Phytotoxicity on Foliage Ornamentals Caused by Bactericides and Fungicides

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Pesticides are routinely employed by ornamental plant producers, and they are generally efficaceous and safe to the crop. The rigid standards for aesthetic quality of foliage ornamentals place equal importance on pesticide safety to the plant and efficacy. When new pesticides become available or new crops are introduced, it is wise to test the safety of each product on each plant. Pesticides labeled for use on a diverse plant group, such as the philodendron genus, should not be assumed to be equally safe on all species or cultivars. Even under the normal conditions in which pesticides are routinely applied, phytotoxicity (plant injury) occasionally occurs. Phytotoxicity can result in a variety of symptoms and may be more severe under certain production situations. The wrong choice of pesticide, whether due to active ingredient, carrier chemical, or rate applied, can result in plant injury. Use on pesticide-sensitive plant species, such as schefflera (Figure 1), can result in plant injury more often than not. The practice of tank mixing pesticides, fertilizers, and / or spreader stickers can prove injurious to plants as can the application of pesticides during adverse environmental or cultural conditions. Even miscellaneous chemicals such as algicides and disinfestants used in the production site, although not plant-directed, can cause phytotoxicity (Figures 2, 3). Phytotoxicity can reduce plant quality and increase time needed to produce salable plants.

Symptoms of Phytotoxicity

Phytotoxicity may express itself in a variety of ways, some obvious and some subtle. Symptoms range from minor leaf speckling to plant death. One of the most common phytotoxicity symptoms is chlorosis. Symptoms generally appear on the new growth and can be confused with fertilizer deficiencies. Sometimes chlorosis is slight and barely noticeable while at other times the tissue turns white within a few weeks of application (Figures 4-8). In other situations, the leaves remain green while the petioles or stems turn chlorotic (Figure 9).

Another common symptom of phytotoxicity is necrosis or burning. Burning can occur on leaf tips, margins, interveinal tissue or simply scattered across the leaf surface. Burning is the most obvious phytotoxicity symptom short of plant death. Burning usually appears within a week of pesticide application, but may take as long as six to 6ight weeks to appear if multiple applications are required and the pesticide is applied only once a month. Burning may be caused in several ways. Contact burns are characterized by a general speckling of the leaf surface with spots found wherever spray droplets landed (Figures 3, 10). Some burns occur at spots on the leaf where spray accumulates and causes localized damage (Figure 11). Other burns occur when the pesticide is absorbed through leaves or roots and is redistributed

(Figure 4), usually appearing on leaf margins where the pesticide accumulates (Figure 5). Finally, some burns occur on young plant tissue which is not fully developed at the time of exposure. This damage can occur on leaf tips or edges which were exposed, while the rest of the leaf which was rolled remains asymptomatic (Figure 11).

Distortion of new growth or cessation of growth is sometimes difficult to diagnose as phytotoxicity unless plants are monitored closely. Distortion of new leaves on rapidly growing plants can occur within a week of pesticide application. This symptom is occasionally attributed to a viral disease since it too can cause distortion of new leaves. Growth distortion symptoms due to pesticide phytotoxicity should be more uniformly distributed throughout a bed or range of plants than symptoms caused by a viral disease. Sometimes a combination of distortion and stunting occurs, which may result in cessation of plant growth (Figure 12). Tips of some distorted leaves appear chlorotic or necrotic and internodes may be shortened (Figures 13, 14).

Be sure that what you are calling phytotoxicity is indeed due to a pesticide application. Many times fertilizer burns and even some diseases appear similar to phytotoxicity symptoms. Avoid confusion by keeping accurate up-to-date records of all treatments (fertilizer or pesticide) which are applied to your plants. Consult a plant pathologist if disease is suspected.

Many symptoms of phytotoxicity are difficult to verify unless some plants of the same age and cultivar were untreated. This is the only way to assess such symptoms as stunting, reduced leaf size or slight chlorosis. It should be remembered that once phytotoxicity develops, most symptoms will not disappear. The plants may outgrow the problem, but leaves with burns or distortion will not become healthy. Phytotoxicity must be avoided since it usually cannot be cured. The key to avoiding phytotoxicity is to follow the label directions and to test the product under your conditions on your plants.

Phytotoxicity Test Procedure

A phytotoxicity test should be performed by all growers whenever new plants or varieties are added to their product mix, they wish to try a new product, or they are using a new tank mix of two or more products. You should always test pesticides on a small group of plants prior to applying them broadscale. The following test is a sample format which could be used to perform a phytotoxicity trial with a pesticide which you have not used before.

1. Select healthy typical plants of each cultivar or type on which the pesticide will be used.

2. Read the pesticide label to determine the application site (roots or leaves), the rate of application (amount per gallon / liter), and the interval of application (number of days between applications). These facts must be determined prior to starting the trial. Many researchers and chemical companies W-111 their products at double the labeled rate in order to obtain a greater margin of safety.

3. Use clean spray equipment and perform the test during the time of day when most of your pesticide applications will occur.

4. The key to a phytotoxicity trial is to have one control set of plants which are sprayed with water only. If the pesticide is normally applied with a spreader sticker, include a set of plants to receive an application of spreader sticker in water since adjuvants such as spreader stickers can cause phytotoxicity as well as the actual pesticide. These two sets of plants will be the ones which you compare to pesticide-sprayed plants for signs of damage. Control plants must be sprayed under the same condi-

tions as pesticide-sprayed plants.

5. Wait two to three weeks before determining that a pesticide is safe. In this period of time most severe phytotoxicity will become apparent; however, plant stunting will not be apparent for a longer period of time. If stunting appears to be a problem, the test must be conducted for several weeks and the pesticide reapplied at the labeled interval. In general, these trials will identify only severe phytotoxicity such as chlorosis and necrosis of leaves.

Tank-Mixing

The desire to save time and money may lead to the common practice of tank mixing several fungicides or a fungicide with other pesticides such as miticides, insecticides or nematicides. Some fungicides are formulated with special spreading agents that can result in plant injury if indiscriminately tank mixed with a second spreader sticker product. Although some pesticide combinations are quite safe for use on many plants, others can cause plant damage. Some situations exist where pesticides are additionally mixed with soluble fertilizers in the interest of greater labor efficiency or due to availability of application equipment. These situations can also result in phytotoxicity.

A number of general observations apply to the tank-mix situation. In choosing among formulations of the same product, select wettable powder (WP) formulations over emulsifiable concentrate (EC) types since the latter are more likely to be phytotoxic and more prone to incompatibility problems because of emulsion sensitivity. The combination of WP with EC formulations or soluble fertilizers may result in breakdown of the emulsifying agent, depending on pesticide concentration and water quality, and hence phytotoxicity and loss in efficacy. Water soluble pesticides (i.e., Acti-dione, Agri-Strep, Aliette, Banol, or Subdue) can usually be mixed with any number of insoluble pesticides. Streptomycin-based pesticides should not be used with EC formulations. If two water soluble pesticides must be tank mixed, a reduction in rate up to 50% for each compound may be needed to avoid phytotoxicity since both pesticides compete similarly for chemical bonding sites with water. Finally, avoid tank-mix combinations for strongly acid and alkaline materials which can result in chemical incompatibility.

A number of pesticides offer safe tank-mix labeling or some label indications of product compatibility. For other pesticide combinations (with or without fertilizers), trial and error is required in the nursery. When preparing any unlabeled tank mix of pesticides, fertilizers, and / or spreader stickers, growers should check the physical and chemical compatibility of these combinations through a simple jar compatibility test. The following steps in performing the jar test should be followed prior to plant testing (see previous section).

JAR TEST PROCEDURE

1. Define the recommended volume or weight of each material per 100 gal. of water carrier.

2. Calculate the appropriate concentration of each chemical per pint of water spray volume.

3. Obtain two quart jars and label “with spreader sticker” and “without spreader sticker.”

4. Add one pint of water to each jar and the required amount of spreader sticker to the appropriately labeled jar.

5. Add the desired chemicals for the tank mix by formulation type and in the calculated amounts per one pint of water. Add first the wettable powders (WP), followed by granules (G), flowables (F), emulsifiable concentrates (EQ, and finally liquids

6. Close jars and shake vigorously to mix.

7. Observe both jars immediately after agitation and again after 30 minutes.

8. If one or both jars remain suspended (mixed) or are resuspended easily after 30 minutes (with minimal agitation), then the tank mix materials are compatible and can be tested on plants. Layering of materials in one or both jars indicates physical incompatibility and a more likely phytotoxic combination. The formation of a solid precipitate or "gunk" that does not resuspend indicates chemical incompatibility and an unacceptable tank mix combination.

9. Choose the compatible combination(s) only and proceed to evaluate these along the previously mentioned steps for plant phytotoxicity.

Environmental Factors Influencing Phytotoxicity

The environment at the time of application may play a role in development of plant injury symptoms. Extremes in temperature can affect pesticide safety on a plant, thus pesticide applications should be made between 60 to 85° F. Certain product labels caution against use when temperatures are 85°F or higher. Examples of these products include cycloheximide (Acti-dione), dinocap (Karathane), lime sulfur and sulfur fungicides. Other pesticides such as Bordeaux mixture, dinocap, and fixed copper products can cause plant injury under cool, dry conditions.

Plant vigor at the time of pesticide application can also affect the margin of pesticide safety. In some cases, stressed plants are more susceptible to pesticide phytotoxicity than non-stressed plants. Stresses may be due to a wide range of causes including extremes of fertilizer, water, temperature, light and high levels of pest pressure. Maintaining plants under optimal conditions will lessen the chances of phytotoxicity.

Summary

Avoiding phytotoxicity is not an impossible task and can be accomplished if several key practices are followed closely.

1. Spray plants only with pesticides known to be safe for the plant. This can be determined by reading the label or state publications on recommended and safe fungicides and through performance of phytotoxicity trials.

2. Do not tank mix unless the combination of products is known to be safe. Unlabeled tank mix combinations should be checked first for compatibility by the jar test. If mixes are compatible, they still must be evaluated on each plant type (see above).

3. Do not spray stressed plants if this can be avoided.

4. Spray plants when temperatures are cool to warm (below 85°F preferably).

5. If the pesticide label instructs that the application is to be to the soil then apply it to the soil. The same holds true for foliar applications. When certain pesticides are applied to the wrong portion of a plant, they cause phytotoxicity which does not occur when applied to the correct site. Likewise, if the label instructs rinsing foliage after application, this must be done to avoid phytotoxicity.

Figure 1. Deformity of new leaves commonly occurs on scheffleras treated with one or more of many pesticides.

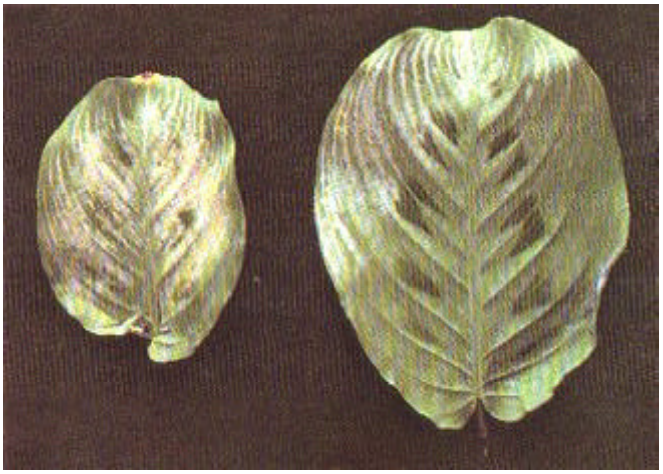

Figure 2. These maranta leaves were accidentally sprayed with a 10% bleach solution used to disinfest walkways.

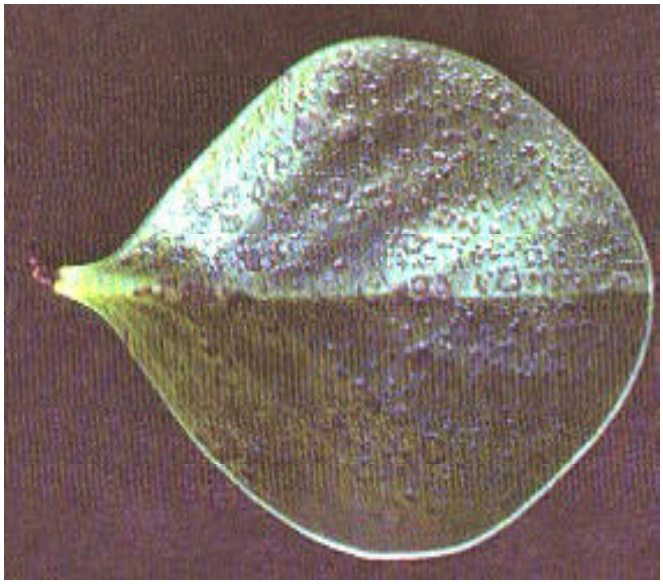

Figure 3. Many copper-based products are used in cooling systems to minimize growth of fungi and algae in the pads. This pepperomia leaf shows the speckled necrosis which occurred when the water from the pads came in contact with them.

Figure 4. Marginal and tip necrosis can develop when plants are treated with an excessive amount of a normally safe fungicide.

Figure 5. Some copper fungicides are very toxic to nephthytis; symptoms are generally marginal chlorosis and necrosis.The leaf on the left is from an untreated control plant.

Figure 6. Obvious chlorosis occurs when ivy plants are sprayed with the bactericide streptomycin sulfate. New leaf tissue appears white after as little as two applications.

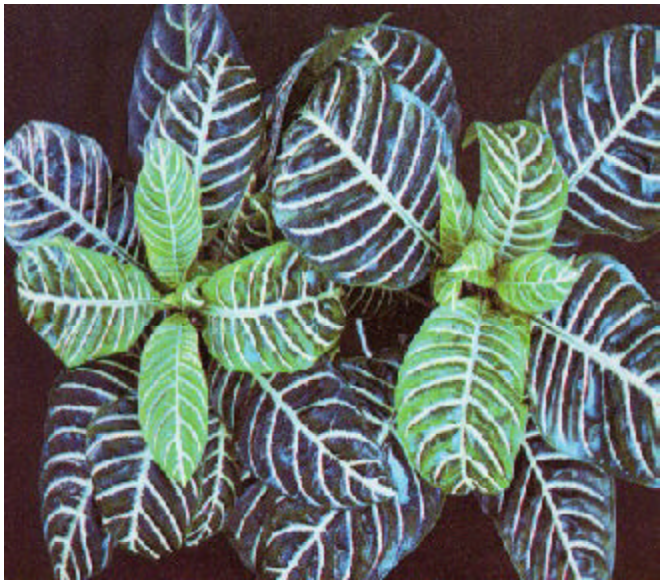

Figure 7. Vinclozolin has proved toxic to zebra plants. Symptoms appear after a single application of this fungicide and are characteristically confined to severe chlorosis of new leaves.

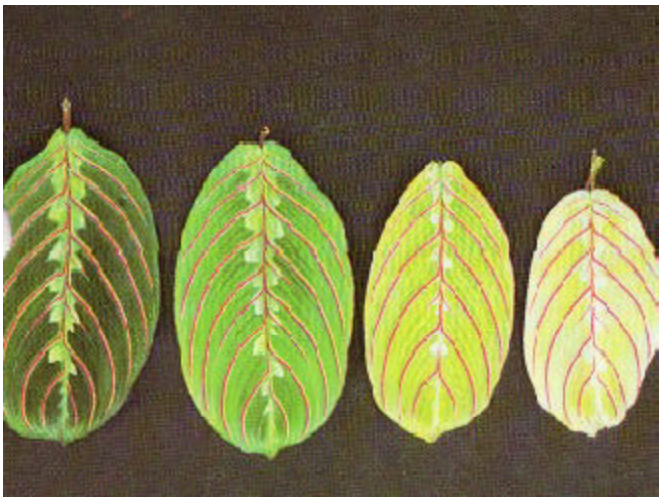

Figure 8. These red marantas show varying levels of chlorosis caused by a single drench applicationof benomyl at the recommended rate. The leaf on the left is from an untreated control plant.

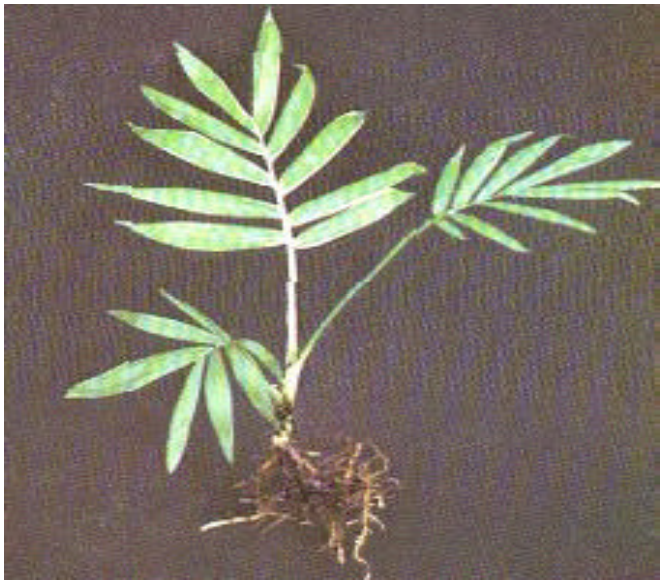

Figure 9. The white petioles of this parlor palm developed following incorporation of ethazole into the potting medium at four times the recommended rate of use.

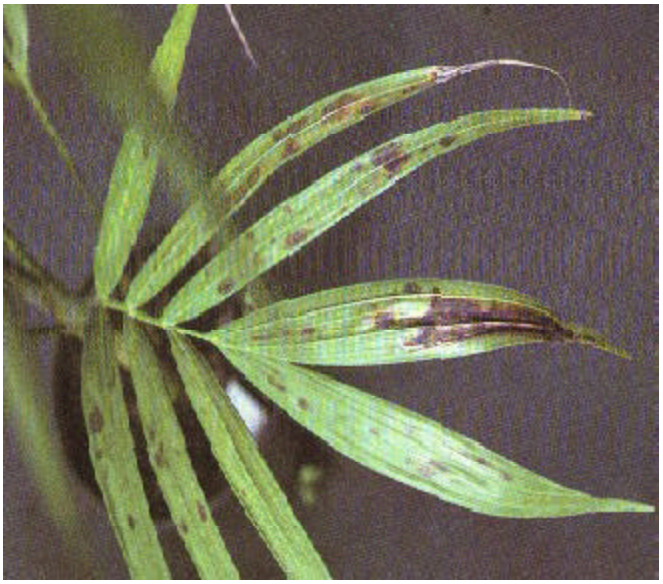

Figure 10. Application of foliar micronutrients can also cause phytotoxicity such as the contact burn on this Areca palm which resulted from an application of Fe 330.

Figure 11. Contact burns occur frequently on foliage plants treated with certain products. This calathea leaf shows necrosis along the inner portion of the leaf where fungicide collected.

Figure 12. Occasionally a single application of a pesticide results in complete inhibition of plant growth. This gloxinia was treated with a low rate of an experimental compound.

Figure 13. The tips of this ivy plant stopped growing following application of one hundred times the recommended rate of a surfactant.

Figure 14. Sometimes the formultion of a fungicide is responsible for phytotoxicity. These lipstick vines were treated with a liquid formulation of iprodione (not commercially available) which resulted in deformity of the new growth. The wettable powder form of this fungicide did not cause these symptoms. The cutting on the left was taken from an untreated control plant.