original application, although most of the injurious volatility occurs within the first 12 to 24 hours.

Grapes

Grapes are sensitive to injury by phenoxy herbicides due to the way the plants metabolize it in the leaf tissue. Several studies have found that they can retain the parent compound in the leaf tissue for three weeks or longer.

Grapevines may be injured by phenoxy type herbicides throughout the growing season. However, grapes are most vulnerable during the first half of the growing season when shoot tips are actively growing through the bloom period. 2,4-D is absorbed into the phloem of the plants and is drawn to the actively growing shoot tips and young leaves. This causes the growth to stop temporarily and to be retarded for several weeks. If the effects are not too severe, normal growth will resume either the same year, or the following year. However, severely injured vines may not recover for two years or more.

2,4-D damage to a peach tree.

Cupping of grape leaves from 2,4-D drift.

Flower clusters are also particularly sensitive to herbicide exposure. Contact with phenoxy herbicides during bloom can greatly reduce fruit set and injured vines may have delayed fruit ripening. Severe injury can prevent complete maturity of the fruit and fruits may never mature regardless of the length of the growing season. Delayed maturity may exist in a vine for one to three years before normal ripening resumes.

Dicamba damage to a pine tree.

With moderate to severe leaf damage, the potential for fruit cluster damage is much higher. Moderately affected clusters set fewer berries while clusters with severe damage may set few or no berries.

A delay or impairment in a vine's ability to develop wood or harden off properly can also occur. This can lead to winter damage because the shoots without proper wood development die over the winter.

The intensity and persistence of the symptoms depends on the level of exposure and age of the plant. Initial symptoms of phenoxy herbicide exposure are twisting and leaf curling, which may occur within hours of exposure. Leaves that are not fully expanded at the time of exposure may be stunted or distorted. Within a week after exposure, general chlorosis may develop at high exposure levels. Leaves will drop and shoot tips may die, followed by stem dieback. Regrowth may exhibit severe shoot and petiole twisting, leaf cupping, stunting, curling, strapping, feathering, roughness of the leaf surface, and fingering of the leaf margins. In addition, veins may be discolored and appear to be joined together and extend to form finger-like projections.

Avoid Problems

As an applicator you are ultimately responsible for managing drift.

- ❑ You must assess the vulnerability of neighboring properties and those areas downwind of the application site. Know if there are sensitive crops around the application site.
- ❑ Evaluate weather conditions for temperature inversions, wind direction, and wind speed before deciding whether or not to spray.
- ❑ Adjust application equipment to reduce the risk of spray drift.
- ❑ Use alternative herbicide products that are not prone to vapor drift. Consult the University of Maryland Extension recommendation guides for alternative products.
- ❑ Use drift-control additives, or thickeners, to help minimize drift.
- ❑ Always read and follow label directions.

A good drift management program uses a combination of all the drift-reducing techniques that are available for making a particular application. Plan ahead to minimize the chances for errors and reduce the potential for drift.

Maryland's Sensitive Crop Locator Website

The Maryland Department of Agriculture is developing a *Sensitive Crop Locator* as part of it's website, www.mda.state.md.us. This tool will assist pesticide applicators in identifying locations where sensitive crops are grown in order to take extra precautions for preventing the potential exposure of these crops to spray drift from neighboring fields.

Pesticide applicators will have access to maps and aerial photographs for searching, identifying and locating sensitive crops adjacent to areas where they intend to spray pesticides.

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MDA 14.02.10 9/10

Preventing Herbicide Damage To Sensitive Crops

The off target movement of herbicides from the site of application, referred to as ***drift***, may cause injury to desirable plants located in adjacent fields, or property. Drift can injure foliage, shoots, flowers and fruits resulting in reduced yields, economic loss and illegal residues on exposed crops. Controlling pesticide drift is an issue that is important to every pesticide applicator.

Crops such as, grapes, tomatoes, tobacco, fruit trees, ornamentals and other specialty vegetable crops are particularly sensitive to drift especially from the family of herbicides known as the phenoxy herbicides.

The phenoxy herbicides are a type of growth hormone that is applied postemergent and causes broadleaf plants to have a rapid and uncontrolled growth that eventually kills the plant. Herbicides containing 2,4-D (2,4-dichloro-phenoxyacetic acid) which are the most commonly recognized products (Weedone, Crossbow) in this family and also includes products such as:

- ❑ 2,4-DB (Butyrol)
- ❑ MCPA
- ❑ MCPP
- ❑ triclopyr (Garlon)

- ❑ dicamba (Banvel)
- ❑ picloram (Tordon)
- ❑ clopyralid (Stinger)

These products are contained in herbicides used for agricultural production as well as in non-crop applications such as brush control, sod production and lawn care.

Drift

Drift can be defined simply as the airborne movement of pesticides to non-target areas. Off-target movement can be in the form of either:

- ❑ ***Particle drift*** which is the movement of small spray droplets from the site of application by wind, or
- ❑ ***Vapor drift*** which is the movement of a pesticide from the site of application in the form of a gas, or vapor, during or after the application.

Weather Conditions

Spray drift is typically the result of small spray droplets being carried off-site by air movement. The main weather factors that cause drift are:

- ❑ Air movement (wind)
- ❑ Humidity
- ❑ Temperature inversions

Air movement is the most important environmental factor influencing the drift of pesticides from target areas. Except in the case of temperature inversions, the early morning and evening are the best times to apply pesticides. This is because windy conditions are more likely to occur around midday when the temperature near the ground increases. Under normal conditions air tends to rise and mix with the air above. Droplets will disperse and normally do not cause problems. However, applications made under low-wind conditions can sometimes result in more extensive drift than those made under high winds.

Wind Meter


Smoke along the ground surface indicates a temperature inversion.

Low relative **humidity** and/or high temperatures can also increase the potential for spray drift. Under these conditions, the evaporation rate of water increases, resulting in smaller spray droplets that are more prone to drift. Therefore applicators should avoid spraying during these conditions.

Another weather condition known as a **temperature inversion** exists when the air at ground level is cooler than the temperature of the air above it. Under these conditions, the air is considered stable because there is little or no vertical air movement. Almost all of the air movement associated with inversions is sideways. This causes small suspended droplets to form a concentrated cloud which can move in unpredictable directions.

Under clear to partly cloudy skies and light winds, a surface inversion can form as the sun sets. With these types of conditions a surface inversion will continue into the morning until the sun begins to heat the ground. Making a pesticide application under these conditions results in a high concentration of small spray droplets suspended in this layer of cool air found near the surface of the ground. These droplets can then be carried for long distances. Drift that occurs over long distances, one mile or more, is frequently the result of applications made under temperature inversions.

Spray Characteristics Affecting Drift

The main factors that influence the ability of a spray droplet to drift are:

- ❑ Droplet size
- ❑ Viscosity
- ❑ Formulation

The spray **droplet size** is the most important factor affecting particle drift. Larger spray droplets are less likely to drift than smaller ones. Spray droplet size also varies with the type and size of nozzle and the spray pressure that is being used. Typically, nozzles with larger orifices used with lower pressures produce larger droplets. However, some new nozzles, such as air-induction nozzles, produce larger droplets when used at higher pressures.

Viscosity (thickness) of the liquid also affects droplet size. The viscosity of a liquid is a measure of its resistance to flow. For example, mayonnaise is more viscous than water. As the viscosity of the liquid increases, so does the droplet size, thus reducing the potential for off-target movement. Formulations such as invert emulsions have a thick consistency that aids in reducing drift.

Drift control additives can help reduce the potential for drift. The number of large droplets can be increased by using certain additives and thickeners. Tests indicate that in some cases drift control additives can reduce downwind drift deposits by 50 to 80 percent. Remember, always follow the label directions about using any spray adjuvant intended for minimizing drift.

The **formulation** of the pesticide is also a major factor, especially in the case of vapor drift. Whenever possible, choose a pesticide that is formulated as a low-volatility product. Avoid applying volatile pesticides on hot days, since some products can even volatilize several hours after application. Many products carry precautions against applications when temperatures will be, or exceed, 85º F.

Application Equipment

The equipment that is used for applying pesticides and how it is set up also plays an important role in drift reduction. Routine maintenance and adjustments to application equipment will help minimize the potential for drift. These practices include:

- ❑ Selecting nozzles that produce coarse droplets.
- ❑ Increasing nozzle size. Larger capacity nozzles reduce drift.
- ❑ Using the lower end of the pressure range. Higher pressures produce smaller droplets. Avoid pressures over 40 to 45 psi.
- ❑ Lowering the height of the sprayer boom. Wind speed increases with height. The correct spray height is determined by the nozzle spacing and spray angle
- ❑ Calibrating spray equipment regularly.
- ❑ Replacing worn nozzles.
- ❑ Using shielded or shrouded sprayer booms when possible.

Damage


2,4-D damage to grape leaves.

The extent of injury from phenoxy herbicides, or other herbicides, is dependent on a number of factors. These factors include: the growth stage of the plant at the time of exposure; whether the plant was directly impacted by drift and/or through volatilization; the distance between the application and the impacted crop; wind and weather conditions; specific characteristics of the application (pressure, nozzles, pesticide applied); and general condition and health of the impacted crop.

Damage has been noted where the application site of a phenoxy herbicide has been up to ½ mile from a vineyard. In addition, volatilization can still occur several days after the