Palo Pinto County Agriculture and Natural Resources Newsletter

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White Grubs in Texas Turfgrass

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White grubs are the larval stage of insects commonly known as May or June beetles (or June bugs). Texas has almost 100 species of these beetles, most of which do not cause significant economic damage to crops or horticultural plantings. A few species, however, commonly damage turfgrass and other cultivated plants.

White grubs, sometimes referred to as grubworms, injure turf by feeding on roots and other under-ground plant parts. Damaged areas within lawns lose vigor and turn brown (Figure 1). Severely damaged turf can be lifted by hand or rolled up from the ground like a carpet.

Figure 1. Golf course fairway damaged by white grubs.

The most important turfgrass infesting white grubs in Texas are the June beetle, Phyllophaga crinita (Figure 2), and the southern masked chafer, Cyclocephala lurida. Warm season grasses like bermudagrass, zoysiagrass, St. Augustinegrass and buffalograss are attacked readily by both types of white grubs, with most lawn damage occurring during summer and fall months.

Figure 2. Adult white grubs, often called May or June beetles, are commonly attracted to lights at nights.

Cool season grasses such as the fescues, bluegrass and ryegrass are also susceptible to the June beetle and southern masked chafer, though such grasses tend to be attacked more frequently by a May beetle, Phyllophaga congrua. Damage from May beetles often appears in the spring and early summer, before injury from other white grubs becomes evident. Other white grub species occasionally recorded as pests in Texas turfgrass include Cyclocephala pasadenae and Phyllophaga submucida.

Another interesting kind of white grub is the green June beetle, Cotinus nitida. These rather large grubs feed primarily on decaying organic matter and normally do not injure turf; however, turf can be damaged by their burrowing activity. Larvae are especially common underneath fruit trees, in compost piles and in soils with high organic content, such as may be found in heavily mulched gar-dens and flower beds.

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Daytime resting places of green June beetle larvae can often be found near such sites and are marked by small mounds of soil on the lawn sur-face. The larvae have a curious habit of crawling on their backs across the soil surface to move from one site to another. Adults of the green June beetle are velvet-green on the top, metallic green below and approximately one inch long. Adults fly during the day and feed on over-ripe fruit.

Life Cycle

Most turfgrass-feeding white grubs in Texas, such as the June beetle and southern masked chafer, require 1 year to complete their life cycle (a 2-year cycle is suspected in a portion of the grub populations in north Texas). The May beetle, Phyllophaga congrua, requires 2 years to develop. For simplicity, the following discussion will be limited to species with 1-year life cycles.

Once a year, in late spring or summer, adult beetles emerge from the soil to mate. Mated females then return to the soil to lay eggs. Within about two weeks the eggs hatch into small white grubs that feed on grass roots. The pupa, or intermediate stage between the larva and the adult, occurs the following spring and is the last immature phase of the insect's development cycle. Adults subsequently emerge from the pupal stage when environmental conditions are favorable in early-to mid-summer. Most damage from white grubs occurs during mid-summer to early-fall when the larger larvae are actively feeding.

Adult. The adult stage of the various white grub species are heavy-bodied beetles, 1⁄2 to 5⁄8 inch long, brown, with long, spindly legs (Figure 2). The June beetle and southern masked chafer emerge from the soil and fly at night, usually after a significant rainfall or irrigation. Flight periods may last for several weeks, during which time mating and egg-laying occur. During flights, large numbers of adult beetles, primarily males, may be attracted to lighted windows or other lights at night. Females, being less active fliers, usually are less common around lighted areas than are males. For this reason, turning off outdoor lights during adult flight periods may not substantially reduce subsequent white grub damage. Heavy white grub infestations often can be found in areas with little or no outdoor lighting.

After mating, female beetles dig 2 to 5 inches into the soil to lay eggs. Each female can lay up to 30 to 40 eggs, which hatch in approximately two weeks.

Larva. White grub larvae are creamy white and C-shaped, with three pairs of legs (Figure 3). After hatching, the white grub passes through three larval life-stages, or instars. These instars are similar in appearance, except for their size. First and second -instars each require about 3 weeks to develop to the next life-stage. The third-instar actively feeds until cool weather arrives. Third-instar larvae are responsible for most turfgrass dam-age due to their large size (1⁄2 to 1 inch-long) and voracious appetites. Feeding by large numbers of third-instar white grubs can quickly destroy turfgrass root systems, preventing efficient uptake of food and water. Damaged turf does not grow vigorously and is extremely susceptible to drying out, especially in hot weather.

Figure 3. Turfgrass-infesting white grub larvae feeding on grass roots. Grubs are most damaging when they reach a length of 1â„2- to 1-inch.

When cool weather arrives, white grubs become dormant until the following spring. During this dormant period white grubs do little or no feeding and cause little dam-age. Occasionally white grubs will be found in turfgrass areas that fail to green up in the spring; however, the damage is primarily the result of feeding that occurred the previous fall. Spring and winter treatments for white grubs with 1-year life cycles generally are ineffective in preventing turf damage.

Pupa. The pupal stage follows the third-instar and is the life stage during which the white grub transforms, or metamorphoses, into an adult beetle. The pupal stage does not consume food and does not move through the soil. This life stage occurs during the spring and lasts approximately 3 weeks. Pupae can be found in small earthen cells three to six inches below the soil surface. White grub treatments applied during the pupal life stage are both ineffective and unnecessary.

Managing White Grubs

Knowing when you have a problem. White grub damage can be detected by the presence of irregular-shaped areas of weakened or dying grass in the lawn. Less severely damaged turf lacks vigor and is more vulnerable to invasion by weeds. Depending on location within the state, damage may appear any time between the months of June and October. Turfgrass damaged by white grubs has a reduced root system and is easily pulled from the soil. Grubs should be readily found in the top few inches of soil, in the turfgrass root zone. Turfgrass usually recovers from white grub damage by fall or the following spring.

At least one turfgrass disease, Take-all Patch, can sometimes be mistaken for white grub damage. Take-all Patch occurs most frequently in spring and early summer and can be distinguished by the rotted appearance of the roots. In contrast with white grub damage, dead spots caused by Take-all Patch may persist into the summer months.

Some Texas lawns never suffer white grub damage, while others are damaged year after year. If your lawn consistently dies out in patches during late summer and if you can verify that white grubs are the culprits, you may benefit from a preventative treatment. On the other hand, if you want to minimize your use of insecticides and don't mind sampling for white grubs, follow the quick decision guide on page 6. By confirming that you have white grubs before treating your yard, you can avoid spending money on grub control and reduce pesticide use.

To confirm whether you need to treat for grubs, examine several soil sections at least 3 to 4 inches across and 4 inches deep (sample sandy soils to greater depths). A good rule of thumb is to examine several soil plugs (up to one square foot per 1000 square feet of turf) from widely scattered parts of the lawn. Take care to include areas at the edges of suspected grub damage. Finding more than five white grubs per square foot justifies treatment, although some lawns with even higher numbers of grubs may show no damage.

Non-chemical controls. Several non-chemical treatments are avail-able for controlling white grubs. Beneficial nematodes within the genera Steinernema and Heterorhab-ditis are tiny worms that attack white grubs and other soil inhabiting insects. These microscopic worms can be purchased in stores or through garden supply catalogs. Commercial nematode products are usually designed to be mixed with water and applied to lawns using a hose-end or hand-held sprayer. Recent research shows that under good conditions commercially-available nematodes can reduce white grub populations by 50% or more.

Nematodes must be supplied with adequate moisture to help them move down into the soil where grubs are feeding. At least 1/4 inch of water should be applied before, and another 1/4 inch of water applied just after, nematodes are sprayed on the lawn. These worms pose no threat to humans or land-scape plants and are an environ-mentally sound alternative for those who prefer not to use pesticides on their lawn.

One microbial pesticide, Bacillus popilliae, or milky spore disease, often is recommended for white grub (Japanese beetle) control in other regions of the U.S.; however, it has not been shown to be effective against Texas turf-infesting white grubs.

Spiked sandals sold for aerating turf have been tried with some success for controlling damaging grub populations. According to one study, repeatedly walking over heavily infested turf with the spiked sandals may reduce grub populations up to 50%. These sandals are available through several garden supply catalogs.

Chemical control. Proper timing and chemical application are critical to suppressing white grubs. New white grub insecticides are more persistent and less toxic to beneficial arthropods and earth-worms. However, these treatments must be applied early enough to kill the smaller (less than 1/2-inch-long) larvae. Once white grubs reach the third-instar life stage, they are more difficult to control with the new products.

The insecticides imidacloprid and halofenozide are used most today for white grub control. Imidacloprid is most effective against small and medium-sized grubs but may kill some grubs larger than 1/2 inch long. Imidacloprid trade names include Merit®, Bayer Advanced Lawn™ Season Long Grub Control and Scott's® Grub-Ex®. The lethal effects of the insect growth regulator halofenozide are limited to early white grub life stages. Halofenozide is ineffective if applied too late, after grubs have reached the third-instar life stage. Halofenozide trade names include Mach 2, Spectracide® Grub Stop™ and Hi-Yield® Kill-a-Grub™.

Fortunately, both halofenozide and imidacloprid can be applied early and persist in the soil. Ideally, both products should be applied within six weeks of egg-laying. In south Texas, apply insecticides for white grubs in early-to mid-June. In central and north Texas, the optimal treatment time is early- to mid-July.

Where grub damage is already evident in lawns and larger grubs are present, use products containing trichlorfon or carbaryl. Because they bind to soil particles and remain close to the surface even after irrigation, pyrethroid insecticides (such as permethrin, esfenvalerate, cyfluthrin and bifenthrin) are less effective against white grubs, especially in clay soils.

Post-treatment irrigation is essential for all grub-control products. To ensure that insecticides reach the root zone, water-in liquid formulations with 1⁄2 to one inch of water immediately after application. Irrigate granular formulations within 24 hours to wash the insecticide into the soil and minimize the chance for exposure to people, pets and wildlife. Use a rain gauge or straight-sided can to verify application of sufficient irrigation water. Two or more irrigation applications may be needed if the soil is wet or difficult to penetrate. Water applied too quickly may cause run-off and pesticide loss. Irrigating the soil prior to insecticide application, particularly when the soils are dry, can improve the effectiveness of insecticides. For dry soils, apply 1⁄4 to 1⁄2 inch of water the day before a treatment to improve spray penetration of the soil and to encourage white grubs to move closer to the soil surface. This makes grubs easier to contact with the insecticide treatment.

Heavy thatch buildup can reduce the effectiveness of insecticide sprays. Thatch is the accumulation of dead plant material, such as dead grass stems, between the soil surface and the turfgrass foliage. Thatch layers greater than 1⁄2 inch can result in greater susceptibility of the turf to plant diseases and can lead to other problems. Recent research has shown that many pesticides bind to thatch, preventing them from reaching the soil and reducing their effective-ness. Dethatching machines or soil aerifiers that remove small plugs of soil can be rented to help remove thatch and enhance penetration of the turf by pesticides. Excessive thatch buildup is more likely to occur with hybrid bermudagrasses, St. Augustine grass and some zoysia grasses. Use of mulching mowers to recycle grass clippings should not cause thatch buildup in regularly mowed lawns.

Environmental Considerations. Unnecessary insecticide applications sometimes create more problems than they solve. Pesticides can have detrimental effects on beneficial organisms, like earthworms, that help decompose thatch. Most insecticides do not discriminate between "good" and "bad" bugs and may kill beneficial insects that help control other pests. Also, unnecessary pesticide applications can increase the risk of insecticide resistance developing among white grub and other pest populations. For these reasons, routine, "preventative" insecticide applications to lawns for white grub control are not recommended.

Figure 4. Drop-type spreaders allow precise placement of insecticide granules.

Heavy rainfall can wash recently applied pesticides out of lawns, especially if the ground is saturated with water when the treatment is applied. Avoid treating lawns just before a heavy rain is expected. Also try to avoid application of pesticides to street gutters and sidewalks. Drop-type spreaders are less likely to scatter pesticide granules off of the target site than are rotary-type spreaders (Figure 4). Pesticide runoff from improper pesticide applications reduces the effectiveness of a treatment and can pollute above-ground and underground water supplies.

One should be aware that some insecticides can be toxic to birds and other wildlife. Always read and follow label directions, including the precautionary statements pertaining to potential environmental hazards. Apply only the labeled rates, avoid pesticide use near streams and ponds, and irrigate treatments promptly to help reduce the risk to non-target organisms, like birds. Never dispose of leftover pesticides down sewer or storm water drains. Such actions can cause toxicity to fish and other aquatic organisms.

Tips for Professionals

- Grubs of the southern masked chafer, *Cyclocephala lurida*, appear to be less destructive than *Phyllophaga crinita* grubs. An approximate economic threshold for masked chafers is 8-10 grubs per square foot. The two species can be distinguished by observing the raster (hair patterns) on the underside tip of the abdomen (see Figure 5). A 10X hand lens is sufficient to see these patterns on mature white grubs.
- Sampling for white grubs can be done using a spade or knife to cut 6-inch square sections of turf, or by using a golf course cup cutter. Four, six-inch squares or ten, four-inch cup cutter core samples are equivalent to one square foot of turf.
- An insect that is occasionally mistaken for a white grub is the billbug. Immature stages of billbugs are small, white, legless larvae commonly found within the top few inches of soil. One species, *Sphenophorus venatus*, is the most common billbug collected from turf in Texas. This species can damage turfgrass, especially zoysiagrasses and hybrid bermudagrasses in the southeastern regions of the U.S., but rarely damages turfgrass in Texas.
- Merit® and Mach 2® are trade names for professional formulations of imidacloprid and halofenozide, respectively. Merit® may provide some late season grub control, but both products are best used early in the season, when grubs are less than ½-inch long.
- Using surfactants in the spray solution may improve control, especially in turf with heavy thatch. Trichlorfon (Dylox®) is short-lived in high pH (greater than 7) soils and spray solutions. Add buffering agents to spray solutions to increase stability of trichlorfon sprays.

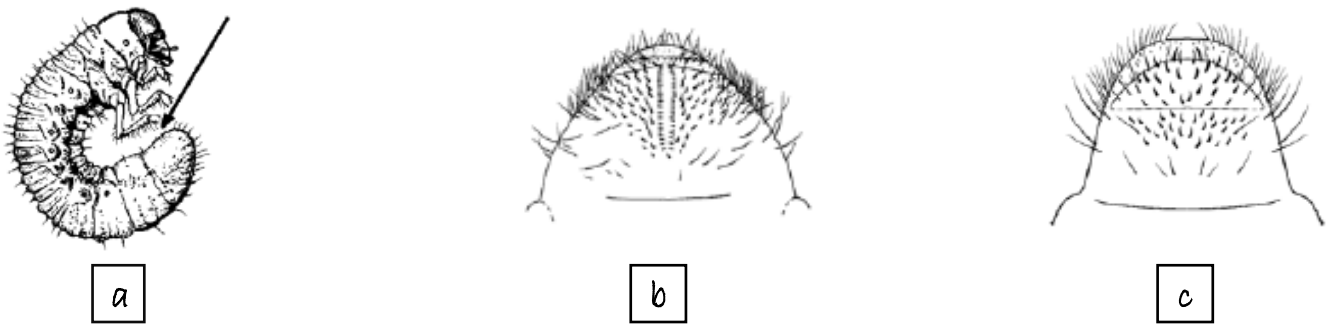
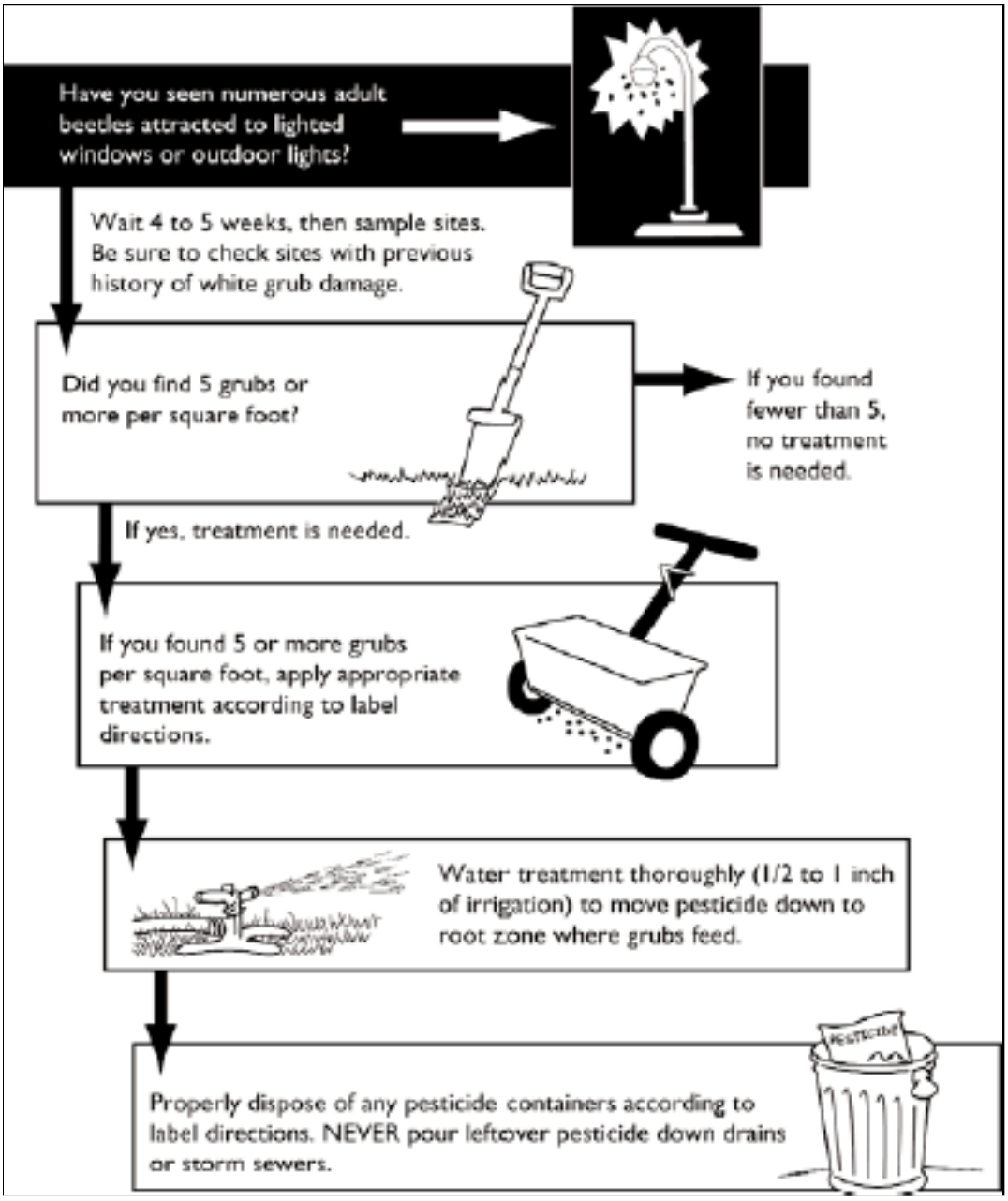


Figure 5. White grub rastral patterns used in species identification are located in the anus (a) and can be observed with a 10X hand lens. June bug larvae, Phyllophaga spp., can be recognized by their seagull-shaped anal slit and by the two parallel rows of spines running longitudinally under the anus (b). Masked chafer larvae, Cyclocephala sp., can be recognized by their straight anal slit and the random placement of spines beneath the anus (c). Scanned images courtesy Dr. Dave Shetlar, Ohio State University.

Quick Decision Guide for Grub Treatment

Not sure you need to treat for grubs? Want to minimize your use of pesticides for economic or environmental reasons? Follow this quick decision guide. Remember that some treatments are effective only on small (less than 1⁄2 inch-long) grubs.



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What Makes Tomato Leaves Twist or Curl?

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If the leaves on your vegetable plants are twisted or curled, the problem could be environmental, chemical, or biological. Sometimes all the leaves on a plant are twisted or curled; sometimes only new growth has symptoms while older leaves are normal. Damage may start moderately then quickly begin to affect new growth. Damage to tomato and other vegetable plants may have one or a combination of causes (Figs. 1-5).

Figure 1. Twisted tomato leaves

There are five primary reasons that tomato leaves twist or curl:

* Wind damage
* Herbicide drift
* Tomato viruses
* Herbicide residue
* Broad mite

Wind damage

High winds, blowing dust and low humidity can damage the leaves and stems on tomato plants. Injury is similar and is often confused with drift damage from phenoxy-type herbicides (Fig. 6). Heat and low moisture can cause the edges of the tomato leaves to die back, then twist and curl.

Hot dry weather may also cause a symptom called physiological leaf roll. This is a self-defense response, where leaves and leaflets curl slightly to prevent further water loss (Fig. 7). Mild leaf roll generally does not lower yields or quality, though severe symptoms may cause flowers to drop and fewer fruit to set.

Figure 2. Severely twisted tomato leaves

Figure 3. Curling leaves on a bean plant

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Figure 4. Curling leaves on an eggplant

Figure 5. Curling leaves on a pepper plant

Figure 6. Symptoms of wind injury in tomato often confused with dicamba injury

Figure 7. Moderate physiological leaf roll

These symptoms may look like damage from other causes, but if wind damage is the only problem, plant health will generally normalize once weather conditions improve.

Herbicide drift

Crops and pastures are often treated with herbicides to prevent or eliminate weeds, and drifting spray can damage tomato plants. Up to 84 percent of the cotton acreage in Texas is sprayed with broad-spectrum herbicides. They are also used on cereal and grain crops. The problem is that wind speeds as low as 5 mph can move these herbicides up to a mile.

Many home gardens are close enough to cotton and corn fields for drifting 2,4-D, dicamba, or other hormone-type herbicides to cause serious damage. Tomato plants are extremely sensitive to these herbicides: they can be injured by concentrations as low as 0.1 ppm. If only a little of the herbicide reaches the tomato plants, they can recover, but yield will definitely suffer (Fig. 8).

Figure 8. Dicamba injury to tomato leaves

In addition to commercial applications, herbicides from home gardeners or their neighbors can drift onto sensitive tomatoes or other vegetables. Weed killers for lawns and landscapes often contain broad-spectrum herbicides such as glyphosate and the growth- regulators such as 2,4-D and dicamba. Examples are Ortho Weed-B-Gon and Fertilome Weed FreeZone. Tomatoes are very sensitive to these herbicides even when applied at extremely low rates. Though the plants may look healthy, drift from these products can reduce the number and the quality of the fruit.

There is no remedy for leaves that are already injured by 2,4-D. If new growth continues to show injury symptoms, harvest any salvageable fruits and pull up the plants.

If new shoot growth is normal, and there is still at least 4 to 6 weeks left in the growing season, the plants may be able to outgrow the injury. New buds and leaves should begin growing within about a week. If not, pull the affected plants and replant.

To minimize herbicide drift following these steps:

- always read and follow the herbicide label instructions
- avoid spraying when wind speed is more than 5 mph
- avoid spraying when wind is blowing toward sensitive crops
- use a hooded sprayer when applying post-emergence herbicides near growing plants
- reduce spray pressure so droplet size is larger and less likely to move with the winds
- reduce the speed of the spray application to avoid movement in the circulating air
- ensure that the dosage applied is correct
- use the correct spray nozzles/tips for the chemical to be applied
- use drift reducing spray additives if available
- wash out all previous herbicide from inside the spray tank

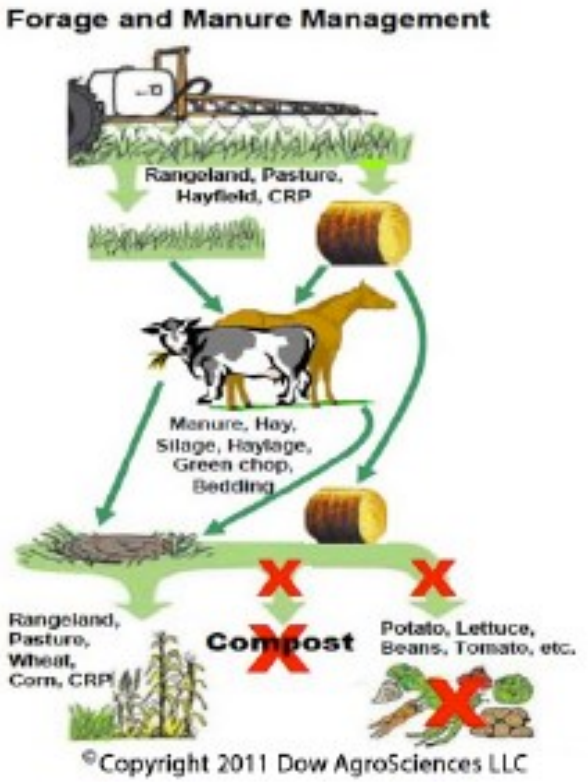
Herbicide residue

Vegetables can be damaged by herbicides left in mulch or compost made with hay or manure from fields that have been sprayed with Grazon, GrazonNext, or GrazonNext HL. The active ingredient in these products is aminopyralid which persists for 18 months on treated hay and hay products. It also persists in the manure of animals that eat Grazon-treated hay. Grazon products are commonly used in pastures because they kill about 100 difficult broadleaf weeds .

The GrazonNext label states that any plant matter collected from fields sprayed with aminopyralid may not be used in compost or where vegetables are to be grown (Fig. 9). The label also states that the “applicator must provide the land manager with a copy of instructions

IMPORTANT USE PRECAUTIONS AND RESTRICTIONS TO PREVENT INJURY TO DESIRABLE PLANTS

- It is mandatory to follow the “***Use Precautions and Restrictions***” section of this product label.
- Manure and urine from animals consuming treated grass or forage may contain enough amnopyralid to cause injury to sensitive brodleaf plants.
- The Applicator must provide the land manager with a copy of the Dow AgroSciences Stewardship instructions regarding uses of forage from areas treated with aminopyralid.
- A printable version of the stewardship instructions can be found at www.aminopyralidstewardshipinstructions.com



regarding uses of forage from areas treated with aminopyralid."

Anyone who sells hay, silage, haylage, green chop, or bedding material that was treated with aminopyralid, is responsible for alerting the buyer that it was treated and must not to be used in composting or were vegetables are grown. Buyers must also ask whether aminopyralid was used on the source forage within the last 18 months.

Additional restrictions in hay and manure use:

- Do not use aminopyralid-treated plant residues, including hay or straw from areas treated within the preceding 18 months, in compost, mulch or mushroom spawn.
- In compost, mulch, or mushroom spawn, do not use manure from animals that have eaten forage or hay from treated areas within the previous 3 days.
- Do not plant broadleaf crops (including soybeans, sunflower, tobacco, vegetables, field beans, peanuts, and potatoes) in fields treated in the previous year with manure from animals that have grazed forage or eaten hay harvested from aminopyralid-treated areas until an adequately sensitive field bioassay is conducted to determine that the amount of aminopyralid residues in the soil will not injure the crop to be planted.
- To promote herbicide decomposition, burn the plant residues or evenly incorporate them in the soil. Aminopyralid breaks down faster in the plant residues and manure when the soil is warm and moist. Irrigation can speed up the process.

Broad mite damage

Broad mites (Polyphagotarsonemus latus) affect many plant families, including tomato, pepper, eggplant, potato, cotton, and citrus. It also attacks ornamentals such as dahlia, zinnia, chrysanthemum, pittosporum, and schefflera that are grown under shade cloth.

Broad mites avoid light and feed on young leaves and flowers. As they feed, they inject toxins that severely twist and distort the leaves. The damage may resemble other types of damage on tomato plants. In Texas, broad mites damage seedlings grown in greenhouses or under shade cloth. Severe broad mite infestations can make the underside of leaves and fruit look bronzed or russetted.

These mites are invisible to the human eye and can be overlooked even under a magnifying glass. They are usually discovered only after plant injury is noticeable. Broad mites are 0.10 to 0.30 millimeters long (Fig. 10), have oval bodies, and can be translucent to pale brown or yellow.

If you cannot see the broad mites readily, look for the eggs, which are white, oval-shaped and have ridges or bumps. This mite's eggs are distinct—they look like Christmas ornaments (Fig. 10). Eggs develop into adults in about 4 to 6 days in hot weather and 7 to 10 days in cool weather.

Figure 10. Broadmites and broadmite eggs

Broad mite populations come and go rapidly depending on food, weather, and light. Infestations are often sporadic and fluctuate from year to year. Broad mites may infest your tomato plants via transplants from greenhouses or the legs and antennae of whiteflies.

Before treating the plants, make sure that broad mites are the problem. Entomologists with the Texas A&M AgriLife Extension Service can diagnose leaf samples for you (http://plantclinic.tamu.edu). If broad mite damage is severe, pull up the plants and dispose of them.

Moderately affected plants can be treated with sulfur-based miticides. However, be sure that the tomato cultivar is tolerant of sulfur before applying it. Do not treat tomatoes when temperatures are higher than 90°F or when

the plants are water stressed—the miticide can damage the plant under these conditions. The plants will likely need additional applications to avoid further damage. Other products known to control mites in general include Horticultural Oils and Insecticidal Soaps. You can alternate these treatments with predatory mites that attack and consume broad mites. Predatory mites are most effective if used before the broad mites get firmly established. Predatory mites are sold by many companies specializing in organic products (Grow Organic, Arbico Organic, Benemites are a few examples)

Tomato viruses

Hundreds of viruses can cause leaf curling and stunting in tomatoes. Though initial virus symptoms can be confused with a phenoxy-based herbicide damage, the disease often progresses to include yellow-green mosaic patterns on the leaves (Fig 11).

Figure 11. Mosaic patterns on tomato leaves

Viruses in the geminivirus group are most often the culprit for virus-based leaf twisting in tomatoes. In Texas, the most common virus encountered is the tomato yellow leaf curl virus.

Geminiviruses spread to tomatoes and other plants exclusively by the sweet potato or silverleaf whitefly (Bemisia tabaci). To reduce the spread of this virus, manage whitefly populations with insecticidal oils and soaps.

This group also includes other viruses:

- the tomato yellow leaf curl virus
- chino del tomato virus
- tomato leaf crumple virus
- pepper huasteco virus
- potato yellow mosaic virus
- Sinaloa tomato leaf curl virus
- Texas pepper virus
- tomato yellow mosaic virus
- tomato yellow streak virus

New tomato varieties have been developed that resist tomato yellow leaf curl. However, these varieties are still susceptible to other virus diseases. As with any tomato leaf damage, you must identify the cause before making any management decisions. To confirm tomato yellow leaf curl virus, submit plant samples to the Texas Plant Disease Diagnostic Laboratory (http://plantclinic.tamu.edu). Pull up and dispose of diseased plants.

Summary

They key to solving the problem of twisted or curled leaves is to identify the source or sources of the problem. Wind damage will resolve once conditions improve. Mites and viruses can be identified by laboratory analysis. Damage caused by herbicide drift or residue in mulch and compost is the most difficult to identify. Regardless of the cause, curled or twisted leaves on tomatoes or other vegetables are a sign that you may need to take action to save your crop.

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