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Blackberry Focus Issue

Small Fruit News Editors: Amanda McWhirt, Doug Pfeiffer, Jayesh Samtani, and Rebecca Melanson

Over the last year, there have been multiple efforts to identify the major issues affecting blackberry production in the Southeastern U.S. and priorities for research in this area. In an effort to clearly make some of these issues/priorities known to stakeholders throughout the region, we decided to make the April 2021 issue of *Small Fruit News* a "focus issue" on blackberry in which we define the issues and discuss current research and/or Extension efforts to address those issues.

One of the efforts, conducted in January 2020, was to update the Pest Management Strategic Plan (PMSP) for Blackberries in the Southeastern U.S. Dr. Sara Villani, an Extension Specialist with North Carolina State University, wrote about this effort in the July 2020 edition of *Small Fruit News*. Part of the reason for updating the PMSP is to identify priorities for research regarding pest management of the crop. Some of the priorities identified for the blackberry PMSP include identification of virus vectors and management of **blackberry yellow vein disease** and identification/clarification of pathogens causing **cane blight** and cane blight management. Both blackberry yellow vein disease and cane blight are discussed in this focus issue.

In late 2019 and early 2020, Dr. Margaret Worthington, Assistant Professor with the University of Arkansas, conducted a survey of the blackberry industry nationwide as well as a meeting to identify priorities for breeding, production, and pest management. The results of this work are included in this issue as well as articles addressing some of the priority issues and pests identified from these efforts including **labor**, **weed control**, and **spotted-wing drosophila** (SWD).

In addition to the previously described efforts to identify priorities for research, members of the Southern Region Small Fruit Consortium, which produces *Small Fruit News*, are currently seeking input from growers on fertilization practices to help direct research in the coming years. To provide input, please complete the short survey here.

Results of a National Stakeholder Survey of the U.S. Blackberry Industry

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A national survey of growers and related industry professionals was recently conducted to assess the current status and needs for research and extension in the US blackberry industry. The survey was launched with the goal of updating production statistics and assessments of stakeholder priorities that were fragmented and out of date, did not reflect new challenges (e.g., emerging biotic and abiotic stresses and labor shortages) or opportunities (e.g., new production techniques and markets) for the blackberry industry.

Many readers of Small Fruit News may recall receiving an invitation (or several invitations!) to complete the U.S. blackberry industry stakeholder survey between November 2019 and January 2020. Hardcopy and online versions of the stakeholder survey were distributed through commodity group meetings, industry collaborators, growers' association networks, and social media. A total of 174 survey responses from 33 U.S. states were received. Forty-nine percent of survey respondents were growers and other stakeholders located in the Southern U.S. Arkansas and North Carolina were particularly well represented with 29 and 24 responses, respectively.

Some important findings of the study included:

- The most important pest and disease issue across all production regions was spotted wing drosophila. Anthracnose and Japanese Beetles were also listed as important pest and disease issues specifically in the South.
- Weed control, postharvest losses, and red drupelet reversion were all identified as nationally or regionally important cultural issues. Southern stakeholders identified weed control and rain during harvest season as their biggest cultural constraints.
- Labor costs and availability were the most important production issues nationwide and in the South. The top postharvest issue in the South and overall was leaky or overly soft berries. Botrytis and other fruit rots, red drupelet reversion, and white drupelet disorder were all also listed as important postharvest issue by Southern stakeholders.
- Stakeholders indicated that the most common complaints from consumers and grocers about blackberries included inconsistent flavor (too tart or not sweet enough) and soft, leaky, or over-ripe berries.
- Most (67%) of respondents agreed that Investment in health benefits research would lead to greater sales volume.
- The top national research priorities identified in this study were control of spotted wing drosophila and breeding for improved flavor, firmness, and disease resistance.

The survey was funded by a USDA Specialty Crops Research Initiative planning grant and the results also guided discussion in a two-day strategic planning meeting held immediately after the 2020 NARBA meeting in St. Louis, MO. Twenty academic researchers and extension specialists working on blackberries across the country and 18 growers and industry representatives participated in a discussion of the major opportunities and challenges facing the national blackberry industry. The discussion in the meeting was very engaging and all participants learned a lot about the issues that growers in other production regions like the Pacific Northwest and California are encountering. Many ideas emerged from these discussions but flavor, postharvest quality, and labor issues were identified as the most important constraints to the growth of the U.S. blackberry industry. The next goal for the project team is to take all this valuable stakeholder input and develop a large interdisciplinary research and extension project that will increase the profitability and sustainability of the US blackberry industry!

The results of this survey were already used to develop an updated Pest Management Strategic Plan for the Southeast and will be submitted for publication in HortScience this summer. We hope the survey will help growers' associations and funding bodies to identify and revise strategic priorities for research and extension efforts! Anyone interested in receiving a full copy of the 128 page survey report should contact Margaret Worthington at mlworthi@uark.edu

Spring Caneberry (Raspberry and Blackberry) Checklist 2021

Dr. Gina Fernandez, Small Fruit Specialist at NC State University

Spring 2021 has been WET in North Carolina, at this time, blackberry buds are just beginning to swell (see figure 1). Chores and timing may be somewhat different in your area or for your cropping system. For IPM recommendations and general production practices, see the 2021 Southeast Regional Caneberry Integrated Management Guide. https://smallfruits.org/ipm-production-guides/

The SRSFC production practices are in the Regional Caneberry Production guide (includes link to PDF format): https://content.ces.ncsu.edu/southeast-regional-caneberry-production-guide

Crop phenology for IPM
The IPM guide above lists these stages of growth or planting age. This is the time of year we are now leaving (or have left a while ago!) the dormant period and by the time the next newsletter comes out, we will likely be harvesting in some locations.

- Dormant (prior to budbreak)
- Delayed dormant (swollen buds) to green tip
- Shoots 6 inches long and before blooms open
- Pre-bloom (when flower buds show white)
- Early bloom (5-10%)
- Full Petal
- Cover sprays
- Pre-harvest (14 days before anticipated harvest)
- Harvest

Plant growth and development during the spring/summer
- Plants deacclimate quickly
- Bud differentiation (additional flowers can be formed)
- Bud break
- Flowering
- Primocane emergence

Pruning and trellising
- Finish pruning and make sure all floricanes are tied to the trellis before budbreak
- Remove canes from field to minimize spread of diseases
- Rotate shift trellises to horizontal position before budbreak; rotate to upright position immediately after flowering.
- For crops that are fall fruiting only, make sure canes are mowed to ground before budbreak.
- Prepare for flower to fruit monitoring (see http://teamrubus.blogspot.com/2015/03/monitoring-flower-to-fruit-development.html)

Weeds
- Weed growth can be very vigorous at the same time as the caneberry crop peaks
- Weed control is best done earlier in the season, with pre-emergent herbicides before harvest commences
- Hand-weed perennial weeds in and around plots

Insect, disease and crop ripening
- Growers with a history of cane diseases and/or mites often find that certain fungicides and oils are most effective just prior to bud break. The period of time in the spring when the plant is flowering is the most important season for control of insects and diseases. Know what your pests are and how to control them.

Water management
- Test irrigation system and look for leaks
- Caneberry plants need about 1”-2” water/week. This amount will be especially critical during harvest

Fertility management See Caneberry Production Guide
https://content.ces.ncsu.edu/southeast-regional-caneberry-production-guide/fertility-management

Marketing and miscellaneous

- Service and clean coolers
- Make sure you have enough containers for fruit in the coming season
- Prepare advertising and signage for your stand

- Contact buyers to finalize orders
- Hire pickers
- Prepare signage for field orientation; it is easier to tell pickers where to go if rows are numbered
- Check buds and canes for cold damage (27°F is temperature that kills all stages of flower buds see http://teamrubus.blogspot.com/2016/04/damage-to-blackberry-flowers-at-27f.html
- Monitor and record (or rather do your best estimate) of peak flowering date for each variety every year. Then later during harvest, check your records for peak harvest of each variety. Over time, it will help you to determine when your peak harvest will occur.

Figure 1. Prime-Ark 45 buds at the Piedmont Research Station, Salisbury, NC. Photo: Katie Sheehan-Lust.

Insects in the 2020 Blackberry Pest Management Strategic Plan

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In January 2020, at the Southern Fruit and Vegetable Conference, a group of berry specialists met to discuss current issues in blackberry culture and pest management. This was for the purpose of producing a Pest Management Strategic Plan, an effort led by Gina Fernandez of North Carolina State University. PMSP documents serve as a source of information, ranking problems for an industry to inform decision making, grant writing, and regulatory decisions.

Great progress is being made in bring this report to fruition, and while it is not yet published, I'd like to discuss some points regarding entomological aspects. An important component of the PMSP is the ranking of research priorities as well as ranking of pests' importance – insects, diseases, and weeds. While insects and mites are considered separately in the document, for this discussion I will consider them together as arthropods.

Priority problems: It will come as no surprise the top ranked research priorities is spotted-wing drosophila. This pest has been a game changer since it moved through the Southeast from 2009-2011 (Burrack et al. 2012). In the Summer 2020 issue of Small Fruit News, there were two articles on SWD, covering conventional and organic management of this insect (Pfeiffer 2020, Sial 2020). SWD can be devastating pest of caneberries, and the tolerable levels are so low, there is a heavy reliance on chemical control. This poses several problems: 1) with its high reproductive rate and high number of annual generations, there is a high risk of insecticide resistance, 2) with elevated insecticide use comes an elevated chance of residues at harvest, a problem in both domestic and international markets, and 3) many of the most effective insecticides are highly disruptive to beneficial arthropods (related to this is the long PHI, or preharvest interval with some of these products). This leads to induction of secondary pests, like spider mites. The PMSP document will consider these problems as needs that must be addressed by the industry. There is a need to keep bifenthrin and malathion as pesticide management tools, but there is also a need for less disruptive chemistries. The PHI for bifenthrin, Asana (esfenvalerate), pyrethroids) is too long. More cultural practices/management research is needed. Marketers have zero tolerance for SWD in berries, which makes this a very high priority for research. Complicating the SWD situation, with high rates of chemical control use, secondary pests are emerging.

Two arthropod-related topics fall into Rank 2 in importance: broad mites, and some general pesticide issues. Broad mite is mite that is not as well known as spider mite, and seems to vary in severity across the region. It causes distorted leaf growth, reduced leaf area and water content in its various hosts (Peña and Bullock 1994). It was first reported from blackberry where it caused leaf-curling in 2007-2009 (Vincent et al. 2010). There is a sexual dimorphism in broad mite, and other tarsonemid mites. The female pupa is attractive to males – a male will pick up a pupa, carry it around on his back until the adult female emerges, whereupon mating occurs. Like spider mites, broad mites exhibit haplo-diploidy, meaning that fertilized eggs give rise to females, and unfertilized eggs give rise to males. Normal dispersal is accomplished by males carrying females off, and this may be facilitated by another means. At times, broad mite is phoretic (hitch-hiking) on whiteflies (Palevsky et al. 2001). The PMSP points out the need for more chemical control tools and for more research on cultural practices in management of broad mite. It is known that there are differences in susceptibility among blackberry lines (Vincent et al. 2010). Hot water soaks of potted host plants can be an effective control tool, but this is relatively impractical for caneberry plants in the field!

Pesticides were also discussed as Rank 2 – There are several issues relating to chemical control that were pointed out by respondents. There is a need to keep malathion and bifenthrin as management tools. A pesticide issue included as Rank 3 is the need for better broad-spectrum chemistries during harvest. A common problem is that PHI values are too long to deal with pests that feed on caneberries at harvest time.

Spider mites ranked in the third tier of blackberry concerns. They will be an emerging problem in tunnels; they are often more problematic in greenhouses and tunnels than in field settings. There should be more cultural practices/management research for spider mites.

General aspects of pest management programs are covered by the PMSP. Seasonal 'at a glance' calendars are provided for both fungicides and insecticides. The report refers the reader to an existing publication for further information on caneberry pest management. The Southern Region Small Fruit Consortium produces separate guides for each of the small fruit crops grown in the Southeast, and this includes caneberries (Oliver et al. 2020). These are revised annually by small fruit specialists throughout the regions. The collection of guides can be found at the Consortium web site (https://smallfruits.org/ipm-production-guides/).

Arthropod pest rankings: While several arthropod pests were rated in the overall discussion of issues of importance, there is a separate section that ranks the importance of blackberry pests. In this discussion of arthropod pests, I will combine mites along with insects, despite their being treated separately in the PMSP.

High: brown marmorated stink bug, green June beetle, Japanese beetle, raspberry crown borer, red imported fire ant, spotted-wing drosophila, broad mite (in places), twospotted spider mite
The species in this category pose major management concerns for blackberry growers. I mentioned above SWD, and don't need to elaborate more now, except to say the need continues for sensitive predictive tools, resistance management options, and non-chemical means of control. I also touched on broad mite. The document mentions a caveat on broad mite importance – "in places". It will be important to follow the course of broad mite, to see if it becomes more of a general issue. The same can be said for imported fire ant. This has been a problem in the Deep South, of little importance in the northern part of our region. However, fire ant is now spreading in Virginia (Miller and Allen 2019), and could come to present problems for blackberry production there as well. Brown marmorated stink bug is a relatively new component of the stink bug community, and is the most problematic of this family. Not only does it feed on buds and berries, but is outcompeting other, less damaging stink bugs

in caneberries (Basnet et al. 2014). Twospotted spider mite is the most agriculturally important mite in the world, and is the main spider mite pest on caneberries. Resistance management is especially critical for spider mites because of their propensity for developing resistance, and so alternative control as especially important. While Japanese beetle and green June beetle are mainly foliar feeders on some crops, they cause direct injury to fruit in caneberries. They can invade plantings as berries are ripening, and being harvested. It will be very important to have alternative controls, and chemical control tools that can be used at this sensitive time. Raspberry crown borer is a moth whose larva feeds in the crown of the caneberry plant, around the ground line. This could be a problem especially in a nursery settings. Infestations are more cryptic than other borers, and infested plants could be shipped to commercial operations.

Medium: blackberry gall midge, flower thrips, green stink bug, raspberry cane borer, rednecked cane borer, Euschistus sting bugs
Green stink bug and brown stink bug have long been pests on fruit crops, and fit in the middle category of importance here. They are not as significant a problem as BMSB. Thrips can be an issue with caneberries, especially in some years, and there has long been a problem in having an adequate suite of insecticides to use in accordance with resistant management. Further information is needed on the importance of thrips-borne viruses in caneberries. Raspberry cane borer and rednecked cane borer can be problems as well, and infestation can reduce yields. Their infestations are more obvious than raspberry crown borer, and as less difficult to deal with. Blackberry gall midge is one of several gall midges that can damage blackberry leaves of blossoms. Effective sampling methods and control protocols are needed.

Low: Blackberry psyllid, leafrollers and leaftiers, rose scale, sharpshooter leafhoppers, strawberry bud weevil, redberry mite
Pests in this category can cause localized problems, but have not risen to the level of widespread concern. Blackberry psyllid can cause reduced cane growth in blackberries (not affecting raspberries), especially if near stands of conifers. Leafrollers have not caused significant problems in recent years. Sharpshooters are xylem-feeding leafhoppers, known especially as vectors of Pierce's disease of grapevines. Strawberry bud weevil is not an important here as it is in strawberry, but can also clip the buds of blackberry.

Emerging: Aphids, mealybugs, sap beetles, whiteflies, yellowjackets
Some emerging pests are growing in severity because of spray programs that eliminate natural enemies. This is especially important with aphids, mealybugs and whiteflies. They will thus be affected by progress made in developing non-disruptive controls for the pests discussed above. Yellowjackets can be problematic because the wasps feeding on berries come and go from their nests, and killing them with insecticides does not address their source.

Chemical controls: The PMSP document will lay out the currently available insecticides/acaricides. As expected in a PMSP such as this, the list of pesticides is a snap shot. Included will be common and trade names, as well as PHI and REI values. A table is included that presents efficacy of the various materials for specific pests. This will be a useful source of information to pest managers in arranging their spray programs, but will serve as a point of discussion on advantages and disadvantages of specific products, and addressing regulatory needs. Much of the information in this section is also available in the pest management guides mentioned earlier.

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Spotted-Wing Drosophila, *Drosophila suzukii* (Matsumura): State of current management and recent research

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Spotted-wing drosophila (SWD), *Drosophila suzukii* (Matsumura), was first introduced into the US in 2008, first reaching the western states from Asia. It reached the Southeast in 2009, and continued to spread through much of the US through 2012, SWD has presented a huge problem for berry growers. This pest has been discussed recently in Small Fruit New, regarding both conventional and organic management (Pfeiffer 2020, Sial 2020).

SWD is a difficult pest to control. Insecticide resistance is a likely obstacle because of the number of eggs produced by females, and the number of annual generations, but factors that are conducive to resistance. Growers should use a combination of tactics to take the pressure off chemical control.

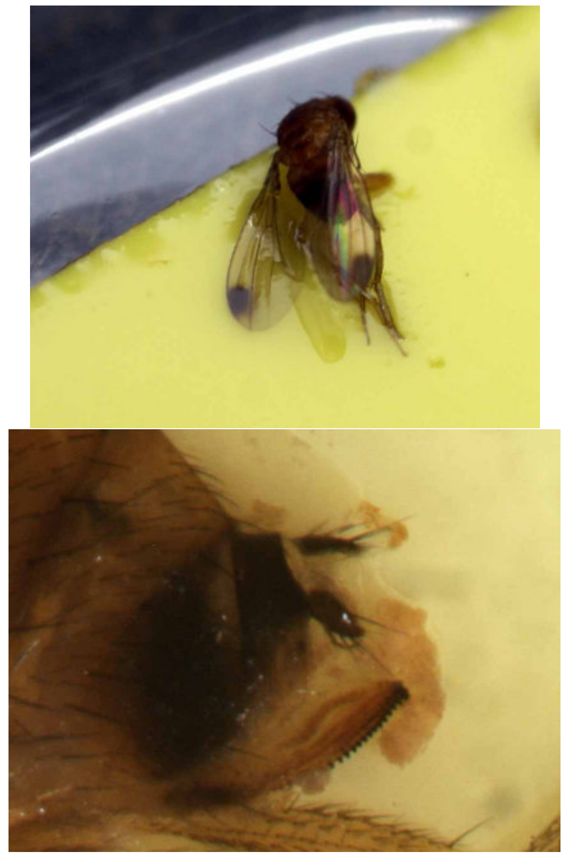

Fig.1. Spotted-wing drosophila adults. a. male showing black spots near wing-tip. b. serrated ovipositor of female.

Hosts: All berry crops are suitable hosts for SWD, with caneberries and blueberries most vulnerable. SWD does not survive as well in grape; nevertheless, females may lay eggs in grape, with subsequent development of sour rot.

Description: By now, most berry growers are familiar with this insect and itenabless appearance. Male SWD is differentiated from native Drosophila species by the presence of a black spot on the leading edge of the wing (Fig. 1a); females lack this spot but have a large serrated ovipositor, visible on the underside of the abdomen (Fig. 1b). This structure allows the insect to insert eggs into the flesh of a ripening fruit, allowing larval establishment ahead of other drosophilids, which colonize rotting or overripe fruit material. Eggs are white, elongate oval, inserted under the skin of the berry, with long respiratory filaments from one end (Fig. 2a). These respiratory horns may be found protruding from an oviposition site with magnification (Fig. 2b).

Fig. 2. Spotted-wing drosophila eggs. a. exposed egg with respiratory filaments. b. respiratory filaments protruding from oviposition hole in a blueberry.

Larvae are translucent maggots 2-3 mm long, with black mouth hooks visible at the anterior end (Fig.

3a). Silvery white tracheal tubes may be visible through the dorsal cuticle with magnification. Respiratory projections are present on the posterior end, giving an appearance of being pointed at each end. Puparia (covering of the actual pupa) (Fig. 3b) are brown, elliptical, about 3 mm long, with respiratory projections from the hind end.

Fig. 3. Spotted-wing drosophila a. larvae in a raspberry, b. puparium

Biology: In eastern Asia, there are up to 13 generations. A life cycle can be completed in 8-14 days, but adults can live up to 9 weeks. Females use the atypically large ovipositor to lay eggs in fruits as they are ripening, earlier than other drosophila species. Eggs are inserted under the skin of ripening fruit; each female lays 7-16 eggs/day. Eggs hatch in 1-3 days, and larval feeding on the flesh causes a collapse of localized tissue after another 2 days, followed by growth of fungal or bacterial organisms.

Monitoring: Traps should be used to detect activity, and when flies are detected, make sure that other control measures are in place. Traps are not effective in providing control. Several commercial traps are available (Trece and Scentry). A trapping guide has been posted (Wallingford et al. 2018), with discussion of several baits, and comparing commercial with homemade traps.

Control:

Chemical control: Control measures are directed against the adults; there are no effective controls for larvae in the fruit. *As vulnerable fruit approach ripeness, weekly spray applications should be* *made.* Because of the high number of offspring and number of generations, there is a high risk of development of insecticide resistance. Consequently, insecticides with different mode of actions should be rotated to prolong the effective life of insecticides. For more details on conventional and organic chemical control, click on the link for [Small Fruit News Summer 2020 edition](#).

Our Southern Region Small Fruit Consortium provides recommendations for SWD in the pest management guides for caneberries, blueberries, strawberries and bunch grapes. In addition, individual states may maintain small fruit management guides that are helpful.

Caneberries: https://smallfruits.org/files/2020/12/2021-Caneberry-Spray-Guide.pdf
Blueberries: https://smallfruits.org/files/2021/01/2021-Blueberry-Spray-Guide.pdf
Strawberries: https://smallfruits.org/files/2020/12/2021-Strawberry-IPM-Guide.pdf
Bunch grapes: https://smallfruits.org/files/2021/02/2021-Bunch-Grape-Spray-Guide.pdf

Cultural control: Netting of 80g weight was effective in controlling injury by SWD (McDermott and Nickerson 2014, Leach et al. 2016, Riggs et al. 2016, Ebbenga et al. 2019). Lighter grades (larger mesh) are not effective. While netting is initially expensive, it becomes cost effective because it may be used for several years.

Harvest fruit promptly and thoroughly to eliminate breeding sites. It is important to harvest all fruit, including those in the interior and lower parts of the plant canopy. This can be problematic in pick-your-own operations. This issue should be kept in mind once SWD established in an area, since at times grape growers may leave berries on the vine to allow greater development of some harvest parameters. Any overripe or rotten fruit nearby should be destroyed. In vineyards, pomace produced during the crushing process should not be dumped near the producing vineyard block. This can become a source for many SWD.

When berries are harvested, it will be helpful to get them as cool as possible, as soon as possible. There is complete mortality of larvae in fruit held for 96 hours at 35˚F, and below 40˚F, eggs and larvae don't develop (Bolda 2010, Burrack 2016). In most cases, such uniform holding conditions are not maintained; fruit cooling should be considered a component of SWD management and not a sole control tactic.

Biological control: Because of the ability of SWD to encapsulate and kill the eggs of our native parasitoid wasps, biological control has not been successful. Research is underway to find parasitic species that are able to attack this species.

Recent research: Because the importance of SWD to berry producers continues, there is a lot of interesting research going on, both in the US and internationally. It beyond the scope of this newsletter article to provide a complete review, but here are some examples. The geographic spread of SWD continues, and there has been a recent first report of injury to berries in Africa, in northwestern Morocco (Boughdad et al. 2021). Researchers continue to delve into the basic biology of SWD. A recent review of chemical ecology (Cloonan et al. 2018) pointed out that current food-odor traps are unlikely to be sufficiently attractive to SWD, and further work on compounds that are attractive and aversive is needed. Nutritional ecology research continues. In a behavioral study (Young et al. 2018), the role of protein and carbohydrate content in female feeding and ovipositional choices was examined. This could lead to improved monitoring strategies. Guedes et al. (2019) used electropenetrography to compare probing, feeding and egg laying behavior in media and strawberry. Landscape level studies continue to inform our SWD ecological understanding. Dropped and waste fruit proved to be an important source of off-season development of SWD, with higher numbers of SWD near cideries and wineries (Bal et al. 2017). A study on spatial ecology in the landscape (Santoiemma et al. 2019) indicated that the risk of SWD outbreaks depends on factors beyond the control of traditionally scaled management. Competition, both intraspecific (Bezerra Da Silva et al. 2019a) and interspecific (Shrader et al. 2020) can be important to SWD. Exposure in intraspecific competition influences pupation site in SWD, with larvae exposed to competition traveling farther to pupate. Interspecific competition with another exotic drosophilid, African fig fly, *Zaprionus indianus*, can affect SWD mortality and developmental time.

Of course, applied research on SWD management continues as well. Biocontrol has been problematic, as indicated above. Recent work has indicated that the pupal parasitoid *Pachycrepoideus vindemmiae* still presents hope in improving biological control of SWD (Bezerra Da Silva et al. 2019b). Lee et al.

(2019) provided a review of biocontrol work, and will be a useful source of information wishing to catch up here. This review included both parasitoids and fungal and bacterial pathogens. There is ongoing research on cultural control as well. For example, Leach et al. (2018) examined the effect of shortening harvest intervals in raspberries. A two-day harvest schedule result3ed in lower SWD infestation than 3-day harvest interval. Sterile Insect Technique (SIT), a technique that has been successful in a range of other pests, is explored for SWD (Sassù et al. 2019). SIT has also been combined with the use of incompatible *Wolbachia* symbiotes (Nikolouli et al. 2020). When males and females are infected with different strains of *Wolbachia*, there has been reduced mating success in other insects, including a fruit pest, plum curculio (Zhang and Pfeiffer 2008, Zhang et al. 2010).

In summary, in addition to proper pest management practices in use today, including appropriate resistance management approaches, work continues on approaches that will aid SWD management in our region.

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Managing Broad Mite in Southeastern Caneberry Plantings

By Aaron Cato - Extension Specialist – Horticulture IPM, University of Arkansas

The buzz about broad mite seems to have picked up across the Southeast after reports of significant infestations in North Carolina during the 2019 and 2020 growing seasons. Broad mite has been a known pest of Southeast blackberry plantings for over a decade. The majority of observed issues were centered around Arkansas, and little occurrence and injury has been reported in many of the states closer to the Atlantic coast.

With the buzz of broad mite reports, growers have understandably been in seek of remedies. Broad mite can be a fickle pest species that may or may not show up, and often environmental conditions can shift the occurrence and seriousness of this pest from year to year. Outlined below is a summary of observations and research regarding broad mite that should lead to successful management of this pest.

What is Broad Mite?

Broad mite, *Polyphagotarsonemus latus* (Banks), is a tarsonemid mite that feeds on new leaf material, flowers, and fruit. Unlike other mite pest species, such as the two-spotted spider mite (tetranychid mite), broad mite is microscopic (0.1-0.2 mm) (Figure 1) and generally goes unnoticed until injury on new growth and reproductive structures is observed. Broad mite is distributed throughout much of the world and occurs as a pest mainly in tropical or subtropical regions such as the Southeastern United States. Broad mite has a large host-range and is most notably a pest in greenhouse production of food and ornamental crops.

Figure 1 – Ambered-colored broad mite adult observed using a dissecting microscope.

Broad Mite in Blackberry
Broad mite was first reported as a pest of blackberry in the United States in 2007 and was further realized as a serious threat to commercial blackberry production in 2014 (Vincent et al. 2010, Johnson & Garcia 2015). Commercial plantings in Northeast Arkansas exhibited large levels of estimated yield loss ($15,000 to $20,000), and infestations were observed in many states across the Southeastern region. Broad mite was initially found to infest greenhouse propagation of blackberry plants, and later infestations of established plants were observed during the early summer months.
Broad mite is a tropical pest species that does not emerge until summer in climates with cold winters. Broad mite emergence likely is different for each blackberry growing region in the Southeast, and growers should be on the look-out for small pockets of damage and adults present on leaves. In Arkansas we usually begin to see populations increase in late-May and we don't generally observe injury or significant infestations until late-June. This varies from year-to-year and sometimes we don't see any injury until August. A good rule of thumb is to begin scouting primocanes when you have green fruit across your plantings, and don't let up until it starts to cool down.

Broad Mite Injury in Blackberry
Broad mite feeding on blackberry is often reminiscent of injury from auxin herbicides and stunts plants in a similar manner. Malformation of plants is due to the toxic nature of the mite's saliva. Feeding leads to stiff, curled leaves with cupped margins, a decrease in internode length, and potentially leaf death and tip dieback in serious infestations (Figures 2, 3). Broad mite will also feed on and damage the fruit and flowers of primocane-fruiting cultivars (Figure 4). Significant yield loss has been observed to primocane crops through a direct effect on developing flowers and fruit. Broad mite also effects the growth of primocanes on florican fruiting varieties and likely leads to significant yield loss in the following year (Figure 5).

Figure 2 – Early signs of broad mite damage to primocanes terminals. Injury is characterized by the bronzed coloration and upturned nature of new leaves, along with twisted and cuppped leaves from older damage.

Figure 3 – Severe injury from broad mite infestations. This primocane was severely stunted, leaves had begun to turn black, and the plant only began to recover after a miticide application.

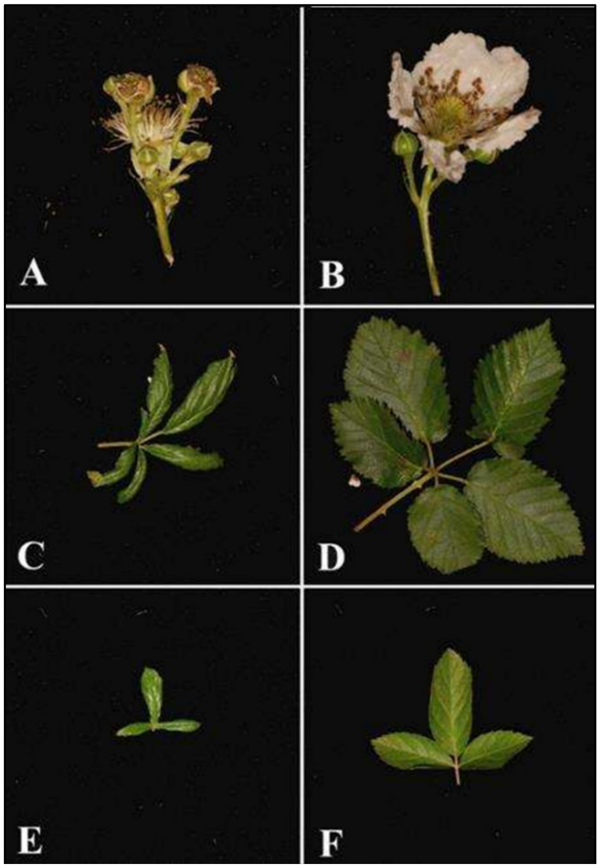

Figure 4 – Broad mite damaged (left) and normal (right) blackberry flowers and leaves. Photo credit Vincent et al. 2010.

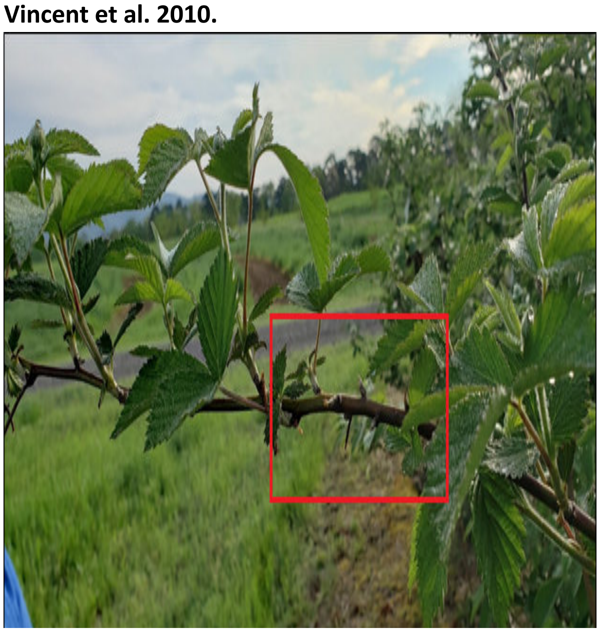

Figure 5 – Floricane from a plant damaged in August from infestations of broad mite. Buds formed during these broad mite infestations did not leaf-out in the following year.

Broad Mite Management in Blackberry

Scouting is key is to broad mite management. Any miticide that is applied before broad mite is present is likely to have no positive effect and could potentially lead to increased issues in the future. It's likely that any pyrethroids or other insecticides used could also promote broad mite issues, as they kill predatory mites. Growers should scout for signs of injury in their plantings throughout the year, especially once the green fruit stage is reached. Damage will generally pop-up in a small area before it spreads throughout plantings. Once any suspected broad mite injury is observed, pull around 10 unfurling leaflets (second-node from the top, leaves should be just starting to lay flat) from surrounding primocanes. Ambered-colored adult broad mites can be seen at about 30x-60x magnification, which is usually available at your local extension office. Also be on the lookout for their distinctly polka-dotted eggs, which indicate that it is time to spray.

Broad mite numbers often build very rapidly and work by Dr. Donn Johnson has indicated that reaching an average of 1-5 mites per leaflet is the sweet spot for control (Johnson and Garcia 2015). Once mites exceed an average of 10 per leaflet, damage is usually widespread and populations can be difficult to effectively manage. Finding eggs in samples along with adult mites is also a good indication that it is time to apply a miticide for control. After applying any miticide for broad mite, continue scouting to assure effectiveness and for the potential of new infestations. Farms in Arkansas that have major broad mite issues often necessitate two applications a year, especially in years when the first infestations begin early.

Broad Mite Control Options

Currently there are many options to control broad mite, but only two that can safely be used in the heat of the summer (above 80-90°F). Products such as M-Pede (potassium salts of fatty acids), Microthiol (sulfur), JMS Stylet Oil (paraffinic oil), or Neem Oil all offered sufficient suppression of broad mite (Lefors et al. 2017). These products can be risky to use in the heat of the summer and can damage blackberry plants if applied when it is too hot. It is important to note that these products were not always found to be effective in efficacy trials (Johnson and Garcia 2015).

Effective miticides that are safe to use in the summer include Magister SC and Agri-Mek SC + NIS (Figure 6). With these two products, growers effectively can make 3 effective applications in a single year for broad mite (2 Agri-Mek + NIS and 1 Magister). In most years only 1-2 applications will be necessary, but we have seen instances where infestations were hard to knock back for more than a few weeks at a time. These products both have a 7-day preharvest interval which may complicate their use in primocane fruiting cultivars.

Miticides applied 15-Jul

Treatment/ Formulation	All Actives/leaflet 15-Jul	22-Jul	29-Jul	8-Aug
Agri-Mek	11.5a	0.5d	8.5a	13.5a
Apta	15.4a	1.5cd	11.8a	20.2a
JMS 1% (applied 7/22)	17.8a	18.3ab	12.7a	12.1a
Magister	13.6a	0.9d	6.7a	20.7a
M-Pede	10.7a	15.6b	17.8a	18.5a
Zeal	11.9a	12.2bc	21.1a	20.3a
Check	15.6a	27.0a	26.2a	21.7a
	NS	$P < 0.05$	NS	NS

Figure 6 – Miticide Efficacy work by Dr. Donn Johnson (Johnson and Garcia 2015). In this trial only Agri-Mek and Magister proved to be effective control options. Other studies have shown oil-based products to be potential options for effective control (Lefors et al. 2017).

Effective Management Plan for Broad Mite

Broad mite shows up too late in Arkansas to affect the floricane crop, but this may not be the case across the entire Southeast. Control efforts generally need to be focused on limiting damage to this years primocanes, which could translate to yield loss in primocane fruiting varieties and lowered yield potential in next year's floricane production. Scout for leaf injury and confirm that it is broad mite damage by sending in samples to your local extension service. If you are observing damage and there is more than 1 broad mite per leaflet across a significant portion of a plant, Agri-Mek + NIS is a good first option. Save Magister for a second shot as a rotation tool if necessary. You will need thorough coverage (75-100 GPA is preferable) to get acceptable control as this pest is often feeding deep inside terminal leaf material.

Give me a call at 479-249-7352 if you have any questions.

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What is the current status of the issue and what do we need to find out?

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Weed management is a familiar and challenging issue for many blackberry producers. According to a University of Arkansas survey, over 20% of growers in nine participating states described weed control as their top concern. And I suspect that plenty of other growers are troubled by these problematic plant species, even if weeds are not their top concern! The most frustrating issue with weeds is that one bad year of weeds can cause problems for years to come, due to the large quantities of seed produced by each weed. Thus, we encourage growers to stay vigilant and remember some intervention is always better than throwing in the towel.

The biggest weed science issue in blackberries is the limited number of herbicide options. This is a common challenge for many specialty crops as chemical companies prioritize registration of herbicides for row crops, such as corn or soybean. Due to lower acreage and increased liability, there is limited financial incentive for companies to invest in registering products for use in specialty crops. Fortunately, the IR-4 project coordinates research to secure supplemental labeling for many specialty crops. This work is critically important for securing a diversity of pesticide options or expanding the permitted uses of products that are already registered.

Some unfortunate news may sound like a flashback to the early 2000's: there is a scarcity of oryzalin (tradename Surflan®). On his North Carolina State Extension website, Dr. Joe Neal shared an unconfirmed statement "The manufacturing facility was damaged and the active ingredient (oryzalin) is in very short supply. It is unclear if oryzalin will or will not be discontinued." In my communication with a chemical company representative, I have only heard that the material is no longer available for research and demonstration purposes. This could be very problematic for blackberry growers as oryzalin had worked its way into a cornerstone of herbicide programs. If oryzalin is not available, growers will have to amend their preemergent weed control strategies, utilizing alternative products where appropriate. There are many programs that could be built around simazine, indaziflam, norflurazon, rimsulfuron, mesotrione, among others. For specific programs and spectrums of control, check the 2021 Caneberry Spray Guide from the Southern Region Small Fruit Consortium.

This shortage of oryzalin is a reminder to be vigilant about weed management throughout the entire year. It is important to understand weed biology in order to target them when they are vulnerable and to prevent seed production with weeds that escape. Effective weed management must rely on complimentary weed management strategies beyond single modes of action or individual chemicals. I am confident that growers will adapt and make use of complimentary strategies through this shortage. If you are using a new product for the first time, be sure to check the label and extension resources. Remember to scout your fields and prevent weed seed production, even if it is happening after fruit set and harvest!

Fresh-market Blackberries: Is Developing a Soft Robotic Gripper Feasible for Harvest?

Dr. Renee Threlfall and Dr. Yue Chen

Research Team:
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Fresh-market blackberries are mostly hand harvested to the maintain quality of this delicate fruit from harvest to consumption. Labor shortages, labor costs, and the slow speed of hand harvesting bottleneck potential fresh-market blackberry industry expansion and market-ready supply. Automated harvesting options (shaking the plants, cutting the stems, or using rigid grippers) are used for other fruits. However, these options are not feasible for harvesting fresh-market blackberries because they might cause quality issues such as berry leakage or red drupelet reversion (drupelets turn from black to red) at harvest or during storage.

Soft robotics provides a novel option for automatic harvesting by using compliant grippers (rubber, silicone, etc.) that enabling task versatility to grasp and manipulate delicate objects with complex, dynamic shapes. A research team at the University of Arkansas is developing engineering-based solutions using soft robotics to implement delicate harvesting of fresh-market blackberries using a custom-designed soft robotic gripper. One of the first steps to develop the soft robotics gripper is to gather data on harvesting fresh-market blackberries that might be needed to design and program the robot.
When a person harvests a blackberry, what fingers are used to grasp the blackberry, how much force is needed to pick the fruit from the plant, and how does this impact fruit quality? In order to answer these questions, the research team created a custom made, force-sensing apparatus with flexible force sensors on the thumb and index, middle, and ring

fingers of a person harvesting fresh-market blackberries (Figure 1). These sensors measured the forces applied during berry harvesting by each finger to the berry surface. The data was recorded for the force-sensing apparatus using a portable water-resistant case housed in a backpack and processed data was transmitted and logged to a mobile work-station (Figure 2).

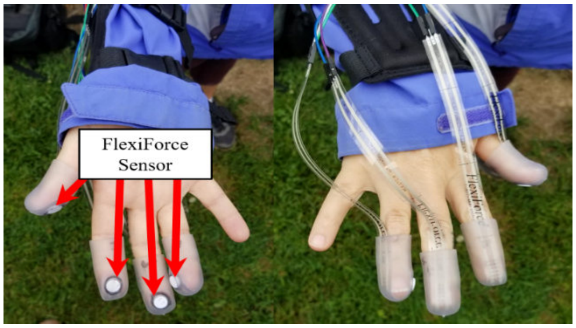


Fig. 1. The force-sensing apparatus for hand harvesting can be seen attached to the thumb and fingers of a person harvesting fresh-market blackberries. The left picture depicts the palm of the harvester's hand, and the right depicts the top of hand.

Over 2,000 blackberries were harvested from a commercial blackberry grower in Arkansas using the force-sensing apparatus. Data analysis indicated that the thumb applied the highest force (0.78 N), followed by the middle (0.40 N), index (0.19 N), and ring finger (0.07 N). These results reflect the anatomical relationship of the hand during picking, where the thumb and middle finger act as the primary force applicators while the index and ring finger act as stabilizers. The research team related the measured force values to quality attributes of the blackberries, which were evaluated in clamshells after 21 days at 2°C. The quality attributes were comparable to harvesting without the force-sensing apparatus, with low leakage (6%), decay (<2%), and red drupelets (5%), ensuring the force-sensing apparatus did not compromise berry quality.

Fig. 2. University of Arkansas graduate students recorded and processed data for the force-sensing apparatus for fresh-market blackberry harvesting using a portable water-resistant case housed in a backpack. The resulting processed data was transmitted and logged to a mobile work-station.

Using these results, a novel, tendon-driven soft robotic gripper was developed using compliant, soft silicone and active force feedback control at the fingertips. The versatile gripper was used to harvest 240 blackberries: 60 berries each at three fingertip force thresholds (0.59 N, 0.69 N, and 0.78 N) and 60 berries as a control with force sensors removed. The blackberries were placed in clamshells as they were harvested (20 berries per clamshell), and their quality attributes were evaluated after 21 days at 2°C. Red drupelets for blackberries harvested with 0.59 N, 0.69 N, and 0.78 N was 0%, 8%, and 16%, respectively, and the control had 0%.

Fig. 3. Prototype of tendon-driven soft robotic gripper with compliant, soft material and active force feedback control for harvesting fresh-market blackberries.

While is it feasible to develop a soft robotic gripper to harvest fresh-market blackberries, more research and development will be needed for commercial implementation. In this research, we were able to determine the number of grippers and the force needed to harvest blackberries with acceptable fruit quality at harvest and during storage. Next, we need to develop robotic perception to find ripe blackberries on the plant for the gripper to harvest and continue evaluations in commercial blackberry farms.

This work has promising potential for soft robotic harvesting of blackberries and lays the foundation for future developments on this gripper. The project team looks forward to working with Arkansas blackberry growers to further evaluate this new soft robotic gripper for harvesting fresh-market blackberries.

Note: This project was funded by University of Arkansas Chancellor's Innovation Fund grant and an Arkansas Department of Agriculture Specialty Crop Black grant. The project team would also like to acknowledge Sta-N-Step Farm, the location of the 2020 evaluations.

Blackberry Yellow Vein Disease

By Ioannis E. Tzanetakis, Professor and Director of the Arkansas Clean Plant Center – University of Arkansas Division of Agriculture

Plants are not immune to viruses. Unlike many other pests and pathogens, once a plant is infected with a virus, it is infected for life. Blackberry is no exception. The most important virus disease in blackberries in the Southern U.S., capable of causing significant yield losses, is blackberry yellow vein disease (BYVD). This disease was first observed around 2000.

What is unique about BYVD?

BYVD is not caused by a single virus but rather by a virus complex that may include blackberry yellow vein associated virus (BYVaV), blackberry chlorotic ringspot virus (BCRV), blackberry virus E, blackberry virus Y, blackberry leaf mottle associated virus (BLMaV), blackberry vein banding associated virus, impatiens necrotic spot virus (INSV), and tobacco ringspot virus (TRSV), among others. BYVaV, BLMaV, and BCRV are the most prevalent viruses in the complex. Symptoms include vein yellowing, mottling, oak-leaf or line patterns, and ringspots (Figure 1). These symptoms initially occur on a small area of affected leaves early in the season and then progressively spread to occur on the majority of the affected leaves. Similarly, symptoms initially develop on only a few leaves but spread to other parts of the plant as the season progresses. As more viruses accumulate in plants, symptoms become progressively stronger and plants become less productive (reduced yields) to the point they need to be replaced. Properly maintained blackberries can typically be productive for 20 years or more. However, once BYVD becomes established in an area and blackberry plants become infected, plants can become unproductive in as few as five years.

Because of the many BYVD-associated viruses that are endemic in the Southern U.S., it is very difficult to mitigate the transmission of all viruses. BYVD-associated viruses can be transmitted by pollen, nematodes, whiteflies, thrips, mealybugs, eriophyid mites, and, potentially, beetles and aphids.

How do we combat such a complex disease?

Several management practices can be implemented to either prevent the introduction of viruses associated with BYVD into new fields or reduce the spread of these viruses. These include:

Scout for BYVD in commercial fields and surrounding areas. Regularly scout fields and surrounding areas for symptoms of BYVD. In some cases, decades-old plants may be infected by a single virus and remain asymptomatic; in others, plants in the second year of production may display typical symptoms of BYVD and be infected with several viruses. Identify and talk to your local University Extension specialist to get an idea of BYVD prevalence in your area. These specialists often regularly visit commercial operations and may be able to provide more information about disease and virus prevalence and/or status in your area. Wild blackberries can also serve as reservoirs for many of the viruses in the BYVD virus complex. Symptoms on these plants indicate that BYVD may be endemic to the area.

Use clean plants. Plant material should be tested and found to be free from all viruses in the BYVD complex before planting in the fields. Clean plants can, of course, become infected after they are established in the field; however, it will take time before enough viruses accumulate within plants to cause yield losses comparable to plants that are es :ablished with known infections.

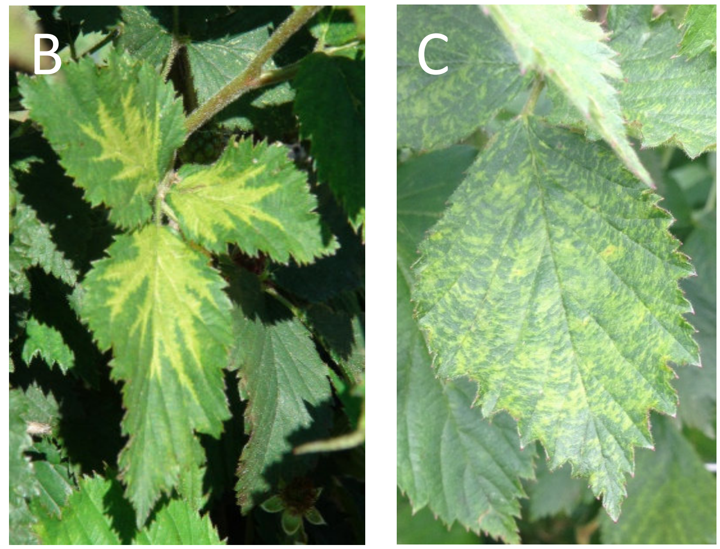
Eliminate weeds in and around blackberry plantings. Many of the viruses in the BYVD complex also infect broadleaf weeds. Removing these weeds in and around plantings can help reduce potential virus reservoirs and can slow virus spread.

Get soil tested for nematodes. TRSV, a virus transmitted by the dagger nematode, is often found in BYVD-affected plant material. Collecting multiple soil cores from plantings and submitting a soil sample for nematode testing can provide insight on whether TRSV poses a threat.

Scout fields for insect vectors. While scouting fields for BYVD, it is also important to scout for potential insect virus vectors, such as whiteflies, and then implement practices to control those vectors, if present. If only a dominant vector is present, successfully controlling this vector could significantly slow virus spread.

More information on viruses and virus diseases of *Rubus* species, which includes blackberries and raspberries, is available in the publication "Viruses and Virus Diseases of *Rubus*", available at https://apsjournals.apsnet.org/doi/10.1094/PDIS-04-12-0362-FE.

Figure 1: Symptoms of blackberry yellow vein disease include chlorosis and ringspots (A), oak-leaf patterns (B), and mosaic (C). Photo credits: I. E. Tzanetakis, University of Arkansas.



Cane blight and cane dieback of blackberry: causal organisms and management recommendations

By Jonathan E. Oliver, Department of Plant Pathology, University of Georgia

<u>Background</u>Numerous cane diseases can reduce the yield and lifespan of caneberries, and the warm, humid environment in the southeastern U.S. can provide ideal conditions for disease development. Among the diseases affecting caneberry production, one of the most devastating is **cane blight**. This disease can rapidly spread under favorable disease development conditions, causing dieback of affected canes and ultimately the decline and death of entire plantings (**Figure 1**). Unfortunately, once it begins spreading and becomes established within caneberry plantings, cane blight can become challenging

Figure 1. Cane blight symptoms include dead/dying canes with a silvery or gray appearance. Damage may be associated with pruning cuts. Credit: E. Smith.

and/or nearly impossible to control effectively and its management poses a significant challenge to growers. Furthermore, in addition to cane blight, other cane diseases capable of causing dieback on affected canes appear to be present in southeastern caneberry plantings, and knowledge regarding the organisms causing **cane dieback** and appropriate management strategies remains limited.

Cane Blight Causal Agent, Infection Process, and Disease Cycle

Cane blight is caused the fungal pathogen *Leptosphaeria coniothyrium* (also known as *Paraconiothyrium fuckelii*). This pathogen infects canes via wounds, and it has been suggested that without wounds for entry, resulting disease issues would be slight (Williamson 2017). Unfortunately, in a typical caneberry planting, potential causes of wounding are abundant. Wounds resulting from cane injury via pruning, machinery, insect damage, freeze damage, herbicide damage, or infection with other pathogens can all provide entry for the cane blight pathogen (Brannen and Krewer 2005). Furthermore, canes can also self-wound (especially thorned cultivars) by rubbing one another or by rubbing on the trellis wire in windy conditions, providing additional opportunities for the pathogen to gain entry.

Once the pathogen enters through wounds, it can form lesions that spread through the vascular tissue of the plant. These spreading lesions eventually grow together and girdle the cane, resulting in death of the portion of the cane above the lesion site (**Figure 2A, B**). Within these lesions, on the surface of the cane, the fungus will produce small, black, embedded pimple-like structures which release fungal spores (**Figure 2C**). During rainfall events, these fungal spores are exuded and splashed into wounds on nearby canes, allowing for subsequent rounds of infection to occur.

Accordingly, some key events in the disease cycle for cane blight are as follows:

1. In early spring, on **floricanes** [2nd year canes] infected during the prior season as **primocanes** [1st year canes], fungal structures embedded within lesions on the cane surface become evident.
2. During spring and summer rain events, fungal spores are produced from these structures on **floricanes**.
3. Fungal spores are splashed by the rain onto **primocanes**, where they infect through wounds.
4. After infection, the fungus forms vascular lesions within infected **primocanes**. (These lesions may not become visible on the surface of the cane until the following season.)
5. Vascular lesions spread within infected **primocanes** during the autumn and winter, causing the death of buds, lateral shoots, and eventual dieback of the entire cane after girdling occurs.
6. The fungus overwinters within lesions on **primocanes**; then, the cycle begins again as in #1 above.

Cane Blight Signs and Symptoms

Visible symptoms of cane blight include lesions on primocanes and floricanes which can grow together, girdling the cane and resulting in cane death (**Figure 2A**). Initially, lesions may be visible near wounds as dark red areas with purple borders. Lesions eventually become gray in appearance (**Figure 2B**)

Figure 2. Cane blight symptoms and signs. (A) Dead and dying floricanes; (B) gray lesion with dark border; and (C) black, embedded fungal spore-producing structures within lesions. Credit: (A and C) Brannen and Krewer 2005; (B) Ellis 2008.

and may be silvery due to the presence of fungal spore masses that dry on the cane surface (Williamson 2017). Within lesions, fungal spore-producing structures may be evident as black bumps (**Figure 2C**).

Other Potential Causes of Cane Dieback

While cane blight is assumed to be the primary cause of cane dieback in the southeastern U.S., recent evidence suggests that other fungal organisms may also be causing cane dieback of blackberry. During the 2017, 2018, and 2019 growing seasons, fungal organisms were isolated from blackberry plants showing symptoms of cane dieback (**Figure 3A**) in eight counties in Georgia (Hemphill et al. 2020). Isolates were identified and used to inoculate cut (wounded) cane terminals on potted blackberry plants to determine if they were capable of causing cane dieback. Among the 126 isolates identified in this work, the causal organism of cane blight, *L. coniothyrium*, was identified from only one location on plants showing cane dieback symptoms, while isolates of *Fusarium oxysporum*, *Pestalotiopsis microspora*, *Colletotrichum siamense*, *Neofusicoccum kwambonambiense*, *N. parvum*, *Lasiodiplodia pseudotheobromae*, and *L. theobromae* were determined to cause significant dieback on wounded blackberry canes (**Figure 3B, C**). Taken together, this information suggests that additional fungal organisms besides *L. coniothyrium* are present and contributing to cane dieback in the southeastern U.S. Furthermore, as multiple fungal isolates capable of causing significant cane dieback could sometimes be isolated from a single diseased cane in this study, it is likely that a disease complex may be involved in the observed field symptoms.

Management

Due to the significance of wound infections and rainfall in the cane blight disease process, recommendations for cane blight management focus heavily on the prevention of unnecessary wounding and the protection of wound sites prior to rainfall events via fungicide applications. No information is available for blackberry regarding cultural controls for other cane dieback-causing organisms; however, based on the lifestyle of these organisms, it is reasonable to assume that cultural management practices recommended for cane blight would likely also be effective for the other causes of cane dieback.

Cultural Controls for Cane Blight and Cane Dieback

Cultural control recommendations for cane blight and cane dieback management include the following:

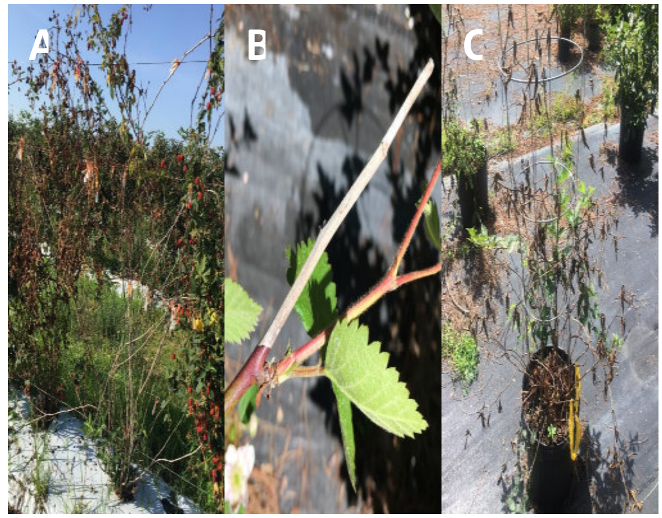


Figure 3. Cane dieback symptoms. (A) Cane dieback symptoms in the field; (B) cane dieback from a cut cane tip; and (C) plant collapse following inoculation of cv. 'Ouachita' with potential dieback-causing fungal organism. Credit: Hemphill et al. 2020.

1. **Minimize wounding of primocanes.** Wounds provide an opening for cane blight and cane dieback organisms to gain entry into the plant and an opportunity for infection. Pruning activities will inevitably lead to wounding, but these activities are necessary in caneberry production operations. Since fungal spores can be spread through rainfall (or overhead irrigation) events, care should be taken to avoid pruning prior to these events. Ideally, pruning should take place when at least four days of dry weather are expected.
2. **Whenever possible, "pinch off" or "tip" tender primocanes rather than relying on severe pruning cuts with shears.** "Tipping" primocanes when they reach the desired height (and continuing to "pinch"-prune during summer pruning) will result in minimal damage to the cane and will allow for quick healing of wounds. To use this method, pruning of primocanes must be timed appropriately, since it will become necessary to use pruning shears once canes become too tall.
   [For additional information on "pinching" and "tipping", see the UGA publication "Cane Blight of Blackberry" available at http://extension.uga.edu/publications/detail.html?number=C894.]

3. **After harvest, promptly remove infected canes and old floricanes.** Since infected canes and old floricanes serve as a reservoir for fungal organisms that can cause future infections, these canes should be pruned out and immediately destroyed (by burning or burying) after harvest. Pruning cuts should be made close to the ground, since remaining stumps can harbor fungal organisms.
4. **Implement practices that promote quick drying of the canopy.** These include thinning plants, establishing a weed-free strip, bedding with black plastic, and using drip (rather than overhead) irrigation. Keeping the canopy dry will decrease fungal infection.
5. **Maintain adequate water and nutrient conditions to avoid stressing plants**. Stressed plants are more susceptible to infection with fungal organisms, and wounds are likely to heal more quickly in healthy plants. Use soil and tissue sampling to ensure adequate fertilization and pH.

Chemical Controls for Cane Blight and Cane Dieback

Chemical control recommendations for cane blight and cane dieback management include the following:

1. **Protect wound sites by applying fungicides after each day of pruning.** This can help to protect wound sites from fungal infection until healing can occur.
2. **For cane blight: apply effective fungicides.** Strobilurin fungicides (FRAC Group 11), such as including Pristine, Cabrio, Abound, and Quilt Xcel, and the DMI fungicide Rally (FRAC Group 3 have all shown efficacy when applied to pruning wounds to protect canes from cane blight.
3. **For cane dieback causing organisms: apply effective fungicides.** Information is very limited regarding chemical controls for cane dieback. However, a recent fungicide trial on potted blackberry plants indicated that Pristine, Switch, and (to a lesser extent) Abound can reduce cane dieback from wounds if these materials are applied prior to infection by select fungal organisms identified previously to cause cane dieback in Georgia (Oliver et al. 2020).

(at www.smallfruits.org). Fungicide availability, labels, and recommended rates change frequently and vary between states and localities. Please consult the various labels for rates, other recommendations, and precautions.

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