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Preventing Foliar Tomato Blights

One of the most revered summer vegetables by home gardeners is the tomato. Wet growing seasons aggravate our most common foliar diseases, often referred to as blights. All of Missouri was very wet in 2008 & 2009; most of the Central, Eastern and Northern parts of Missouri were also wet in 2010. These diseases are caused by two fungi, Septoria leaf spot and Early Blight, and two bacteria, Bacterial Spot and Speck. The disease descriptions are presented below, and one web site link provides color pictures, to aid one in trying to diagnose a foliar problem they may have experienced. However, correct diagnosis can be extremely challenging, especially when two or more diseases are occurring at the same time, as has often been the case in the last three years. It is best to have plant problems either diagnosed by a local extension agent or submitting the sample to the Plant Diagnostic Clinic. Please note that bacterial diseases are controlled with different chemicals than fungal diseases, as the biology of the diseases is different. Many gardeners have been applying a fungicide when they have had a bacterial disease, which will not provide any control. However, the most serious problem has been inattention to disease prevention, which begins at planting, and is the focus of the remainder of this article.

Preventing foliar diseases should start by minimizing disease inoculum, which can be harbored on diseased plant residue or wooden stakes in contact with it. Dispose of tomato residue away from the vegetable garden, or burn it. If tomato diseases have been a problem, consider changing to metal stakes/support or sterilize wood stakes by soaking in a bleach solution. Proper spacing is also crucial to preventing disease. It is better to give a little more space than is required than crowding plants. Over-crowding plants encourages disease by increasing the humidity, decreasing air movement, and increasing competition between the plants. Several common foliar diseases exist in the soil and are spread to the plant by splashing water from irrigation and rain. Mulching around plants will help by reducing water-splashed soil and the pathogens that are spread with the particles. . However, organic mulches like straw will suppress soil temperatures and may keep the soil too wet during periods of heavy rainfall in the spring. This can aggravate a common root/stem rot- Fusarium wilt (see below). Commercial growers use plastic mulch (usually black) to warm the soil and prevent splashing of soil particles, but home gardeners are often reluctant to use plastic because it requires irrigation under the plastic. Black weed barrier cloth, 'landscaping fabric' or a similar product is an ideal choice of material as it allows water to pass through, while still providing the benefits of plastic mulch.

Many gardeners wait until they see disease symptoms before they apply a chemical for disease control. This is later than desired, as 'preventing' the disease is easier than controlling it. Applying a chemical control is best

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In This Issue

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Using Trees in Stormwater Management Plans

Over the past ten years, there has been a dramatic increase in interest in methods for reducing or eliminating urban and suburban stormwater runoff. This has been stimulated by the implementation of "Phase II" regulations of the Clean Water Act published in 1999 and requiring smaller towns to develop stormwater management plans. These plans rely on accepted "Best Management Practices" (BMPs) that can be implemented to reduce or slow the movement of stormwater from properties. These BMPs include a wide range of approaches, including rain gardens, wetlands, bioswales, porous pavement, green roofs and many other interesting and creative ideas. Although many BMPs utilize plants because of their ability to slow down water and transpire it to the atmosphere, trees are often not featured. This is partially due to the general perception that tree roots disrupt engineered features like the berms used in rain gardens and bioswales. However, there is ample evidence that trees can significantly reduce stormwater runoff if used appropriately.

Figure 1. A swamp white oak planted in porous pavement in a parking lot at Missouri Botanical Garden.

A study conducted in Fayetteville, Arkansas revealed that increasing tree canopy cover in the city from 27% to 40% reduced stormwater runoff by 31%. This translated to an estimated savings of $92 million due to reduced need for engineered retention structures. Trees can slow water movement in many ways. Tree leaves intercept some of the precipitation in a rainfall event and reduce the velocity of the droplets. This, in turn reduces splashing and soil compaction, keeping the soil more porous. Decomposing leaf litter creates a spongy layer at the soil surface, holding the water until tree roots can take it up. Deep tree roots also help to channel water deeper into the soil where it can be stored for future use by the trees.

The St. Louis Metropolitan Sewer District, in cooperation with the Missouri Department of Conservation, Missouri Botanical Garden, Shaw Nature Reserve, Missouri Department of Agriculture and Grow Native published an excellent guide entitled; "Landscape Guide for Stormwater Best Management Practice Design" (http://www.shawnature.org/documents/pdf/MSD.pdf). The guide gives lists of native Missouri plants recommended for planting in various practices. Many tree species are listed as suitable for planting on pond margins or slopes.

An interesting approach being tried in various parts of the US is diversion of rainwater into streetside bioswales through curb cuts. In some cases trees are planted in a synthetic "structural soil" consisting of large rocks with a small amount of soil and hygroscopic gel. The structural soil (patented by Cornell University) can be compacted to support streets and sidewalks but still contains large spaces where tree roots can grow. Thus a tree has access to a large root growth zone that can also serve as a temporary water reservoir. This method can reduce the peak flow of stormwater from a rainfall event by up to 80%.

As small and mid-sized Missouri towns struggle to comply with Phase II stormwater regulations, we will see many more interesting and creative ways to use plants in stormwater management plans. Hopefully trees will be included in most of the plantings.

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If Your Lawn is Cool, Stop Fertilizing it NOW!

Common lawn grass species used in Missouri are tall fescue, Kentucky bluegrass, and zoysiagrass. Of these, tall fescue or tall fescue/Kentucky bluegrass mixtures are most common due to the lower cost and ease of establishment (seed vs. zoysia sodding or sprigging), and relative pest and drought tolerance compared to other species. Both of these grasses are cool-season C3 grasses, meaning their form of photosynthesis allows best growth in the moderate temperatures of spring and fall. Because of this, recommendations center on fertilizing during these two seasons to match flushes of growth. However, fertilizing too late or too heavily in the spring can have dire consequences for your lawn when the summer heat rolls around.

Nitrogen is frequently of limited availability in the soil, and generally is the nutrient that most restricts plant growth and vigor. Nitrogen is therefore the most important nutrient out of the big 3 (nitrogen, phosphorous, and potassium) commonly found in a bag of fertilizer, and annual fertilizer recommendations for lawns are based around supplemental nitrogen applications. Suggested nitrogen fertilizer rates are from 2-4 lbs N/1000 sq ft per year for cool-season lawns, and from 1-2 lbs N/1000 sq ft per year for warm-season lawns

Nitrogen applications can have a profound effect on the severity of turfgrass diseases (see figure). Too little nitrogen can promote diseases such as dollar spot and anthracnose, which are most common on golf courses and sports fields. Conversely too much nitrogen creates succulent tissues, which greatly promote the two most common and devastating diseases that occur during the summer on home lawns: brown patch and *Pythium*. In lawn situations, you can kill your grass more readily with nitrogen kindness in the spring by encouraging these two diseases.

Brown patch is favored by warm (highs in the mid 80°Fs), humid conditions that start in late spring and occur throughout the summer. As the name implies, the disease occurs in straw colored, bleached patches that can get to 2-4 feet in diameter. On the outer margins of patches, individual leaves will show characteristic lesions that have straw-colored interiors and dark brown outer margins. Brown patch is more severe on tall fescue than Kentucky bluegrass.

Note: Interestingly, brown patch has a "kissing cousin" called large patch that can severely affect zoysiagrass lawns in the fall and spring… again most severely when nitrogen

Turfgrass diseases are greatly affected by nitrogen applications. The three most prominent lawn diseases including brown patch, large patch, & *Pythium* are favored by lush growth resulting from excessive nitrogen application.

Brown patch is the most common lawn disease in Missouri. It affects mainly tall fescue and occurs during warm, humid periods in late spring and remain prevalent throughout the summer.

Pythium blight is not as commonly observed on Missouri lawns. It is favored by extremely high rainfall or moisture and sustained above 90°F temperatures. Kentucky bluegrass is more susceptible than tall fescue, but *Pythium* did affect many tall fescue lawns during last year's extreme summer.

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control applications, one can wait to see disease symptoms before continuing with chemical control.

Chemical control by home gardeners of the bacterial diseases is primarily with copper products, which are available in formulations that are approved as organic products. In the last couple of years an organic fungicide has become available to home gardeners which is labeled 'for control or suppression' of all the foliar tomato blights, bacterial and fungal. Serenade Garden by AgraQuest has an active ingredient of QST 713 strain of Bacillus subtilis, a beneficial bacterium. Home gardeners should also consider including a product into their spray solution that enhances coverage and adherence to plant tissues. A number of companies manufacture and sell 'spreader/sticker' which help the solution to spread evenly out on surfaces instead of 'beading up' and rolling off. Once the solution has dried, its adherence to a surface is improved when rainfall occurs. Given these two benefits, the addition of a 'spreader/ sticker' to a spray solution will improve the level of control.

An important cultural control method often overlooked is vigorous growth- dark green foliage typical of a plant with adequate nutrition grown in full sun. Tomatoes in a somewhat shady location (e.g. 3 hours or more per day) will be more disease prone. Nitrogen (N) is the element most often limiting to plant growth, and tomatoes have the highest N requirement of all vegetables. Side dress recommendations are one pound of actual N per 100 linear feet of row at three times- one to two weeks before the first fruit ripens, two weeks after picking the first ripe fruit and one month later. Nitrogen can be supplied from natural or synthetic sources, with the latter easier to estimate and apply, as well as more quickly available to the plant. For detailed information about fertilizing vegetables see the MU Guide 'Steps in Fertilizing Garden Soil: Annual Flowers and Vegetables- http://extension.missouri.edu/explorepdf/agguides/hort/g06950.pdf

- **Anthracnose (fungus)**: Anthracnose fruit rot was prevalent throughout the Midwest last year, aggravated by the very warm and humid summer conditions. It is spread in an odd way, establishing in the leaf lesions of Early Blight and then splashed onto the fruit. The chemical controls for Early Blight also control it. Infections begin on green fruit and, symptoms become most apparent when ripe. Small, water-soaked, slightly sunken circular spots on fruit (sometimes called 'ripe rot'). Cultural controls consist of sanitation*, crop rotation, weed control, proper plant spacing and staking, and watering at the soil level. Chemical control includes applications of chlorothalonil, maneb, or mancozeb.
- **Bacterial spot (bacterium)**: small, angular, water-soaked spots on leaves and stems. Raised, crusty spots on fruit. Cultural controls include planting healthy transplants, sanitation*, crop rotation, using metal stakes (or treat wooden stakes) and watering at the soil level. Chemical controls include copper hydroxide or similar copper based products.
- **Bacterial speck (bacterium)**: The foliar symptoms of speck consist of small (1/8-1/4 in.) black lesions, often with a discrete yellow halo. The lesions of bacterial spot are similar, but tend to have a greasy appearance, whereas those of speck do not. Speck seems to curl the leaves more severely than spot. Both diseases affect flowers. Lesions on stems and petioles cannot be distinguished. Bacterial speck and spot are more clearly differentiated by symptom development on the fruit. Bacterial speck lesions are slightly raised, but are generally much smaller (1/16 in.) than those of bacterial spot. Bacterial speck lesions are very superficial and do not crack or become scaly as in bacterial spot. Control methods are the same for Bacterial spot.
- **Early blight (fungus)**: starts at bottom of plant and advances upwards, as dark-brown circular spots with concentric rings, or "targets," on leaves. Tissues around spots become yellow. When spots are numerous, leaves wither and dry up. Plant healthy transplants; other controls are the same as for anthracnose.
- **Fusarium wilt (fungus):** lower leaves turn yellow and dry. Leaves roll up and wilt during hot part of day. Inner stem tissues have dark discoloration. Cultural control includes planting healthy, disease-resistant** transplants, sanitation*, and crop rotation. No chemical controls are available. Disease resistance traits have been bred into many tomato varieties. These varieties are much less susceptible to the diseases than they do not have a resistance, but by no means are they immune. Good cultural practices are still crucial. Resistance to these pests is usually listed on the plant label using the following abbreviations: V = Verticillium Wilt; F = Fusarium Wilt; FF = Fusarium Wilt race

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1 and 2; N = Nematode; T = Tobacco Mosaic Virus; A = Alternaria (Early Blight); and TSW = Tomato Spotted Wilt.

- **Septoria leaf spot (fungus):** small, roughly circular spots with dark-brown borders and gray centers on leaves. Leaves may die and drop off if heavily infected. Cultural controls include planting healthy transplants, sanitation*, crop rotation, using metal stakes (or treat wooden stakes) and watering at the soil level. Chemical controls are the same as for controlling anthracnose.

***Sanitation includes removing plant debris from the garden, whether it originates in the current growing season or the previous year.** Remove affected plants from the garden and destroy them so that they do not act as a source of disease-causing microorganisms. Discard any plant, transplant, or seed piece that does not look healthy. Diseased plants should not be added to home compost piles; the temperature reached in most home compost piles is not high enough to kill plant pathogens.

There are a number of additional diseases and physiological disorders. For more information, including color pictures, see ***'Tomato diseases and disorders'*** from the Department of Plant Pathology by Iowa State University. http://www.extension.iastate.edu/Publications/PM1266.pdf

Common Diseases of the Home Garden by MU Extension provides descriptions and recommended control practices for the popular vegetable crops in Missouri and their most common diseases. http://extension.missouri.edu/explore/agguides/hort/g06203.htm

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has been applied at the wrong time during these periods. If you have zoysiagrass in your lawn, disregard most of the theme of this article, and start fertilizing soon.

Pythium is commonly referred to as a "water mold" and has spores that swim in films of water with motile flagella. *Pythium* needs a bit more moisture and a bit more heat (highs in the 90°Fs) than brown patch to affect lawns in Missouri. *Pythium* may appear patch-like but will have a greasy or matted appearance, and mycelium is often readily visible in the early mornings. The disease is more severe on Kentucky bluegrass than tall fescue, which may also be a reason it is not as common as brown patch on lawns in MO. Along with its high moisture requirement, *Pythium* is more prevalent in shaded or over-watered areas.

In the summer of 2010, extended heat and frequent rains provided a perfect storm for both of these diseases. In many cases, fungicide applications were necessary to curtail significant damage in cool-season lawns, and many required subsequent renovation and reseeding in the fall. The one common thread I found in the most severely impacted lawns was a single mistimed nitrogen application in mid-May. This application was the bump, the heat and moisture were the set, and the brown patch and Pythium solidly spiked home lawns into submission last year. Avoid the mistake again this year, and hold off fertilizing your fescues or bluegrasses until the fall.

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Bounce Away Fungus Gnats

Do pesky fungus gnats drive you crazy around your houseplants in your home or office? While these small adult flies are a nuisance, they can harm plants, but not humans. Fungus gnats are problematic where plants are overwatered, especially in peat-based media. Larvae feed on algae, fungi, and plant roots in the growing medium. Usually, non-chemical methods are used to control these gnats on plants growing indoors by watering less frequently, removing algae, or re-potting plants using clean media.

Researchers at University of Illinois and Kansas State University recently evaluated a different approach to repelling adult fungus gnats, using Bounce® original brand fabric softener dryer sheets. The idea for this work came from Master Gardener and trade magazine claims that sheets of Bounce® tucked into pockets of clothing repel mosquitoes. Adult fungus gnats were tested in special containers in the laboratory to determine how many flew into a compartment containing moist growing media or one with moist media and a Bounce® dryer sheet. Results from these experiments showed that 45% of the total number of adult gnats released into the test chamber was collected from the compartment with moistened media, while only 18% were present in the compartment with media and the dryer sheet.

To further investigate the repelling properties of the dryer sheets, volatile compounds were identified. One of the major volatiles detected from the dryer sheets was linalool, which is commonly used in cosmetics and perfumes to produce a floral odor. This compound is also naturally-occurring in plants such as lavender, marjoram, coriander, and basil. In other studies, linalool was toxic to two spotted mites and other insects (sawtoothed grain beetle, German cockroach, Mexican bean weevil, English lesser grain borer, and rice weevil). Also, the citrosa plant (*Pelargonium citrosum*), which is advertised as a natural mosquito repellant, contains approximately 6.8% linalool.

While researchers demonstrated that Bounce® dryer sheets repel fungus gnats, the period time that dryer sheets are effective as a repellent, the minimum distance required from plants for repellency, as well as the impact of the sheet on egg laying, larva, and plant damage remain unknown. However, this study validates claims that dryer sheets repel fungus gnats and with further development of dryer sheet placement near plants, it may be an alternative strategy to deal with those pesky fungus gnats.

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Ground Covers: Solutions for Problem Landscape Areas

Many landscapes have problem spots where nothing seems to grow properly or look attractive. The area below a large tree possessing a dense leaf canopy is a good example. Plants need light in order to thrive and, unfortunately, the area beneath a tree receives relatively little. Couple this with the competitive nature of the root system of many species of trees and one has a problem area to deal with. Fortunately, there are species of plants commonly referred to as ground covers that occupy areas such as the preceding quite well and serve as an attractive solution to the problem site.

By definition ground covers are (relatively) low, dense-growing plants requiring minimal maintenance that establish a monoculture in areas of the landscape. They can be classified into those that tolerate shade and those that require copious sunlight. The latter ground covers are often used for special purposes such as to prevent soil erosion or choke out weeds. For the sake of this article we will concentrate on those ground covers which can tolerate heavy shade such as in the situation described above.

Shade-tolerant ground covers fall into two distinct groups: evergreen and deciduous. Bugle weed (*Ajuga reptans*), creeping lily-turf (*Liriope spicata*), English ivy (*Hedera helix*), perwinkle (*Vinca minor*), Japanese spurge (*Pachysandra terminalis*), and wintercreeper euonymus (*Euonymus coloratus*) are among the best evergreen ground covers for shady areas. While most are planted for their foliage, several of the preceding (e.g. bugle weed and periwinkle) bear attractive flowers in the spring of the year as well.

Bishop's goutweed (*Aegopodium podograria*), lily-of-the-valley (*Convallaria majalis*), mock strawberry (*Waldsteinia fragarioides*), sweet violet (*Viola odorata*), sweet woodruff (*Galium odoratum*) and wild ginger (*Asarum europaeum*), and are deciduous ground covers that also thrive in shady areas. There are a number of other accent plants (e.g. hosta and fern) that can be used in heavily shaded areas, but they tend have lesser ground cover effect.

In addition to shade and roots, other factors may produce problems for plant growth and development beneath a tree. Trees with heavy canopies often shed water (especially during light rains) greatly reducing the availability of moisture to plants below. Hence, frequent watering of newly planted ground covers is needed for rapid establishment. Even after established, watering often becomes a necessity, especially in

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periods of dry weather. Adequate soil preparation through the incorporation of organic matter will help to encourage root growth and ease stress on newly planted ground covers. This, along with adequate water and fertility should cause them to establish themselves faster.

The accumulation of leaves is yet another problem for ground covers to contend with under trees, especially if the trees are large. Ground covers should never be allowed to be totally covered with leaves. This is especially critical for evergreen ground covers during the fall and winter. While a thin covering in the winter is not harmful, it should not be so think as to totally block light which evergreen plants need year around.

Leaves that are very soft (e.g. maple) and hold moisture should be totally removed from ground covers to prevent them from matting during wet weather those suffocating the plants beneath them. Leaves of species with stiffer leaves (e.g. oak) have a lesser tendency to suffocate plants below them when wet, if they are not too thick. Removing leaves from ground covers is more of a task than raking them from the lawn; therefore a leaf (lawn) vacuum can help reduce the work. A few leaves may be allowed to remain since they will not harm the plants below them and quickly break down during the ensuing growing season. This helps to add valuable organic matter to the soil occupied by the ground cover.

Growth rates vary by species, but most plants that tolerate shade do not grow quickly simply because there is little light for photosynthesis. Initial spacing of ground covers depends both on species planted and how rapid one wants a dense stand of that species. In most cases planting on six- to eight-inch centers is needed for quick cover. For those wishing to economize, wider spacing may be practiced with the realization it will require more time to establish a dense stand. If wider spacing is practiced, mulching the area between plants will help to conserve moisture, control weeds and make the area more attractive.

Under large trees with shallow, aggressive roots it might be difficult or impossible to improve the soil and plant the entire area. In such cases, it probably is more practical to establish pockets of improved soil where there are fewer roots and establish ground cover plants in those pockets. Once established, the ground cover's roots should compete fairly well with the tree's roots and establish an attractive, uniform stand. Remember, however, that the roots of trees like improved soil and will establish themselves in the pockets created. For this reason frequent watering and occasional fertilization especially is important for ground cover establishment and continued growth.

Finally, while ground covers tend to choke out competing weeds once established, shade-tolerant weeds can be problematic while the ground cover establishes itself. As mentioned above, mulching between plants can help prevent weeds. If weeds do appear they should be removed promptly to prevent them from slowing the development, speed of cover and general attractiveness of the desirable ground cover.

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Those Are Greenbugs...

Dead patches of cool-season grasses, such as Kentucky bluegrass and tall fescue, have been reported around the central Missouri region in the past several weeks. While greenbugs exist every year, this is the first reported cases in over 20 years. Greenbugs will also feed on annual bluegrass and chewings fescue. Close inspection of the damaged areas will reveal clusters of green aphids lined up on leaf blades.

The greenbug is an aphid or sometimes referred to as a "plant louse." They have a piercing, sucking mouth-part that removes sap from turfgrasses. When feeding, they inject saliva that is toxic to plant tissue causing the tissue around the feeding site to die. Damaged begins as chlorotic (yellowing) lesions that eventually turn brown. With the loss of sap and the translocation of toxins throughout the plant, the whole plant, including roots, will die. Heavy infestations can amount to 2000 to 3000 aphids per square foot. If left untreated, damaged sites will require re-seeding or re-sodding.

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Greenbugs seem to favor heavily fertilize turfgrasses in shaded areas; however, damage has been seen in just the opposite – open areas under low fertility. Damage may also occur along foundation walls, fences or other upright structures. As infestations spread, the highest numbers of greenbugs will be noticed in the green grass on the perimeter of damaged patches.

Greenbugs can become windborne and move to new sites. They can also be carried on grass clippings attached to mowers or boots, in bagged clippings, or on infested sod. Lawn care operators should be particularly careful not to transport greenbugs from infested sites to non-infested sites.

Management:

In most years, greenbug populations are easily controlled by natural predators, such as lady beetle larvae, lacewings, and tiny parasitic wasp. When infestations are high, large numbers of these predators may be observed.

Endophyte-infested varieties of tall fescue, fine-leafed fescue, or perennial ryegrass are resistant to greenbugs. Consider over-seeding damaged areas with one of these turfgrass species with endophyte.

Insecticides may be the only solution in heavily infested areas. If damage is localized, spot treatments may be adequate; however, treat up to 6 feet beyond the damaged area. Liquid formulations of insecticides work best; granular formulations are less effective. Treated areas should not be irrigated or mowed within 24 hours. The goal is to leave residues of insecticides on the leaf blade. Rainfall, soon after an application, may reduce the effectiveness of the insecticide. Areas should be inspected for greenbugs and retreatment may be necessary.

Greenbugs are fairly easy to control with contact and systemic insecticides; however, multiple applications may be required for complete control. Several products are available for lawns (commercial and residential) and are listed below. Note that some products (Acephate, Orthene, etc.) are labeled for golf course and sod farms only and Orthene does not have a landscape label. Other insecticides are labeled for control of aphids on lawns and in general on landscape ornamentals. Keep in mind that many of the products listed below need to be applied by a licensed applicator since several of these products are restricted use pesticides. Products like Sevin and Merit can be purchased over-the-counter for homeowner use. Always read the product label before purchasing and prior to use.

Table 1. Products for Greenbug Control[1]

Common Name	Trade Name
acephate	Acephate Orthene T&O 75 Orthene T&O 97
bifenthrin	Onyx Talstar
carbaryl	Sevin
chlorpyrifos	Dursban
clothianidin	Arena
clothianidin + bifenthrin	Aloft
cyfluthrin	Tempo
cypermethrin	Demon
imidacloprid + bifenthrin	Allectus
imidacloprid	Merit
lambda-cyhalothrin	Demand Scimitar
permethrin	Astro
thiamethoxam	Meridian

[1]Check product labels for use sites and rates.

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Prepare for Japanese Beetles

With record numbers of Japanese beetles trapped in several counties across the state in 2010, most experts feel those numbers will only rise for 2011. Perhaps it is time to think about defensive practices when no end is in sight for this particular pest.

Japanese beetles were accidentally introduced to the United States in 1916 by way of New Jersey. Since that time, they have become one of the most devastating landscape pests in the eastern United States. As little as 10 to 15 years ago, Missouri was somewhat free of this critter with only a few scattered pockets of beetles being found in a few counties. Now, we may be lucky to have just a few counties that are free of this pest.

Large areas of turfgrass and pastures provide desirable habitat for developing grubs with no effective natural enemies. Grassed levees around crops of corn and soybeans in river bottoms may lead to destruction of these plants. Needless to say, we have abundant habitat for this particular insect and numbers this year are highest historically for Missouri.

While the grubs are damaging to several plant roots (turfgrasses included), the adults beetles also feed on 300 to 400 plant species. Listed in table 1 are just a few plants likely to be damaged by Japanese Beetles.

Adult beetles are 3/8" long, metallic green beetles with copper-colored wing covers. White tuffs of hair protrude along the underside of the wing covers. This is a dead-ringer characteristic for Japanese beetle. Adult beetles will usually start their feeding at the top of a plant and work their way down. Adults will feed on the upper side of leaves between leaf veins giving a skeletonized appearance. Odors from damaged leaves may serve as an attractant for drawing more beetles to desirable food sources. Adults can be highly mobile, up to several miles; however, most will make short flights to feed or lay eggs. There is no guarantee that adults will lay eggs in and around a site where they feed.

Egg lying begins immediately following emergence in the spring and mating. Clusters of beetles can be noticed on vegetation during the early day, usually in full sunlight. Females fly down later in the day to burrow 2 to 3 inches into the soil to deposit 40 to 60 eggs (mid to late June). Egg hatch occurs in July and grubs grow very quickly, achieving nearly full size by August. Grubs continue to feed on roots of turfgrasses and other plants in home lawns, gardens, parks, golf courses, and cemeteries.

Soil moisture is important for the survival of eggs and small grubs during the summer months. Females prefer moist soils to lay eggs. Irrigated lawns, sports fields, and golf courses will often have higher grub populations, especially during droughty periods. Older grubs move deeper into the soil profile where moisture exists, becoming more tolerant of droughty conditions.

Most individuals are familiar with white grub damage. Root pruning by grubs will create brown patches of dead turf that easily pulls up and separates from the soil. Many often refer to it, "like rolling up a carpet." Early lawn damage from feeding grubs includes slightly discolored patches that may be sunken and beginning to wilt. These normally show up in late July to early August, but some years as late as September. This is when to investigate the existence of grubs in these patches and treat when numbers reach 5 to 10 per square foot.

Damage reduction and control can be accomplished several ways. Just as we listed plants susceptible to adult beetles, we also have a list of plants that are less likely to be damaged by adult Japanese beetles. They are listed in table 2.

Selection of less desirable landscape species is a good first step to plant selections in Japanese beetle infested areas. Removing beetles by hand may provide some protection for small plantings when numbers are low. However, the presence of beetles left unscathed will only attract more beetles. Shaking small plants is one way to remove beetles. Protecting small plants with cheese cloth is another.

Many garden centers sell traps. Sex attractant hormones lure beetles to the traps and can attract thousands of beetles a day. Unfortunately, research indicates that traps attract far more beetles than are actually caught. If traps are used, place them far away from landscape plants and gardens.

Several over-the-counter and commercial insecticides are labeled for adult and larval (white grub) Japanese beetles. Products containing pyrethroids such as cyfluthrin (Bayer Advanced Lawn & Garden Multi-Insect Killer), acelepryn (Acelepryn), bifenthrin (Talstar One, Onyx), clothianodin (Arena), deltamethrin (Deltagard), imidacloprid (Merit), lambda-cyhalothrin (Scimitar, Spectracide Triazicide), permethrin (Spectracide Bug Stop Multi-Purpose Insect Control), and thiamethoxam (Meridian) offer good control for professionals and homeowners. Carbaryl (Sevin) is also

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effective for both adults and grubs. Pyrethroid products will provide 2 to 3 weeks protection, while carbaryl provides only 1 to 2 weeks protection. For those wanting an organic approach, Neem products like Azatrol or Neem-Away will provide 3 to 4 days deterrence of feeding. Sequential applications of all products may be needed under extended periods of activity. Always follow label directions and note any precautions for bees. On food crops, follow the recommended pre-harvest interval before harvest begins.

Predicting the outcome of such a large outbreak of Japanese beetles is difficult. Since adult beetles are quite mobile, controlling grubs in a lawn may not protect landscape plants from adult feeding. Because you notice adult beetles in your landscape, does not necessarily mean that you need to treat a lawn. Treating landscapes plants will offer some protection from adult beetles when noticed. Perhaps the best approach for lawns is one of, "wait and see." Others will want to treat immediately.

Reference:
Japanese Beetles in the Urban Landscape, M.F. Potter, D.A. Potter, and L.H. Townsend. University of Kentucky Cooperative Extension Service – College of Agriculture, EntFact 451.

For more news about Japanese Beetle, visit our website:

http://ppp.missouri.edu

Table 1. Plants favored by Japanese Beetles

Scientific Name	Common Name
Acer palmatum	Japanese maple
Acer platanoides	Norway maple
Aesculus hippocastanum	Horsechestnut
Althaea rosea	Hollyhock
Betula populifolia	Gray birch
Castanea dentata	American chestnut
Hibiscus syriacus	Rose-of-Sharon, Shrub Althea
Juglans nigra	Black walnut
Malus species	Flowering crabapple, apple[1]
Platanus acerifolia	London planetree
Populus nigra italica	Lombardy poplar
Prunus species	Cherry, black cherry, plum, peach, etc.
Rosa species	Roses
Sassafras albidum	Sassafras
Sorbus americana	American mountain ash
Tilia americana	American linden[2]
Ulmus americana	American elm
Ulmus procera	English elm

[1]Some cultivars (e.g. Baccata v. jackii, Jewelberry, Harvest Gold, Louisa) are relatively resistant.
[2]Tilia tomentosa 'Sterling' and Tilia americana 'Legend' are less susceptible than other lindens.
Information provided by the Cooperative Extension Service – University of Kentucky, EntFacts – 451.

Table 2. Less Susceptible Plants to Japanese Beetles

Scientific Name	Common Name
Acer negundo	Boxelder*
Acer rubrum	Red maple
Acer saccharinum	Silver maple
Buxus sempervirens	Boxwood
Carya ovata	Shagbark hickory*
Cornus florida	Flowering dogwood
Diospyros virginiana	Persimmon*
Euonymus species	Euonymus (all species)
Fraxinus americana	White ash
Fraxinus pennsylvanica	Green ash
Ilex species	Holly (all species)
Juglans cinerea	Butternut*
Liriodendron tulipifera	Tuliptree
Liquidamar styraciflua	American sweetgum*
Magnolia species	Magnolia (all species)
Morus rubra	Red Mulberry
Populus alba	White poplar
Pyrus communis	Common pear*
Quercus alba	White oak*
Quercus coccinea	Scarlet oak*
Quercus rubra	Red oak*
Quercus velutina	Black oak*
Sambucus canadensis	American elder*
Syringa vulgaris	Common lilac
Most evergreen ornamentals, including Abies (fir), Juniperus, Taxus, Thuja (arbor vitae), Rhododendron, Picea (spruce), Pinus (pine) and Tsuga (hemlock) are not attacked.	

**Species marked with an asterisk may suffer occasional light feeding.*
Information provided by the Cooperative Extension Service – University of Kentucky, EntFacts – 451.

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June Gardening Calendar

Ornamentals

- **Week 1:** Deadhead bulbs and spring flowering perennials as blossoms fade.
- **Week 1:** Early detection is essential for good control of vegetable pests. Learn to identify and distinguish between pests and beneficial predators.
- **Week 1** Watch for bagworms feeding on many garden plants, but especially juniper and arborvitae.
- **Week 1:** Thin seedlings to proper spacings before plants crowd each other.
- **Weeks 2-4:** Plant tropical water lilies when water temperatures rise above 70 degrees.
- **Weeks 2-3:** When night temperatures stay above 50 degrees, bring houseplants outdoors for the summer.
- **Weeks 2-3:** Apply a balanced rose fertilizer after the first show of blooms is past.
- **Weeks 2-3:** Rhizomatous begonias are not just for shade. Many varieties, especially those with bronze foliage do well in full sun if given plenty of water and a well-drained site.

Lawns

- **Weeks 1-4:** Water turf as needed to prevent drought stress.
- **Weeks 1-4:** Mow lawns frequently enough to remove no more than one-third the total height per mowing. There is no need to remove clippings unless excessive.
- **Weeks 1-4:** Gradually increase the mowing height of zoysia lawns throughout the summer. By September, the mowing height should be 2 to 2.5 inches.

Vegetables

- **Weeks 1-2:** Plant pumpkins now to have Jack-o-lanterns for Halloween.
- **Weeks 1-2:** As soon as cucumber and squash vines start to 'run,' begin spray treatments to control cucumber beetles and squash vine borers.
- **Weeks 2-4:** Set out transplants of Brussels sprouts started last month. These will mature for a fall harvest.
- **Weeks 2-4:** To minimize diseases, water with overhead irrigation early enough in the day to allow the foliage to dry before nightfall.
- **Weeks 2-3:** Start seedlings of broccoli, cabbage and cauliflower. These will provide transplants for the fall garden.
- **Weeks 3-4:** Control corn earworms. Apply several drops of mineral oil every 3 to 7 days once silks appear. Sprays of B.T. are also effective.

Fruits

- **Week 1:** Oriental fruit moths emerge. Most serious on peaches where first generation attacks growing tips. Shoots will wilt. These should be pruned out.
- **Week 1:** Thinning overloaded fruit trees will result in larger and healthier fruits at harvest time. Thinned fruits should be a hands-width apart.
- **Week 1:** Enjoy the strawberry harvest
- **Week 2-3:** Renovate strawberries after harvest. Mow the rows; thin out excess plants; remove weeds; fertilize and apply a mulch for weed control.

Miscellaneous

- **Weeks 3-4:** When using any gas powered equipment, be sure to allow the engine a few minutes to cool before refilling empty fuel tanks.
- **Weeks 3-4:** A mailbox mounted on a nearby post makes a handy place to store and keep dry any small tools, seeds, labels, etc. frequently used in the garden.

Gardening Calendar supplied by the staff of the William T. Kemper Center for Home Gardening located at the Missouri Botanical Garden in St. Louis, Missouri. (www.GardeningHelp.org)