity, and herbicide additives. Differences in the amount of herbicide uptake within the plant often explain the year-to-year variation in herbicide effectiveness.

Like soil-applied herbicides, postemergence herbicides differ in their ability to move within a plant. Nonmobile (contact) postemergence herbicides must thoroughly cover a plant for good control. Mobile herbicides move within the plant to the site of action.

Plants that can rapidly degrade or deactivate a herbicide can escape the toxic effect. The ability of some plants to rapidly degrade a herbicide is the basis whereby plants are differentially susceptible to some herbicides. However, plants under stress (hot or cold temperatures, high humidity, or physical injury) may be affected by herbicides to which they normally are tolerant. Misapplication, especially excessive rates, can overwhelm the ability of the plant to degrade or deactivate the chemical and result in plant injury.

Insecticides

Insecticides may act as nerve poisons, stomach poisons, muscle poisons, desiccants, growth regulators, and/or sterilants. The mode of action of organophosphate, carbamate, and synthetic pyrethroid insecticides is to interfere with the normal function of the nervous system. Some insecticides, such as dormant oils, have a purely physical effect by clogging air passages.

Organophosphate, carbamate, and synthetic pyrethroid insecticides are widely used today to control insects, ticks, and mites. Organophosphate and carbamate insecticides have very similar modes of action, while synthetic pyrethroids work at a different site.

Organophosphate and carbamate insecticides work at the synapse gap of the nervous system. Normally,

acetyldholine (ACh) carries nerve impulses across the gap. After the nerve impulse has passed, the Ach molecule is broken down by the enzyme acetylcholinesterase (AChE)and the synapse gap is returned to the normal state, ready to carry another impulse.

The AChE enzyme functions to prevent persistent "activation" of the nerve junction. Certain chemicals including organophosphorus and many carbamate pesticides block the action of the enzyme AChE and acetylcholine accumulates causing an over-stimulation of the nerves or nerve junctions.

Symptoms of this poisoning are (1) contraction of the pupil of the eye, (2) tightness of the chest, (3) increased bronchial (respiratory tract) secretions, (4) sweating, (5) tearing of eyes, (6) rapid pulse rate initially followed by a decrease in the pulse rate, (7) nausea, vomiting, abdominal pain and diarrhea, (8) involuntary urination, (9) muscle twitching, (10) cramps and (11) increased salivation.

A lethal dose of a cholinesterase inhibiting organophosphorus compound is reported to produce death due to respiratory failure (asphyxia). Symptoms of carbamate poisoning are essentially the same as those produced by the organophosphate compounds.

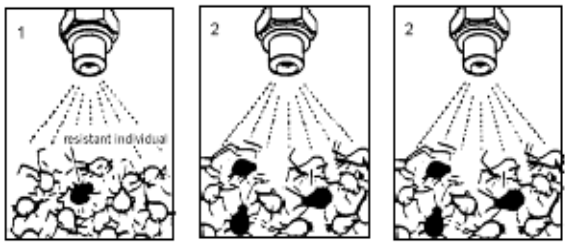
Synthetic pyrethroid insecticides do not work at the synapse gap. Instead, they work on the membrane that surrounds nerve fibers. These insecticides affect the movement of some vital chemicals into and out of the nerve fibers and interfere with the ability of the nerve to carry an impulse. Since both work on the nervous system, the symptoms that they produce are similar. In terms of insecticide resistance, the mode of action is different. For example, horn flies in some parts of Kentucky have become resistant to some pyrethroid insecticides. They are susceptible to organophosphates and these need to be used where resistance has shown up.

Fungicides

Strictly speaking, fungicides are chemicals used to kill or to halt the development of fungi. It is also, as used here, a general term for chemicals used to control both fungi and bacteria. Some fungicides are used as eradicants because they are capable of destroying fungi that have already invaded and begun to invade plant tissues. Their mode of action is to inhibit the metabolic processes of the growing fungal organisms. Most act as protectants to prevent infection, however. Modes of action range from preventing fungal spore germination and penetration of tissues to interference with fundamental cellular activities such as respiration.

Pesticide Resistance

Most pests are susceptible to pesticides and are effectively controlled by them. Some pests become tolerant to one or more pesticides that once were effective against them. These pests are considered to be resistant. Resistance may show a step-by-step progression. For example, after several applications of a particular pesticide, higher rates are needed to get the same degree of control that used to be achieved with a lower rate. Finally, the pesticide has no effect, regardless of the rate used. Switching to a pesticide from a different chemical class (and different mode of action) may help. However, sometimes resistance to one pesticide group also provides cross-resistance to other types of chemistry.



This drawing illustrates how pesticides can build up in a pest population. Resistance to pesticides involves a change in the genetic characteristics of pest populations which are inherited from one generation to the next. Increased or frequent use of the pesticide often hastens resistance

Resistance involves a change in the genetics of the pest and is inherited from one generation to the next. Usually, a pest population has a few individuals that are able to breakdown or chemically modify a pesticide. They can survive an application. Their offspring are resistant, also.

Resistance develops fastest when control is based entirely on one pesticide or a group of closely related

pesticides. Resistance management uses as many different control options as possible.

TOXICITY OF PESTICIDES

Toxicity is a measure of the ability of a material to cause harmful effects. Toxicity of a pesticide depends upon:

- The type and amount of active ingredient.
- The type and amount of carrier or solvent ingredients.
- The type and amount of inert ingredients.
- The type of formulation (EC, WP, G, etc.).

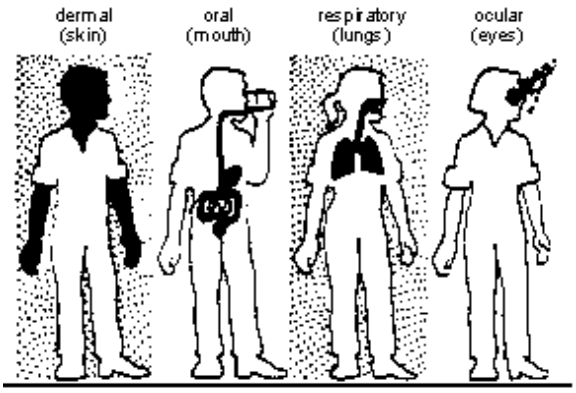
Pesticides can cause three types of harmful effects: 1) immediate or acute effects, 2) chronic or delayed effects, and 3) allergic effects. Acute effects are illnesses or injuries that may appear immediately after exposure (usually within 24 hours) to a pesticide. This may be through mouth, skin, or inhalation exposure. Delayed effects, also called chronic effects, do not appear until at least 24 hours after exposure. They may be due to repeated exposure over days, months or years, or to a single exposure that does not show a harmful reaction until much later. Allergic effects are harmful reactions that some people develop in response to substances that do not cause the same reaction in most other people. The first exposure to a substance may cause a sensitization that will lead to allergic responses with subsequent exposure.

One method of measuring acute toxicity is to determine the chemical dosage that will kill one-half (50%) of the group. Thus, the figure LD50 (lethal dose 50 percent) can be applied by mouth (oral) or skin (dermal) exposure. The LD50 value is usually expressed on a weight to weight basis, i.e., milligrams of chemical per kilogram of body weight for a given test animal. Other information generally specified in reporting LD50 values includes species, strain, age and sex of the experimental animal administration route, concentration of test material and vehicle used to administer the chemical.

LD50 values have become the universally accepted means of expressing toxicity. Acute oral LD50 values provide a means of comparing one chemical to another and thus a means of evaluating the relative toxicity of chemicals when administered orally. Many are and will be tempted to use the values in an absolute sense, i.e., direct extrapolation of LD50 to humans even to the point of calculating the LD50 dose for man. The relevance of these animal values to man is questionable. Further assumption could lead to serious consequences. One should assume in the absence of information to the contrary, that the chemical is at least as toxic to humans as it
is to the most sensitive test animal.

Toxicity vs. Hazard

A hazard of using a chemical is the danger it presents or possibility or probability that injury may result from using a substance.



The most common ways for pesticides exposure to occur are through the skin (dermal), through the mouth (oral), through the lungs (respiratory), and through the eyes (ocular).

Hazard can be expressed as toxicity of a product times time of exposure.

Relatively short exposures from just a few seconds to minutes, to very toxic materials can produce symptoms and cause serious injury. This hazard is recognized by most people. However, health problems can result from long term exposure (days, weeks, and years) to products that are not acutely toxic. Occupational exposure should be minimized through the use of appropriate protective equipment and personal hygiene (washing, laundering clothing,
etc.).

Pesticides may enter the body through the mouth, skin, eyes, or lungs. Dermal or skin exposure is usually the most common means, about 80% of work related cases of pesticide poisoning. Reportedly, over 97 percent of the pesticide to which the body is subjected during

most exposure situations and especially to applicators of liquid sprays, is deposited on the skin.

Not all pesticides are absorbed equally into the body. The list below gives an idea of the variation.

	% Absorbed
thiourea	1
2,4-D	6
malathion	7
parathion	9
lindane	9
carbaryl (Sevin)	75

Also, pesticides may be more readily absorbed through the skin on certain parts of the body.

	% Absorption
forearm	9
palm of hand	12
abdomen1	9
back of hand	21
back of ear	34
forehead	36
armpit	64
groin	100

Studies have shown that absorption of the insecticide parathion varies depending on the where it occurs on the body. Absorption through the skin of the head and neck area was found to be greater than other sites tested with the exception of the skin of the armpit, the ear canal and the scrotum. Absorption through cuts, abrasions or other disruptions of the skin may be as much as eight times that through intact skin.

Oral exposure to pesticides during ordinary spraying has not been measured. Respiratory exposure can be very significant when spraying in dosed areas with very small particulate spray such as a mist spray, dusts and materials that vaporize rapidly under normal conditions such as fumigants.

SAFE STORAGE OF PESTICIDES

The following standards apply to the safe storage of Restricted Use pesticides:

- Sites of RU pesticides shall be of sufficient size to adequately and neatly store all stocks in designated and segregated areas.

- Sites shall be cool, dry, airy, or, if possible, have an exhaust installed to reduce concentrations of toxic fumes and to hold down temperatures. Ventilation shall not connect with offices or other areas frequented by people.

- Sites shall be adequately lit so that labels and information can be easily read.

- Storage sites shall be equipped with fire fighting equipment such as fire extinguishers of Class 10 ABS minimum, sprinkler systems, or alarm systems.

- Storage sites shall be kept securely locked at all times other than when authorized personnel are in the area. Entrance to storage sites shall be plainly labeled on the outside with signs containing the words "Danger" or "Poison" and "Pesticide Storage Area".

- Floor sweep compound of adsorptic clay, sand, sawdust, hydraed lime, or similar materials shall be kept on hand to absorb spills or leaks. The contaminated material shall be disposed of according to label directions as an excess pesticide.

EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT

This law, also known as Title III of the Superfund Amendments and Re-authorization Act (SARA) functions to create a partnership among industry, state and local government officials, emergency response personnel, and other interested persons. Industry is required to report inventory of extremely hazardous substances to local and state response personnel. It involves four major activities:

1. **Emergency planning (Sections 301-303) –** Local committees must organize collected chemical information and develop emergency response plans for their community. Facilities where extremely hazardous substances are present above specified threshold planning quantities must be among those who participate.

2. **Emergency notification (Section 304) –** Facilities must report accidental releases of certain hazardous substances above reportable quantities to the Kentucky Emergency Response Commission and Local Emergency Planning Committees.

3. **Community right-to-know reporting (Section 311-312) –** Facilities required to prepare or have available a Material Safety Data Sheet for hazardous chemicals must submit detailed information to the State Emergency Response Commission, a Local Emergency Planning Committee, and the local Fire Department.

4. **Toxic chemical release reporting (Section 313) –** Manufacturing facilities that release certain toxic chemicals must report the total amount of emission to EPA and state officials.

The community right-to-know section affects all facilities where hazardous chemicals are present and requires a report on the amount, type, and location of those chemicals. The reports are used by local planners and fire departments and rescue squads for the emergency planning process of Title III. This allows them to respond safely to chemical accidents. In addition, the public in every state now has the "right-to-know" where large quantities of hazardous chemicals are manufactured, used, or stored.

Chemical Abstract Service Number (CAS) – Usually not on the product label but should be listed on the MSDS. The List of Extremely Hazardous Substances and the List of Toxic Chemicals should have these numbers. For mixtures, list CAS numbers for as many parts of the mixture as possible.

Extremely Hazardous Substances (EHS) – one of about 366 acutely toxic substances which are top priority in terms of planning. The reporting threshold 500 pounds or the specific Threshold Planning Quantity for that chemical, whichever is lower.

Hazardous chemicals – chemicals that require an MSDS but that are not on the Extremely Hazardous Substances list. Reporting is required if more that 10,000 pounds of these chemicals are stored.

Material Safety Data Sheet (MSDS) – provides information about the chemical substances in a product, first aid measures, safe handling procedures for spills and accidents and acute and chronic health information.

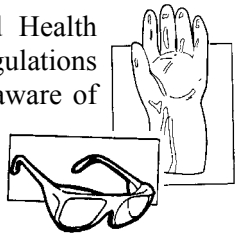
Reportable chemical – hazardous chemicals and extremely hazardous substances present at a facility in amounts greater than the reporting threshold.

Reportable Quantity (RQ) – the number of pounds of a chemical, that if accidentally released, triggers emergency reporting.

Threshold Planning Quantity (TPQ) – the number of pounds, that if manufactured, used, or stored on your property, requires a report to the local and state committee.

State Emergency Response Agency – Kentucky Disaster and Emergency Services Boone National Guard Center Frankfort, KY 40601 (502) 564-8682

WORKER RIGHT TO KNOW



The Occupational Safety and Health Administration (OSHA) has regulations to ensure that employees are aware of any hazardous materials with which they may be working and how they can protect themselves.

Recently revised worker protection standards identify two types of employees:

agricultural workers – those who perform tasks related to cultivation and harvesting of plants on farms or in greenhouses, nurseries, or forests, and

pesticide handlers – those who handle agricultural pesticides (mix, load, apply, clean or repair equipment, etc).

The provisions of the standard are intended to:

— Eliminate exposure to pesticides by:

1. prohibiting applications that lead to exposure and keeping workers out of areas during treatment;

2. establishing restricted-entry intervals, ranging from 12 to 72 hours, the minimum time to wait before entering a treated area; regulations for personal protective equipment need by pesticide handlers and early-entry workers;

3. notifying workers about treated areas so that they can avoid accidental exposure.

— Reduce harm from exposure by:

1. having decontamination supplies, such as soap, water, and towels, available for routine washing and emergency decontamination.

2. having transportation available in case of poisoning or injury by a pesticide, and providing information about the pesticide(s) to which the worker may have been exposed.

— Inform employees about pesticide hazards by:

1. required pesticide training;

2. post a pesticide safety poster;

3. provide handlers and early-entry workers with pesticide label safety information;

4. provide centrally-located access to specific information on location of recent pesticide treatments.

MATERIAL SAFETY DATA SHEETS

Material Safety Data Sheets (MSDS) provide information about the chemicals within a product, first aid measures, and safe handling information and procedures for
emergency response to accidental spills or releases. Unlike the pesticide label there is no required format and the amount and quality of information on them varies.

The manufacturer prepares the MSDS and provides it to distributors with the first product shipment and with the next shipment after an update. Distributors must supply copies to their customers if requested to do so.

The major sections of a typical MSDS include:

Material identification – Brand name, chemical name and family, and manufacturer.

Hazardous ingredients – Hazardous components of the material, their percentages by weight, known health hazard rating, and permissible exposure limit for an 8 hour work day.

Physical data – Tell what the material is like and how it behaves. This information aids in designing ventilation systems and providing adequate fire and spill equipment and procedures.

Fire and explosion data – This includes flash point, lowest autoignition temperature (at which it will ignite without a spark or flame).

Human health data – Gives potential routes of exposure during normal use or during an emergency. Indicates carcinogenic potential if applicable, as well as, acute and chronic health hazards. This section includes signs and symptoms of exposure and medical conditions that can be aggravated by exposure.

Employee protection – States the personal protective equipment needed, ventilation, and special precautions.

Reactivity data – Describes the conditions to avoid to prevent an unwanted reaction and the toxic substances that can be produced by fire, etc.

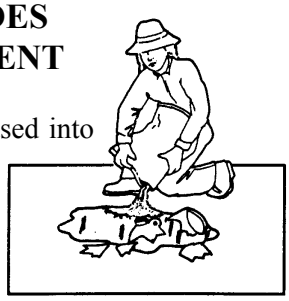
Spill and leak procedures – Gives methods for proper handling of spills and leaks, disposal information and significant environmental hazards.

Special precautions and storage data – Special precautions described.

Shipping data – usually optional and one of the last sections on the sheet.

Animal toxicity data – Toxicity values for laboratory animals and other species such as birds and fish.

FATE OF PESTICIDES IN THE ENVIRONMENT



Once a pesticide has been released into the environment, either by application or a spill, various processes determine its fate. These are:

- ADSORPTlON or binding of the pesticide to the soil
- TRANSFER or movement of the pesticide from one place to another
- DEGRADATION or breakdown of the pesticide

Adsorption

This is similar to iron filings (pesticide particles) sticking to a magnet (soil particles). Fine textured clay soils and soils with high organic matter content are much more adsorptive than coarse, sandy soils. Since water molecules compete with pesticides for soil binding sites, wet soils tend to adsorb pesticides less than do dry soils. Other factors, including soil pH and chemical properties of the pesticide, also have an effect.

The types of problems caused by adsorption are:

- reduced pest control because pesticide is tied up in soil
- plant injury from "carry over" of pesticides that are released in sufficient amounts to injure a rotational crop. This also can lead to illegal residues in food or feed crops.
- pesticides bound to soil particles can be washed away by rain or blown by wind.

Transfer

Pesticides can be transferred in the environment through volatilization, runoff, leaching, uptake, or crop removal.

- Volatilization is the conversion of a liquid or solid to a gas that then moves off into the air. Volatilization is affected by tendency of the pesticide to become a gas. It increases in high air temperatures, wind speed, and lower humidity.

  Volatilization can mean injury to nontarget plants due to drift. Pest control may be reduced because less pesticide remains at the application site. Incorporation or use of less volatile products or formulations can reduce potential problems.

- Runoff occurs when water moves over a sloping surface; it can carry pesticides that are mixed in it or bound to eroding soil. Slope or grade of the treated area as well as texture and moisture content of the soil rate of rainfall tillage practices and amount of surface residue determine runoff rate.

  Runoff can lead to injury of nontarget plants, harm to nontarget animals such as fish and other aquatic life. Pesticide runoff into streams and other surface waters can injure crops, livestock, humans, and may contaminate surface and groundwater. Incorporation of the pesticide can reduce runoff. Reduced tillage cropping systems, contour planting, or buffer strips can slow the movement of runoff water and keep it out of sensitive areas.

- Leaching, the third transfer process, moves pesticides in water within the soil. Leaching potential is determined to a great extent by the chemical properties of individual pesticides.

Pesticides are more likely to leach in the soil if they.

- Are not bound strongly to soil particles.
- Are soluble in water.
- Remain in the soil for a long time.

Soil characteristics that favor leaching are: coarse, sandy texture; low organic matter content; or fast draining soils.

The most significant leaching often occurs when a heavy or long rain follows an application. This movement can reduce pesticide level in the soil enough to cause poor control of the pest. Most important, leaching can contaminate the groundwater. Careful attention to developing weather systems can play a major role in preventing leaching.

Uptake is the movement of pesticides into plants or animals. Once inside, the pesticide may be broken down or remain until the crop is harvested or the plant decays.

Crop removal or harvest removes the pesticide from the treatment site. Washing and processing can remove or degrade the residue.

Degradation

Degradation of pesticides in the environment can occur by the action of microbes, chemical degradation or light degradation. Microbial degradation occurs as fungi, bacteria, and other microorganisms use pesticides, or other chemicals in the environment, as energy sources. This occurs most often in the soil Repeated use of the same pesticide can allow the buildup of microorganisms that can degrade it. Premature breakdown of the pesticide can result in poor control.

Chemical degradation results from breakdown that does not involve microorganisms. One of the most common reactions is hydrolysis- a result of the pesticide reacting with water.

The final process, photodegradation, is a breakdown as the pesticide is exposed to sunlight. Sunlight can cause the breakdown of pesticides on foliage and on the soil surface.

GROUNDWATER

Groundwater is the source of water for wells and springs. Most is found in saturated zones of rock sand or gravel called aquifers. Rain, melting snow, and surface water such as streams raise the water table, which is the upper level of the aquifer. Over 85% of the Kentuckians living in rural areas depend on groundwater.

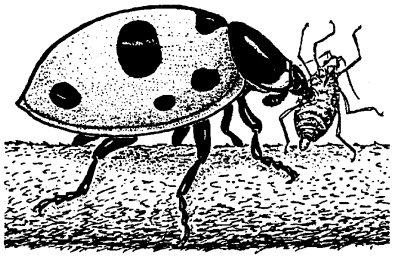
Geology controls the occurrence and movement of groundwater and therefore has an important effect on groundwater quality. Different types of rocks have different permeabilities (measure of how fast water can move through them). The physiographic regions of Kentucky are based primarily on the types of rocks that lie beneath them.

The Ohio River Valley and Jackson Puchase are composed of loose sediments ranging from gravel to sand, silt and clay. The underlying groundwater recharges rapidly after rains or irrigation. The limestone and dolomite that underlie the Mississippian and Bluegrass regions tends to dissolve along fractures and weak areas. Development of sinkholes at the surface, connected by open solution channels beneath the surface, is called a karst system. Surface water is free to move directly through sinkholes and rapidly through underground solution channels. Pollutants can easily contaminate the ground water in karst systems.

The potential for groundwater pollution also is affected by its distance from the surface and the number of faults, fractures, and sinkholes that pollutants can move through from the surface.

INTEGRATED PEST MANAGEMENT (IPM)

Sustainable production of adequate food and fiber for a rapidly expanding population while maintaining a healthy environment and safe water supply has become a top priority in recent years. The use of pesticides as the only means of controlling pest problems has some serious disadvantages:



1) Pests may become resistant to one or several pesticide classes.
2) Pests that previously were insignificant can become major problems.
3 Pesticide residues are more likely to exceed acceptable levels.
4) Destruction of beneficial organisms and natural enemies can lead to greater pest problems.
5) Environmental damage or groundwater contamination can be serious.
6) Long term control or management strategies are ignored.
7) Excessive control costs.

Pest management involves the integration of the most effective chemical and non-chemical methods with those of the ecosystem to lower and regulate pest populations. Success depends on the degree to which the integration of actions is guided by an

understanding of the population dynamics of the pest and the general principles of ecology.

The philosophy of pest management is to "manage" a pest population rather than to "eradicate" it. The objective is to maintain pest populations below the economic threshold established for that pest on a certain crop. The general steps include correct identification of the pests or suspected pests as well as an assessment of potential for economic loss.

A pest is a plant or animal present in great enough numbers at a time when it can cause economic losses, or affect health or comfort. The numbers necessary to be a pest vary with the pest itself and the nature of the injury that it can cause.

The economic threshold is the number or density of a pest at which damage can no longer be tolerated It is the level at which a control measure should be initiated to keep the pest from causing economic losses. Economic thresholds are available for some key pests. In some cases, there may be "suggested treatment guidelines" or other rule-of-thumb" estimates that can be used to aid in making control decisions. Use of these tools will reduce the chances of making unneeded pesticide applications and increase the potential of gaining a return of the investment of treatment cost.

The information needed to use economic thresholds is generally obtained through systematic field examination or scouting. Correct identification of insects, weeds and diseases is essential to implementing pest management. The appropriate scouting procedure must be followed so that the information collected is useful. Economic thresholds for some soybean insect pests are based on percentage defoliation of the plants while others use numbers per 4 foot of row. Information in IPM is available through your County Cooperative Extension office.

Methods of Pest Control

Natural Control – is any condition that reduces the survival or slows down reproduction and growth of a pest organism and cannot be altered at will by man. The weather, especially temperature and moisture, is the major natural control force. It can encourage or discourage insect or plant disease outbreaks.

Cultural Control – is any manipulation of the environment that makes it less favorable for the pest. Crop rotation and sanitation are often recommended to reduce disease problems that can develop as a result of growing the same or closely related crops in the same field for several consecutive years. Host plant resistance is another major cultural control method, utilizing plant characteristics that discourage or tolerate pest infestations.

Mechanical Control – involves the measures that destroy the pest outright, such as using a swatter to kill a fly or cultivation to control weeds. Screens may be used as a barriers to prevent pests from entering an area.

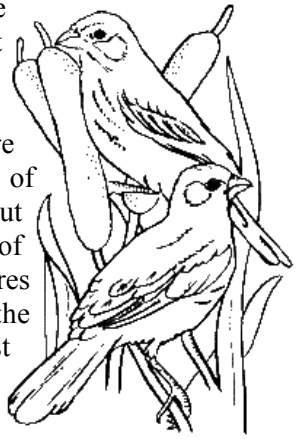
Regulatory Control – uses quarantine and inspection procedures to prevent the entry and establishment of foreign plant and animal pests in a country or area. A trapping program to detect gypsy moth infestations in Kentucky is part of a regulatory control program. If possible, infestations are eradicated, suppressed or contained

Biological Control – involves the use of natural enemies, such as parasites, predators, or pathogens to keep pests below economically damaging levels. Small parasitic wasps have been released in Kentucky to aid in the management of alfalfa weevils.

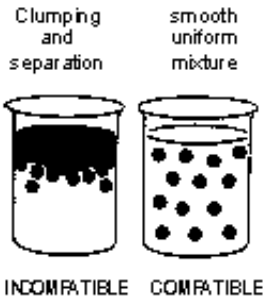
Chemical Control – is the use of pesticides to control pest problems. We normally think of chemical control as the use of herbicides, insecticides, or fungicides but it may involve repellents, attractants, hormones, antibiotics, fumigants, or growth regulators.

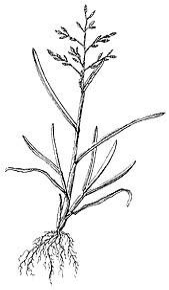
ENDANGERED SPECIES

Congress passed the Endangered Species Act which protects and conserves animals, plants, and their habitats that are threatened or in danger of becoming extinct throughout all or a significant part of their range. The law requires that critical habitats the species need to survive must be protected. Labels and bulletins will be developed



to identify these areas and to indicate any precautions that must be taken with specific pesticides used in the areas. The publication ID-103, Kentucky's Endangered and Threatened Species, is available through your county extension office.





Foxtail

Dandelion