



In watermelon and other cucurbits, pollen must be transferred from male flowers to female flowers for pollination to occur. The ovary (pictured) looks like a miniature watermelon. Photo credit: S. Ausmus, USDA ARS

Reasons Vegetables Produce Flowers but Not Fruit

Gardeners sometimes find that their plants are flowering but not producing fruit. “Fruit” is used here in the botanical sense and includes the consumed part of vegetable plants, such as cucumbers, tomatoes and snap beans. This lack of production can occur for a variety of reasons.

Most squash, cucumber and melon plants, all of which are “cucurbits,” produce separate male and female flowers on the same plant. The first flowers that appear are generally male, so they do not produce fruit. The first female flowers appear later. Of course, it is still necessary to have male flowers at that time to provide pollen.

Female squash, cucumber and melon flowers can be identified by the presence of a swollen area under the petals that looks like a miniature fruit. This is the ovary of the flower. Male flowers, on the other hand, have a narrow stem. If only male flowers are present, wait. Female flowers will likely develop soon.

While many cucurbits have male and female flowers on the same plants, there are exceptions. Some cucumber varieties, such as Dasher II, are gynoecious, meaning that they only produce female flowers. When these are grown, another variety must be planted to provide pollen. Likewise, a seeded or diploid watermelon variety must be present to provide pollen for seedless or triploid watermelon plants.

If both female and male flowers are present but no fruits form, a lack of pollination is one possibility. If there are few bees in the area, or if they are just not active, this could be part of the problem. If you use insecticides, wait until late afternoon or early evening — when bees are no longer active — to apply them. To encourage more bee activity, you can also plant flowering plants like zinnias nearby. Weather can affect bee activity. Honeybees typically do not fly during rain, so prolonged rainy weather can result in reduced fruit production.

If pollination by bees is insufficient, one option is to hand-pollinate cucurbit plants. You can either touch the pollen-

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bearing anther of the male flower directly to the stigma of the female flower, or you can use a paintbrush to transfer the pollen. It is a good idea to do this in the morning. Besides a lack of pollen transfer from male to female flowers, there are other reasons that vegetables sometimes produce flowers but not fruit.

In tomatoes, nighttime temperatures below 55 degrees Fahrenheit or above 75 degrees can interfere with pollination. Daytime temperatures above 90 degrees can cause blossoms to drop. If you plant tomatoes after April in Louisiana, use “heat-set” (heat-tolerant) varieties. High temperatures can also cause blossom drop in beans, and planting snap beans between mid-May and mid-August is not advised. “Yardlong,” or asparagus beans, on the other hand, can tolerate high temperatures. These are closely related to the heat-tolerant southern peas (black-eyed, purple hull, crowder and cream peas). Excessively dry or wet soil can cause blossom drop in some vegetables as well. Provide adequate but not excessive water. If soil is poorly drained, consider planting in a raised bed or in containers with drainage holes.

Pollination problems in sweet corn can result from how the planting is arranged. Corn is wind pollinated. For good pollination, plant corn in several rows next to each other rather than one or two long rows. If you are experiencing a lack of productivity in your vegetable garden and none of these issues seem to explain it, you can contact your local extension agent for assistance.

Mary Helen Ferguson, Ph.D.
Associate Extension Agent

Blossom Drop and ‘June Fruit Drop’ in Citrus Are Normal

Citrus trees can cause home growers a lot of unnecessary worry when the ground seems to be littered with shed blossoms or dropped, immature fruit. Fruit and blossom drop can be caused by several factors, most of which are not very serious or can be easily prevented. While appearing catastrophic, blossom and fruit drop in citrus can be a normal coping mechanism when it comes to balancing what the trees can handle.

All types of citrus naturally produce more blossoms than they could possibly hope to develop into fruit. Up to 98% of blossoms can drop under normal conditions, with the remaining 2% forming a heavy, bountiful crop. The surviving 2% of blossoms can be impacted by a number of factors that may significantly damage the future fruit yield. Late frosty or unseasonably cold weather can bring about a blossom drop, as can high wind conditions. Irregular watering or rainfall can also trigger a drop.

A fungi called *Colletrichum acutatum* can cause a disorder known as post-bloom fruit drop (PFD). This can cause serious problems in humid areas, such as southeast Louisiana. Picking the old crop in a timely manner and



Blossom drop is normal in citrus trees.

trimming the “buttons” off the tree (woody twig ends where the stem met the fruit) can help to control this pathogen. Practice good orchard sanitation by removing old, rotting fruit, as well as raking up dropped leaves and twigs or other debris.

Some trees, including mandarin-family citrus, such as satsumas, may skip a year of blooms or produce fewer fruits. This condition is called “alternate bearing” behavior and is perfectly normal. Trees take a break for a year and then come back heavy the following year under ideal conditions.

Fruit drop can be alarming, especially when young trees shed most of the fruit that had begun to develop earlier in the season. Young trees and newly planted citrus trees do not have support systems in place to maintain a bumper crop of fruit. By shedding fruit, the tree rids itself of a burden so that it can divert resources toward continued growth and development into a healthy, mature tree.

Typically, this drop of immature fruit happens in May or June and is thus called “June drop.” A drop during this time is considered normal and unavoidable.

Mature trees may also experience June drop depending on weather conditions and overall tree health. High temperatures and humidity may trigger this shedding of fruit from pea up to walnut-size growth stages. Because irregular soil moisture can also trigger June Drop, soil moisture should remain consistent through irrigation or supplemental watering as needed.

Fertilizing trees properly in the spring (January and February, with a light application in June) can also help to ensure that a good crop of developing citrus won’t just drop to the ground. Healthy trees can support and develop more fruits, so annual care plays a large role in crop success. For more information on Louisiana Citrus care, fertilization rates and pruning, please refer to the Louisiana Home Citrus Production (Publication No. 1234). Find it online at <https://www.lsuagcenter.com/articles/connected/louisiana-home-citrus-production>.

Anna Timmerman
Assistant Extension Agent

Water-Wise Gardening

Water is our most precious natural resource. Americans use an average of 29 gallons of water per day, according to the Environmental Protection Agency, with 30% or 8.5 billion gallons each day used for gardening and lawn care. With two-thirds of the world's population projected to face water scarcity by 2025, it is time to plan for shortages.

You can make water-wise landscaping decisions and create a functional, easily maintained landscape by following a few guidelines that will help conserve water, money and time.

The EPA recommends these key tips for water-smart landscaping:

- Plan before you plant.
- Make water-wise plant selections.
- Go easy on the turf.
- Water wisely. The timing matters.
- Use automatic irrigation that is efficient and well designed and work with irrigation professionals.
- Use mulches to conserve moisture.
- Harvest rainwater.

Planning before you plant is the first step when making water-wise landscape decisions. Did you know that plants help conserve water and improve water quality by slowing and collecting rain?

Next, select the right plant for the right place based on your regional conditions. Take into account the annual rainfall and average temperatures for your area. To achieve the need for minimum irrigation, choose plants that are adapted to low water environments, such as native plants.

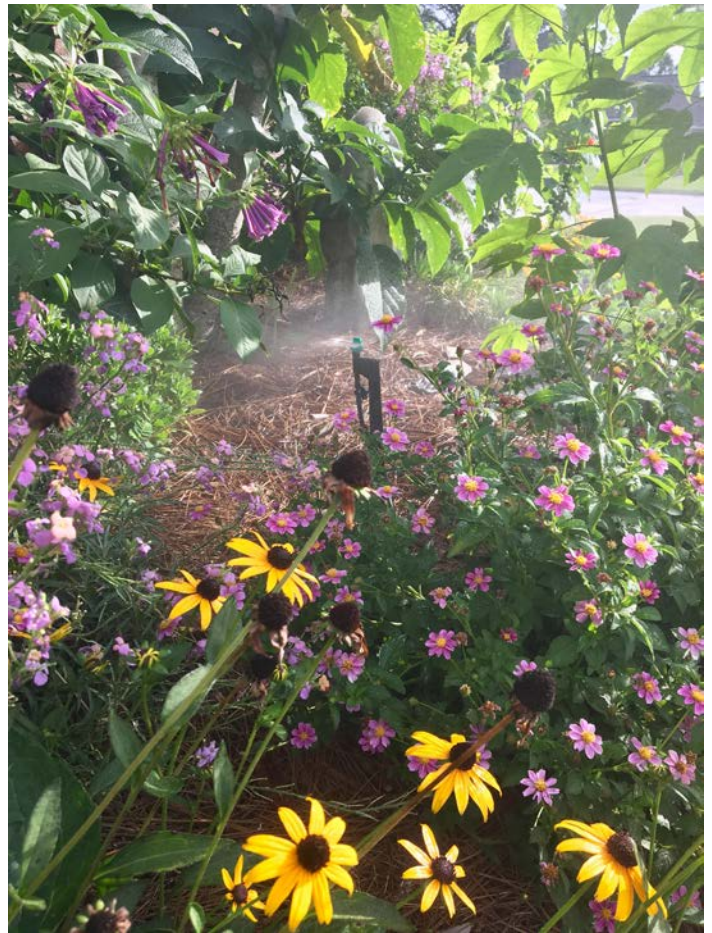
For the most water conservation, limit or eliminate turfgrass in your landscape. This will not only conserve water, but it will also conserve time and money spent on maintaining grass and cut back on watering and mowing tasks — bonus! Keep in mind that some grasses are more drought tolerant than others, such as centipedegrass and zoysia. St. Augustinegrass, bermudagrass and carpetgrass require more water.

Group plants with similar water needs in “hydrozones” that reduce water use according to each zone. Turf and bedding plants will require the most water, whereas well-established shrubs and trees with extensive and deep root systems require less.

Timing matters. Automatic irrigation systems can be a real time saver. It can also help you get a little extra shut eye because the best time to water plants is early in the morning between the times of 2 a.m. and 8 a.m.

Watering during the heat of the day reduces the efficiency because more water is lost to evaporation. Watering in the evening between 6 p.m. to midnight can encourage fungal diseases as plants remain wet for extended periods.

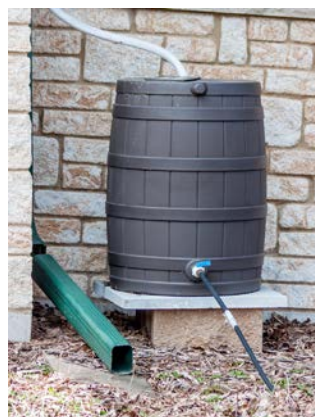
Schedule irrigation according to each hydrozone for particular plant needs and in response to decreased rainfall. In addition to conserving water, adequate irrigation is more effective and efficient, encouraging deeper root growth and creating healthier plants that are more drought tolerant.



Water early in the morning between 2 a.m. and 8 a.m.

Work with irrigation specialists when designing, installing and scheduling irrigation systems. A properly designed irrigation system will conserve water, while an improperly designed and scheduled system will waste water and money.

Use mulch. Mulch covers the soil, conserving water by preventing evaporation and preserving water at the root mass while providing a source of organic matter to landscape beds. Mulch can also help prevent compaction and provide weed control and is also attractive.



Rain barrel

Lastly, harvest rainwater. Louisiana has an average annual rainfall of 60 inches. Harvest rain with equipment such as barrels and cisterns to help supplement your irrigation program.

Do your part to help conserve water for future generations by following these water-wise guidelines. Consult LSU AgCenter publication No. 3062, Introduction to Landscape Irrigation in Louisiana, at lsuagcenter.com for more tips.

*Heather Kirk-Ballard, Ph.D.
Consumer Horticulture Specialist*



Checklist for June, July, August

June

1. In the lawn: Watch for chinch bugs, which are active from June to September. To prevent damage, ensure a vigorously growing lawn that can defend itself more readily. Use insecticides only if needed.
2. In the landscape beds: Plant ornamental grasses. They add beauty and texture to landscapes and they are low maintenance once established. They thrive in the summer for a beautiful fall flower display. Muhly grass (*Muhlenbergia capillaris*) is the fall selection for 2021 Louisiana Super Plants.
3. Trees and shrubs: Prune hydrangeas and gardenias after they have completed their bloom. Remove suckers from crape myrtles. June begins hurricane season. Check shade trees carefully for dead or unhealthy limbs and remove them ahead of the storms. Take down any large trees that look unhealthy or if they have any rotten or decayed areas.
4. Fruits: Cut back canes of blackberries that have already produced. To keep the rest of the plant compact you can also cut the whole plant back to 3 feet. If drought conditions occur, keep figs well-watered to prevent fruit drop.

July

1. In the lawn: Apply a second application of slow-release fertilizer as the label recommends. Be sure to cut your lawn once a week or every other week depending on growth and rain activity. Cut your lawn at the proper heights for your turfgrass: bermudagrass, 1-1 ½ inches; centipedegrass, 1-2 inches; St. Augustinegrass, 2-3 inches; and zoysia, ½-1 ½ inches.
2. In the landscape beds: Cut back daylilies to around 4 inches to remove spent flower stalks and old foliage. This is a good time to trim leggy annuals.
3. In the landscape beds: You can begin planting warm-season annuals, perennials and caladium bulbs this month. Thin border plants and clumping ground covers, such as monkey grass, liriopse, and hostas, this month.
4. Trees and shrubs: Plant palms this summer through late August. Some cold hardy palms to consider for Louisiana are saw palmetto, windmill palm, cabbage palm and needle palm.



Chinch bug damaged lawn.

August

1. In the lawn: Sodding, aerification and dethatching can still be done throughout the month of August. Be on the lookout for large patch. Treat with fungicides containing one of these active ingredients: maneb, myclobutanil, PCNB, propiconazole, thiophanate-methyl or triadimefon.
2. In the landscape beds: Pinch back coleus to prolong foliage and to prevent flower spikes. Divide overcrowded daylilies and Louisiana irises and share with friends and family.
3. Trees and shrubs: Mulch trees. Prune ever-blooming roses back by one-third of their height to encourage a vigorous fall bloom.
4. Fruits: Harvest season for apples, figs, pawpaws and pears. Spray figs with copper-based fungicides after they have finished producing to prevent fig leaf rust.

Heather Kirk-Ballard, Ph.D.
Consumer Horticulture Specialist

Winter in Summer?

Why not plant something new this summer? We have our warm season stand-bys — tomatoes, peppers, okra, cucumbers, melons, squash and others. Tips for these crops are presented at the end of this article. But I challenge you to try and grow pumpkins in Louisiana. Last summer the LSU AgCenter held a statewide pumpkin growing contest for 4-H youth. Over 800 students received seeds of the Cinderella pumpkin variety. Cinderella isn't really a pumpkin. Rather, it is a large winter squash. In Louisiana, pumpkins can be hard to grow, but decorative and winter (edible) squash are easier. Winter squash are beautiful and come in a range of shapes, sizes and colors. They are called "winter" even though they are grown in the summer because they have a thick rind that allows them to keep for many months, unlike summer squash, which have a short shelf life. Some of my favorite winter squash varieties include Cinderella, which can range from a light tan to a deep coral color and anywhere from 6 pounds to 40 pounds depending on how you fertilize and how great



Assortment of winter squash and pumpkins

you are at attracting pollinators. Other fun varieties include Shokichi Shiro, which has a light silver-gray color; Silver Moon, a white squat squash; and Turk's Turban, a beautiful squash that is orange, green and white. There are too many to name and so many you should try growing. If you are interested, here are a few tips.

Winter squash vine out, so be sure to give them plenty of space. In our recent 2020 LSU AgCenter winter squash trial we spaced plants 3 feet apart down each row. Watch out for cucumber beetles, slugs, snails and worms, the major insects that affect this crop. If you must spray to kill these, please do so at dusk. This is because we need bees and other pollinators to bring pollen back and forth from male to female flowers. Fertilize before you plant with a complete fertilizer, such as 13-13-13, and side-dress weekly with nitrogen as flowers begin to develop. Keep an eye out for downy mildew and powdery mildew, two of the most notorious diseases that attack winter squash. To help prevent disease water at the base of the plant, space plants

adequately and use a preventative fungicide. Harvest when the rind of the squash is hard enough that your fingernail won't poke through it. The stem of the winter squash should also look thick and corky, not fresh and light green. Why not give it a try? Even just saying winter in summer might cool you off a bit!

General Summer Vegetable Planting Tips

June

- Collard greens, cucumber, watermelon, cantaloupe, okra, southern peas, pumpkin and summer squash can all be direct-seeded into the garden during June. Wait until late June to plant pumpkins if you want them ready for early October and Halloween decorating.
- You can plant sweet potato slips this month.
- In mid-June, plant a summer crop of heat-set tomatoes. Planting heat-set tomatoes is VERY important. These cultivars have been bred to set fruit during high nighttime temperatures, whereas other cultivars will not. If managed correctly, heat-set tomatoes will produce fruit through October. Preferred varieties include Florida 91, Solar Set and Sun Master, Phoenix and Bella Rosa.



Watermelon on the vine, okra and summer squash

July

- Transplant another fall crop of heat-set tomatoes (late July). These will take you through the first freeze. Transplant bell peppers as well.
- Direct-seed okra, southern peas, cucumbers, squash, cantaloupe and watermelons throughout July. Direct-seed pumpkins in early July — the first week of the month for an early October harvest.
- Late July to early August is a good time to start thinking about your fall garden. Order broccoli, Brussels sprouts, cauliflower, Chinese cabbage, cabbage and all your root crop seeds. This is very important because all the good gardeners are also ordering seeds now. And you don't want the leftovers!



Brussels sprouts

August

- Plant bush lima beans in the garden.
- Start seeds of broccoli, Brussels sprouts, cauliflower, Chinese cabbage, cabbage, cucumbers, squash, mustard greens and shallot sets for an early fall garden start in September. Start your seeds on a table outdoors under the shade. Do NOT forget to keep them moist.
- You can transplant broccoli and Brussels sprouts as early as mid-August in the garden but beware



Irish potatoes

of worms. They will get you this time of year. I personally like to wait until mid-September to transplant fall crops. But some people like the thrill of being the first on the block with the fall produce. In a garden rush? At the end of this month, direct-seed beets and lettuce for an early crop.

- Late August is the perfect time for a fall crop of Irish potatoes. It is really hard to find them at the hardware store, so many people save the smaller potatoes from their spring harvest for a fall planting. If you are doing this, you do not need to cut the potatoes into pieces. Just plant the small potatoes whole.
- Are your okra and eggplants looking a little spindly? Cut them back about knee height and add a little fertilizer. They will flush out again and produce until the first freeze.

Enjoy the Garden,

*Kathryn "Kiki" Fontenot, Ph.D.
Associate Professor, LSU AgCenter School of Plant,
Environmental and Soil Sciences*

Tips for Summer Care of Turfgrass

Summer is the peak growing season for lawns in Louisiana. If you did not fertilize during the spring, you still have time to fertilize and get your yard in good shape prior to fall. Keep up a good fertility program through early to late August. Remember to apply all granular materials on a dry lawn and water very soon after application. Make sure your lawns are getting adequate amounts of moisture during the summer months, but don't overwater. Water deeply only once or twice per week or as needed, based on the amount of rainfall. The purpose of irrigation is to supplement rainfall. I am not a fan of watering lawns everyday unless we are in severe drought.

Consider aerifying compacted soil. I've seen aerification completely change thin lawns caused by compacted soil into thick and healthy turf. Aerifying helps with water percolation and increases the turf's rooting depth and makes for a more drought-tolerant lawn. Lawn care companies can aerate, or you can rent an aerator from a rental store and do it yourself. If your soil is prone to compaction, consider aerating one to three times this growing season. Aeration may be the game changer that your lawn is missing.

Fertilizing the lawn

St. Augustinegrass and zoysiagrass both respond well to fertilizer applications. St. Augustinegrass may be fertilized up to three times during the growing season — April, June and mid-August. Fertilize zoysiagrass twice per growing season — in April and again in July.

Bermudagrass is an even bigger fertilizer user and can be fertilized from three to five times during the growing season, especially if you like to mow grass. Carpetgrass and centipedegrass are not big fertilizer users. Usually, two applications (April and July) will take care of centipedegrass, and one application will be sufficient for carpetgrass (April).

Centipedegrass should receive its second and final fertilizer application in July. For centipedegrass, apply only one-half pound of actual nitrogen per 1,000 square feet. For example, apply 3 pounds of 17-0-17 per 1,000 square feet or 5 pounds of 10-0-10 per 1,000 square feet. St. Augustinegrass would need 6 and 10 pounds of the aforementioned fertilizers.

If your lawn is not performing well, there could be a nutrient deficiency in the soil. The only surefire way to know what your soil needs is to collect a soil sample and submit it for testing at the LSU AgCenter Soil Testing and Plant Analysis Lab. In order to simplify the soil sampling and submission process, there are pre-addressed submission boxes with sampling instructions at several garden centers throughout the state and at your local parish extension office. Once submitted, the results will be sent to your home mailbox and/or email, usually in less than two weeks. Your parish LSU AgCenter extension agent can help you interpret the results from the soil sample and tell you

exactly what's needed nutrient-wise to make your lawn beautiful.

Correct mowing heights are highly important

You may not know this, but there is a correct mowing height for your lawn. St. Augustinegrass is very finicky when it comes to mowing height. Don't cut it too short and don't allow it to get too tall. It likes to be maintained around 3 inches, the tallest mowing height of all the lawns grown in Louisiana. If you cut St. Augustinegrass too short, it becomes stressed and more prone to disease and weed infestations.

Centipedegrass is often maintained too tall. Centipedegrass should be mowed to 1 to 1.5 inches. This helps prevent thatch buildup. Zoysiagrass also likes to be mowed in the 1-to-1.5-inch range. Bermudagrass should be mowed from 1 to 2 inches, shorter mowing heights are better when more frequent mowing is possible. Keep mower blades sharp to ensure a clean cut and good lawn health.



Armyworm defoliating bermudagrass.

Insect pests

Watch for chinch bugs in St. Augustinegrass and bermudagrass lawns and treat with an LSU AgCenter-recommended insecticide such as bifenthrin (Talstar and many other trade names). Chinch bug problems show up as yellowish-brown to straw-colored areas of the lawn during hot, dry weather. These insects extract plant juices from turfgrass stems and crowns while pumping toxic salivary fluids into the lawn. The fluids disrupt the plant's vascular system. The damage actually resembles herbicide damage.

Check for chinch bugs in the lawn by saturating suspected areas with a gallon of water mixed with a few squirts of lemon dishwashing soap. This soapy solution irritates chinch bugs and brings them up near the grass surface so you can see them and determine if the bugs are causing the lawn damage. If it's hot and dry and there are dead spots in your St. Augustinegrass, chinch bugs are the first thing that I would consider.

Additional insect problems that appear during the summer include armyworms and tropical sod webworms. These moth larvae or "worms" can cause severe lawn damage very quickly and will need to be killed with

insecticides to prevent further damage. Tropical sod webworms can devastate St. Augustinegrass and carpetgrass lawns. Tropical sod webworms crushed St. Augustinegrass in 2020. Let's hope that our cold winter reduced moth populations for 2021. Armyworms prefer bermudagrass and can completely defoliate acres of pasture and lawns. Carbaryl, bifenthrin and chlorantraniliprole insecticides are options for tropical sod webworms, armyworms and chinch bugs infesting the lawn.

Be mindful of these pests as you walk through your lawns. Investigate damaged areas and treat accordingly.



Tropical sod webworms feeding on St. Augustinegrass.

Virginia buttonweed and other summer weeds

In late spring to early summer, Virginia buttonweed starts forming mats that can eventually smother out the lawn. Pull up small populations of Virginia buttonweed or carefully treat with herbicides like metsulfuron (MSM Turf and other trade names) or Celsius. These herbicides work well with repeated applications spaced four to six weeks apart. Metsulfuron and Celsius can be safely applied on St. Augustinegrass, centipedegrass, bermudagrass and zoysiagrass during warm weather. Carpetgrass will be damaged by Celsius herbicide. Bahiagrass will not tolerate metsulfuron or Celsius. When it comes to “managing” buttonweed, it is important to start spraying early in the growing season (April) and spray often. Don't wait until September to make your first herbicide application.

Common lespedeza is a mat-forming annual legume that emerges in the spring and lingers deep into fall throughout Louisiana. By late summer, the plant matures and becomes woody-like and tough on lawnmower blades. Metsulfuron works well on this weed but early summer applications are more effective.

Torpedograss is a perennial grass that's mainly a problem in south Louisiana, but I do get calls from north Louisiana as well. There are few lawn problems more devastating than a torpedograss infestation. Torpedograss is extremely tolerant of herbicides and easily outcompetes slow growing grasses like centipedegrass.



Common lespedeza



Virginia buttonweed

The weed often starts from soil brought in during flower bed construction. However, it quickly spreads from the flower bed to the lawn. The ability to suppress torpedograss in lawns depends on the turfgrass species. Selectively removing torpedograss out of lawn grasses and sports fields is rarely completely achievable. Quinclorac (Drive and other trade names) is an herbicide that is somewhat effective in suppressing torpedograss in bermudagrass and zoysia. Unfortunately, you cannot use quinclorac in centipedegrass and St. Augustinegrass.

Sethoxydim (Bonide Grass Beater and other trade names) will temporarily injure torpedograss that is infesting centipedegrass, but it does not provide long-term control. The torpedograss recovers, and the weed re-infests the centipedegrass again. Unfortunately, there are no selective herbicide options for torpedograss that is infesting St. Augustinegrass. Often, complete renovation is necessary when centipedegrass and St. Augustinegrass are severely infested.

If you decide to renovate and install a new lawn, consider sodding the lawn with zoysiagrass (semi-shady or full sun lawns) or bermudagrass (for full sun only). Converting to zoysiagrass or bermudagrass will allow the use of quinclorac, the most effective selective herbicide on torpedograss. Installing zoysia may be the better fit for Louisiana because of its good shade and drought tolerance. Zoysia is not a high maintenance grass when managed properly. Maintain zoysia at 1 to 1.5 inches with a sharp mower blade and fertilize twice per year. There are several sod farmers in Louisiana that grow zoysia, so it is readily available.

Proper lawn maintenance keeps your lawn healthy and reduces the need for the use of pesticides. If it becomes necessary to use a pesticide in the lawn, it is highly important to always read and follow their labels before using. The label will tell you how to use the product safely to achieve satisfactory results. You will find the label attached to the product's container.

*Ron Strahan Ph.D.
Associate Professor, LSU AgCenter*

Susceptibility to Satsuma Cultivars to Citrus Canker Caused by *Xanthomonas axonopodis* pv. *citri*

Citrus is the most popular fruit tree grown commercially and in home backyards in Louisiana. Satsumas dominated citrus production with 63% of total citrus acreage. In 2018, 183,408 bushels of satsumas were produced in the state with a total gross farm value of \$6.2 million, according to the 2018 Louisiana Summary Agriculture and Natural Resources.



Figure 1: Citrus canker lesions present on the upper leaf surface of a grapefruit tree (source of natural citrus canker bacterium).

During the last decade, satsuma production has drastically reduced by 54,526 bushels, which is attributed to diseases and natural disasters. After Hurricane Katrina in 2005, Louisiana lost the majority of its citrus industry, and the total acreage was greatly reduced. In 2008 and 2010, citrus greening and sweet orange scab were confirmed in the state for the first time, respectively (Hummel and Ferrin, 2010; Singh and Ferrin, 2011). In June of 2013, citrus canker (Figure 1) was re-confirmed in the state for a second time in Orleans Parish (Singh, 2013). The disease was first reported in Louisiana in 1914 (Loucks, 1934) and was considered eradicated in 1940 (Dopson, 1964). Since 2013, citrus canker has been rapidly spreading to all commercial and backyard citrus production areas in the state. Currently, citrus canker is reported in 10 Louisiana parishes, including Plaquemines, where the

majority of the commercial citrus is grown (Louisiana Department of Agriculture and Forestry Cooperative Agriculture Pest Survey Report 2019).

All citrus varieties are susceptible to citrus canker; however, some varieties are less susceptible than others. Copper-based fungicides may suppress the disease but not control it. No bactericides have been labeled to use on citrus to manage citrus canker in Louisiana. Without effective management options, citrus canker has the potential to adversely affect the survival of Louisiana's valuable citrus industry. Therefore, it is critical to develop alternate methods to mitigate the spread of citrus canker in the state. One of the alternate methods is to discover satsuma cultivars that are highly tolerant and can withstand high disease pressure in our canker-conducive environment.

The results from an annual citrus cooperative agricultural pest survey (CAPS) conducted by the LSU AgCenter and the Louisiana Department of Agriculture and Forestry from 2014-2016, revealed that satsumas are highly tolerant to citrus canker with only 2.5% disease incidence. In some situations, the satsuma samples were collected from trees planted in the same backyard with heavily infested grapefruit, Meyer lemon, navel orange and other citrus varieties. The CAPS lacked data on types of satsuma cultivars that were sampled. The cultivar susceptibility data plays a critical role when promoting different types of satsumas to commercial and backyard growers in canker-infested areas. The objective of this study was to screen susceptibility of satsuma cultivars against citrus canker under natural disease inoculum conditions.

Five cultivars of satsuma, including Brown's Select, Louisiana Early, Miho, Owari and St. Ann were screened along with three citrus varieties with known varying degrees of susceptibility to citrus canker disease ranging from a highly susceptible (HS) Ruby Red grapefruit, a moderately susceptible (MS) Hamlin sweet orange and a least susceptible (LS) sweet kumquat. Trees grown in 3-gallon pots and to 18 months of age were placed under diseased mature grapefruit trees at a public garden in New Orleans and a commercial citrus orchard in Paulina. The study was conducted during 2018 and 2019 growing periods at both experimental sites.

The disease onset among the five satsumas varied at both New Orleans and Paulina sites during 2018 and 2019, but Brown's Select, Miho and Owari satsumas had consistently delayed onset of citrus canker with only 20% of incidence within weeks two and three after experimental tree were placed (Figure 2). Miho had an additional delayed disease onset that extended into week four with only 20% disease incidence in 2019 in Paulina. Similarly, Owari developed canker lesions during week five at the New Orleans site with 20% disease incidence. Louisiana Early and St. Ann satsumas were highly inconsistent in getting infected with citrus canker. The highly susceptible ruby red grapefruit and moderately susceptible Hamlin sweet orange had a large number of trees getting infected early during the screening periods (Figure 2).

In the New Orleans public garden (grapefruit trees planted in a courtyard surrounded by a brick wall), the satsuma cultivars Miho and Brown's Select showed the lowest average number of lesions in both years (Table 1) and a delayed disease onset compared with the other satsuma cultivars (Figure 3). Miho, for instance, never developed citrus canker symptoms after the three week-period in which the experimental trees were placed. In Paulina, in an opened orchard, Miho and St. Ann had the lowest average number of lesions per leaf in the two years of evaluation (Table 1), and Miho exhibited delayed onset of disease (Figure 3). The cultivars Brown's Select and Miho in New Orleans had the smallest number of 3.07 and 0.21 lesions per leaf, respectively. In Paulina the satsuma cultivars with the lowest number of lesions per leaf were observed on St. Ann (0.49 lesions per leaf) and Miho (1.69 lesions per leaf) (Table 1).

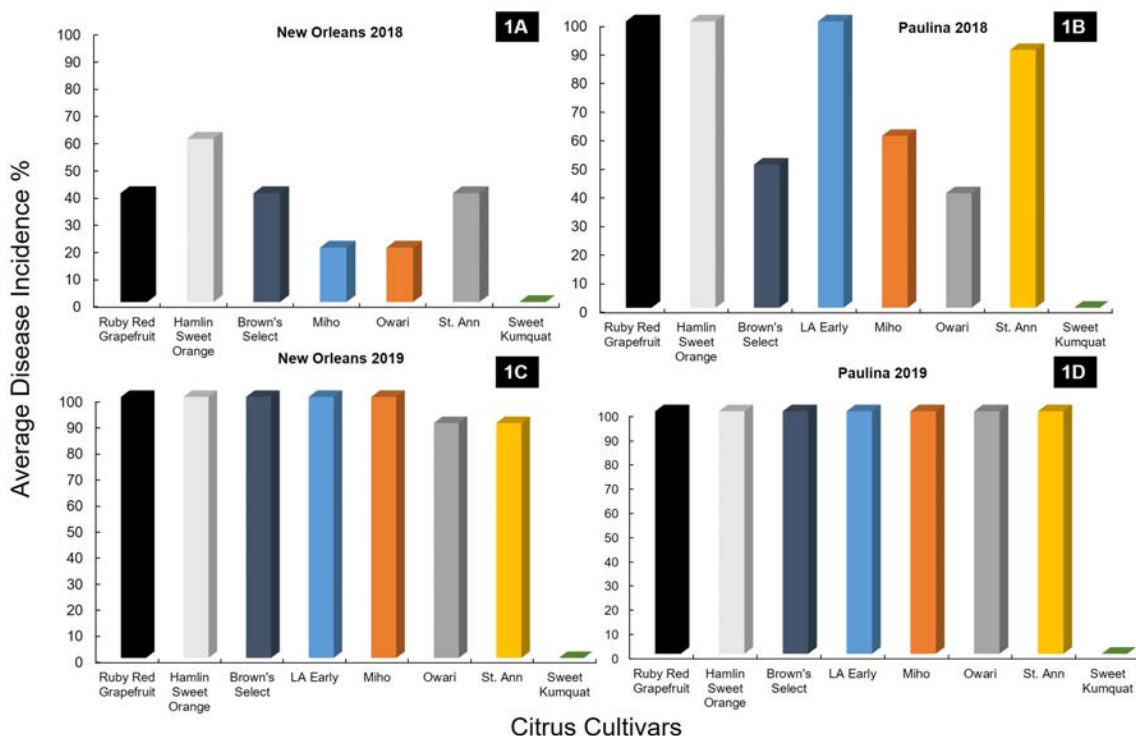


Figure 2: Disease incidence shown as mean percentage of experimental screened citrus cultivar trees infected with citrus canker at the end of the experiment in New Orleans (1A and 1C) and Paulina (1B and 1D) during 2018 and 2019, respectively.

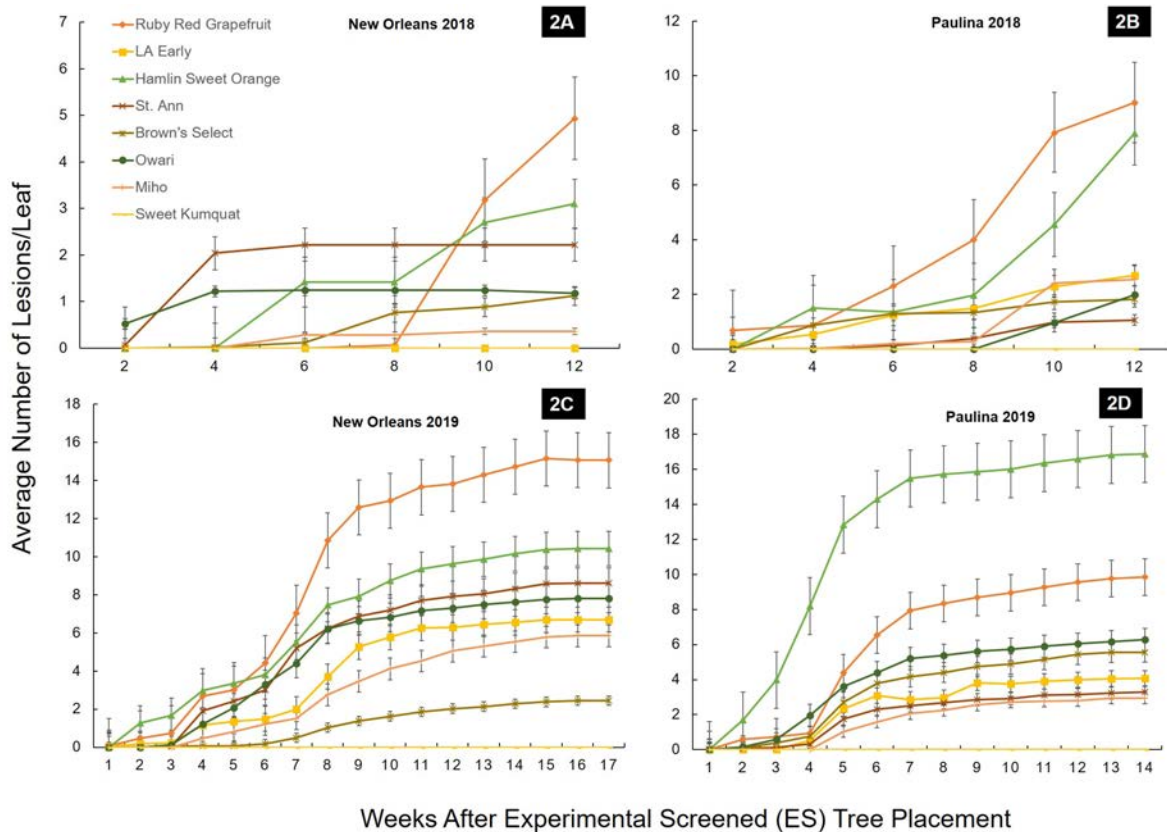


Figure 3: Disease severity expressed as average number of citrus canker lesions per leaf on experimental screened citrus cultivars trees in New Orleans (2A and 2C) and Paulina (2B and 2D) during 2018 and 2019 screening period, respectively.

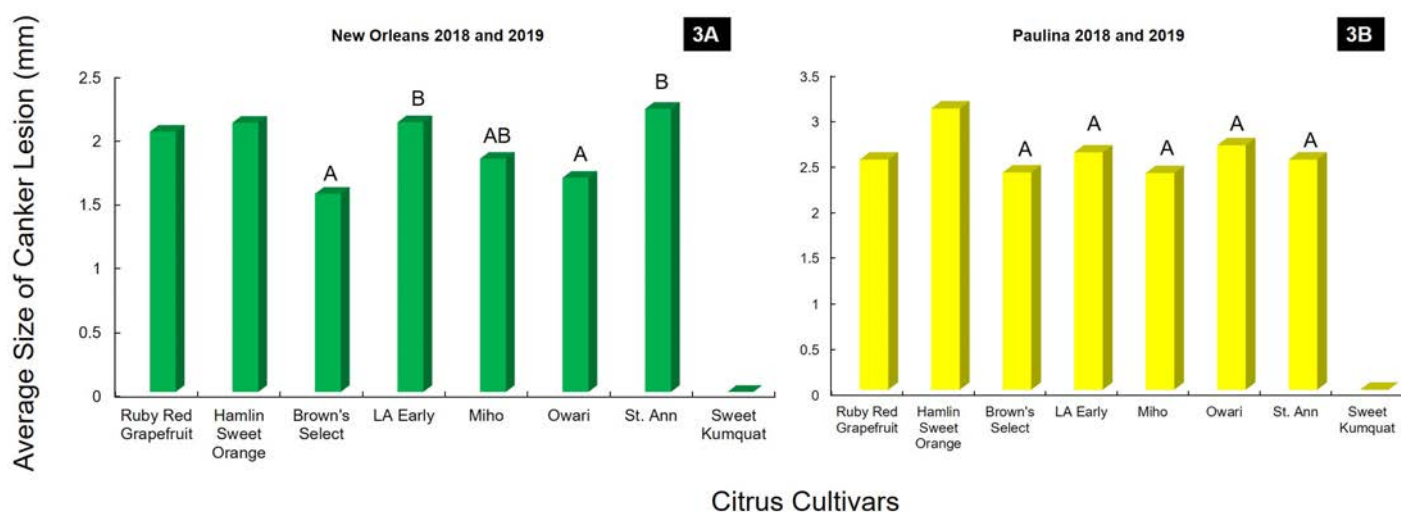


Figure 4: Average diameter (mm) of citrus canker lesions on experimental screened citrus cultivars trees in New Orleans (3A) and Paulina (3B) during 2018 and 2019 screening period, respectively.

The disease pressure on mature grapefruit trees at New Orleans and Paulina was 100% during both years, and the weather conditions were conducive for canker at both sites. Despite the high disease pressure and weather conditions, satsumas Brown's select, Miho and Owari performed the best and had less disease with delayed onset of symptoms.

The size of canker lesions is also an important predictive parameter on canker impact and spread. Lesions on leaves and twigs are probably the most epidemiologically significant inoculum for secondary infections, as canker lesions remain active for many months, and the bacteria produced on lesions are dispersed by water splashes resulting in infection and further production of more canker lesions. In this study difference in canker lesion size among the five satsuma cultivars was observed in New Orleans but not in Paulina (Figure 4).

In Louisiana, environmental conditions are optimal for citrus canker development, and a lack of effective chemicals to manage the disease pose a continuous challenge for citrus growers. The popularity of growing satsumas in Louisiana orchards and backyard gardens may help reduce the disease spread and development. This study provides field-based scientific evidence that Brown's Select, Miho and Owari consistently had less disease severity with delayed incidence and, therefore, categorized as less susceptible to citrus canker compared to Louisiana Early, St. Ann, Hamlin sweet orange and ruby red grapefruit. Additionally, the smaller lesion size on both Brown's Select and Miho may result in lesser canker inoculum production for secondary infections. Louisiana growers must incorporate these satsumas in their future plantings as an alternate citrus canker management strategy.

Furthermore, in addition to the satsuma cultivar susceptibility data, this study provides the field-based data on sweet kumquat resistance to citrus canker. This information can be readily incorporated into citrus hybrids by conventional breeding.

In conclusion, this study provides valuable and reliable field-based scientific information on satsuma susceptibility to citrus canker in Louisiana, which can help the growers select less susceptible cultivar to mitigate this high-impact disease.

Acknowledgments

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	2018		2019	
	New Orleans	Paulina	New Orleans	Paulina
Ruby Red grapefruit (HS)	1.36	4.14	9.2	6.11
Hamlin sweet orange (MS)	1.44	2.88	6.64	11.64
Brown's Select	0.48 AB	1.17 C	1.20 A	3.41 AB
LA Early	-	1.40 C	3.93 B	2.52 AB
Miho	0.21 A	0.90 B	3.07 AB	1.69 A
Owari	1.10 BC	0.49 A	4.92 B	4.07 B
St. Ann	1.75 D	0.43 A	5.34 B	2.02 A
Sweet kumquat (LS)	0.0	0.0	0.0	0.0

Table 1: Mean number of citrus canker lesions per leaf in ES citrus cultivars trees in New Orleans and Paulina during 2018 and 2019.

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School of Plant, Environmental and Soil Sciences

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155 J. C. Miller Hall - LSU, Baton Rouge, Louisiana 70803
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William B. Richardson, LSU Vice President for Agriculture, Louisiana State University Agricultural Center, Louisiana Agricultural Experiment Station
Louisiana Cooperative Extension Service, LSU College of Agriculture
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