as crop rotation, delayed planting, early harvest, etc. However, if a release of a commercially reared natural enemy, predator, parasite, or competitive agent is desired, contact your local Extension Specialist for recommended sources.

Pesticide Safety and Use

All pesticides listed in this publication are registered and cleared for suggested uses according to federal and state regulations in effect on the date of this publication. Follow the current label.

Trade names are used for identification only; no product endorsement is implied, nor is discrimination intended against similar materials.

Label Formulations

The recommendations within this publication list only one formulation of a given pesticide. Growers should be aware of other formulations. The rates to be applied are on the product label.

Before Using Pesticides

Read and post safety rules and list of poison control centers. See instructions on safe storage of pesticides on page 22. You should become familiar with the information on storage and toxicity of pesticides listed in the appendix of this guide. Similar pesticide products may not have the same crop uses. Always be certain the crop is listed on the product label before ordering or using the product.

DO NOT use concentrations greater than stated on the label. DO NOT apply more pesticide per acre or more frequently than the fewest number of days between applications recommended by the label.

Instruct your family, co-workers and farm laborers on the safe use of pesticides, protective clothing and reentry regulations concerning pesticides. See farm worker protection standards on page 20.

DO NOT spray or dust when bees are active in the field. Morning or late evening is usually the best time to spray.

Precautions

- Read and follow all directions and safety precautions on labels.
- Store pesticides in original containers, out of reach of children, pets and livestock.
- Dispose of empty containers immediately in a safe manner and place. Triple rinse.
- DO NOT contaminate forage, watersheds or water sources.
- Become familiar with life cycles of pests to properly time applications.
- Keep a complete diary of applications: crop, date of planting, pests, weather conditions, materials, date of application and amounts applied.
- Adhere to farm worker protection standards.

Poison Control Centers for the New England states are listed on the back cover. **For an emergency, EPA maintains a 24-hour medical consultation service in case of pesticide poisoning: 1-800-424-8802.** DO NOT use this number on a regular basis; use it only in an emergency! It is set up primarily for consultation with physicians and other health professionals needing assistance in the treatment of pesticide poisonings.

Reentry Period

Be sure all treated areas are posted to keep out unauthorized persons.

Persons must not be allowed to enter the treated area until after sprays have dried or dusts have settled and until sufficient time has passed to insure that there is no danger of excessive exposure. Follow label reentry restrictions. At no time during the reentry period are farm workers allowed to enter the treated area to engage in activity requiring substantial contact with the treated crop. Protective clothing and safety equipment may be needed for all persons, including farm workers, entering the treated areas.

Information About Pesticides

A pesticide is referred to: (1) by a common name or (2) by a trade or brand name (trade names are capitalized in this guide).

Labeled Formulations: The recommendations within this publication usually list only one formulation. Growers should be aware of other formulations. The rates to be applied are on the label.

Note: There may be several products registered with the same active ingredient. Each label is different, and some crops may be listed on some

labels but not on others.

It is the responsibility of the user to read the label and be sure that the material selected is labeled for the proposed use.

Labels are for your protection and information: Look for the percentage (by weight) or amount of material in the formulation. Compare costs of two similar products on the basis of effectiveness, the amount of actual pesticide contained and the quantity of the formulations needed/acre.

Follow all safety precautions. Some pesticides are extremely dangerous to handle. Protect yourself and your employees.

Control of target pest not on the label: Before applying a pesticide on a target pest not listed on the label for a given crop, contact your regional and state Extension specialist for clarification.

To avoid illegal residues: Adhere strictly to days to harvest (dh). Accurately calibrate your equipment; never exceed label recommendations. Prevent drift to adjacent properties or crops, or contamination of bodies of water. The applicator is held responsible for problems caused by drift or contamination. High-volume, low-pressure, ground applications cause less drift than low-volume, high-pressure, air-blast, ground applications; aerial applications or dust.

Emulsifiable concentrates (EC) are less troublesome to spray equipment than wettable powders (WP). The water-based flowable concentrates and wettable powders are less likely to cause plant injury than oil-based concentrates of similar materials.

Wettable powders/suspendable powders (WP) are less likely than ECs to cause injury to sensitive plants or to cause trouble when mixed with fungicides or other pesticides.

Dry flowables (DF) are similar to wettable powders in their formulation but are pelletized to minimize dust.

Flowables (F) are liquid formulations with similar properties to latex paint. Clean equipment immediately after use.

Tank mixture and aerial application: Check the label and consult your state pesticide regulatory agency.

Disposal of pesticides-Read the label: Contact your state pesticide regulatory agency for instructions on disposal of chemicals.

Farm Worker Protection Standards for Pesticides

According to EPA regulations, it is the responsibility of the owner or employer to protect regular farm workers as well as pesticide handlers, crop advisers, and the other people performing tasks on the farm from exposure to pesticides.

Employers are required to post the location of the nearest emergency medical facility and information about each pesticide application including location and description of treated area, product name, EPA number, active ingredient(s), time and date of application, and the restricted entry interval (REI). Pesticide information must remain posted for 30 days after the REI expires, and workers must be informed about the location of the posting. Commercial handlers must inform employers and provide the appropriate posting information before they apply pesticides.

Employers must make prompt transportation available in the case of suspected pesticide poisoning. Information from the pesticide label and about how the exposure occurred must also be provided by the employer. Decontamination sites must be provided to workers and handlers. Supplies for washing, including sufficient water, soap and towels must be available within one-quarter mile of workers. Eye-flush water must be immediately available if protective eyewear is required.

Nontrained and unprotected workers must be kept out of treated areas by the employer. Employees must protect early-entry workers by taking protective actions including waiting at least four hours after the application before entering and providing clean personal protective equipment and instruction in its use. Unless they are certified applicators, all workers must be provided training specified by the worker protection standards if they enter treated areas during part of the REI.

Oral or posted warnings must advise each worker who might enter within one-quarter mile of a treated area during application or an REI. Warning signs must be visible at all usual entrances, include specific warning words and symbols, and be a certain size and color.

Handlers who mix, load, flag, apply, assist with application or dispose of pesticides are protected by

Table 7. Toxicity information for some pesticides commonly used in small fruits[†].

Trade Name(tm)	Common Name	Manufacturer	EPA Reg #	Signal Word	REI	Crops (PHI)
INSECTICIDES/MITICIDES						
Acramite	bifenzate	Uniroyal	400-503	Caution	12 hrs	S(1), G(14)
*Agri-mek	abamectin	Syngenta	100-898	Warning	12 hrs	S(3), G(21)
*Asana	esfenvalerate	DuPont	352-515	Warning	12 hrs	B(14)
Aza-Direct	azadirachtin	Gowan	71908-1-10163	Caution	4 hrs	S(0), B(0), R(0), G(0)
Biobit	*Bacillus thuringiensis*	Valent	73049-54	Caution	4 hrs	S(0), R(0), G(0)
*Brigade	bifenthrin	FMC Corp.	279-3108	Warning	4 days[a]	S(0), R(3)
*Capture	bifenthrin	FMC Corp.	279-3069	Warning	4 days[a]	R(3)
Confirm	tebufenozide	Dow AgroSciences	707-238	Caution	4 hrs	B(14), R(14)
*Danitol	fenpropathrin	Valent	59639-35	Warning	24 hrs	S(2), G(21)
*Diazinon	diazinon	Various	Various	Caution[z]	24 hrs	S(5), G (28)
Dipel	*Bacillus thuringiensis*	Valent	73049-39	Caution	4 hrs	S(0), B(0), R(0), G(0)
Dibrom	naled	Amvac	5481-479	Danger/Poison	48-72hrs	S(1), G(3)
*Guthion	azinphos methyl	Bayer CropScience	264-733	Danger/Poison	2-21 days[b]	S(5), B(7), R(14), G(21)
Imidan	phosmet	Gowan	10163-169	Warning	24 hrs	B(3), G(14)
Kelthane	dicofol	Dow AgroSciences	62719-414	Danger[z]	48 hrs	S(3), G(7)
*Lannate	methomyl	DuPont	352-342	Danger[z]	2 - 7 days**	S(3), B(3), G(14)
*Lorsban	chlorpyrifos	Dow AgroSciences	62719-220	Warning	24 hrs	S(21)
M-Pede	insecticidal soap	Dow AgroSciences	53219-6	Warning	12 hrs	S(0), B(0), R(0), G(0)
Malathion	malathion	Various	Various	Warning	12hrs	S(3), B(1), R(1), G(3)
Phaser	endosulfan	Bayer CropScience	264-638	Danger/Poison	24 hrs	S(4), B(PH), G(7)
PyGanic	pyrethrins	MGK Co.	1021-1771	Caution	12 hrs	S(0), B(0), R(0), G(0)
Pyrellin	pyrethrins/rotenone	Webb Wright Corp.	30573-2	Caution	12 hrs	S(0), B(0), R(0), G(0)
Pyrenone	pyrethrins	Bayer CropScience	432-1033	Caution	12 hrs	S(.5), B(.5), R(.5), G(.5)
Savey	hexythiazox	Gowan	10163-250	Caution	12 hrs	S(3), R(3)
Sevin	carbaryl	Various	Various	Caution	12 hrs	S(7),B(7), R(7), G(7)
*Sniper	azinphos methyl	UAP - Platte	34704-691	Danger/Poison	2-21 days[b]	S(5), B(7), R(14), G(21)
Spintor	spinosad	Dow AgroSciences	62719-294	Caution	4 hrs	S(1), B(3),R(1), G(7)
Stylet Oil (JMS)	Paraffinic oil	JMS Flower Farms	65564-1	Caution	4 hrs	S(0), B(0), R(0), G(0)
Surround	kaolin	Engelhard Corp.	70060-14	Caution	4 hrs	B, R, G[b]
Thiodan	endosulfan	Universal Crop Protection		1386-338-72693	Warning	48 hrs S(4)
Vallero	cinnemaldehyde	Emerald BioAgricultre	58866-12-65626	Caution	4 hrs	S(0), B(0), R(0), G(0)
*Vendex	hexakis	Griffin	1812-413	Danger/Poison	48 hrs	S(1), G(28)
FUNGICIDES						
Abound	azoxystrobin	Syngenta	100-1098	Caution	4 hrs	B(0), G(14)
Armicarb	potassium bicarbonate	Helena	5905-541	Caution	4 hrs	S(0), B(0), R(0), G(0)
Aliette	fosetyl-aluminum	Bayer CropScience	264-516	Caution	12 hrs	S(0), B(0), R(60)
Bayleton	triadimefon	Bayer CropScience	3125-320	Caution	12 hrs	G(14)
Bravo Ultrex	chlorothalonil	Syngenta	50534-201-100	Danger	12hrs	B(42)
Cabrio	pyraclostrobin	BASF	7969-187	Caution	24 hrs	S(0), B(0), R(0)
Captan	captan	Various	Various	Danger	4 days***	S(0), B (0), G(0)
Dithane	mancozeb	Dow AgroSciences	707-241	Caution	24 hrs	G(66)
Elevate	fenhexamid	Arvesta	66330-35	Caution	12 hrs	S(0), B(0), R(0), G(0)
Elite	tebuconazole	Bayer CropScience	264-749	Warning	12 hrs	G(14)
Ferbam	ferbam	UCB Chemical Corp.	45728-7	Caution	24 hrs	G(7)
Flint	trifloxystrobin	Bayer CropScience	264-777	Caution	12 hrs	G(14)
Kaligreen	potassium bicarbonate	Nichimen America	70231-1	Caution	4 hrs	S(1), B(1), R(1),G(1)
Kocide	copper hydroxide	Griffin	1812-334	Danger	24 hrs	S(0), B(0), R(0)
Kumulus	sulfur	Micro Flo Co.	51036-352	Caution	24 hrs	S(0), B(0), R(0), G(0)
Lime Sulfur	calcium polysulfide	UAP - West	34704-321	Danger	48 hrs	B(0), R(0)
Manzate	mancozeb	Griffin	1812-415	Caution	24 hrs	G(66)
Nova	systhane	Dow AgroSciences	62719-411	Warning[z]	24 hrs	S(0), R(0), G(14)
Oxidate	hydrogen dioxide	Biosafe Systems	70299-2	Danger	0	S(0), B(0), R(0), G(0)
Procure	triflumizole	Uniroyal	400-431	Caution	12 hrs	S(1), G(7)
Quadris	azoxystrobin	Syngenta	100-1098	Caution	4 hrs	S(0),
Ridomil	mefenoxam	Syngenta	100-801	Caution	48 hrs	S(30), B(30), G(45)
Ronilan	vinclozolin	BASF	7969-85	Caution	12 hrs	R(9)
Rovral	iprodione	Bayer CropScience	264-453	Caution	24 hrs	S(PB), B(0), R(0), G(7)
Rubigan	fenarimol	Gowan	62719-134	Warning[z]	12 hrs	G(30)
Serenade	*Bacillus subtillis*	AgraQuest	69592-7	Caution	4 hrs	B(0), G(0)
Stylet Oil (JMS)	paraffinic oil	JMS Flower Farms	65564-1	Caution	4 hrs	S(0), B(0), R(0), G(14)
Sulfur	sulfur	Various	Various	Caution	24 hrs	S(0), B(0), R(0), G(0)
Switch	cyprodinil/fludioxonil	Syngenta	100-953	Caution	12 hrs	S(0)

Table 7. Toxicity information for some pesticides commonly used in small fruits†.

Trade Name(tm)	Common Name	Manufacturer	EPA Reg #	Signal Word	REI	Crops (PHI)
FUNGICIDES CONTINUED ...						
Syllit	dodine	UAP - Platte	55260-5-34704	Danger	48 hrs	S(14)
Thiolux	sulfur	UAP West	100-835	Caution	24 hrs	S(0), B(0), R(0), G(0)
Thiram	thiram	UCB Chem Corp.	45728-24	Caution	24 hrs	S(3)
Topsin-M	thiophanate-methyl	Cerexagri	4581-403	Caution	12 hrs	S(1)
Trilogy	neem oil	Certis USA	70051-2	Caution	4 hrs	S(0), B(0), R(0), G(0)
Vanguard	cyprodinil	Syngenta	100-828	Caution	12 hrs	G(7)
Ziram	ziram	Cerexagri	4581-140	Danger	48 hrs	B(ns), G(21)
HERBICIDES						
Casoron	dichlobenil	Uniroyal	400-168	Caution	12 hrs	B(ns), G(ns)
Dacthal	DCPA	Amvac Chem. Co.	5481-490	Caution	12 hrs	S(ns)
Devrinol	napropamide	United Phosphorus Inc.	100-1035-70506	Caution	12 hrs	S(ns), B(ns), R(ns), G(ns)
Formula 40	2,4-D	Nufarm Americas	228-357	Danger	48 hrs	S(ns)
Fusilade	fluazifob	Syngenta	100-1070	Caution	12 hrs	S(nb), B(nb), R(nb), G(nb)
Gallery	isoxaben	Dow AgroSciences	62719-145	Caution	12 hrs	B(nb), R(nb), G(nb)
Goal	oxyfluorfen	Dow AgroSciences	62719-424	Danger	24 hrs	S(pp), G(nb)
*Gramoxone Extra	paraquat	Syngenta	10182-280	Danger	24 hrs	S(21), B(21), R(21), G(ns)
Karmex	diuron	Griffin	1812-362	Caution	12 hrs	B(ns), R(ns), G(ns)
*Kerb	pronamide	Dow AgroSciences	707-159	Caution	24 hrs	B(ns), R(ns), G(ns)
Poast	sethoxydim	BASF	7969-58	Warning	12 hrs	S(7), B(30), R(45), G(50)
Princep	simazine	Syngenta	100-526	Caution	12 hrs	B(pf), R(pf), G(pf)
Rely	glufosinate ammonium	Bayer CropScience	264-652	Warning	12 hrs	G(14)
Roundup	glyphosate	Monsanto	524-445	Warning	12 hrs	B(14), R(14), G(14)
Scythe	pelargonic acid	Dow AgroSciences	53219-7	Warning	12 hrs	S(0), B(0), R(0), G(0)
Select	clethodim	Valent	59639-3	Warning	24 hrs	S(4), B(nb)
Sinbar	terbacil	Dupont	352-317	Caution	12 hrs	S(70), B(70), R(70)
Solicam	norflurazon	Syngenta	100-849	Caution	12 hrs	B(60), R(60), G(60)
Surflan	oryzalin	Dow AgroSciences	62719-112	Caution	24 hrs	B(ns), R(ns), G(ns)
Touchdown	sulfosate	Syngenta	100-1117	Caution	12 hrs	B(30), R(30), G(30)

[redacted]

††See below for description of toxicity class and signal word.

††† potassium salts of fatty acids

[b]no preharvest interval is required but application close to harvest is not recommended because of persistent residues.

[redacted]

[Þ]REI varies up to 21 days for different crops and different activities. Check the label.

ns= phi not specified, may be dictated by use pattern; nb=for use on non-bearing fields; pp=labeled for pre-plant applications; pf=labeled for pre-fruit formation application;

TOXICITY CATEGORY	SIGNAL WORDS* REQUIRED ON LABEL	ORAL LD_{50} (MG/KG)	PROBABLE LETHAL ADULT HUMAN DOSE
I Highly Toxic	DANGER and POISON, plus skull and crossbones symbol	0 to 50	A few drops to 1 tsp
II Moderately Toxic	Warning	50 to 500	1 tsp to 2 tsp
III Slightly Toxic	Caution	500 to 5,000	1 oz to 1 pint (1 lb)
IV Almost non-toxic	Caution	more than 5,000	1 pint (1 lb)

***Please Note**: certain products may use signal words which do not correlate with LD_{50} ratings due to some special property of the chemical. For example, chlorothalonil has a very low toxicity (LD50 10,000 mg/kg) yet had DANGER and WARNING signal words on many of its formulations, due to a possibility of an extreme allergic reaction in some people.

standards similar to those just listed, as well as by the requirement of voice contact at specified intervals in some cases.

For more information, contact your State Pesticide Coordinator, local EPA office or your Cooperative Extension Specialist.

Toxicity of Pesticides

All pesticides are poisonous. However, some are more toxic and/or hazardous than others. The toxicity of the pesticide is usually stated in the precaution on the label. For example, a skull and crossbones figure is always found on the label of highly toxic (Toxicity Class I) materials. Those of medium toxicity (Toxicity Class II) carry less severe warning statements.

The toxicity of a pesticide is expressed in terms of oral and dermal LD_{50}. LD_{50} is the dosage of poison that kills 50% of test animals (usually rats or rabbits) with a single application of the pure pesticide for a given weight of animal (mg/kg of body weight). The lower the LD_{50} value, the more toxic the material. Oral LD_{50} is the measure of the toxicity of pure pesticide when administered internally to test animals. Dermal LD_{50} is the measure of the toxicity of pure pesticide when applied to the skin of test animals. Generally, an oral application is more toxic than a dermal application.

Restricted-Use Pesticides

In accordance with federal and state pesticide regulations, those pesticides that are highly toxic and those that persist and accumulate in the environment are placed on a restricted-use list and shall be sold and used only by certified applicators.

In some instances, states may require additional permits for certain pesticide users.

Poisoning Information

Adapted from the 1999 Ohio Vegetable Production Guide

Poison Control Centers are listed on back page. Make sure your doctor has a copy of this list and the Note to Physicians that is placed on the labels of dangerous pesticides.

Treatment for pesticide poisoning is very precise. The antidotes can vary for the different pesticides. In an emergency, call your doctor and provide specific information on the trade name and common name of the pesticide exposed to. Your doctor will then consult the center if necessary.

Table 7 lists pesticides that are commonly recommended for small fruit, insect, disease and weed control along with their signal word (warning, caution, danger) and re-entry interval (REI).

Pesticide Storage

Pesticides should always be stored in their original containers and kept tightly closed. For the protection of others, especially firefighters, the storage area should be posted as Pesticide Storage and kept securely locked.

Herbicides, especially hormone-like weed killers such as 2, 4-D, should not be stored with other pesticides (primarily insecticides and fungicides) as they can volatize and adsorb to other pesticides.

Store pesticides in a cool (between 40 and 80½ F), dry, well-ventilated area that is not accessible to

Formulation	General Signs of Deterioration
Emulsifiable Concentrate (EC)	Evidence of separation of components such as sludge or sediment. Milky appearance does not occur when water is added.
Oils	Milky appearance does not occur when water is added.
Wettable Powders, Suspendable Powders (WP, SP)	Excessive lumping; powder does not suspend in water.
Dry Flowable, Granular (DF,G)	Excessive lumping or caking.

After freezing, place pesticides in warm storage (50½to 80½F, or 10½C). Shake or roll container every few hours to mix product or eliminate layering. If layering persists or if all crystals do not completely dissolve, DO NOT use product. If in doubt, call the manufacturer.

children and others who do not know or understand the safe and proper use of pesticides.

Any restricted pesticide or container contaminated by restricted pesticides must be stored in a secure, locked enclosure while unattended. That enclosure must bear a "pesticide storage" warning sign readable at a distance of 20 feet. If any pesticide has to be stored in other than its original container, that container must be labeled with the name and concentration of the active ingredient and the signal word and warning statements for the pesticide along with a copy of the label. Keep an inventory of all pesticides stored in an area away from the storage site, so that it may be referred to in case of an emergency at the storage site.

Make available to personnel at all times: a respirator with chemical cartridge, gas mask with canister, goggles, rubber gloves and aprons, fire extinguisher and a detoxicant for spilled materials suggested by your local fire department. Instruct all personnel on proper use of the above equipment and on what to do in case of emergency. A shower stall with plenty of soap should be made available on the premises. Prompt washing in case of accidental spillage may be a matter of life and death.

Keep your local fire department informed of the location of all pesticide storage areas. Fighting a fire that includes smoke from burning pesticides can be extremely hazardous. Firefighters should be cautioned to avoid breathing any smoke from such a fire. A fire with smoke from burning pesticides may endanger people in the immediate area or community. They may have to be evacuated if the smoke from a pesticide fire drifts in their direction.

Winter Storage of Pesticides

Plan pesticide purchases so that supplies are used by the end of the growing season. When pesticides are stored for the winter, keep them at temperatures above freezing, under dry conditions and out of direct sunlight. The following points should be observed:

- Read the label. Special storage recommendations or restrictions will be printed on the label.
- Write the purchase or delivery date of the product on the label with waterproof ink. Products may lose their effectiveness over several years.
- Ventilation is important for storage of most pesticides.
- Store herbicides separately from other pesticides to avoid cross contamination. See chart at the bottom of page 23 for signs of quality deterioration.

Sprayer Calibration

- Clean sprayer and replace all worn parts.
- Fill tank with clean water.
- Adjust spray pressure and speed of tractor for nozzle size and output, using manufacturer's recommendations.
- Spray 1/8 acre (5,445 sq ft). Distance of travel will vary with boom width. For example, a 22-ft boom must travel 248 feet to cover 1/8 acre, or an air blast sprayer covering a 44-ft swath must travel 124 feet to cover 1/8 acre. Note: There are several potential disadvantages in using air-blast sprayers.

Table 8. Approximate dilutions for small volumes of spray mixes

Formulation	100 gallons	5 gallons	3 gallons	1 gallon
WETTABLE POWDER	5 pounds	15 tablespoons	9 tablespoons	3 tablespoons
	4 pounds	13 tablespoons	8 tablespoons	3 teaspoons
	3 pounds	10 tablespoons	6 tablespoons	2 tablespoons
	2 pounds	8 tablespoons	4 tablespoons	4 teaspoons
	1 pound	3 tablespoons	2 tablespoons	2 teaspoons
	1/2 pound	5 teaspoons	1 tablespoons	1 teaspoon
EMULSIFIABLE CONCENTRATE	5 gallons	1 quart	1 1/4 pints	13 tablespoons
	4 gallons	1 1/2 pints	1 pint	10 tablespoons
	3 gallons	1 1/4 pint	3/4 pint	1/4 pint
	2 gallons	3/4 pint	1/2 pint	5 tablespoons
	1 gallon	1/2 pint	8 tablespoons	3 tablespoons
	1 quart	3 tablespoons	2 tablespoons	2 teaspoons
	1 pint	5 teaspoons	1 tablespoon	1 teaspoon

Contact Cooperative Extension for more information.

- Measure amount of water needed to refill tank. The above amount was applied to 1/8 acre; thus, eight times this amount is the gallonage per acre.
- Adjustment in gallonage may be made either by varying tractor speed or changing nozzle sizes or pressure. Recalibrate after making an adjustment.
- Calculate acres to be covered by tank of spray mixture and add required amount of pesticide for total area to be sprayed.

Calibrate your spray equipment frequently and regularly.

Adjuvants

Adjuvants are nonpesticide chemicals that are added to pesticides or to pesticide spray mixtures to improve their chemical or physical characteristics. Adjuvants can reduce or eliminate many spray application problems by performing specific functions. These functions include spreading, wetting, sticking, reducing drift, buffering, improving compatibility, reducing foaming and improving the effectiveness of certain pesticides. Although several adjuvants perform more than one function, no one adjuvant can perform all of these functions.

The most important source of information you have to determine whether or not to use an adjuvant is the pesticide label. Some prohibit the use of adjuvants. Sometimes the use of an adjuvant will cause severe crop injury or loss. Some labels provide no mention of adjuvants; in this case, consult the manufacturer or pesticide dealer.

The most common types of adjuvants are nonionic surfactants, crop oil concentrates, spreader/stickers, drift control agents, buffering agents, compatibility agents and foam-reducing agents.

Water

Protect Groundwater

There is considerable public concern about water quality, and agriculture is coming under increasing scrutiny regarding practices that can affect water quality. Many pesticides and fertilizers are soluble in water and can leach through the soil to contaminate underlying groundwater. Several factors affect the movement of chemicals in the soil and their likelihood of reaching groundwater. Consideration of these factors can minimize the threat to groundwater.

Pesticide Characteristics: Solubility is very important in the leaching of a pesticide. Chemicals that are highly soluble in water are easily leached as water moves downward. If practical, use the least soluble material at the lowest effective rate.

Adsorption is the binding of a chemical to the surfaces of soil particles and organic matter. Some chemicals are tightly adsorbed and do not easily leach from soils.

Persistence refers to the amount of time a chemical will stay in the environment before being broken down into nontoxic substances. The rate of breakdown is affected by sunlight, temperature, soil pH, moisture and microbial activity. Pesticide persistence is measured in terms of half-life which is the length of time needed for one-half of the amount applied to break down. Persistent chemicals break down slowly, increasing the chance for them to leach from the soil. Conversely, short-lived materials may be degraded before significant leaching occurs. Many pesticides are broken down by sunlight (photodegradation) and/or microbial action. Incorporation of pesticides into the soil reduces or eliminates photodegradation. As depth in the soil increases, there is less microbial degradation. Any practice that slows degradation increases persistence and the likelihood of leaching. Generally, foliar applied materials are more likely to break down before significant leaching occurs than those that are applied to the soil.

Soil Characteristics: Soil texture and organic matter greatly influence the movement of pesticides and fertilizers. Fine textured soils and those with high amounts of organic matter are highly adsorptive, whereas sandy soils low in organic matter are not. Highly permeable soils with permeable underlying layers allow for rapid downward movement of water and dissolved chemicals. Know your soils and apply chemicals accordingly.

Water Table: High water tables are especially vulnerable to contamination because little time is required for chemicals to reach groundwater.

Fertilizers: Nitrogen (N) in the nitrate form is highly soluble, persistent and not adsorbed to soil particles. Nitrate N is not only leachable but is recognized as a health threat at concentrations above 10 ppm in drinking water. Infants are most susceptible to nitrate in drinking water. The ammonium