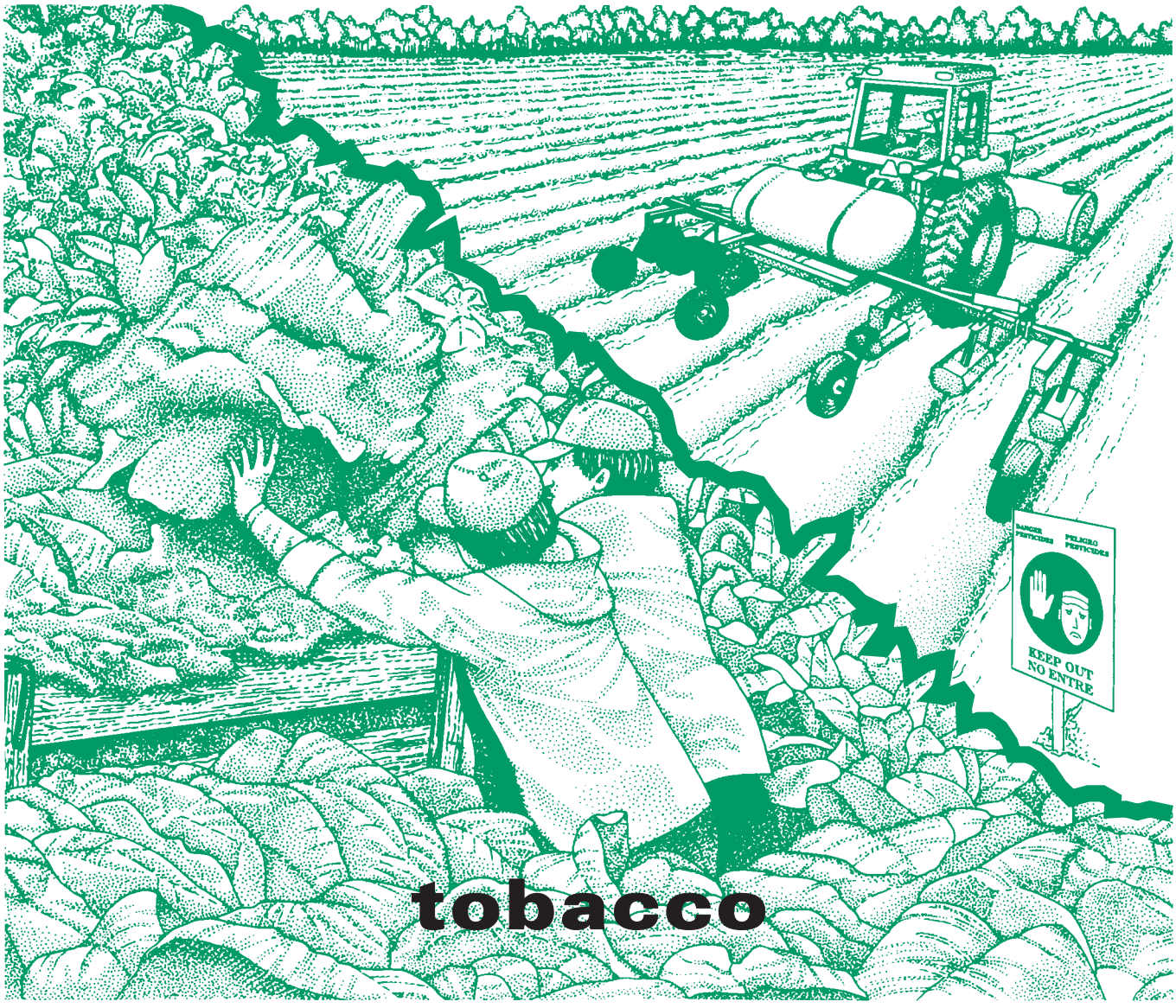
PESTICIDES & Human Health

Throughout the world, pesticides are used to produce food, fiber, and forest products by controlling pests and diseases and regulating plant growth. Although targeted for specific pests, if handled improperly, pesticides can cause short- or long-term adverse health effects when people are exposed to them.

Pesticide handlers, mixers, and applicators generally run the greatest risk of occupational exposure to pesticides. But field workers may also be exposed to pesticides and their residues, especially when working with crops that require intensive hand-labor, such as tobacco. Regardless of occupational category, the health and safety of all agricultural workers are important anad therefore, everyone should take precautions to minimize exposure and to prevent adverse health effects.

This publication is intended for agricultural producers, growers, agents, consultants, and health care providers. It summarizes the basic principles of toxicology and describes the pesticides available for use on tobacco in North Carolina, the timing of their application, and their potential adverse effects on human health. It also describes measures to protect human health and to diagnose and treat pesticide poisoning.



PESTICIDES & Human Health

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Basic Principles of Toxicology

Toxicology is the science that studies the hazards, risks, and adverse effects associated with exposure to various substances or to radiation; toxicologists are the professionals who carry out these studies. A *hazard* is a state or set of circumstances that may result in an undesired event—such as exposure to a toxic pesticide. *Risk* refers to the probability that a substance will produce harm under specified conditions.

Toxicology Basics: Risk Factors

The risk of being poisoned by any substance, including pesticides, is affected by the following factors:

- Toxicity
- Dose
- Route of exposure
- Duration of exposure
- Frequency of exposure
- Exposure to other chemicals
- Health status

Toxicity

Some substances are inherently more toxic than others. *Toxicity* is a measure of the harmful effects that a substance can cause. Toxicity levels vary by organism (e.g., humans, birds, fish), as well as by age, sex, physical condition, and reproductive status. A given pesticide may be highly toxic to fish but not to humans, or highly toxic to young fish but not to older fish.

Toxicity of Various Substances (Rat LD_{50} mg/kg)

Sugar (sucrose)	29700
Alcohol	14000
Salt (sodium chloride)	3000
Malathion	1375
Aspirin	1000
2,4-D	375
Ammonia	350
Carbaryl	250
DDT	113
Arsenic (arsenic acid)	48
Strychnine	2
Nicotine	1
Dioxin (TCDD)	0.001
Botulinum toxin	0.00001

Dose

All substances—even sugar or salt—are potential poisons if the dose is high enough. Dose and inherent toxicity influence the type and degree of toxic response. Pesticides raise special health concerns for an obvious reason: they are poisons designed to kill specifically targeted organisms or cure diseases, but they may adversely affect exposed humans as well. Sometimes these effects can be produced by relatively small doses.

How do toxicologists evaluate hazard? One way is to evaluate the relationship between dose and toxic response (Fig. 1). This relationship is expressed as a *dose-response curve* and commonly uses lethal effects on test rats as the measure of toxicity. Increasing the dose typically produces a corresponding increase in the mortality of rats.

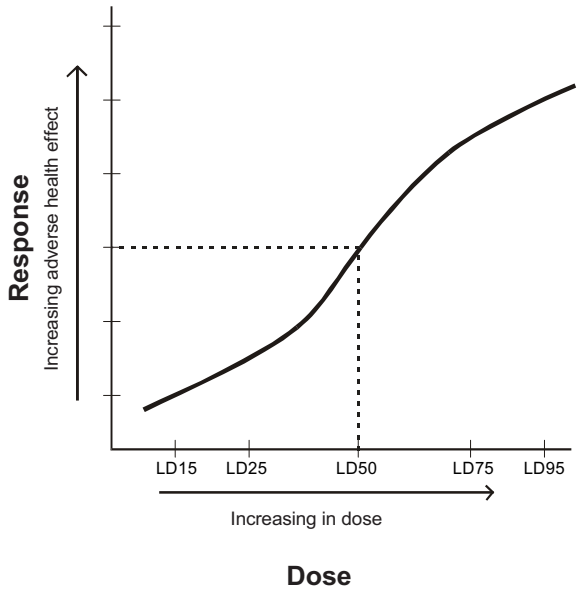


Fig. 1. Example of a typical dose-response curve.

Statistically, the greatest confidence in the relationship between dose and response occurs at the 50% mortality level. Toxicologists thus use the standard term of LD_{50} (i.e., the *lethal dose* required to kill 50% of the test organisms in a specified amount of time) to assess the relative lethality of substances. Some pesticides have a relatively low LD_{50} which means that they are highly toxic; others have a relatively high LD_{50} which means that they are only slightly toxic.

An LD_{50} is usually expressed as milligrams per kilogram (mg/kg) of body weight. This ratio is important to remember when considering the potential effects of pesticides on humans because the toxic dose will differ substantially with weight. The dose of a substance capable of seriously harming a 77-pound (35-kilogram) child is substantially less than the dose capable of seriously harming a 154-pound (70-kilogram) adult.

Route of Exposure

How hazardous a substance is and the overall risk it poses often depends on the route by which it enters the body. People can be exposed to chemicals, including pesticides, in three primary ways (Fig. 2):

- By *breathing* pesticide dust or fumes through your nose or mouth (inhalation exposure).
- By *swallowing* the chemical (oral exposure). This can occur by eating unwashed foods contaminated by pesticide residues or by eating, smoking, or chewing gum or tobacco without washing your hands after working with pesticides or in treated areas.
- By *absorbing* the chemical through your skin or eyes (dermal exposure). This can occur through spills and splashes, open cuts or sores on the hands and forearms, or contaminated clothing; it can also occur by wearing inadequate personal protective clothing or equipment.

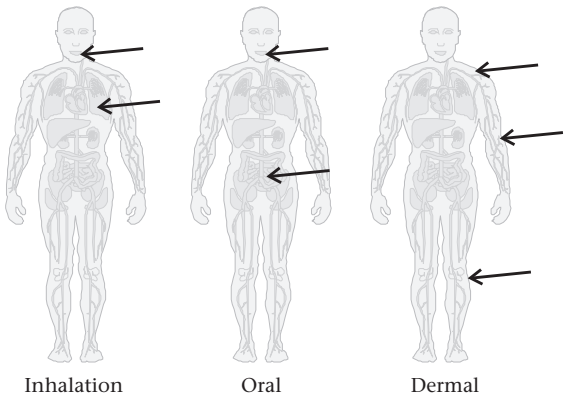


Fig. 2. The three primary routes of exposure to toxic substances.

For each route of exposure, additional factors may influence the dose of pesticide that enters your body. For example, the dose that enters by the eyes or skin (i.e., the dermal route) depends largely on the part of the body that is exposed and the condition of the exposed skin. Different parts of the body absorb pesticides in differing amounts. The variation depends largely on the skin type and thickness (Fig.3). The upper side of the forearm, for example, is 8 times more absorbent than the arch of the foot. In addition, skin damaged from cuts, abrasions, and rashes may absorb pesticides more readily than skin in good condition.

Duration of Exposure

The length of time a person is exposed to pesticides also influences both the hazard and the toxic response. Toxicologists refer to the duration of exposure as either acute or chronic. *Acute* exposures are short-term events that generally last less than 24 hours, but may occur at relatively high doses. Acute exposures generally produce short-term symptoms of pesticide poisoning and may require immediate medical attention. *Chronic* exposures are long-term events that occur over weeks, months, or years; typically, such exposures involve relatively low doses. Chronic exposures generally produce symptoms associated with long-term health problems and diseases.

Frequency of Exposure

How often pesticide exposure occurs influences the potential for adverse health effects. For example, long-term occupational exposure (frequently over periods ranging from months to years) to even small amounts of *some* pesticides *may* cause adverse health effects. Conversely, less frequent but higher-level exposures may also result in health problems. The absence of acute symptoms does not mean that long-term health effects may not occur. Likewise, a short-term exposure does not necessarily mean that long-term health effects will be observed.

Exposure to Other Chemicals

In addition to the active ingredient, most pesticides contain solvents or carriers that are referred to as *inert* ingredients on the label. Some people may develop allergies or sensitivities to these inert ingredients and experience health effects that are similar to pesticide poisoning, but that are unrelated to the active ingredient. These inert ingredients may also be directly toxic to humans if the dose received is high enough. Often, two different pesticide products are mixed together to create a single product with increased effectiveness. Such mixing may also influence the risk of pesticide poisoning and toxic response in humans.

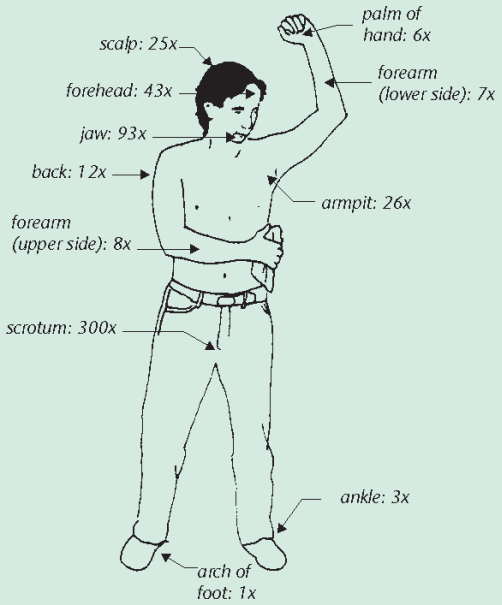


Fig. 3. Different parts of the body absorb chemicals, including pesticides, in different amounts.

Acute Pesticide Poisoning

Organophosphate and Carbamate Pesticides

Two classes of pesticides are most often associated with acute pesticide poisoning in humans: the organophosphate (OP) and carbamate insecticides. Although specifically designed to target insect nervous systems, these pesticides have similar effects on human and other mammalian nervous systems.

Both pesticide classes inhibit the nervous system enzyme acetylcholinesterase. Nervous system impulses are transmitted in the body across open spaces called synapses through the action of the chemical transmitter acetylcholine. After a nervous system impulse has passed across the synapse, acetylcholinesterase breaks down and clears away the acetylcholine from the synapse and prepares it for the next impulse. Both OP and carbamate insecticides inhibit acetylcholinesterase activity so that the acetylcholine cannot be removed. The result is a build-up of acetylcholine and continued nerve impulse transmission, which eventually results in the symptoms of acute or short-term pesticide poisoning. Untreated, such poisoning can cause death.

Symptoms of Short-Term OP or Carbamate Poisoning

Any of the following symptoms may indicate acute pesticide poisoning from *OPs or carbamates*.

- Drooling (salivation)
- Excessive tear production (lacrimation)
- Frequent urination
- Diarrhea
- Small pupils in the eyes (miosis)
- Cannot adapt to low or differing light conditions (blurred vision)
- Vomiting, nausea (emesis)
- Slowed heart rate (bradycardia)
- Respiratory secretions, coughing (bronchorrhea)

Treatment of OP or Carbamate Poisoning

Fortunately, OP and carbamate pesticide poisoning can be treated with medications administered by a physician. Although both pesticide classes produce similar toxic effects on humans (i.e., inhibition of acetylcholinesterase), each class has different long-term effects and each requires different medical treatment.

The effects of OP poisoning on the acetylcholinesterase enzyme are irreversible without medical treatment. OPs can cause permanent neurological damage or death. The effects of carbamate poisoning on the acetylcholinesterase enzyme are usually reversible without treatment, but like OPs, carbamates may cause serious adverse health effects if the person is not treated by a doctor. Organophosphate poisoning is treated with a combination of atropine sulfate and pralidoxime chloride (Protopam, 2-PAM). The atropine and the 2-PAM are administered intravenously by a doctor. The 2-PAM serves as an important addition in the overall therapy for OP poisoning, especially when treatment occurs within 36 hours of contact with the OP. Carbamate poisoning is treated only by the intravenous administration of atropine sulfate.

Monitoring of OP or Carbamate Poisoning

Those frequently exposed to OP or carbamate pesticides should have routine monitoring tests to determine whether their health is being adversely affected. The tests involve blood samples, which are analyzed for acetylcholinesterase enzyme activity. Ideally, handlers or workers should have a blood acetylcholinesterase measurement made *before* the application season or *before* any pesticide exposure. This measurement provides a baseline acetylcholinesterase activity level. Such measurements are important because acetylcholinesterase activity varies widely among individuals, and the baseline provides a reference point for later comparison. Generally, a depression of 25 percent or more in acetylcholinesterase activity indicates overexposure to OP or carbamate pesticides (Morgan 1989). Individuals with a significant decrease in blood acetylcholinesterase activity should avoid any additional pesticide exposure until enzyme activity returns to safe levels.

Other Pesticides

Pesticides other than OP or carbamates — including other insecticides, herbicides, and fungicides — can also cause symptoms of short-term pesticide poisoning. Thus, it is important to always know the hazards of the pesticide and its potential for causing acute toxicity.

Any of the following symptoms may indicate acute pesticide poisoning *not specific to OPs or carbamates*.

- Nausea, vomiting, diarrhea
- Itching, skin rash, or irritation
- Eye or throat irritation
- Headache
- Excessive sweating and tear production
- Difficulty breathing
- Weakness or dizziness
- Jumpiness or edginess
- Stomach or muscle cramps

Conditions Confused with Acute Pesticide Poisoning

Seek Medical Help

Green tobacco sickness, heat stress, and pesticide poisoning can be hard to tell apart because the symptoms are very similar. If you experience any of these symptoms, seek medical help. Always tell the doctor if you have been exposed to pesticides, what crop you have been working in, and how much water you have been drinking so that the cause of the symptoms can be properly identified and treated.

Heat Stress

People become sick with heat stress when they work in extremely hot, humid weather, especially if they are not drinking enough water. Heat stress occurs when a body is overworked and exposed to more heat than it can tolerate. Heat stress is not caused by exposure to pesticides, but the symptoms are similar to those caused by pesticide exposure or green tobacco sickness; these symptoms can include:

- Nausea and vomiting
- Weakness and dizziness
- Severe thirst and dry mouth
- Confusion or slurred speech
- Heavy sweating or lack of sweating
- Headache and chills

Treatment of Heat Stress

- Immediately move the victim to a cool or shaded area.
- Rapidly cool the victim by sponging or splashing the head and body with cool water.
- Remove any personal protective equipment or clothing that may be making the victim too hot.
- Replace fluids; give the victim water or juice to drink.
- Call 911 and keep the victim still and quiet until professional medical help arrives.

Prevention of Heat Stress

- Drink plenty of cool liquids such as water or juice.
- Take frequent breaks in cool or shaded areas.
- Learn the signs and symptoms of heat stress.
- Alter work schedules based on daily weather conditions to avoid excessive heat.
- Stop working if you have symptoms of heat stress.

Green Tobacco Sickness

Some people working with tobacco become sick when the nicotine from wet leaves is absorbed directly through the skin. Symptoms of green tobacco sickness are similar to those caused by heat stress or exposure to pesticides; these symptoms can include:

- Nausea and vomiting
- Weakness and dizziness
- Stomach cramps
- Difficulty breathing
- Paleness and excessive sweating
- Headache

Symptoms of green tobacco sickness can start 1 to 2 hours after beginning work and can last for 12 to 24 hours.

Treatment of Green Tobacco Sickness

Several medications to treat the symptoms of green tobacco sickness are available without a prescription. Choose ***only one*** of the following: Benadryl (diphenhydramine), Dramamine (dimenhydrinate), or Dramamine II or Bonine (meclizine). Always check with a doctor or pharmacist before taking these medications, especially if you have asthma, prostate problems, or glaucoma or if you are pregnant or breast-feeding. These medications may cause drowsiness, so do not take them while driving or operating farm machinery. Do not drink alcoholic beverages while taking these medications.

Prevention of Green Tobacco Sickness

- Wear clothing that covers your skin such as a long-sleeved shirt, long pants, and gloves.
- Wear a plastic rain suit (coat and pants) if the tobacco plants are wet from dew or rain. Drink plenty of liquids to avoid heat stress (see above) if you wear a rain suit.
- Change your clothes if they become wet with sap or water from the plants.
- Bathe in cool water after work to remove sap and nicotine from the skin.
- Wash your work clothes before wearing them again.
- Stop working if you develop symptoms of green tobacco sickness.

Skin Irritation and Allergy

Some pesticides may produce toxic responses that are primarily related to acute skin conditions caused by irritation or allergies. Pesticide allergies and skin-related diseases are important health concerns for both applicators (handlers) and workers. Farm workers are especially vulnerable to skin-related diseases because of their intensive hand contact with treated plants and soil and the cuts, abrasions, and natural chemicals produced by some plants. Some of these conditions may be serious enough to cause lost work time. In addition, injured skin may be more susceptible to exposure to pesticides or other chemicals.

Skin Irritation and Allergy

A pesticide classified as an *irritant* will cause an acute toxic response in anyone having contact with the chemical, if the dose is high enough. In contrast, pesticides that cause *allergic* reactions do so only in sensitized individuals, not in everyone. There are two main types of acute responses of the skin to contact with chemicals, including pesticides, that are observed in agricultural workers; these are primary irritant dermatitis and allergic contact dermatitis. Dermatitis, or inflammation of the skin, is commonly referred to as a skin rash and is characterized by redness, pain, heat, and swelling. The amount of skin inflammation is generally related in a *dose-response* manner to exposure; an increase in the dose of chemical or physical irritant typically produces a corresponding increase in inflammation. Skin rashes can differ in their type, characteristics, production, progression, and severity.

Prevention and Treatment of Skin Irritation and Allergy

Several medications are available without a prescription to treat the symptoms of dermatitis caused by skin irritants and allergens. These include topical steroid creams such as those containing 0.5% hydrocortisone and may be used to help alleviate pain and itching. Always use any medication according to label directions. Because the response of skin to physical or chemical irritants and allergens may be similar, any persistent dermatitis should be treated by a doctor (dermatologist) to prevent worsening conditions and secondary bacterial infections.

Always read the precautionary statements on the pesticide label to determine whether the chemical is an irritant. In addition, workers should wear proper clothing and protective equipment such as a wide-brimmed hat, long-sleeved shirt, long pants, socks, shoes, and gloves to help protect the skin from the following:

- Excessive sunlight
- Extremely hot or cold weather
- Residues from farm chemicals such as fertilizers, pesticides, cleaners, and fuels
- Cuts, abrasions, and punctures from plants with hair-like projections, thorns or sharp-edged leaves
- Irritations or allergies from contact with natural plant substances such as oils or other compounds (for example, contact with poison ivy)
- Biting and stinging insects or other animals

Consequences of Acute Allergic Reactions to Pesticides

Allergies are chronic health conditions; however, allergic reactions are acute and generally require immediate care and response. Allergies to pesticides or their solvents and carriers (inert ingredients) are serious health concerns because allergies and allergic responses:

- May be permanent
- Tend to get worse with recurrent exposure
- Can be fatal
- Often develop not only to the chemical that originally triggered the response, but also to similar substances.

Long-Term Health Effects

Potential long-term health effects from exposure to pesticides are difficult to isolate from the influence of other risk factors such as diet, lifestyle, and genetic makeup. However, *some* pesticides *may* cause adverse health conditions such as allergy, nervous system damage, liver damage, cancer, genetic damage, reproductive problems, or birth defects. These may occur even if symptoms of short-term pesticide poisoning have not been previously observed. This is why it is extremely important to know the hazards of the specific chemical and to take adequate precautions.

When pesticides are registered by the U.S. Environmental Protection Agency, they are tested and evaluated for potential long-term health effects. If a pesticide is found to cause any adverse long-term health risks or conditions associated with exposure, they are printed on the pesticide Material Safety Data Sheet (MSDS), which can be obtained from the pesticide dealer or manufacturer. For example, the EPA classifies cancer-causing pesticides as *Known*, *Probable*, or *Possible* human carcinogens based on the supporting scientific evidence and data.

Pesticide Label: Important Information for Protecting Health

The pesticide label, along with the product's accompanying Material Safety Data Sheet (MSDS), are the most important sources of information available to agricultural workers and health care providers for protecting human health. Pesticide labels are divided into sections that contain specific information about the product. The EPA mandates that this information appear on all pesticide products.

Signal Words

When classifying pesticide toxicity, the EPA uses specific *signal words* and mandates that these words be clearly printed on pesticide labels. The signal words are *Danger, Warning,* and *Caution* (Table 1). They indicate the relative toxicity of the pesticide, the dose required to cause a toxic response, and the exposure route of greatest concern.

Two labeling requirements are particularly important:

- When a pesticide label has the signal word *Danger* with the word *Poison* in red letters and the skull-and-crossbones symbol, the pesticide is extremely hazardous if swallowed, inhaled, or absorbed through the skin.
- When a pesticide label only has the signal word *Danger* (without the word *Poison* and the skull-and-crossbones symbol), the pesticide is an extremely hazardous skin or eye irritant (i.e., it is highly corrosive).

Use of some of the most hazardous pesticides has been restricted by the EPA, which means that they can only be bought and applied by, or under the supervision of, someone who is certified or licensed. These pesticides have the words *"Restricted Use Pesticide"* printed on the label.

Table 1. Pesticide signal words

Signal word	*Toxicity*	*Oral LD_{50} (mg/kg)*	*Oral dose required to kill an adult*	*Skin or eye irritation*	*Dermal LD_{50} (mg/kg)*	*Inhalation LC_{50} (mgIL)*
Danger	Highly toxic	0 to 50	Taste to a teaspoon	Corrosive	0 to 200	0 to 0.2
Warning	Moderately toxic	50 to 500	Teaspoon to an ounce	Irritant	200 to 2000	0.2 to 2.0
Caution	Slightly toxic	Over 500	Ounce to a pint	Mild irritant	over 2000	2.0 to 20

Precautionary Statements

To classify the most dangerous routes of acute exposure, the EPA uses specific *precautionary statements,* which are printed on pesticide labels. These statements address the three main routes of exposure (swallowing, breathing, and absorbing) and the potential for skin and eye irritation. The precautionary statements correspond to the signal words *Danger, Warning,* and *Caution* and thus reflect the toxicity of the pesticide by stating which routes of exposure are most hazardous (Table 2).

Table 2. Common precautionary statements on pesticide labels for acute exposure routes of greatest concern

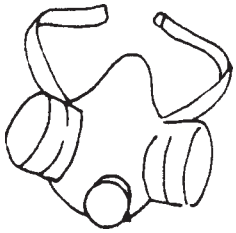
Exposure route	*Highly toxic*	*Moderately toxic*	*Slightly toxic*
Oral exposure	Fatal if swallowed, *or* Can kill you if swallowed.	Harmful or fatal if swallowed, *or* May be fatal if swallowed.	Harmful if swallowed, *or* May be harmful if swallowed.
Inhalation exposure	Poisonous if inhaled, *or* Can kill you if breathed; do not breathe dusts, vapors, or spray mist.	Harmful or fatal if inhaled, *or* May be fatal if breathed; do not breathe dusts, vapors, or spray mist.	Harmful if inhaled, *or* May be harmful if breathed; avoid breathing dusts, vapors, or spray mist.
Dermal exposure	Fatal if absorbed through the skin, *or* Can kill you by skin contact; do not get on skin or clothing.	Harmful or fatal if absorbed through the skin, *or* May be fatal by skin contact; do not get on skin or clothing.	Harmful if absorbed through the skin, *or* May be harmful by skin contact; avoid contact with skin or clothing.
Skin irritation	Corrosive, causes severe skin burns; do not get on skin.	Causes skin irritation, *or* Causes skin burns; do not get on skin.	May irritate skin; avoid contact with skin.
Eye irritation	Corrosive, causes irreversible eye damage, *or* Causes severe eye burns or blindness; do not get in eyes.	Causes eye irritation, *or* Causes eye burns; do not get in eyes.	May irritate eyes; avoid contact with eyes.

Exposure Prevention

Ways to minimize your exposure to pesticides:

- Know the chemical and its associated hazards. Each pesticide has its own instructions, toxicities, and precautions.
- Read and follow the instructions specified on the pesticide label. If you do not fully understand these instructions, ask someone such as a dealer or a local Cooperative Extension Service agent to explain them.
- Wear the appropriate personal protective equipment (PPE) specified on the pesticide label. This typically includes equipment such as chemical resistant gloves and some type of respirator.

- Wash your hands before eating, drinking, smoking, using the bathroom, or chewing gum or tobacco. NEVER eat, drink, or smoke while handling pesticides or in treated areas.
- Comply with the waiting intervals mandated for field re-entry (REI) and harvest specified on the pesticide label.
- Wash work clothes separately and before wearing them again.



Ways to minimize exposure of others to pesticides:

- Mix and load pesticides in a designated spill containment area and with the proper PPE.
- Do not allow unprotected people in areas where mixing, loading, application, or disposal of pesticides occurs.
- Apply pesticides only when necessary and use integrated pest management (IPM) techniques; NEVER exceed label recommendations.
- Use application techniques that minimize drift and surface water and groundwater contamination.
- Recycle pesticide containers. Call the Pesticide Section of the North Carolina Department of Agriculture and Consumer Services at (919) 733-3556 or ask a local Cooperative Extension Service agent about programs that recycle pesticide containers. NEVER re-use empty pesticide containers for any purpose.
- Wash work clothes separately from the family's laundry so that the rest of the laundry is not contaminated.
- Store and mix pesticides in their original containers or in well-labeled mixing equipment, NEVER in empty food or beverage containers.
- Store pesticides in a locked room or cabinet away from children and pets; children account for about 30 percent of all hospitalized pesticide poisoning cases in North Carolina.

Pesticide Law Prevents Exposure Through the Worker Protection Standard

The law states that agricultural employers must:

- Become familiar with the *Agricultural Use Requirements* section on pesticide product labels.
- Provide basic and full *pesticide safety training* for both workers and handlers.
- Provide the *personal protective equipment* that is specified on the pesticide label.
- Maintain a *central notification area* for safety posters, medical information, and information about pesticide applications.
- Provide prior notice of pesticide applications by *posting signs and/or giving oral notification.*
- Provide *decontamination supplies* such as water, soap, and paper towels for both handlers and workers in the field, or within ¼ mile of the field, so that all employees can wash their hands and bodies, if necessary.
- Provide *pesticide safety information* and *emergency assistance,* such as providing for transportation or transporting employees to the doctor, hospital, or clinic if they become sick while working with pesticides.
- *Not retaliate against (fire or harass) employees who ask for their legal right to know* or who report a pesticide violation to the N.C. Department of Agriculture and Consumer Services or who file a rights violation or pesticide exposure complaint with the N.C. Department of Labor.

For additional information on compliance with the Worker Protection Standard, call the Pesticide Section of the N.C. Department of Agriculture and Consumer Services (919-733-3556). Refer to the *N.C. Pesticide Law of 1971* or to the U.S. EPA's *How To Comply Manual.*

Emergency Response

In Case of Emergency:
If you have symptoms of pesticide poisoning, immediately:

- Leave the site of exposure. Wash all exposed areas with soap and plenty of water; change your clothes.
- Call 911 or emergency medical personnel. Go to the nearest doctor, hospital, or clinic. Get help; do not drive yourself.
- Follow the first-aid instructions on the pesticide label. If you do not have the label or do not understand it, ask someone to get it or explain it to you.
- If you get pesticides in your eyes, rinse them with clean water for 15 minutes.
- If you inhale pesticide fumes, get to fresh air or an uncontaminated area; sit down, remain calm, and breathe as normally as possible.
- If you swallow pesticides, refer to the first-aid instructions on the pesticide label or call the N.C. Poison Control Center at 1-800-848-6946.
- Tell the doctor that you have been exposed to pesticides; provide the pesticide name and label.

Consult Pesticide Label for:

- Brand Name
- Classification
- Product Use
- Ingredient Statement
- Formulation
- U.S. EPA Registration Number
- Name and Address of Manufacturer
- Precautionary Statements
- Hazards to Humans and Domestic Animals
- Signal Word
- Route of Exposure
- Personal Protective Equipment
- Specific Protective Actions
- Statement of Practical Treatment (First Aid)
- Note to Physician
- Signs and Symptoms of Poisoning
- Antidote Statement
- Environmental Hazards
- Emergency Telephone Number
- Physical and Chemical Hazards

Health Implications of Pesticides Used on Tobacco

The *North Carolina Agricultural Chemicals Manual* lists about 60 pesticides (insecticides, herbicides, fungicides, fumigants, and growth regulators) that are available for use on tobacco in North Carolina. They differ in their timing of application from greenhouse and early field control to harvest (Table 3), range from highly toxic to slightly toxic, and have various acute exposure routes of greatest concern (Tables 4 to 7). Therefore, the potential for human exposure and toxic effects differs greatly among the chemicals. Consequently, users must always read and understand the label before mixing and applying any pesticide.

Specific information on the human health implications of the pesticides available for use on tobacco is presented in the tables that follow. Each table has a similar format and lists the following: the chemical name and its various trade or brand names; the chemical class of the compound; the EPA signal word and its corresponding acute toxicity classification (highly toxic, moderately toxic, slightly toxic); the oral lethal dose of the chemical required to kill 50 percent of test rats (LD_{50}) and the equivalent oral lethal dose for a 154-pound (70-kilogram) adult; the acute exposure route(s) of greatest concern (the one(s) that need the greatest protection to prevent exposure); and the restricted entry interval (REI) for human activity in treated areas.

Many of the insecticides available for use on tobacco in North Carolina have the signal word *Danger* and thus are classified as highly toxic to humans based on one or several of the primary routes of exposure (Table 4). Most of these highly toxic tobacco insecticides are either organophosphate or carbamate compounds and therefore tend to pose a greater risk of acute pesticide poisoning to humans. Some herbicides available for use on tobacco are also classified as highly toxic to humans (Table 5) because some of these chemicals may cause extreme skin or eye irritation and therefore require special protection to prevent exposure. Many of the fungicides and fumigants available for use on tobacco have the potential to be highly toxic to humans (i.e., carry the signal word *Danger*), primarily based on their capacity for skin and eye irritation and inhalation toxicity (Table 6). Most of the growth regulators that are classified with the signal word *Danger* (Table 7) represent a relatively high risk to human health because of their toxicity, timing of application, and pattern of use (Table 3). For example, these chemicals are usually applied during topping and suckering and immediately prior to harvest, activities that generally require intensive hand-labor and thus increase the probability of human exposure.

Table 3. Pesticides commonly used on tobacco and their application periods




	Plant Bed	*Greenhouse*	*Field, preplant*	*Transplant*	*Field, post transplant*	*Field, topping and suckering*	*Field, at harvest*
Application period (in months)	January - February	February - April	March - May	April - May	May / June	July	August - September
Insecticide	Acephate Carbaryl 5% bait Disulfoton Metaldehyde Metaldehyde + carbaryl bait	Acephate Imidacloprid Metaldehyde	Acephate Aldicarb Carbofuran Chloropyrifos Disulfoton Ethoprop Fenamiphos Fonofos Oxamyl	Acephate (in transplant water) Imidacloprid (in transplant water)	Acephate *Bacillus thuringiensis* Carbaryl Endosulfan Imidacloprid Malathion Metaldehyde Methidathion Methomyl		Acephate *Bacillus thuringiensis*
Herbicide	Dazomet Metam sodium Methyl Bromide Sethoxydim		Benfluralin Clomazone Dazomet Metam sodium Napropamide Pebulate Pendimethalin Sulfentrazone	Clomazone Napropamide	Napropamide Pendimethalin		
Fungicide, Fumigant	Ferbam Mancozeb Metalaxyl Methyl Bromide Streptomycin (in burley tobacco)	Mancozeb	Chloropicrin Dichloropropene Dichloropropene + chloropicrin Methyl bromide + chloropicrin Metalaxyl		Mancozeb Metalaxyl		
Growth regulator						Butralin C8-10 fatty alcohol C10 fatty alcohol C10 fatty alcohol + Maleic hydrazide Flumetralin Maleic hydrazide Maleic hydrazide + butralin Maleic hydrazide + flumetralin	Ethephon

Table 4. Human health implications of insecticides available for use on tobacco

Chemical name and trade name	*Chemical class*	*Signal word*	*Acute toxicity*	*Oral LD_{50} in rats*†	*Equivalent human oral lethal dose*‡	*Acute exposure routes of greatest concern*§	*REI*†† *(hrs.)*
Aldicarb Temik 15G	carbamate	danger	highly toxic	5.3 mg/kg	0.37 g (0.01 oz)	Restricted use pesticide due to acute toxicity and groundwater contamination. *oral:* highly toxic *inhalation:* moderately toxic *dermal:* moderately toxic This product causes acetylcholinesterase inhibition and is rapidly absorbed through the skin and eyes.	48
Carbofuran Furadan 4F	carbamate	danger	highly toxic	7.34 mg/kg	0.5 g (0.02 oz)	Restricted use pesticide due to acute oral and inhalation toxicity. *oral:* highly toxic *inhalation:* highly toxic *dermal:* moderately toxic This product causes acetylcholinesterase inhibition.	48
Disulfoton Di-Syston 15G Di-Syston 8EC	organophosphate	danger	highly toxic	14–52 mg/kg	2.3 g (0.08 oz)	Restricted use pesticide due to acute oral, dermal, and inhalation toxicity. *oral:* highly toxic *inhalation:* highly toxic *dermal:* highly toxic This product is rapidly absorbed through the skin.	48
Endosulfan Golden Leaf Phaser 3EC Thiodan 3EC	organochlorine	danger	highly toxic	Golden Leaf: 44.9 mg/kg Phaser: No LD_{50} on MSDS Thiodan: 44.9 mg/kg	3.1 g (0.1 oz)	Golden Leaf and Thiodan: *oral:* highly toxic *inhalation:* moderately toxic *dermal:* moderately toxic *eye irritation:* moderately toxic Phaser: *oral:* highly toxic *inhalation:* moderately toxic *dermal:* moderately toxic *eye irritation:* highly toxic	24
Ethoprop Mocap 6 EC Mocap 10G Mocap Plus 4-2EC	organophosphate	6EC: danger 10G: warning 4-2EC: danger	6EC: highly toxic 10G: moderately toxic 4-2EC: highly toxic	6EC: 15.9–46.7 mg/kg 10G: 160–425 mg/kg 4-2EC: 16.7 mg/kg	6EC: 2.2 g (0.08 oz) 10G: 20.5 g (0.7 oz) 4-2EC: 1.2 g (0.04 oz)	6EC: Restricted use pesticide due to acute dermal toxicity. *oral:* highly toxic *inhalation:* highly toxic *dermal:* highly toxic 10G: *oral:* moderately toxic *inhalation:* moderately toxic *dermal:* moderately toxic 4-2EC: Restricted use pesticide due to acute oral, inhalation, and dermal toxicity. *oral:* highly toxic *inhalation:* highly toxic *dermal:* highly toxic Products are rapidly absorbed through the skin.	48

† From Material Safety Data Sheet (MSDS), based on formulation. LD_{50} (lethal dose) refers to the dose required to kill 50% of the test organisms.

‡ Calculated for a 70-kg (154-lb) adult human (1 kg = 2.2 lb).

§ See Table 2 for accompanying precautionary statements.

†† REI refers to restricted entry interval.

Continued

Table 4. Human health implications of insecticides available for use on tobacco (continued)

Chemical name and trade name	*Chemical class*	*Signal word*	*Acute toxicity*	*Oral LD_{50} in rats*†	*Equivalent human oral lethal dose*‡	*Acute exposure routes of greatest concern*§	*REI*†† *(hours)*
Chloropyrifos Lorsban 4EC Lorsban 15G	organophos-phate	4EC warning 15G caution	4EC moderately toxic 15G slightly toxic	4EC 268–444 mg/kg 15G >2000 mg/kg	4EC 25 g (0.9 oz) 15G 140 g (5 oz)	4EC: *oral:* moderately toxic *dermal:* slightly toxic *skin irritation:* moderately toxic *eye irritation:* moderately toxic Prolonged or frequent skin contact may cause allergic reactions. 15G: *oral:* slightly toxic *eye irritation:* moderately toxic	4EC: 24 15G: 12
Metaldehyde Deadline Bullets		warning	moderately toxic	630 mg/kg	44.1 g (1.6 oz.)	*oral:* slightly toxic *eye irritation:* slightly toxic	12
Metaldehyde + carbaryl bait	See individual components						
Acephate Orthene 75 SP	organophos-phate	caution	slightly toxic	1030–1447 mg/kg	86.7 g (3 oz)	*oral:* slightly toxic *eye irritation*: moderately toxic	24
Bacillus thuringiensis Agree Biobit FC Dipel 4L Dipel 10G M-Peril Condor XL discontinued '98 Dipel 2X Javelin WG	biological	caution	slightly toxic	>4000 mg/kg	280 g (10 oz)	Agree: *oral:* slightly toxic *dermal:* slightly toxic *eye irritation:* moderately toxic Biobit FC, Dipel 4L, Dipel 10G, or M-Peril: No specific route of entry of greatest concern Condor XL: *dermal:* slightly toxic Dipel 2X: *dermal:* slightly toxic *eye irritation:* moderately toxic Javelin WG: *inhalation:* slightly toxic *dermal:* slightly toxic	4
Imidacloprid Admire 2F Provado 1.6F	chloronicotinyl	caution	slightly toxic	4143–4870 mg/kg	315 g (11 oz)	*oral:* slightly toxic *dermal:* slightly toxic	12
Malathion Malathion 57EC	organophos-phate	caution	slightly toxic	3946 mg/kg	276 g (10 oz)	*oral:* slightly toxic	12

† From Material Safety Data Sheet (MSDS), based on formulation. LD_{50} (lethal dose) refers to the dose required to kill 50% of the test organisms.
‡ Calculated for a 70-kg (154-lb) adult human (1 kg = 2.2 lb).
§ See Table 2 for accompanying precautionary statements.
†† REI refers to restricted entry interval.

Continued

Table 4. Human health implications of insecticides available for use on tobacco (continued)

Chemical name and trade name	*Chemical class*	*Signal word*	*Acute toxicity*	*Oral LD_{50} in rats*†	*Equivalent human oral lethal dose*‡	*Acute exposure routes of greatest concern*§	*REI*†† *(hours)*
Fenamiphos Nemacur 3E	organophosphate	danger	highly toxic	10.6–24.8 mg/kg	1.2 g (0.04 oz)	Restricted use pesticide due to high acute toxicity and toxicity to wildlife. *oral:* highly toxic *inhalation:* moderately toxic *dermal:* highly toxic *eye irritation:* highly toxic	48
Fonofos Dyfonate 4EC Dyfonate 15G	organophosphate	4EC: danger 15G: warning	4EC: highly toxic 15G: moderately toxic	4EC: 10–22.5 mg/kg 15G: 61.2–180 mg/kg	4EC: 1.1 g (0.04 oz) 15G: 8.4 g (0.3 oz)	Restricted use pesticide due to acute dermal toxicity. 4EC *oral:* highly toxic *inhalation:* highly toxic *dermal:* highly toxic 15G *oral:* moderately toxic *inhalation:* moderately toxic *dermal:* moderately toxic Products are rapidly absorbed through the skin.	48
Methidathion Supracide 2EC	organophosphate	danger	highly toxic	56 mg/kg	3.9 g (0.1 oz)	Restricted use pesticide. *oral:* highly toxic *inhalation:* slightly toxic *dermal:* moderately toxic *skin irritation:* slightly toxic *eye irritation:* highly toxic	48
Methomyl Lannate 2.4 LV Lannate 90 SP	carbamate	danger	highly toxic	2.4 LV: 160 mg/kg 90 SP: 17–24 mg/kg	2.4 LV: 11.2 g (0.4 oz) 90 SP: 1.4 g (0.05 oz)	Restricted use pesticide due to high acute toxicity to humans. 2.4 LV: *oral:* highly toxic *inhalation:* moderately toxic *dermal:* moderately toxic *eye irritation:* highly toxic 2.4 LV contains methanol. 90 SP: *oral:* highly toxic *inhalation:* moderately toxic *dermal:* moderately toxic	48
Oxamyl Vydate L	carbamate	danger	highly toxic	37 mg/kg	2.6 g (0.09 oz)	Restricted use pesticide due to acute toxicity to humans, other mammals, and birds. *oral:* highly toxic *inhalation:* moderately toxic *dermal:* moderately toxic Product contains methanol.	48
Carbaryl Sevin 4F Sevin 50W Sevin 80S	carbamate	50W: warning 80S: warning 4F: caution	50W: moderately toxic 80S: moderately toxic 4F: slightly toxic	50W: 406 mg/kg 80S: 281 mg/kg 4F: 590 mg/kg	50W: 28.4 g (1 oz) 80S: 19.7 g (0.7 oz) 4F: 41.3 g (1.5 oz)	50W and 80S: *oral:* moderately toxic *inhalation:* slightly toxic *dermal:* slightly toxic *eye irritation:* slightly toxic 4F: *oral:* slightly toxic *inhalation:* slightly toxic *dermal:* slightly toxic *eye irritation:* slightly toxic	12

† From Material Safety Data Sheet (MSDS), based on formulation. LD_{50} (lethal dose) refers to the dose required to kill 50% of the test organisms.

‡ Calculated for a 70-kg (154-lb) adult human (1 kg = 2.2 lb).

§ See Table 2 for accompanying precautionary statements.

†† REI refers to restricted entry interval.

Table 5. Human health implications of herbicides available for use on tobacco

Chemical name and trade name	*Chemical class*	*Signal word*	*Acute toxicity*	*Oral LD_{50} in rats*[†]	*Equivalent human oral lethal dose*[‡]	*Acute exposure routes of greatest concern*[§]	*REI*[††] *(hours)*
Metam Sodium Vapam 3.18L	methyl isothiocyanate precursor	danger	highly toxic	1294–1428 mg/kg	95 g (3.4 oz)	*oral:* slightly toxic *inhalation:* slightly toxic *dermal:* moderately toxic *skin irritation:* highly toxic *eye irritation:* slightly toxic Prolonged or frequently repeated skin contact may cause allergic reactions.	48
Methyl Bromide (98%) Brom-O-Gas	Volatile Organic Compound (VOC)	danger	highly toxic	214–250 mg/kg	16.2 (0.6 oz)	Restricted use pesticide due to acute toxicity. *inhalation:* highly toxic *skin and eye irritation:* highly toxic Contains chloropicrin: respiratory and eye irritant and strong tear-producing agent.	48
Napropamide Devrinol 2E Devrinol 50 DF	aryloxy-alkanamide	2E: danger 50DF: caution	2E: highly toxic 50DF: slightly toxic	2E: 3690 mg/kg 50DF: >5000 mg/kg	2E: 258 g (9.1 oz) 50DF: 350 g (12.4 oz)	2E: *oral:* slightly toxic *dermal:* slightly toxic *skin irritation:* highly toxic *eye irritation:* highly toxic 50DF: *oral:* slightly toxic *eye irritation:* moderately toxic	12
Clomazone Command 4EC Command 3ME		4EC: warning 3ME: caution	4EC: moderately toxic 3ME: slightly toxic	4EC: 1406 mg/kg 3ME: >5000 mg/kg	4EC: 98 g (3.5 oz) 3ME: 240 g (8.5 oz)	4EC: *oral:* slightly toxic *inhalation:* slightly toxic *dermal:* slightly toxic *eye irritation:* moderately toxic 3ME: *eye irritation:* moderately toxic Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals.	12
Dazomet Basamid 99G	methyl isothiocyanate precursor	warning	moderately toxic	640 mg/kg	45 g (1.6 oz)	*oral:* highly toxic *skin irritation:* slightly toxic *eye irritation:* slightly toxic	24
Sethoxydim Poast 1.5 EC	cyclohexane-dione oxime	warning	moderately toxic	4100 mg/kg	287 g (10.1 oz)	*oral:* slightly toxic *eye irritation:* moderately toxic	12
Benfluralin Balan DF	2,6-dini-troaniline	caution	slightly toxic	500 mg/kg	35 g (1.2 oz)	*oral:* slightly toxic *inhalation:* slightly toxic *dermal:* slightly toxic	12
Pebulate Tilliam 6E	thiocarbamate	caution	slightly toxic	1300–1400 mg/kg	94.5 g (3.3 oz)	*oral:* slightly toxic	12
Pendimethalin Pentagon DG Prowl 3.3E	2,6-dini-troaniline	caution	slightly toxic	Pentagon DG: >5000 mg/kg Prowl 3.3E: 3956 mg/kg	Pentagon DG: 350 g (12.4 oz) Prowl 3.3E: 277 g (9.8 oz)	Pentagon DG: *dermal:* slightly toxic *eye irritation:* moderately toxic Prowl 3.3E: *oral:* slightly toxic *dermal:* slightly toxic	12
Sulfentrazone Spartan 75DF		caution	slightly toxic	2416 mg/kg	169 g (6 oz)	*oral:* slightly toxic *inhalation:* slightly toxic *dermal:* slightly toxic *eye irritation:* moderately toxic	12

† From Material Safety Data Sheet (MSDS), based on formulation. LD_{50} (lethal dose) refers to the dose required to kill 50% of the test organisms.

‡ Calculated for a 70-kg (154-lb) adult human (1 kg = 2.2 lb).

§ See Table 2 for accompanying precautionary statements.

†† REI refers to restricted entry interval.

Table 6. Human health implications of fungicides and fumigants available for use on tobacco

Chemical name and trade name	*Chemical class*	*Signal word*	*Acute toxicity*	*Oral LD_{50} in rats*†	*Equivalent human oral lethal dose*‡	*Acute exposure routes of greatest concern*§	*REI*†† *(hours)*
Chloropicrin Chlor-O-Pic 100 Chloropicrin 100	Volatile Organic Compound (VOC)	danger	highly toxic	Chlor-O-Pic 100: 250 mg/kg No LD_{50} data on MSDS for Chloropicrin 100	17.5 g (0.6 oz)	Restricted use pesticide. *oral:* moderately toxic *inhalation:* highly toxic *skin irritation:* moderately toxic *eye irritation:* moderately toxic Chloropicrin fumigant can cause marked irritation to the upper respiratory tract; it is a strong tear-producing eye irritant. Low concentrations, below those necessary to cause serious systemic intoxication, can cause painful eye irritation.	48
Methyl bromide (98%) Brom-O-Gas	Volatile Organic Compound (VOC)	danger	highly toxic	214-250 mg/kg	16.2 g (0.6 oz)	Restricted use pesticide due to acute toxicity. *inhalation:* highly toxic *skin irritation:* highly toxic *eye irritation:* highly toxic Inhalation may be fatal or cause serious acute illness or delayed lung or nervous system injury. Product contains chlorocpicrin as a warning agent. Chloropicrin may irritate the upper respiratory tract; even at low levels it may cause painful irritation to the eyes, producing watering.	48
Methyl bromide + chloropicrin Terr-O-Gas 67 Tri-Con 67/33	Volatile Organic Compound (VOC)	danger	highly toxic	Terr-O-Gas: 214–250 mg/kg No LD_{50} data on MSDS for Tri-Con	16.2 g (0.6 oz)	Restricted use pesticide due to acute toxicity. *inhalation:* highly toxic *skin irritation:* highly toxic *eye irritation:* highly toxic Inhalation may be fatal or cause serious acute illness or delayed lung or nervous system injury. This product contains chloropicrin, which may irritate the upper respiratory tract and may cause painful irritation to the eyes, producing watering.	48
Dichloro-propene + chloropicrin Telone C-17	Volatile Organic Compound (VOC)	danger	highly toxic	304–519 mg/kg	28.8 g (1 oz)	Restricted use pesticide due to acute toxicity, carcinogenicity. *oral:* moderately toxic *inhalation:* highly toxic *dermal:* moderately toxic *skin irritation:* moderately toxic *eye irritation:* highly toxic May cause allergic skin reaction. Prolonged contact may cause lung, liver, kidney damage, and respiratory system irritation. Contains 1, 3 dichloropropene, which has been determined to cause tumors in lab animals. Chloropicrin is a strong tear-producing eye irritant; low concentrations can cause painful eye irritation.	120

† From Material Safety Data Sheet (MSDS), based on formulation. LD_{50} (lethal dose) refers to the dose required to kill 50% of the test organisms.
‡ Calculated for a 70-kg (154-lb) adult human (1 kg = 2.2 lb).
§ See Table 2 for accompanying precautionary statements.
†† REI refers to restricted entry interval.

Continued

Table 6. Human health implications of fungicides and fumigants available for use on tobacco (continued)

Chemical name and trade name	*Chemical class*	*Signal word*	*Acute toxicity*	*Oral LD_{50} in rats*[†]	*Equivalent human oral lethal dose*[‡]	*Acute exposure routes of greatest concern*[§]	*REI*[††] *(hours)*
Dichloropropene Telone II	Volatile Organic Compound (VOC)	warning	moderately toxic	224–300 mg/kg	18.3 g (0.6 oz)	Restricted use pesticide due to acute toxicity, carcinogenicity. *oral:* moderately toxic *inhalation:* highly toxic *dermal:* moderately toxic *skin irritation:* moderately toxic *eye irritation:* moderately toxic May cause allergic skin reaction. May cause lung, liver, and kidney damage and respiratory system irritation upon prolonged contact. Contains 1,3-dichloropropene, which has been determined to cause tumors in lab animals.	72
Metalaxyl Ridomil Gold EC Ridomil Gold WSP Ridomil 2E (discontinued) Ridomil 50W (discontinued)	acylalanine	Gold EC: warning Gold WSP: caution Ridomil 2E: warning Ridomil 50W: warning	Gold EC: moderately toxic Gold WSP: slightly toxic Ridomil 2E: slightly toxic Ridomil 50W: slightly toxic	Gold EC: 1172 mg/kg Gold WSP: 1172 mg/kg Ridomil 2E: 1290–3000 mg/kg Ridomil 50W: 685 mg/kg	Gold EC: 82 g (3 oz) Gold WSP: 82 g (3 oz) Ridomil 2E: 150 g (5 oz) Ridomil 50W: 48 g (2 oz)	Gold EC and Gold WSP: *oral:* slightly toxic *dermal:* slightly toxic *eye irritation:* moderately toxic Ridomil 2E and Ridomil 50W: *oral:* slightly toxic *inhalation:* slightly toxic *dermal:* slightly toxic *eye irritation:* moderately toxic Do not use in greenhouses.	48 12
Ferbam Ferbam Granuflo 76% WDG	thiocarbamate	caution	slightly toxic	> 5000 mg/kg	350 g (12 oz)	*skin irritation:* slightly toxic *eye irritation:* slightly toxic Do not use in greenhouses.	24
Mancozeb Dithane DF	ethylenebis (dithiocarbamate)	caution	slightly toxic	> 5000 mg/kg	350 g (12 oz)	*skin irritation:* slightly toxic *eye irritation:* slightly toxic	24
Streptomycin (sulfate or nitrate) Agri-mycin 17	aminoglycoside	caution	slightly toxic	9000 mg/kg	630 g (22 oz)	This product may cause allergic skin reactions.	12

Other nematode control

1. Non-fumigants (See Table 4 for insecticide health and safety information.)
   Fenamiphos (Nemacur 3SC, 15G)
   Aldicarb (Temik 15G)
   Ethoprop (Mocap 6EC, 10G)
   Ethoprop + Disulfoton (Mocap Plus 4-2EC, 10-5G)
   Oxamyl (Vydate 2EC)
   Carbofuran (Furadan 4F)
   Chloropyrifos (Lorsban 4E)

2. Non-fumigant tank mixes (See Table 4 for insecticide health and safety information.
   Fenamiphos + Chloropyrifos (Nemacur 3SC + Lorsban 4E)
   Fenamiphos + Ethoprop (Nemacur 3SC + Mocap 6EC)
   Fenamiphos + Disulfoton (Nemacur 3SC + Di-Syston 8EC)
   Fenamiphos + Fonofos (Nemacur 3SC + Dyfonate 4EC)

† From Material Safety Data Sheet (MSDS), based on formulation. LD_{50} (lethal dose) refers to the dose required to kill 50% of the test organisms.
‡ Calculated for a 70-kg (154-lb) adult human (1 kg = 2.2 lb).
§ See Table 2 for accompanying precautionary statements.
†† REI refers to restricted entry interval.

Table 7. Human health implications of growth regulators available for use on tobacco

Chemical name and trade name	*Chemical class*	*Signal word*	*Acute toxicity*	*Oral LD_{50} in rats*[†]	*Equivalent human oral lethal dose*[‡]	*Acute exposure routes of greatest concern*[§]	*REI*[††] *(hours)*
Butralin Butralin FC	2,6-dinitoraniline	danger	highly toxic	> 2000 mg/kg	140 g (5 oz)	*oral:* moderately toxic *eye irritation:* highly toxic Prolonged or frequently repeated skin exposures may cause allergic reactions in some individuals.	12
C10 fatty alcohol + maleic hydrazide FST-7 Leven-38		danger	highly toxic	3900–5000 mg/kg	312 g (11 oz)	FST-7: *oral:* moderately toxic *eye irritation:* highly toxic Leven-38: *oral:* slightly toxic *eye irritation:* highly toxic	24
Ethephon Prep	ethylene generator	danger	highly toxic	3270 mg/kg	229 g (8 oz)	*oral:* slightly toxic *inhalation:* slightly toxic *dermal:* moderately toxic *skin irritation:* highly toxic *eye irritation:* highly toxic	48
Flumetralin Prime Plus	2,6-dinitoraniline	danger	highly toxic	4400 mg/kg	308 g (11 oz)	*oral:* slightly toxic *inhalation:* slightly toxic *dermal:* slightly toxic *eye irritation:* highly toxic Prolonged or frequently repeated skin exposures may cause allergic reactions in some individuals.	24
Maleic hydrazide + Butralin	See individual components						
Maleic hydrazide + Flumetralin	See individual components						
C8–C10 fatty alcohol Various trade names including: Fair 85 Offshoot T Sucker Plucker	fatty alcohol	warning	moderately toxic	25,000–28,000 mg/kg	1900 g (67 oz)	Fair 85: *oral:* slightly toxic *eye irritation:* moderately toxic Offshoot T: *oral:* slightly toxic *eye irritation:* slightly toxic Sucker Plucker: *oral:* slightly toxic *inhalation:* slightly toxic *dermal:* slightly toxic *eye irritation:* moderately toxic	24
C10 fatty alcohol Antak	fatty alcohol	warning	moderately toxic	> 10,000 mg/kg	700 g (25 oz)	*oral:* slightly toxic *skin irritation:* slightly toxic *eye irritation:* moderately toxic	24

[†] From Material Safety Data Sheet (MSDS), based on formulation. LD_{50} (lethal dose) refers to the dose required to kill 50% of the test organisms.
[‡] Calculated for a 70-kg (154-lb) adult human (1 kg = 2.2 lb).
[§] See Table 2 for accompanying precautionary statements.
[††] REI refers to restricted entry interval.

Continued

Table 7. Human health implications of growth regulators available for use on tobacco (continued)

Chemical name and trade name	*Chemical class*	*Signal word*	*Acute toxicity*	*Oral LD_{50} in rats*†	*Equivalent human oral lethal dose*‡	*Acute exposure routes of greatest concern*§	*REI*†† *(hours)*
Maleic hydrazide Various trade names including: Fair 30 Fair Plus Fair 80 SP Royal MH-30 Royal MH-30 SG Royal MH-30 XTRA Sucker Stuff Sucker Stuff 60WS Super Sucker Stuff		caution	slightly toxic	3800–5000 mg/kg	308 g (11 oz)	Fair Products: *oral:* slightly toxic *eye irritation:* moderately toxic Sucker Stuff and Super Sucker Stuff: *oral:* slightly toxic Royal MH-30 and Royal MH-30 SG: *eye irritation:* moderately toxic Royal MH-30 XTRA: *dermal:* slightly toxic *eye irritation:* moderately toxic Sucker Stuff 60WS *oral:* slightly toxic *dermal:* slightly toxic *eye irritation:* moderately toxic	12

† From Material Safety Data Sheet (MSDS), based on formulation. LD_{50} (lethal dose) refers to the dose required to kill 50% of the test organisms.
‡ Calculated for a 70-kg (154-lb) adult human (1 kg = 2.2 lb).
§ See Table 2 for accompanying precautionary statements.
†† REI refers to restricted entry interval.

Other Sources of Pesticide-Related Information

Printed Materials

Ellenhorn, M.J., S. Schonwald, G. Ordog, and J. Wasserberger. 1997. *Ellenhorn's medical toxicology: diagnosis and treatment of human poisoning* (2nd ed.). Williams & Wilkins: Baltimore, MD. 2047 pp.

Klaassen, C.D., M.O. Amdur, and J. Doull. 1996. *Casarett and Doull's toxicology: the basic science of poisons* (5th ed.). McGraw-Hill: New York, NY. 1111 pp.

Morgan, D.P. 1989. *Recognition and management of pesticide poisonings*. EPA-540/9-88-001, 4th ed. U. S. Environmental Protection Agency: Washington, DC. 207 pp.

North Carolina Agricultural Chemicals Manual. 1998. College of Agriculture and Life Sciences, North Carolina State University: Raleigh, NC. 454 pp.

Schuman, S. H. and W. M. Simpson, Jr. 1997. *AG-MED: the rural practitioner's guide to agromedicine*. American Academy of Family Physicians. 103 pp.

Internet Materials

Extoxnet (Extension Toxicology Network). URL: http://ace.ace.orst.edu/info/extoxnet/
Site includes pesticide information profiles of 168 common pesticides and other toxicological information.

Pesticide Poisoning Handbook. URL: http://hammock.ifas.ufl.edu/txt/fairs/pp/19729.html
Site includes complete reference on toxicology, signs, symptoms, diagnosis, and treatment of pesticide poisoning in humans.

Physicians's Guide to Pesticide Poisoning. URL: http://www-aes.tamu.edu/doug/med/pgpp.htm
Site includes complete reference on pesticide toxicology, labels, and regulations, plus signs, symptoms, diagnosis, and treatment of pesticide poisoning in humans.

C&P Press Crop Protection Reference. URL: http://www.greenbook.net
Site includes searchable list of current pesticide product labels and Material Safety Data Sheets.

Pesticide Labels On-Line. URL: http://www-aes.tamu.edu/labels.htm
Site includes an index of pesticide manufacturers.

Where to Find Material Safety Data Sheets on the Internet. URL: http://www.ilpi.com/msds/index.chtml
Site includes extensive list of sites with MSDSs, including general, government, and non-profit sites, and sites for chemical manufacturers and suppliers and pesticide manufacturers.

National Pesticide Telecommunications Network. URL: http://ace.orst.edu/info/nptn/
Site includes resources and links to sites with information on pesticides, regulatory issues, pest control information, poison centers, and pesticide databases.

National Library of Medicine Toxicology Tutor. URL: http://sis.nlm.nih.gov/toxtutr1/index.htm
Site includes information on basic principles of toxicology written at the introductory college student level.

Contact Numbers

Health Emergencies:

Emergency Medical Personnel ---------- 911*
North Carolina Poison Control Center ---------- 1-800-848-6946* (toll free)

To Ask Questions or Report Violations:

North Carolina Department of Agriculture and Consumer Services,
Pesticide Section ---------- 919-733-3556*
North Carolina Department of Labor ---------- 1-800-522-6762 (toll free)
Agricultural Safety and Health Section ---------- 919-733-8731*
North Carolina Department of Health and Human Services, Occupational
and Environmental Epidemiology Section ---------- 919-733-3410*
National Pesticide Telecommunications Network --------- 1-800-858-7378 (toll free)

*Spanish is spoken

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