Small Fruit News

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Louisiana Blackberry Weed Control Study Looks at Organic Mulches and Herbicide Options

Dr. Ron Strahan (Associate Professor, LSU Extension Weed Specialist), David Sexton (LSU Extension Research Associate Specialist), Stuart Gauthier (County Agent/Regional Horticulture Agent, LSU AgCenter)

Weed management continues to be one of the major issues facing blackberry growers in Louisiana. Grower concerns prompted LSU AgCenter, Weed Scientist Dr. Ron Strahan and St. Martin Parish County Agent, Stuart Gauthier to look at current weed control options. The efficacy of synthetic and organic herbicides as well as organic mulches, inorganic plastic mulch and landscape fabric were evaluated at an on-farm weed control demonstration trial established at the D&D Blackberry Farm in Breaux Bridge, LA in late winter 2020. Herbicides and mulches were fully installed by March 3rd. A non-selective herbicide was used to destroy existing weed populations prior to mulch installation and herbicide applications.

The herbicides evaluated in the weed control demonstration included synthetic preemergence herbicides Princep (simazine), Surflan (oryzalin), Devrinol (napropamide), and Sinbar (turbacil). Organic herbicides evaluated included Preen Garden (corn gluten), a preemergence herbicide and Scythe (pelargonic acid), a postemergence herbicide. The organic herbicides were applied monthly for the duration of the study. Organic mulches evaluated at this location included pine bark, pine straw and sugarcane bagasse. Two Inorganic row coverings, GCI 500 Series Landscape Fabric and 1.25 mil black non-degradable plastic mulch were included in the weed control demonstration as well. Weed control plots were evaluated monthly.

All mulches tested were equally effective in managing annual weed populations. Combinations of mulches + preemergence herbicides were highly effective as well. However, perennial weeds such as bahiagrass, bermudagrass, blue vervain, Virginia buttonweed, and yellow and purple nutsedge were the most common weeds infesting test plots regardless of weed control method used.

Bagasse is a free mulch option in sugarcane production areas of Louisiana

The combination of pine straw mulch and heavy crop canopy suppressed weeds

Mulch	Cost/Acre	Comments
Pine bark	$13,068	Labor intensive and expensive; heavy
Pine straw	$6185	Light material; may get dispersed by wind
Sugarcane bagasse	free	Free by-product of sugarcane production; labor intensive; attracts fire ants
GCI 500 series fabric	$7200	Most effective weed control evaluated
1.25 mil non-degradable plastic mulch	$580	Effective at suppressing most broadleaf and grassy weeds. Easily penetrated by nutsedge.

Summary of herbicide performance (0= no control 10 = complete control)					
Herbicide	**Rate/Acre**	**Cost/Acre**	**Broadleaf Control Rating**	**Annual Grass Control Rating**	**Sedge Control Rating**
Simazine 4 L	2 qt	$15	8	5	0
Oryzalin 4 EC	6 qt	$127	6	8	0
Napropamide 50 DF	8 lbs	$124	8	8	0
Turbacil 80 WDG	1 lbs	$58	9	7	0
Corn gluten	870 lbs	$2,540	5	5	0
Pelargonic acid	8% solution v/v	$243	6	6	3

Earlier weed control work conducted in the fall of 2019 at D & D Berry looked at the winter weed control of annual bluegrass and other winter annuals using a similar line-up of herbicide options. Napropamide 50 DF (Devrinol) provided the best winter weed suppression in the trial.

Devrinol @ 80 days after treatment

Simazine @ 80 days after treatment

Learn more about blackberry weed control options from Dr. Ron Strahan, LSU AgCenter Weed Scientist at https://www.youtube.com/watch?v=giB3RLY9LLI

GROWERS CHECKLIST STRABWERRIES SUMMER

by Barclay Poling (ret.) and Mark Hoffmann
NC State University

JULY

- Make key decisions about varieties and plant types for next season. **Order your plants!!** Remember, tips need to arrive 4-6 weeks prior to planting.
- Other immediate field operations: remove and recycle plastic – some growers use tobacco balers to compress the plastic before it goes to the landfill; consider planting a cover crop.
- Before making the same plant order as last year, critically evaluate the relative profitability of your different markets (U-pick, Ready Pick, and/or Off-farm). For example, if you experienced further decline in U-Pick sales, this may the time to scale back Chandler production (this variety is primarily a U-Pick variety)
- If your crop was really late this year, have you considered growing an early ripening variety Sweet Charlie? But, you will have to hurry to place this plant order, as Sweet Charlie supplies may be limited.
- One thing you do not want to do is go with extra early Chandler planting dates. If Chandler is producing in excess of 100 flowers per plant, your planting date is probably too early – consider a

slightly later planting date if you keep running into problems with excess blooms and small berries. Also, early plantings have the undesirable effect of making the crop later in the spring by another 3-5 days (that might mean not being open on a critical weekend).
- Don't wait until the last minute to order plants or tips – tips need to arrive one month prior to planting.
- Soil test in early July. Lime early in the summer if necessary to raise **pH to 6.0 to 6.2**. Incorporate lime when existing beds are broken down.
- Use overhead irrigate to soften soil as needed and subsoil completely.
- If growing your own tips, get a mist system set up (also order soil, trays, fertilizer)
- Stick tips by mid-to-late August, depending on location.
- Make a fumigation plan, set a schedule, talk to custom fumigator and/or acquire necessary materials. **If you fumigate your own: Check all your PPE (respirator, Tyvac, chemical resistant gloves, rubber boots) for functionality.** Be sure to allow appropriate plant-back intervals and an additional cushion in case of bad weather.
- If you fumigate your own: Check out your fumigation rig and do any adjustments and repairs well in advance of fumigation.
- **Renew respirator fit testing (must be current within one year of fumigation).**
- **Make sure you have new respirator cartridges.**

AUGUST

Preparing for Next Season

- If raising your own plugs, be sure to order soil, trays, and fertilizer if growing tips.
- Stay in close contact with your plant supplier this summer and do not be afraid to ask for periodic reports updates on plant health.
- After soil testing, lime early in the summer to raise pH to 6.0 to 6.2. Incorporate lime when existing beds are broken down.
- Use overhead irrigation to soften soil as needed and subsoil completely.
- Get mist system set up by early August if growing your own tips.
- Stick tips by mid-to-late August, depending on location.
- For planting in mid-Sept (Western NC), apply preplant fertilizer in mid-August.
- Make a fumigation plan, set a schedule, and acquire necessary materials. Be sure to allow appropriate plant-back intervals and an additional cushion in case of bad weather.
- Check out your fumigation rig and do any adjustments and repairs well in advance of fumigation.
- Renew respirator fit testing (must be current within one year of fumigation.

Planning Your Plant Order

- Before making your plant order, critically evaluate the relative profitability of your different markets (U-pick, ready-pick, and/or off-farm). **Plant varieties according to your predicted markets!!**

- Diversify. A combination of varieties can give you more weeks of fruiting, and not so much fruit in just a short two-week period! If your crop was really late this year, consider an early ripening variety.
- Consider diversifying plant type. Fresh dugs can produce an earlier crop than plugs, and fruit size can be very impressive in the early season. You may also wish to experiment with California cutoff plants as another strategy for producing larger berries in the mid-season when Chandler plug berry size drops off.
- If you grow 'Chandler' from plugs: consider planting dates over a week's time, so that not all your crop peaks at the same time.
- Consider the potential water situation for the season ahead – plugs are far more efficient in water utilization than fresh dugs.

Caneberry Chores

This list was developed by Dr. Gina Fernandez, Small Fruit Specialist at NC State University. Chores and timing may be somewhat different in your area or for your cropping system.

Plant growth and development

- Fruit development for floricane-fruiting types
- Rapid primocane growth
- Flower bud development for primocane-fruiting types later in summer
- Floricanes produce fruit and begin to senesce

Pruning and trellising

Floricane-fruiting raspberries:

- May need to adjust primocane numbers if canes are too thick (i.e. remove less vigorous primocanes at their base)
- Train primocanes to grow in the middle of the row of fruiting floricanes
- Pinch black raspberry primocanes at 2 to 3 ft. to promote lateral growth

Primocane-fruiting raspberries:

- Train primocanes within a trellis to hold canes erect

Erect floricane -fruiting blackberries

- Tip the new primocanes when they are about 6" to 12" below the top wire of the trellis to encourage lateral branching, tipping is better than cutting with a pruners to prevent Cane dieback. (Note we are now using a different term for this complex, as there are now several causal organisms that can case cane dieback https://smallfruits.org/2021/04/cane-blight-and-cane-dieback-of-blackberry-causal-organisms-and-management-recommendations/)
- Continue tipping at monthly intervals to maintain desired branching and height of canopy (laterals should reach top wire)
- Control cane dieback after tipping with fungicide treatment

- Prune out spent floricanes after they have produced fruit, do not thin out primocanes until mid-to late winter
- Train primocanes to grow in between the floricane to minimize interference with harvest. Shift trellises or V-trellises make this relatively easy

Trailing floricane-fruiting blackberries

- Train new primocanes to middle of trellis, on the ground in a weed-free area, or temporarily to trellis outside of fruiting area (depends on trellis type)
- Cut back side shoots to 18" (after dormancy in cold climates)
- Remove spent floricanes after harvest

Primocane-fruiting blackberries

- Tip canes twice, soft tip once when they reach 1.5 ft and then soft tip the laterals at 1.5 ft.

Weed management

- Mow along side of row to maintain the width of the bed to 3 to 4 ft.
- Weed growth can be very vigorous at the same time as the crop peaks.
- Weed control is best done earlier in the season before harvest commences.
- Mow middles regularly to allow pickers to move through rows easily.

Insect and disease scouting

- Scout and treat for these pests:
  Insects
  - Spotted winged drosophila
  - Raspberry crown and cane borers (canes girdled and wilt)
  - Psyllid
  - Two-spotted spider mite
  - June beetle
  - Japanese beetles
  - Stink bugs
  - Fire ants

  Diseases
  - Botrytis
  - Rusts
  - Orange felt (orange cane blotch) (blackberry)
  - Sooty blotch (blackberry)
  - Orange rust
  - Powdery mildew
  - Double blossom (blackberry)
  - Cane blight/dieback (blackberry)
  - Powdery mildew

If virus symptoms are present, affected plants may need to be rouged to prevent spread

Water management

- Raspberry and blackberry plants need about 1-2 inches of water/week; this amount is especially critical during harvest.
- For blackberries (not raspberries) in warmer climates only, consider installing an overhead system for evaporative cooling to reduce sunscald. Turn on once or twice a day from 10 am to 3 pm for short periods of time (approx. 15 minutes) at mid day only.
- Give plants a deep irrigation after harvest.

Nutrient management

- Take leaf samples after harvest and send to a clinic for nutrient analysis
- Blackberry growers typically use drip irrigation through the spring and

early summer to supply about 50 lb/N acre. Growers should ease off N during harvest, but give plants additional nitrogen (about 10-30 lbs/acre) after harvest. Amounts needed will vary with plant health, crop load and soil conditions. Check with your local Extension agent for recommendations.

Harvest and marketing

- The busiest time of the year for a blackberry or raspberry grower is the harvest season. Each plant needs to be harvested every 2-3 days. For larger plantings, that means fruit is picked from some part of the field every day of the week.
- Pick blackberries when shiny black for shipping. Those that are dull black are fully ripe and suitable for PYO only.
- Pick directly into clamshells with absorbent pads, or for PYO use clean cardboard flats, take-home baskets, or sanitized re-usable containers.
- Keep harvested fruit in shade and move into coolers as soon as possible to lengthen the shelf life of the fruit.
- Use forced-air precoolers for best removal of field heat.
- Store at 32 to 34°F and 95% relative humidity.
- Freeze excess fruit for jam, juice, or wine.
- Keep good records of what cultivars are picked, what fields are picked and when they are picked. Good record keeping will help you predict harvest potential in the future.
- Keep your customers informed with social media.

Upcoming meetings

There will be a field day sponsored by the NC Commerical Blackberry and Raspberry Association Sept 24 at Lewis Farm and Nursery in Rocky Point. For registration and other information: http://teamrubus.blogspot.com/2021/06/2021-blackberry-field-day.html

North American Raspberry & Blackberry Conference. February 21-24, 2022: In Gaithersburg, MD, near Washington, DC, at the DoubleTree by Hilton. In-person AND virtual. Includes an opening reception on Monday, Feb. 21, a full day tour on Tuesday, Feb. 22, and educational sessions and a trade show on Wed-Thurs, Feb. 23-24. Check NARBA's website for more information. https://www.raspberryblackberry.com/

Small Fruit Certification Course: Food Safety Inservice Training for Extension Educators

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Regional Extension Agent- Food Safety, Commercial Horticulture, Poultry
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Do you occasionally get questions about produce safety certifications and regulations, but don't have time to take a multiday course? This free two hour course may be for you. The Small Fruit Certifications course provides Extension agents and specialists with a broad overview of certifications and regulations affecting small fruit producers in the

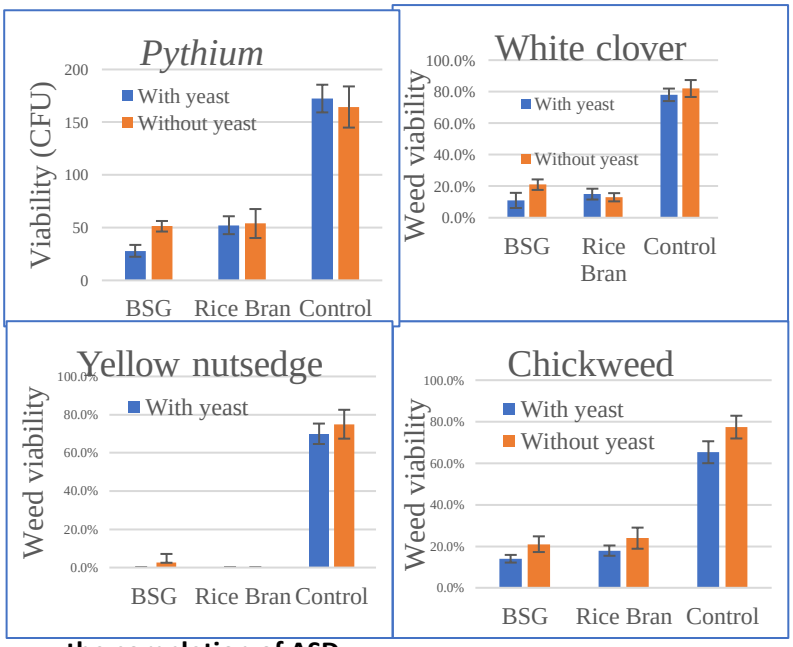
southern region. The course covers the basics of the National Organics Program, Certified Naturally Grown, Primus Global Food Safety Initiative, United States Department of Agriculture, Good Agricultural Practices, and the Food Safety Modernization Act. Upon completion, participants receive a certificate of attendance. The program was developed by Auburn University, the University of Georgia, and Clemson University and sponsored by the Southern Region Small Fruit Consortium. Enroll at https://www.aces.edu/go/SmallFruitCertifications.

Pythium and weed control efficacy with anaerobic soil disinfestation using brewers spent grain and yeast amendment

Danyang Liu, Jayesh Samtani, Jeffrey Derr, Charles Johnson, Xuemei Zhang, Virginia Tech. and David Butler, University of Tennessee

Anaerobic soil disinfestation (ASD) is a promising preplant method that could be a potential alternative to chemical fumigation. Anaerobic soil disinfestation involves incorporating carbon amendments into the soil of beds to be planted, covering the bed with black polyethylene tarp, and irrigating the soil to field capacity. The effectiveness of ASD in pest suppression could be influenced by multiple factors, including environmental conditions, application rates, and properties of the carbon sources used. Most importantly, the ASD effect is likely to be dependent on the specific carbon source. Moreover, the cost of ASD depends on the rates and types of carbon sources applied, since the recommended carbon source rates should be around 10 to 20 tons per hectare. More widely studied carbon sources such as rice bran and molasses are less available and less economical for Virginia and the mid-Atlantic region. There is a need to evaluate carbon sources with greater local availability that maintains pest control similarly to rice bran or molasses. Reducing the needed amount of a carbon source should also reduce the total cost of treatment. There is an opportunity to develop new methods to enhance the ASD effect at lower carbon rates. Thus, we initiated two greenhouse trials and an open-field trial over two growing seasons to achieve the following goals: 1) evaluating local carbon sources for ASD treatment, 2) optimizing a novel method of mixing carbon with distiller's yeast for control of several weed species and *Pythium* spp. (an important causal agent of black root rot complex) in greenhouse trials, and 3) assessing the weed density, yield, and fruit quality of strawberries following ASD treatments in field conditions. These studies were funded in part by North American Strawberry Growers Association Research Foundation and the Southern Region Small Fruit Consortium.

We conducted greenhouse trials at the Southern Piedmont Agricultural Research and Extension Center at Blackstone, VA. In this article, we will briefly discuss our greenhouse studies. We evaluated ASD with a locally available carbon source, brewer's spent grain (BSG) from local breweries, and the yeast amendment strategy. The yeast amendment mixed with carbon sources could stimulate bioethanol fermentation along with ASD. A previous study had shown that residue from bioethanol production could enhance the effect of ASD treatment. BSG is a solid byproduct of the beer-brewing process. The main composition of BSG is exhausted barley malt grain husks. The fermentable polysaccharides in BSG make it a potential resource for yeast fermentation. Our target weeds were yellow nutsedge, common chickweed, redroot pigweed, and white clover, which are troublesome weeds for strawberry production and many other crops. In addition, two greenhouse trials evaluated the effect of ASD in controlling *Pythium irregulare*., which contributes to the black root rot complex in strawberry. The first greenhouse trial evaluated BSG at a standard rate (4 mg of carbon per g of soil) and distiller's dry yeast (10 kg per hectare). There were six treatments: pots applied with BSG at a standard rate with and without yeast, pots with rice bran with and without yeast, and pots without carbon addition with and without yeast. The second greenhouse trial compared BSG at one-third and one-half carbon rates (1.33 and 2 mg of carbon/g of soil), without, and with yeast. The standard rate of BSG without yeast was used as a reference. A non-ASD treatment was included as a control. Studies were conducted in PVC containers. All ASD treatments, regardless of C rate and yeast, significantly suppressed all weed species and *Pythium irregulare* in the greenhouse trials compared to the non-ASD control. The ASD treatments with reduced BSG rates and without yeast failed to suppress weeds and *Pythium irregulare* compared to ASD with the standard BSG rate. However, adding yeast increased control of redroot pigweed, common chickweed, and white clover, resulting from ASD with either reduced rates of BSG compared to ASD with the standard rate of BSG. Yeast also enhanced control of redroot pigweed, common chickweed, white clover, and *Pythium irregulare* due to ASD using the standard rate of BSG. The economic cost of carbon inputs is one of the major hindrances for the widespread adoption of ASD to control soilborne pathogens. The outcome of this work may lead to the reducing of carbon input while enhancing ASD effectiveness, and thus expanding the implementation of ASD in production horticulture.



the completion of ASD in greenhouse trial 1. BSG = ASD withbrewer's spent grain. Control = non-treated control. CFU is an indication of *Pythium* viability.

We will present findings from the field studies in a future newsletter edition.

Japanese beetle – direct or indirect pest?

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We are now into the Japanese beetle (JB) season – This is an annual threat for us, though the severity varies quite a bit from year to year. Some invasive pests have been with us that we no longer think of them as invasive, but JB truly is. JB was introduced into New Jersey about 1913, and has been spreading since. It is now spread through most of the eastern states, though absent in much of the Deep South (see map). JB is absent through most of the West, being limited by dry soils. There have been individual introductions, generally followed by eradication efforts. Of particular concern is California, since so much of our food comes from that state, and JB has a very broad host range.

JB is noted by its coppery-colored elytra (the front wings of a beetle), green pronotum, with tufts of white hairs along the edge of the abdomen. Like all scarab beetles, JB has a lop-sided club on the end of the antennae. There are three segments on that club, and the inner surfaces are lined with sensory hairs that detect air movement and host odors. Just before taking off, theses segments are spread, in effect their flight control system!

In my IPM class, I talk about direct injury versus indirect injury – to the harvested part of the plant versus any other part. I ask the class whether JB is a direct pest or an indirect pest. It's a trick question, because it's both. They type of feeding depends on the crop. On caneberries and peach, it causes direct injury, making a real mess of berries and peaches. On grape and apple, it causes indirect injury, with most feeding on leaves (unless fruit is already injured, especially if overripe). This of course will affect the number of feeding insects that can be tolerated.

JB in crop settings are highly affected by the surrounding habitat. The larvae feed on grass roots, a habit that makes this species, as well as other white grubs, the most important pest of turf crops. JB will breed in lawns, pasture and other grassy areas. Consequently, if a fruit planting is surrounded by pasture, JB pressure will be

higher. There are also climatic factors that cause variation severity from year to year. Scarab eggs are poor at retaining water. If soils are too dry, there is greater natural mortality of JB eggs (this is one reason JB has a hard time establishing in arid areas). In drought years, there is less successful establishment of eggs and young larvae in the soil; consequently, there will be fewer adults the following season. A rule of thumb is 10 inches of rain over June, July and August.

Let's look at two crops where the beetles cause direct versus indirect injury – fruit versus leaf injury.

Caneberries: Caneberries are very vulnerable to JB feeding. Berries consume ripe berries eagerly sometime in high numbers. While JB can be an issue on both floricane and primocane-bearing varieties, the fruiting period of primocane-bearing varieties pushes more into the JB adult feeding period. Control of JB on caneberries is complicated by the extended blooming/ripening/harvest events. Ripening berries that are attractive to JB and must be protected occur concurrently with open blossoms, where bee safety is a concern. An additional concern is Pre-Harvest Interval (PHI) of effective materials. Ideally, it would be great to be able to spray the day before or the day of harvest; this is often not possible. Growers may have to settle for 3-day PHI, which may work into their schedule for practical reasons.

There are several materials that can be used here. Among conventional synthetic materials, Sevin XLR Plus has rapid action against JB, but its 7-day PHI may interfere with harvest schedules. The neonicotinoids Actara and Admire Pro each have 3-day PHI in foliar applications. Assail has a 1-day PHI. There are some OMRI-approved alternatives as well. Some of these are neem-based, with azadirachtin as the main active ingredient. Aza-Direct, Neemix and Trilogy all have a 0-day PHI (Neemix and Trilogy should be applied as a blend. Azadirachtin has a complex mode of action. It is partly an insect growth regulator, when it blocks the production of the molting hormone ecdysone. Obviously, this will affect larvae and not adults, so does not really relate here, where we have adults attacking the fruit. It also works as an anti-feedant/repellant. It is important to remember that once JB are established and feeding, the plants are more attractive. If one waits until the beetles are well established, the attractiveness of the beetle-infested plants will work against the repellant quality of the azadirachtin. Surround (kaolin) is another OMRI-approved option, but has some label restrictions that

limit its utility: "Apply on fresh market berries only up to the first three weeks after fruit set as trace residues can be difficulty to remove after harvest. Application of plain water via normal sprayer prior to harvest can help to reduce Surround WP residues." A newer organic alternative is beetleGone, a preparation of *Bacillus thuringiensis*. This is the subspecies *galleriae*, toxic to Coleoptera. Many growers are more familiar the type of Bt that is effective on caterpillars – subspecies *kurstaki*.

Grapes: By contrast, JB is primarily a leaf feeder on grapevines. Young vines can be completely defoliated and must be protected stringently. With mature vines, the situation is more nuanced. JB causes a skeletonizing type of foliar injury, leaving veins in place after removing leaf tissue. The JB adults do most of their feeing in the upper canopy of their various hosts, whether grapevines or apple trees. One factor that allows the vines to tolerate some feeding is that light that passes through the skeletonized leaves will impinge on leaves below, that would otherwise have been shaded. That only goes so far though, because the impact comes not just from loss of photosynthetic area, but is also a water loss problem, from edges of feeding wounds.

Some feeding occurs before véraison, and some after. Our earlier work on JB feeding on grapevines showed that feeding after véraison has a greater impact that that before the beginning of ripening occurs. This is because this is the time berries become the sinks for photosynthates. When beetles were caged on grapevines, feeding pre véraison had little impact. After véraison, an average of 10-11% leaf area loss averaged of the whole vine resulted in lowered fruit sugars.

There is a selection of materials to use here as well. Among the conventional synthetic materials, we have Sevin XLR, a carbamate, Imidan (an organophosphate, probably impractical because of the 14-day Restricted Entry Interval), the neonicotinoids Belay, Actara and Assail, and Avaunt. For organic control, Neemix plus Trilogy can be a useful mix, beetleGone, and here Surround has greater utility than in caneberries.

Our summer rains can be quite variable, but it's worth paying attention to get an idea of the potential JB pressure in the coming season.

New information on fungicide options for diseases of muscadine grapes

Bill Cline, Entomology and Plant Pathology Department, NCSU Horticultural Crops Research Station, Castle Hayne, NC
Phil Brannen, Plant Pathology Department, and Shane Breeden, CAES, University of Georgia, Athens, GA

Muscadine grapes are widely grown in the southeastern U.S. for wine and for commercial fresh market and pick-your-own sales. Production is increasing and has expanded to other countries, especially production of fresh-market cultivars. Muscadines are resistant to some diseases that affect bunch grapes, such as downy mildew and Botrytis bunch rot, but are susceptible to a number of other diseases, including powdery mildew, black rot, bitter rot, and ripe rot (Fig 1).

Muscadines are included with all other grapes for purposes of pesticide labeling, so

products that are tested and approved on bunch-type grapes are also legal for use on muscadine grapes. However, most new products have never been tested on muscadines. The efficacy of these products on muscadines is not known, and there is a risk that spray injury from untested products can render grapes unmarketable (Fig 2).

Testing of new fungicides on muscadine grapes is not funded by fungicide manufacturers, who may not even be aware of the need for separate testing on this species. With support from the Southern Region Small Fruit Consortium, we decided to address this lack of information in 2020 by conducting concurrent experiments were conducted in GA and NC in 2020 on 'Carlos' muscadine grapes to address this lack of information. Twelve products were evaluated: Aprovia (benzovindiflupyr), Aprovia Top (difenoconazole + benzovindiflupyr), Gavel (mancozeb), Switch 62.5W (cyprodinil + fludioxonil), Miravis Prime (pydiflumetofen + fludioxonil), Luna Experience (fluopyram + tebuconazole), Topguard EQ (azoxystrobin + flutriafol), Kenja (isofetamid), Badge SC (copper oxychloride + copper hydroxide), Procure 480SC (triflumizole), Merivon Xemium (fluxapyroxad + pyraclostrobin), and Elite (tebuconazole).

Fungicides were applied to randomized, replicated plots in NC and GA during the 2020 growing season. Crop safety (phytotoxicity) and leaf spot disease incidence were visually evaluated throughout the season. Ripe fruit was harvested and sorted to determine efficacy of products against fruit rots. For complete materials and methods, see the report linked below.

RESULTS

Disease pressure was adequate for evaluation of fungicides against bitter rot, Macrophoma rot, and angular leaf spot. Incidence of ripe rot was sparse although treatment effects were visible. Black rot and powdery mildew were minimal and were not evaluated. Based on these studies, a total of 12 fungicides have been reviewed for phytotoxicity on muscadines (none observed). Several fungicides (Aprovia, Aprovia Top, Switch, Miravis Prime, Topguard EQ, Kenja, Procure, and Merivon) were effective against more than one disease and significantly increased marketable yield.

Figure 1. Muscadine fruits with symptoms of ripe rot (above) and powdery mildew (below).

This project was funded by the Southern Region Small Fruit Consortium and published in Plant Disease Management Reports:

Figure 2. Spray burn on muscadine grapes caused by a phytotoxic tank mix

Cline, W.O., Brannen, P.M., and Breeden, S. 2021. Evaluation of fungicides for control of muscadine grape diseases in North Carolina and Georgia, 2020. Plant Disease Management Reports 15:PF006.

Full report here: Cline et al muscadine PDMR.pdf

Twospotted spider mite and integration of biocontrol

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There are two main spider mite pests that affect fruit crops in the east, but the most important one in our small fruit crops is the twospotted spider mite (TSM), *Tetranychus urticae*. This species is whitish to straw colored, with two large black spots. These spots are actually the gut contents seen through the cuticle. Each time the mite molts during its development, the gut contents are voided, so there are some brief intervals when the mites are lacking their spots! The eggs are spherical, and clear translucent.

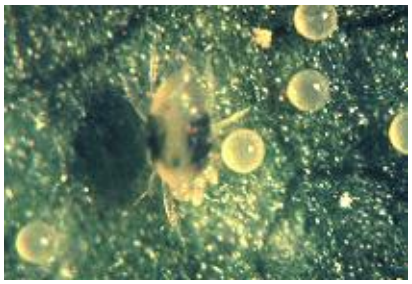

Fig. 1. Twospotted spider mite female and eggs. (Photo Mid-Atlantic Orchard Monitoring Guide)

The host range of twospotted spider mite is very broad – feeding on many distantly related plant species. This makes this polyphagous mite the most agriculturally important mite in the world. TSM overwinters as adults in the ground cover, showing up in the canopy later in the season. The total life cycle requires only 8-12 days. The average fecundity, or eggs per female, also goes up – usually 90-100 eggs, but up to 200. And in the fall, you may notice another difference. There is an overwintering morph that looks quite different. The adult mites become bright orange, with no spots. This photo shows a group of mites that have gathered at the calyx of an apple just before harvest.

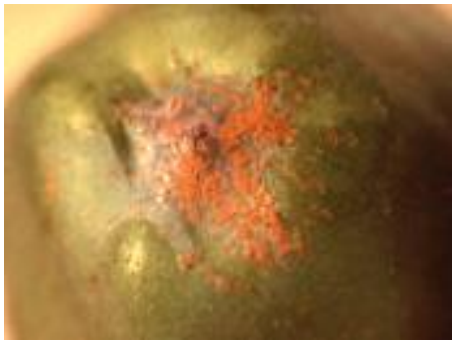

Fig. 2. Overwintering morph of twospotted spider mite.

In humid parts of the country, like our southeastern states, the usual spider mite pest in orchards and vineyards is European red mite (ERM), *Panonychus ulmi*. This mite appears a dark, brick-red color with white spots or tubercles. A related pest of citrus, citrus red mite, looks similar but without the white tubercles. Even on these fruit crops, TSM will often predominate in hot, drought years.

ERM overwinters on tree bark in the egg stage. In cases of severe infestations, those reddish eggs can give the undersides of scaffold limbs a reddish color. These overwintering eggs hatch from the pre-pink through bloom of apple. The mites then move to leaves to begin their development. The first stage out of the egg is the larva – a 6-legged stage, not much bigger than the egg itself. It only lasts a day or so. This is followed by two nymphal stages, both 8-legged. These are the protonymph and deutonymph stages. Finally, the 8-legged adults are produced. The adult female is oval and dome-shaped. The male tapers to a blunt point at the hind end.

The life cycle of ERM takes 20-25 days – less time, as little as 10-12 days when it's hot. Females live about 18 days, and lay about 35 eggs each. I'll come back to these figures in a little while. There can be 10-12 generations annually. The overwintering eggs start to appear fairly early, in mid-August.

Let's take a few seconds to summarize the differences between TSM, the usual spider mite in small fruit crops, and ERM, the usual spider mite pest in vineyards and orchards. TSM develops faster than ERM – 10 days versus 25 days. TSM has a higher reproductive rate – 100 eggs per female compared with 35. In addition, TSM has a more severe impact on leaf function, making it more injurious on a per-mite basis. This is probably the result of having to feed more to fuel the faster development and greater reproduction. Consequently, we should cut in half any action thresholds that were developed for the more usual ERM. Another thing to keep in mind is that TSM can be harder to kill. If TSM is the predominant spider mite, and there is a rate range on an acaricide label, use the upper end of the rate range.

The photo in Fig. 3 shows a male ERM waiting for the adult female to emerge from the deutonymph stage. The same behavior is seen in TSM. At this time, the female produces a sex pheromone that attracts the male to her side. As soon as she emerges, mating will take place. Spider mites have an unusual type of reproduction, that is probably one of the several factors that contribute to this family being the leading arthropod group for pesticide resistance. They show a mode of reproduction called arrhenotoky, or haplodiploidy. This means that if females are mated, and the eggs fertilized, they give rise to female offspring. These are diploid, with genes contributed by both parents. If a female remains unmated, and the eggs don't get fertilized, she gives rise to male offspring. These are haploid, with genes from the mother alone. So if a lone female survives an acaricide spray because she happens to be resistant, she doesn't have to find a mate – she can produce offspring anyway, and being haploid, these WILL carry her genes for resistance. And yet if mating is available, that will allow for the recombining of genes that is great for the formation of new strains. These mites are adapted for both rapid population growth, AND recombining genes.

Fig. 3. Adult male European red mite (above) waiting for female to emerge after molting.

Spider mites are usually secondary pests. They rise to pest status when natural enemies are removed from the system, usually by sprays. Now let's look at some of the predators that feed on spider mites. There is a complex of predatory mites, mostly in the family Phytoseiidae. In commercial orchards, the most common one in our area is *Neoseiulus fallacis*. You may see it called *Amblysius fallacis*, an older name. These mites are teardrop-shaped, and flatter in appearance than spider mites. They are also much more active, as you would expect from a predator.

Fig. 4. *Neoseiulus fallacis*, a predator of spider mites. (Photo Mid-Atlantic Orchard Monitoring Guide)

Neoseiulus females lay about 100 eggs each. Development of immatures takes about 8 days, and they live about a month as adults. Their favored prey is spider mites but they can sustain themselves on other mites or pollen. They do best at 50-80 degrees F, but can tolerate higher temperatures if there is high humidity. They do well feeding on mites on strawberry. Remember that they overwinter in the ground cover, so they are already in close proximity to the crop!

Neoseiulus follows two different hunting strategies, depending on prey density. At high prey density, they follow a random path. This is likely to bring them in contact with prey. At low prey density, they follow leaf edges, and they may attempt to disperse aerially. If starving, they will face into the breeze, lift their front end, and allow themselves to be carried off. Growers can estimate predator prey rations to determine likelihood of successful biological control. If there is a ratio of 1:10 – 1 *fallacis* for every 10 ERM, there is a good likelihood of control. Higher ratios increase the chances of successful control. Even 1:20 can be successful on some varieties.

There is an important way of categorizing biological control. At the upper level, we can distinguish between conservation biological control, and augmentation of natural enemies. In conservation biological control, we aim to protect naturally occurring populations of predators and other natural enemies. This is mainly done through selection of pesticides that are least toxic to the beneficial species. Under augmentation, natural enemies may be increased, either by

an inoculative release (releasing a few with the goal of establishment) or by an inundative release (releasing large numbers of natural enemies to overwhelm the pest population, whether or not the predators successfully establish).
Neoseiulus is available commercially from several insectaries. It is very helpful to explore the web sites and online catalogs of these insectaries – they contain biological information that is helpful in selecting the right predator for your situation, and other ways of making your plan successful. Here is a non-exclusive list:

- Green Methods - https://greenmethods.com/
- IPM Labs - https://www.ipmlabs.com/
- Koppert - https://www.koppertus.com/
- ARBICO - https://www.arbico-organics.com/

Let's say a few words about chemical control of mites. In the 1980s and into the 90s, we were in a tough spot – effective chemical had dwindled to a very few. In fact, in some orchards, because of resistance history, there no compounds that were very effective. Now we are in a much better position. We have acaricides in several mode of action classes, shown by the IRAC number on the label (Insecticide Resistance Action Committee). Since spider mites are so prone to develop resistance, it is important to rotate among different MOA classes. This is an important part of a resistance management plan. It is also important to select materials of the lowest toxicity to predators possible – this applies to other insecticides directed against other pests, as well as acaricides. By making life easier for natural enemies, we can also lower the need for chemical intervention, shepherding the useful life of effective materials.

Arkansas Strawberry Variety Trial Results: 2020 and 2021 Seasons

Dr. Amanda McWhirt, Horticulture Specialist, University of Arkansas

We have conducted strawberry variety evaluations over the last two years to compare ten strawberry cultivars for yield, and fruit quality measures in Arkansas. Trials were conducted at the University of Arkansas Vegetable Research Station near Ft. Smith (zone 7b). In both years plug plants were planted in late September into plasticulture beds and managed using standard fertility and fungicide programs recommended for the Southeast. Row covers (1 oz) were used for freeze and frost protection as needed. During both seasons there were significant cold events that resulted in cold injury to strawberry crowns and blooms. Most notably in November of 2019 there was an early freeze event (temps near 20°F) prior to the plants hardening off that resulted in severe cold injury to the crowns of young plants and in February 2021 artic air (0 to -10°F) during crop dormancy also injured strawberry crowns. As a result we also rated the strawberry varieties for cold injury to crowns. See a previous article to learn more about our assessments of cold injury to strawberry crowns and see pictures: https://smallfruits.org/2020/10/impact-of-fall-cold-injury-to-strawberry-crowns-on-spring-yield/?cat=26
Strawberry yields were lower in 2020 compared to the 2021 season (Table 1). Low yields in 2020 are likely related to the more severe cold injury observed following the November 2019 freeze event. Very high rates of cull in 2020 were related to rain injury and animal damage. Rain damage in 2021

continued to be a contributing factor to cull rates, but animal damage was greatly reduced.

Our results indicate that the NCSU strawberry breeding program releases 'Rocco' and 'Liz' are both well adapted to be grown in Arkansas. 'Rocco' produced early season fruit similar to 'Sweet Charlie' but had larger fruit size, a longer fruiting season and higher yields. The lowest incidence of cold injury to crowns was observed for 'Rocco' in both years.

In both years 'Liz' was among the highest yielding cultivars that we tested and was comparable in season to 'Camarosa'. During the 2021 season 'Liz' had higher rates of cull than in the 2021 season but had cull rates fairly similar to 'Camino Real' in 2021.

'Fronteras' consistently produced the largest fruits size but had the highest incidences of cold injury in both years, and this injury likely resulted in reduced fruit yields.

The day-neutral type 'Albion' performed relatively poorly with low yield and high rates of cull fruit during both seasons. In 2021 another day-neutral type 'San Andreas' was trialed and had higher yields and lower cull rates than 'Albion'.

Informal taste tests were conducted with station staff and in 2020 and 'Ruby June' was a favorite. In that year 'Ruby June' had the highest level of fruit brix of the cultivars we tested. Additionally, 'Camino Real', 'Fronteras', 'Liz' and 'Rocco' were rated favorably for flavor in that season.

We thank the Mid-American Strawberry Growers Association for their support of these trials. Also, we want to acknowledge the University of Arkansas Vegetable Research Station staff for their tremendous support of this research.

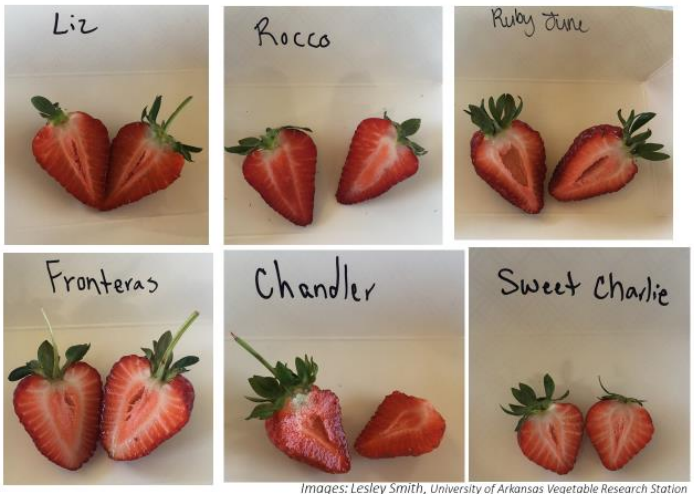

Figure 1: Strawberry fruit cut in-half during 2021 season. Images from Lesley Smith, University of Arkansas Vegetable Research Station.

Table 1. Marketable yield, cull rates, average berry weight, fruit soluble solids (Brix) and cold damage ratings for ten strawberry cultivars planted at the University of Arkansas Vegetable Research Station (zone 7b) during the 2020 and 2021 spring harvest season.

Cultivar	Reps	Marktable yield (lbs/plant)		Percent cull		Berry wt (g)		^{0} Brix		Cold Damage Rating *	
		2020	*2021*	*2020*	*2021*	*2020*	*2021*	*2020*	*2021*	*2020*	*2021*
Albion	4	0.60	0.81	50.5%	34.8%	24.2	28.2	7.8	6.6	2.3	1.0
Camarosa	4	1.38	1.26	25.8%	28.6%	20.2	15.0	7.5	5.9	1.0	1.0
Camino Real	4	1.14	1.35	35.2%	18.6%	19.1	28.9	6.7	5.5	0.8	1.0
Chandler	4	1.17	1.67	30.0%	23.8%	15.0	20.1	7.3	5.8	0.8	1.0
Fronteras	4	0.86	1.53	41.7%	27.6%	26.5	31.2	7.0	5.3	3.0	1.8
Liz	4	1.23	1.81	42.6%	22.4%	21.8	18.9	7.4	6.7	1.3	1.0
Rocco	4	1.35	1.93	27.5%	26.9%	18.0	18.9	7.8	6.5	0.3	0.8
Ruby June	4	0.97	1.25	33.0%	32.7%	19.3	21.8	8.0	6.3	1.3	1.3
San Andreas	4	.	1.28	.	29.3%	.	24.4	.	5.7	.	1.3
Sweet Charlie	4	0.68	0.90	25.1%	21.5%	14.9	15.0	7.8	7.5	1.0	1.0

*Cold damage to crowns assessed in March using rating scale of 0-3, where 0: none, 1: minor, 2: moderate and 3: severe

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