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2021 Strawberry School reaches over 7,000 growers, gardeners & extension personnel

Sarah Cato, Program Tech-Horticulture,
University of Arkansas System Division of Agriculture

Dr. Aaron Cato (left), Horticulture IPM Extension Specialist & Dr. Amanda McWhirt (right), Horticulture Production Extension Specialist, filming for the 2021 Southeastern Strawberry School

In 2021 the University of Arkansas extension horticulture team hosted the 2021 Southeastern Plasticulture Strawberry School, with funding from the Southern Region Small Fruit Consortium. The Strawberry School was a six-part webinar series that started in February of and ended in October 2021. In the series, Drs. Amanda McWhirt and Aaron Cato, in conjunction with over 15 specialists from across the region, followed the strawberry crop through the year and featured webinars on topics relevant to strawberry production for that season. Program staff Lizzy Herrera and Sarah Cato were key to developing the webinars into YouTube videos and coordinating with participants.

During the course of the webinar 659 people were registered and a total of 587 participants attended the live webinars from 33 states in the U.S. and 32 countries outside of the U.S. All of the presentations for the series were recorded and uploaded to the Strawberry School page on Southern Region Small Fruit Consortium website. In total, the recordings have over 6,500 views. Through live attendees and later-viewed recordings, the 2021 Southeastern Plasticulture Strawberry School has reached over 7,000 views.
This webinar series was made possible by funding from the Southern Region Small Fruit Consortium.

Pruning Blueberries

Bill Cline, Entomology & Plant Pathology Department, NCSU

Cultivated blueberries are upright, deciduous, woody perennials, forming multi-stemmed bushes with maximum unpruned heights varying from 6-8 feet (highbush, southern highbush) to 10-15 feet (rabbiteye). All cultivated species require annual pruning to manage bush height and shape. Pruning also prevents over-cropping, increases berry size, and removes dead, diseased or insect-infested wood.

Pruning is second only to hand harvest in terms of annual labor expense. So how is pruning accomplished quickly and economically, and what is the easiest way to explain pruning goals to a crew of workers entering the field for the first time? The following teachable steps, in order, can be used at each bush to rapidly eliminate undesirable growth, selecting for flexible, upright, and productive canes.

Tools and Techniques

Most blueberry pruning is done during the dormant (winter) season after the leaves have fallen. Mature canes can be up to two inches in diameter, so long-handled loppers capable of cutting large stems are essential. Smaller one-handed pruners are used for finish work and for shaping young bushes. Make flush cuts to avoid leaving stubs. Pruning cuts are not treated, though some authorities recommend timing standard fungicide sprays to occur immediately after pruning, especially when late spring and summer cuts are made on actively-growing bushes.

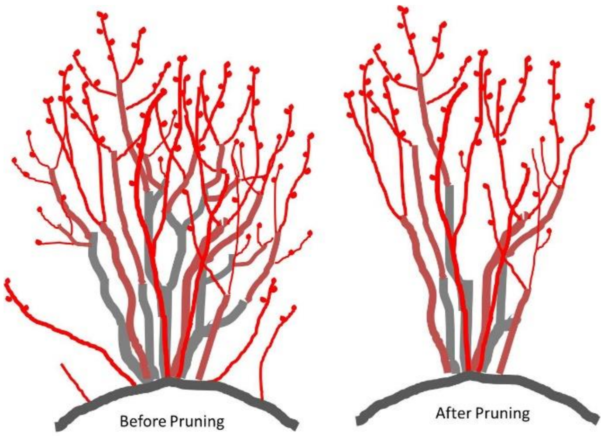
<u>Steps in Winter Pruning (November – March)</u>

STEP ONE: Define the crown. Pruning starts at the ground, not at the top of the bush. Visualize a circle 12 to 18 inches in diameter around the crown of the bush, and remove ALL shoots of any age that have emerged from the ground outside the circle. This narrows the base of the bush to facilitate machine harvest, but is also a good general step for hand-harvested fields as well.

Long handled loppers and hand pruners

STEP TWO: Remove low-angled canes and crossovers. Low-angled canes that are too close to the ground are undesirable because the fruit is more likely to contact the ground, or to be contaminated by rain-splashed soil. Remove these low-lying branches, and also any canes that angle through the bush (crossovers). What remains is a narrower bush consisting of the most upright canes.

STEP THREE: Open the center. If needed, remove one to three large canes from the



center of the bush to reduce crowding, improve air circulation and phase out older canes. Old canes to target for removal are larger and grayer in color, and are more likely to be covered with a fuzzy growth of foliose lichens. The goal should be to move through the field rapidly by making large cuts close to the ground.

STEP FOUR: Thinning and heading back. As a blueberry cane ages, it branches repeatedly, resulting in smaller and smaller diameter lateral twigs in successive years. If left unpruned, this results in excessive numbers of unproductive, matchstick-sized shoots, each with a few tiny berries. To avoid reaching this stage, thin canes by making cuts to selectively remove clumps of twiggy, brushy-looking, matchstick-sized laterals. At this time also cut (head back) any long whips or canes that are too tall.

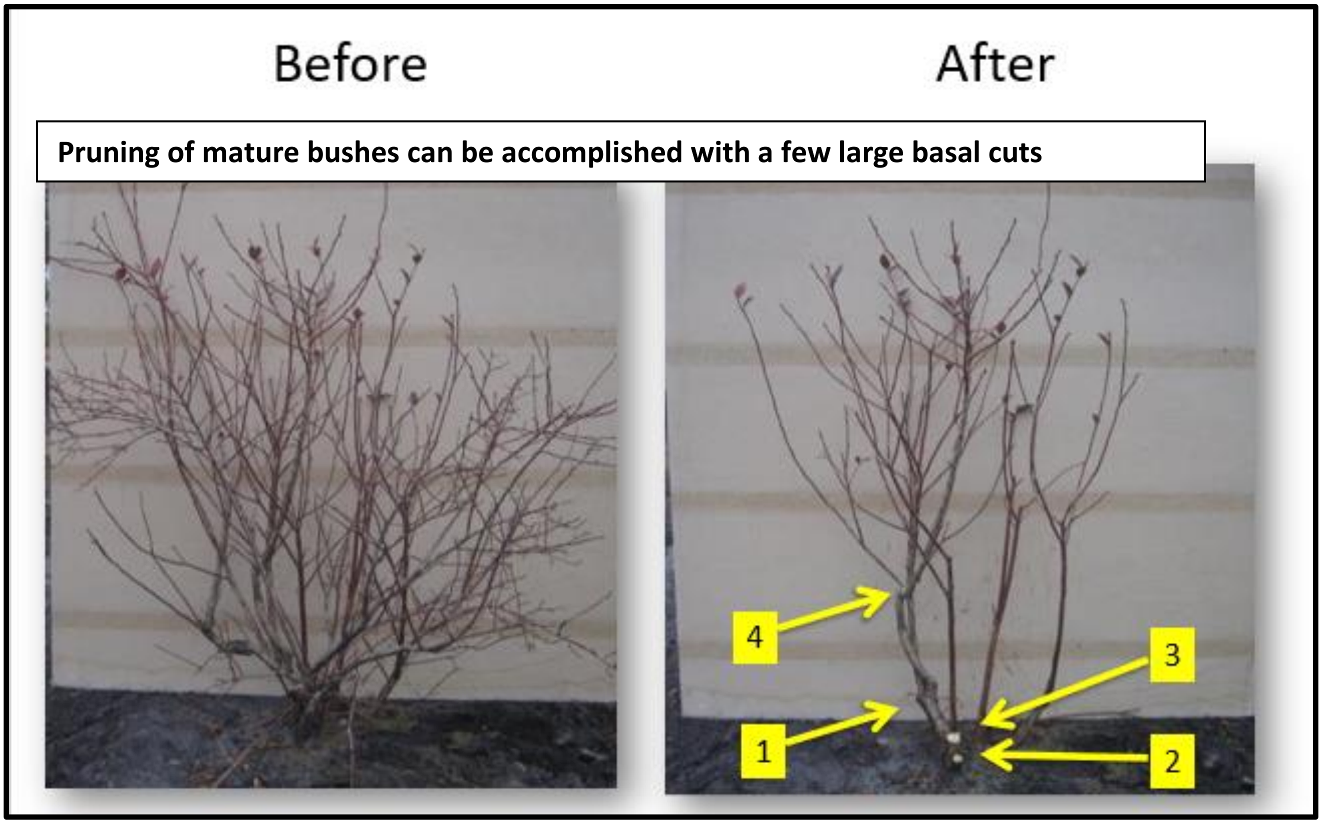
About Flower buds

Yield reduction via flower bud removal always occurs when winter pruning is done properly. This is often a sore subject with growers who are trying to maximize yields. Flower buds are readily visible during winter pruning, and it is tempting to leave too many. This is a mistake! Expect to remove at least a third of the flower buds during pruning. Why? Because overloading the bush with fruit in one year will stress the plant and cause reduced yields in following years and will eventually require even more severe pruning to bring the bush back into production.

Blueberry flower buds form in late Summer

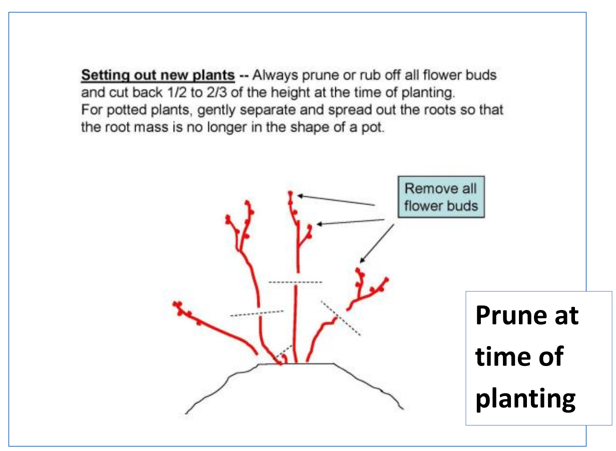
Conclusion

These basic hand-pruning steps can be used with any blueberry bush with any blueberry bush. Every cultivar has a slightly different growth habit, and only experience will tell you how to manage each. Some cultivars produce too many new shoots from the ground and require a lot of thinning, while others are less prone to sprouting. Your goal should be to have a multi-trunked bush with strong canes of all different ages emerging from the ground, so that as each older cane is removed, a younger cane is already there to replace it.

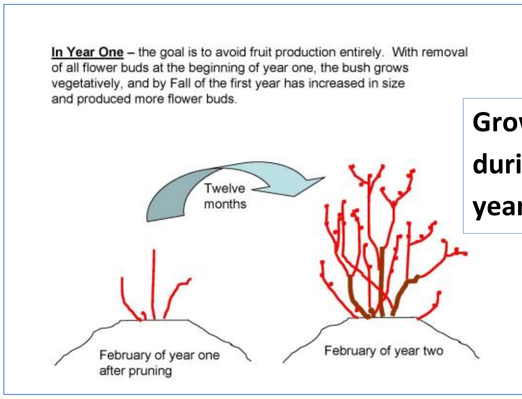


Pruning Young Blueberry Plants

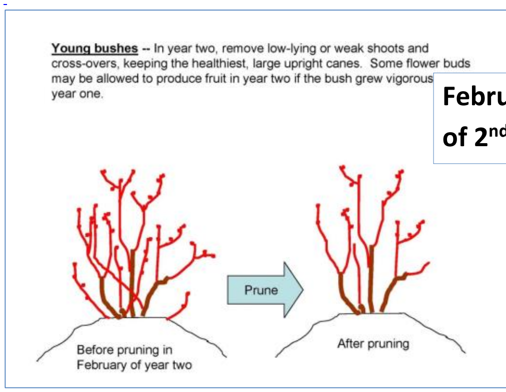
Young blueberry bushes are usually planted in late winter while fully dormant and leafless. In North Carolina, this translates to February or early March. During the first year, flower buds are removed by pruning, or by stripping off flowers by hand after the blooms emerge. In subsequent years, flower buds must be thinned to prevent overcropping and to promote the vegetative growth so vital to the establishment of a full-sized bush.



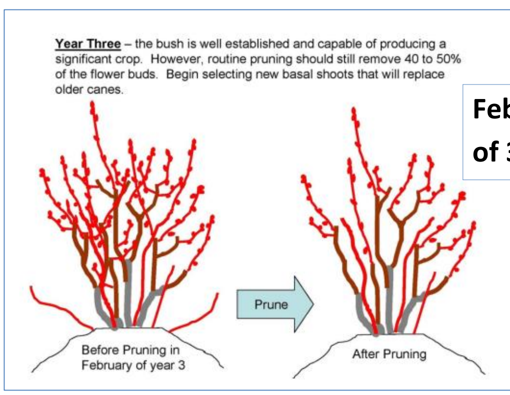
The diagrams below show growth of a single blueberry bush for the first three years, with "before" and "after" pruning comparisons each February.



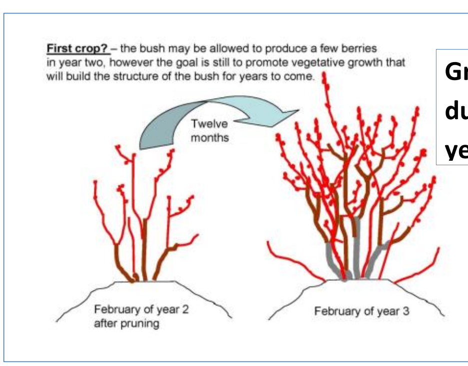
Growth during 1st year



February of 2nd year



February of 3rd year



Growth during 2nd year

The Southern Fruitcast Covers the Latest Developments in Small Fruits

Aaron Cato, University of Arkansas

The Southern Fruitcast is hosted by Aaron Cato and Amanda McWhirt, extension IPM and production specialists for fruits and vegetables at the University of Arkansas. This podcast currently has 15 episodes that cover the people, technology and latest developments in small fruit production in the Southeast. Episodes can be found at www.uaex.edu/southernfruitcast.
This purpose of this podcast is to be an easily accessible source of information about small fruits for growers and extension agents. Below we categorized each episode by the main topic and the small fruit crop they are most relevant to. This should allow you to find the episodes and information provided by this podcast that is most relevant for your operation and listen at your convenience while you work on the farm.

General information about Small Fruits
Episode 5 – *Farm-to-school Marketing and Strawberries with Randy Arnold*
In episode 5 we are joined by Randy Arnold, owner of Arnold Farms in Alma, AR. Randy shares with us his experience with marketing to local schools in farm-to-school

Topic	Ep. #	Subject	Guest	Role
General information about Small Fruits	5	Farm-to-School Marketing	Randy Arnold	Grower
	8	Substrate Production	Ryan Dickson	University
	9	Marketing Small Fruits	Ekko Barnhill	Grower
	10	Louisiana Small Fruit Production	Mary Helen Ferguson and Kiki Fontenot	Agent + University
	11	Fungicide Resistance Testing	Emran Ali	University
Blackberry and Raspberry	1	Blackberry Cultivars	John Clark	University
	4	Fresh Market Blackberry Production	Ervin Lineberger	Grower
	7	White Drupelet disorder	Eric Stafne	University
	12	Spotted Wing Drosophila	Hannah Burrack	University
Blueberry	7	Blueberry Planting Rejuvenation	Eric Stafne	University
	12	Spotted Wing Drosophila	Hannah Burrack	University
Grape and Muscadine	2	Grape Disease Management	Phil Brannen	University
	4	Fresh Market Muscadine Production	Ervin Lineberger	Grower
	14	Arkansas Quality Wine	Renee Threlfall and Amanda Fleming	University
	15	Mating Disruption and Spotted Lanternfly	Doug Pfeiffer	University
Strawberry	3	Strawberry Cultivar Options	Gina Fernandez	University
	6	Strawberry Disease Management	Guido Schnabel	University
	13	Fertility and Disease Management	Jayesh Samtani	University

programs, as well his yearly on-farm festival called “fun on the farm” that hosts 1,000 students from area schools who visit the farm and learn about agriculture.

Episode 8 – *Substrate Production of Small Fruits with Dr. Ryan Dickson*

In this episode we are joined by Dr. Ryan Dickson, a Horticulture professor specializing in greenhouse production at the University of Arkansas. Ryan gives us an excellent explanation of substrate production, as well as pros and cons of this type of production system vs. production in field soil. We also cover the feasibility of soil-less substrate production systems for small fruit crops in the Southeast and why Southeastern growers would look to adopt such a system.

Episode 9 – *Marketing Small Fruits with Ekko Barnhill*

We are joined by Ekko Barnhill from Barnhill Orchards in Lonoke, AR, a diversified farm that sales products all 12 months of the year to farmers markets, restaurants and through their farm store. We discussed considerations for marketing small fruit, how small fruit can help boost the sales of other commodities, and unique ways to bring products into the marketplace.

Episode 10 – *Small Fruit Production in Louisiana with Mary Helen Ferguson and Kiki Fontenot*

In this episode we are joined by Mary Helen Ferguson, Associate Extension Agent for Horticulture at LSU, and Kiki Fontenot, Associate Professor and Extension Specialist at LSU. They provided excellent insight into Louisiana’s production practices, how they may differ from other growing regions in the Southeast and talked about many of the challenges that Louisiana’s’ producers face.

Episode 11 – *Fungicide Resistance Testing with Dr. Emran Ali*

In this episode we are joined by Dr. Emran Ali, plant pathologist and director of the Plant Molecular Diagnostic Lab at UGA. Emran discussed the basics of pesticide resistance, fungicide resistance testing that the Plant Molecular Diagnostic lab offers and how to send in samples to assure you get good results.

Blackberry and Raspberry

Episode 1 – *Inaugural Southern Fruitcast featuring Dr. John Clark*
This episode features an interview with Dr. John Clark, University of Arkansas fruit breeder and distinguished professor. He discussed commercial blackberry production and breeding efforts in the Southeast.

Episode 4 – *Muscadine and Blackberry Production with Ervin Lineberger*
Ervin Lineberger, owner of Kildeer Farms in Kings Mountain, North Carolina, joins us for episode 4. Ervin shares with us his experience with blackberries and muscadines, provides insight into the future of muscadines as a commodity, and offers advice for growers who are looking to tap into the small fruit market.

Episode 7 – *Blueberry Planting Rejuvenation and White Drupelet Disorder of Blackberry with Dr. Eric Stafne*
In this episode we are joined by Dr. Eric Stafne, extension and research professor in fruit crops at Mississippi State University. The main topics of this episode revolve around Eric’s work in blueberry planting rejuvenation and white drupelet disorder in blackberry, where Eric provided excellent insight into his most recent findings and offered some recommendations for Southeastern growers.

Episode 12 – *Spotted Wing Drosophila with Dr. Hannah Burrack*
In this episode we are joined by Dr. Hannah Burrack, Professor of Entomology and Extension Specialist at North Carolina State University. Hannah provided wonderful insight into the last 10 years of spotted wing drosophila research and did an excellent job telling us what that research means for people trying to manage this pest in Blackberry and other crops.

Blueberry

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Grape and Muscadines

Episode 2 – *Southeast Grape Disease Management with Phil Brannen*
Dr. Phillip Brannen, extension fruit disease specialist at the University of Georgia, joins us to discuss factors influencing disease management in Southeast vineyards. Phil provides excellent insight into problems plaguing Southeast grape and muscadine production, and discusses a variety of solutions that Southeast growers can take

advantage of to maximize their success and profitability.

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Episode 14 – *Arkansas Quality Wine with Dr. Renee Threlfall and Amanda Fleming*
In this episode we are joined by Dr. Renee Threlfall and Amanda Fleming from the University of Arkansas. Renee and Amanda provide excellent insight into commercial wine production in Arkansas and discuss their newly launched program, the Arkansas Quality Wine Program.

Episode 15 – *Mating Disruption and other Chlorpyrifos Alternatives with Dr. Doug Pfeiffer*
In this episode we are joined by Dr. Doug Pfeiffer, Professor and Fruit Entomologist from the Department of Entomology at Virginia Tech. This episode includes a breakdown of everything involved with mating disruption and is a must-listen for growers or agents looking for ways to sustainably manage grape root borer or peachtree borer. We also discussed other alternatives to chlorpyrifos and even delved into spotted lanternfly and its potential to harm Southeastern vineyards.

Strawberry

Episode 3 – *Strawberry Cultivar Selection and NC State Small Fruit Breeding with Gina Fernandez*
In this episode we are joined by Dr. Gina Fernandez, Professor of Horticulture and strawberry, blackberry, and raspberry breeder at North Carolina State University. Gina came on the podcast to discuss how her new strawberry releases, Rocco and Liz, fit in with the current popular southeastern commercial cultivars. She also discussed many of her other breeding efforts such as her work with anthracnose resistance in strawberry.

Episode 6 – *Southeast Strawberry Disease Management with Guido Schnabel*
In this episode we are joined by Dr. Guido Schnabel, a plant pathologist at Clemson University. Topics discussed include fungicide selection, common resistance issues, dip applications before planting, when to use soil applied fungicides, options for fumigation, and much more.

Episode 13 – *Strawberry Fertility and Disease Management with Dr. Jayesh Samtani*
In this episode we are joined by Dr. Jayesh Samtani, Assistant Professor and Small Fruit Extension Specialist in the school of Plant and Environmental Sciences, at Virginia Tech. Topics covered in this episode include pre-plant nitrogen rates, using the SAS fungicide scheduling system in a new growing region, alternatives to fumigants for strawberry producers, and an ongoing survey relating to fertility practices in blackberry.

2022 Mid-Atlantic Strawberry Programs to be held in Virginia Beach on February 28 and March 1, 2022

Roy D. Flanagan III, Agriculture and Natural Resources Extension Agent, Virginia Beach, Virginia Cooperative Extension

As I sit here writing this article, I am realizing that a lot of the details of this year's programs are not firm, but here is what I know for sure at this point and I thought I would share a little about the history of this event.

Starting in the late 1990s, Virginia Cooperative Extension Agent, Cal Schiemann realized that Southeast Virginia growers were not traveling the large strawberry-centric meetings and including strawberry as a topic into already existing local meetings was not impactful. So, in 1999 the first Virginia Beach Strawberry School was held. Over the years the meeting grew to include a field walk program the day before the Strawberry School. These events were held annually in Virginia Beach and became a largely attended meeting, growing well beyond the boundaries of Virginia. In 2018, we renamed the program Mid-Atlantic Strawberry Programs to better represent the scope of attendees, which regularly come from as far north as Pennsylvania and as far west as Ohio. Now we run three programs over the course of two days to pack as much relevant and timely information into our time with the growers here as possible. All programs are offered at no cost to the growers, RSVP is requested.

Programs for 2022 are:

Strawberry Field Walk (*Feb. 28, 2022 12:30 p.m-dark)*: An opportunity to join some of our region's strawberry experts and growers in the fields. The program and discussion will come from the situations seen in the fields and the questions from growers. We will visit two Virginia Beach Strawberry Farms. The exact locations and details are TBD.

Evening Program *(Feb. 28, 2022 5:30-9:00p.m. or so)*:

Location: Creeds Ruritan Community Complex, 1057 Princess Anne Rd., Virginia Beach, VA 23457

Topic: Soil Fumigant Certified Applicator Training

This three + hour program will be an in-person opportunity to get the required training and certification to fumigate with your private pesticide applicator license. The certification covers you for three years. We are still waiting on a full blessing from EPA through the Virginia Department of Agriculture and Consumer Services. Dinner will be included and attendees at this program.

Strawberry School and Trade Show *(March 1, 2022 8:00a.m.-4:00 p.m.)*:

Location: VB Advanced Technology Center, 1800 College Crescent, on the VB Tidewater Community College Campus.

The Regional strawberry experts will be providing us with information on fertility programs, variety selection, overall strawberry production considerations, a forecast for the 2022 crop, and more. There will also be an update from the Virginia Strawberry Association during their annual business meeting to be held at lunchtime. We will also have ample time for attendees to visit with our awesome program sponsors and learn about their products and services.

Lunch is included for the attendees of this program. **To make sure you get the details later or for any questions, please drop me an email at royf@vt.edu**

North Carolina State University takes the lead on a $5,294,195 USDA SCRI project to develop cleaner propagation technology for the strawberry industry

Mark Hoffmann, Small Fruits Extension Specialist (NCSU) and Amanda Lewis, Small Fruits Communication Assistant (NCSU).

The journey of a strawberry plant does not start when it is transplanted into the growing field. On the contrary, before a grower receives a plant, it already has a large and complex journey behind it. One could say that it is impossible to understand strawberry production without understanding those dynamics between the strawberry nursery and fruit production. Strawberry nurseries are the bedrock of the entire strawberry supply chain. Without nurseries, there would not be the abundance of plant material that is needed for annual hill strawberry plasticulture production.

The life of a strawberry plant usually starts in virus-free tissue culture systems. From there, plants are propagated in greenhouses and later moved into open-field settings (Figure 1) for many years and in several locations, all belonging usually to a single strawberry nursery. Most of those 'full system nurseries' are located either in California, Canada, or North Carolina. At the end of this multi-year and multi-site cycle, plants are dug and sold as bare-root plants to growers in all America (Figure 2). While bare-root plants are the most common transplant in California and Florida, some nurseries also cut daughter plants (tips) off the runners. These tips are then usually sold to plug plant producers. Those plug producers are usually local operations, located in Virginia, Canda, North Carolina, Ohio, South Carolina, Georgia and other states. Plug plants are mostly used in the Eastern United States and Canada.

Figure 1: A strawberry propagation field in Macdoel (Northern California) in August 2021, shortly before the digging season begins.

As everyone can imagine, this complicated process of plant production, shipping, and planting is far from perfect and comes with some larger problems for both nurseries and growers. For example, nurseries are using Methyl Bromide (MB)-Chloropicrin mixes for soil disinfestation. However, with no viable alternatives on the horizon for strawberry nurseries, the industry hangs on the lifeline of [critical use exemptions](). One owner of a large nursery in California brought up the point when we talked to him last year, "If Methyl Bromide was phased out today, the nursery industry will need alternative propagation tools tomorrow."

Figure 2: Freshly dug strawberry plants (before trimming) in Northern California

In addition, plant material can still be a symptomless carrier of diseases, that probably did not show while under nursery conditions, but show up in the humid and hot climate of the Southeast. Diseases such as Anthracnose crown and fruit rot, *Botrytis* fruit rot, *Phytophthora* crown rot, angular leaf spot and many more cause problems for growers every year.

To move on from this situation, the nursery industry is in dire need of new MB free tools to propagate strawberry plants. Those tools also need to ensure plants can be propagated in a cleaner and less cost intensive fashion. Controlled environment technology (Figure 3) can be such a tool. While it is more common in Europe, the industry in United States has yet to adopt such technology.

Figure 3: Strawberry propagation in a propagation chamber at the Phytotron at North Carolina State University.

More than three years ago, Dr. Mark Hoffmann had recognized the nationwide implications of these problems. While being very apparent in North Carolina and the rest of the Southeast, it was clear that this was just part of a much larger, system wide issue. At the same time, research on strawberry propagation was already underway in the controlled environment group with Dr. Ricardo Hernández at NCSU.

In 2017, Dr. Hoffmann took the lead on a more comprehensive project on strawberry propagation. Over three years, he put together a collaborative nationwide project with key stakeholders and scientists, focusing on the aim to develop new propagation tools for the cleaner and more effective strawberry propagation. The technologies developed were protocols to optimize propagation and conditioning of strawberry plants in controlled environment, greenhouses, and field environments.

Dr. Hoffmann leads a team of 19 PIs and Co-PIs in 11 institutions across the country. This team collaborates with more than 30 industry partners world-wide, some of which are in North Carolina, California, and Canada. The team applied for funding for the first time in 2020, but without success. However, through the determination of every team member to make this work, and the will of strawberry nurseries and stakeholders to collaboratively work towards such a goal, the second project proposal was successful.

In November 2021, the USDA-NIFA Specialty Crop Research Initiative (SCRI) awarded Dr. Hoffmann's team with $5,294,195 for a four year project to investigate the application of controlled environment technology in strawberry propagation. The aim of this nationwide project is to develop and transfer new propagation technology to stakeholders across the country, eventually providing new tools for strawberry propagation in a MB-free era.

This is the first time a nationwide, coordinated research and extension project on strawberries is funded without having the lead institution in California or Florida. The project will benefit not just growers in the Southeast, but eventually every grower in the United States, and expands on the efforts of the National Clean Plant Network (NCPN). The project is driven by a critical need identified by the entire strawberry industry: providing technology that will allow the strawberry industry to acquire a sustainable source of clean plant material through innovation, collaboration, translational science, and outreach.

The team lead is entirely rooted at North Carolina State University (Figure 4). Dr. Mark Hoffmann is the Project Director. He holds an appointment as Small Fruits Extension Specialist and Assistant Professor. Dr. Ricardo Hernández is Co-Project Director. He is a nationwide renowned Controlled Environment expert and Associate Professor at NCSU. Dr. Gina Fernandez is also Co-Director of the project. She took on the NCSU strawberry breeding program in 2017 and is a distinguished Professor in the Department of Horticultural Science at NCSU.

Researchers from the USDA-ARS, Virginia Tech, Rutgers, University of Maryland, The Ohio State University, Cornell University, University of Florida, UC Davis, UC ANR and the strawberry center at Cal Poly San Lius Obispo are also engaged in this project.

More information can be found under: strawberries-pip.cals.ncsu.edu.

Figure 4: The project director (PD) and Co project directors (Co-PDs) of the Strawberry Propagation SCRI project are all member of the Department of Horticultural Science at NC State University. From left to right: PD Dr. Mark Hoffmann (Assistant Professor and Small Fruits Extension Specialist); Co-PD Ricardo Hernández (Associate Professor and Controlled Environment Specialist); Co-PD Gina Fernandez (distinguished Professor and Strawberry Breeder).

Investigating the Potential of Disease Resistant *Vitis vinifera* (European) Grape Progeny for the Southeast

Elina Coneva and Kassie Conner
Auburn University

Pierce's disease (PD) on grapes is the major limiting factor for growing *Vitis vinifera* (European) grapes in Alabama and the southeastern U.S. Generally, PD infection causes vine decline, yield loss, and vine death typically occurs within two to three years of infection. Management efforts are focused on the development of grape selections resistant to this devastating bacterial disease. The UC Davis grape breeding program has developed predominantly *V. vinifera* progeny breeding lines with PD resistance and has recently released five new cultivars for commercial use. Information on production technology for the newly developed hybrids is lacking for Alabama and the S.E. region.

An experimental site was established at the Chilton Research and Extension Center near Clanton, Alabama in 2017 with the purpose to: 1) investigate the production potential of newly developed Pierce's Disease (PD) resistant 94% *Vitis vinifera* grape '502-20' in Alabama where the PD risk is high and to: 2) establish the optimal planting distance for sustainable production. Three planting distances (6' X 12', 7' X 12', and 8' X 12'), where tested to evaluate the cropping potential, vegetative growth, and assess the fruit quality of '502-20' grape. Vines are trained to the high-cordon divided canopy Watson training system utilized for improved vineyard management practices, improved canopy environment, and enhanced fruit quality.

During the early spring, vines were dormant pruned to 12 spurs per vine (6 spurs/cordon) with two buds per spur retained for a total number of 24 buds retained per vine. The dormant pruning weights were recorded for each individual plant and vine flowering progression was observed. Young shoots were trained and tied to the support wires as soon as they reached the proper length. Shoot thinning was conducted in early spring to maintain the desirable shoot number in the canopy. Petiole samples were submitted to the Plant Diagnostic Lab where Dr. Conner conducted a PCR test to establish the presence of *Xf* infection in the experimental vines.

The final stages of berry veraison and fruit maturity were documented during the summer. Fruit was harvested on August 7, 2020 and on August 13, 2021. Each season, the total yield per vine and the total cluster number per vine were measured and recorded. A five cluster per vine sample was collected to determine mean cluster weight. Other fruit quality attributes such as mean berry weight was determined on a sub-sample of 50 berries per vine. To record berry soluble solids content, the juice from 10 berries was extracted.

Our data on dormant pruning weight per vine suggests planting distance did not significantly affect the vigor of 502-20 vines, which was very uniform for all treatments in 2020, while in 2021 season the 7' X 12' planting distance resulted in slightly reduced vine vigor based on the results for plant dormant pruning weight (Figure 1).

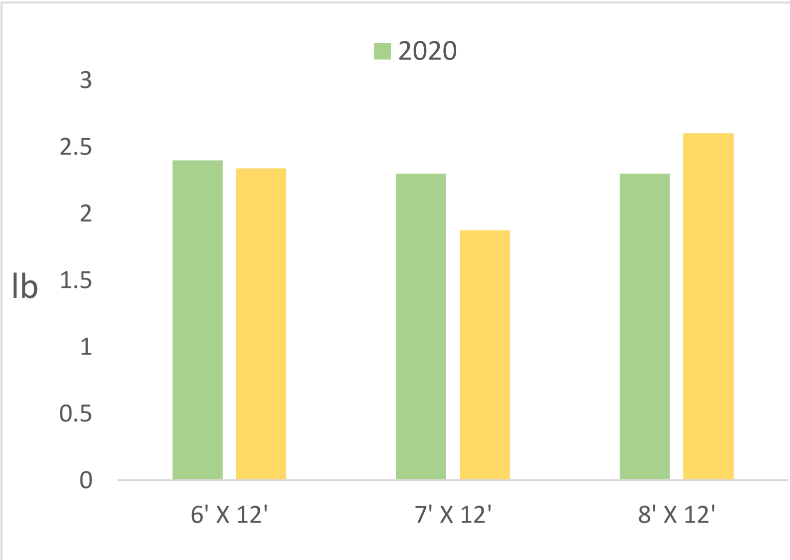


Figure 1. Effect of planting distance on dormant pruning weight (lb) of predominantly V. vinifera selection 502-20 grown at the CREC, Clanton, AL, 2020-2021.

Results for total yield per vine (Table 1) suggest similar cropping level (between 8.5 and 8.8 kg/vine) regardless of planting distances during 2020. During the next season, the 6' X 12' and 7' X 12' treatments yielded between 8.0 and 8.6 kg/vine respectively, while the 8' X 12' planting distance resulted in significantly higher crop of 12.6 kg/vine.

Average number of clusters/vine was not statistically different during the reported period, and varied between 27.7 and 31.6 during 2020 and between 35 and 54 in 2021 with the 8' X 12' treatment producing the highest number of clusters (31.6 and 54.0 respectively) in both seasons (Table 2). Mean cluster weight varied between 367.2 g for vines planted at 6' X 12' to 394.3 g for vines planted at 7' X 12' during the 2020 season, and was between 569.0 and 621.2 g in 2021 (Figure 2). The 7' X 12' planting distance resulted in the largest cluster size in both study years, although no statistical difference between the treatments was found.

No statistical difference was found to affect the mean individual berry weight between planting distance treatments. In general, mean berry size was larger in 2021, likely due to the rainier season with above average rain events and rainwater accumulation (Table 3). Berry soluble solids content was similar for all planting distances in 2020 and was highest for the 8' X 12' distance in 2021, while the 7' X 12' planted grapes had the lowest sugar content of 16.3%.

Petiole samples were collected from each individual vine after harvest in mid-October, 2021 to test for the presence of *Xylella fastidiosa* infection. The conducted PCR analysis returned negative results. No Pierce's disease infected vines were found from the PD resistant predominantly *V. vinifera* selection 502-20 after five years of cultivation in the high PD risk zone of central Alabama, while the adjacent PD tolerant American and French-American hybrid bunch grapevines were showing 37% infected plants in 2021.

The study results are promising as yield and fruit quality of 502-20 grape suggest that cultivation of high-value PD resistant European grape progeny can provide an excellent opportunity for the development of value-added products and can contribute to sustain rural communities in the Southeast by creating conditions for economic growth and development, while boosting existing industries such as the local agritourism. Research will continue to more completely evaluate the cropping potential and determine the optimal cultivation

Table 1. Effect of planting distance on yield of 502-20 grape selection, 2020-2021.

	Total Yield, kg	
	2020	2021
6' X 12'	8.5	8.0 b
7' X 12'	8.8	8.6 b
8' X 12'	8.8	12.6 a

technology for PD resistant predominantly *V. vinifera* grape.

Table 2. Effect of planting distance on number of clusters and mean cluster weight of 502-20 grape selection, 2020-2021.

Planting density	Average No. of clusters/ vine		Mean cluster weight, g	
	2020	2021	2020	2021
6' X 12'	28.0	35.0	367.2	569.0
7' X 12'	27.7	35.0	394.3	621.2
8' X 12'	31.6	54.0	377.0	597.9

Table 3. Effect of planting distance on individual berry weight and SSC of '502-20' grape, 2020-2021.

Planting distance	Mean berry weight, g		Brix, %	
	2020	2021	2020	2021
6' X 12'	2.0	2.8	18.7	17.1 ab
7' X 12'	2.1	2.9	18.5	16.3 b
8' X 12'	2.2	2.8	18.4	18.1 a

Figure 2. Fruit clusters of 502-20 grape grown at the CREC, Clanton, AL, 2021.

Determining Hand Harvest Parameters and Postharvest Marketability Impacts of Fresh-market Blackberries to Develop a Soft-robotic Gripper for Robotic Harvesting

Andrea Myers, M.S. Graduate Student, and Dr. Renee Threlfall, Research Scientist, University of Arkansas System Division of Agriculture Food Science Department

Introduction

Fresh-market blackberries (*Rubus L.* subgenus *Rubus* Watson), known for health promoting benefits, are hand-picked to maintain quality from harvest to consumption. As value and demand grows for fresh-market blackberries, harvest labor shortages and costs hamper potential industry expansion and supply. While conventional mechanical harvesting of blackberries decreases labor costs and time to harvest the delicate nature of blackberry fruit, coupled with dense plant canopy, has prohibited mechanical harvesting for fresh-market blackberries.

Robotic harvesting has the potential to impact the fresh-market blackberry industry. A research project was initiated at the University of Arkansas System (UA System) Division of Agriculture by Drs. Renee Threlfall and Yue Chen to investigate the feasibility of a robotic harvester of fresh-market blackberries and their marketability. This project is supported by the University of Arkansas Chancellor's Innovation and Collaboration Fund Grant and from the Arkansas Department of Agriculture's Specialty Crop Block Grant Program. Andrea Myers and Anthony Gunderman, graduate students, worked on the development of a soft-robotic gripper as part of their research.

Measuring force

The first step in developing the robotic harvester was determining a method to measure force. Ultimately, the apparatus used was designed with resistive force sensors placed beneath silicone finger covers positioned on the thumb, index, middle, and ring fingers of the right hand. Sensors were located on the fingers to maximize contact with the berry surface during harvesting. (Fig.1). Voltage data was measured with a single power source, non-inverting op-amp circuit. Voltage measurements were sent through Bluetooth and then converted to force values. Data recording and processing were conducted in a portable, water-resistant cause housed in a backpack (Fig. 2).

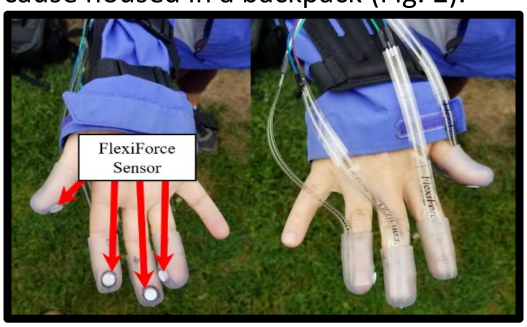


Figure 1: Hand with force sensors used for force measurements to harvest blackberries

Figure 2: Harvesting blackberries while recording force measurements

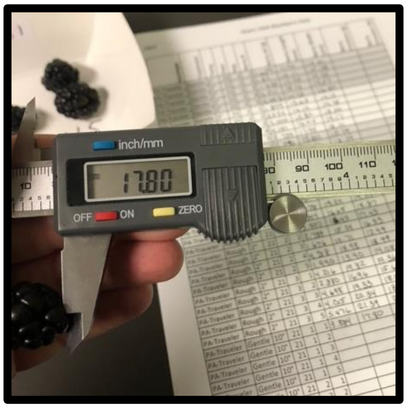
Blackberry harvest

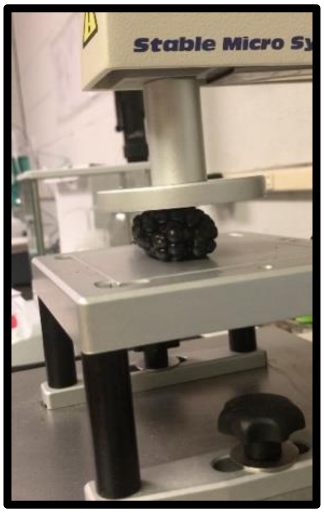
The blackberries were grown at a commercial farm in Fayetteville, AR and harvested at peak ripeness in June-July 2020. Four cultivars (Natchez, Osage, Prime-Ark® Traveler, and Sweet-Ark™ Caddo) were harvested. The blackberries were harvested by hand using the custom-made force sensing apparatus (Fig. 3) and then transported to the UA System Food Science Department in Fayetteville for analysis.

Figure 3: Hand with sensors harvesting a ripe blackberry

Berry analysis-physical and composition

The blackberries physical (weight, length, width, and firmness) attributes were analyzed at harvest (Fig. 4). Five berries from each clamshell were analyzed (Fig.5). The berries were frozen and then thawed at room temperature and squeezed through cheesecloth to extract juice for composition (soluble solids, pH, and titratable acidity) analysis (Fig.6). At harvest Sweet-Ark™ Caddo was the largest berry in terms of weight (8.10 g), length (29.06 mm), and was the firmest blackberry (8.79 N). Osage was the smallest berry in weight (3.76 g), width (19.05 mm) and was the softest berry (6.27 N). Soluble solids ranged from 12.47 - 11.63%, Natchez and Sweet-Ark™ respectively. Osage had the highest pH (3.39) and Natchez had the lowest (3.07). Natchez had the highest titratable acidity (1.40%) and Prime-Ark® Traveler had the lowest (1.07%).





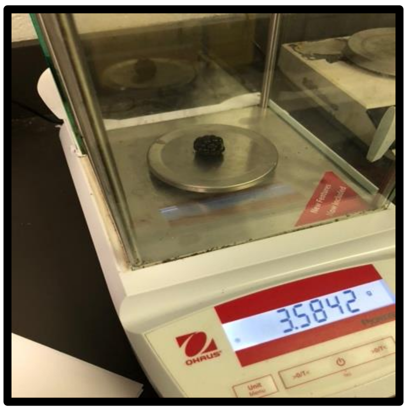
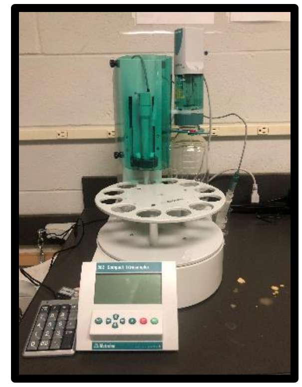


Figure 4:Tools used to measure physical attributes: precision scale to measure blackberry weight (left), digital calipers to measure blackberry width and length (middle), and texture analyzer to measure blackberry firmness (right)

Figure 5: Five blackberries per clamshell evaluated



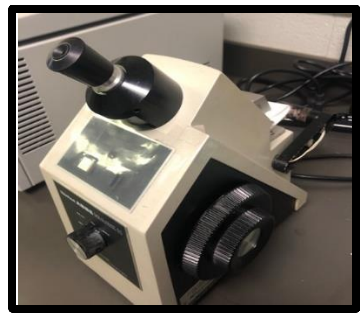


Figure 6: Equipment used to measure composition juice (left) included a refractomoter (middle) and titrosampler (right)

Berry analysis-marketability

The marketability attributes (weight loss, leakage, decay, and red drupelet reversion) were evaluated at harvest and at 21 days post-harvest (Fig. 7). Cultivar did not impact any marketability attributes after 21 d of storage at 2 °C. Leakage was less than 10%, decay was less than 2%, and red drupelet reversion was less than 9% for these cultivars. The average leakage was 6%, decay was 0.4% and red drupelet was 5% across all cultivars.

Figure 7: Measuring leakage by rolling blackberry on white paper towel (left), blackberry with decay (middle), and red drupelet reversion (right)

Force analysis

The force measured on the thumb and fingers was different for each cultivar of blackberries (Table 1). 'Sweet-Ark™ Caddo' (1.18 N) had the highest force on the thumb, and 'Prime-Ark® Traveler' (0.51 N) had the lowest. For the index and middle fingers, 'Natchez' had the highest force (0.27 N and 0.49, respectively) and 'Osage' had the lowest (0.09 N and 0.31 N, respectively). In addition, 'Sweet-Ark™ Caddo' also had the lowest force on the middle finger (0.31 N). For the ring finger, 'Sweet-Ark™ Caddo' (0.15 N) had the highest force, and 'Prime-Ark® Traveler' (0.01 N) had the lowest. Generally, the size of the berry was related to the force needed to harvest. 'Caddo', the largest berry, had the greatest force needed to harvest, whereas 'Prime-Ark® Traveler', the smallest berry, had the least force needed to harvest.

Table 1: Forces measured (N) to hand harvest blackberries by cultivar and finger

Cultivar	**Thumb**	**Index**	**Middle**	**Ring**
Natchez	0.75	0.27	0.49	0.05
Osage	0.65	0.09	0.31	0.03
Prime-Ark® Traveler	0.51	0.10	0.37	0.01
Sweet-Ark™ Caddo	1.18	0.17	0.31	0.15
Average of cultivars	***0.77***	***0.16***	***0.37***	***0.06***

Regardless of cultivar, the thumb applied the highest average force (0.77 N), followed by middle finger (0.37 N), index finger (0.16 N), and ring finger (0.06 N). The thumb and middle finger were the primary force applicators while the index and ring fingers stabilized the berry. In terms of providing guidance to develop a robotic soft gripper, the underutilization of the ring finger (4% of total applied force) in the harvest of blackberries illustrated only three fingers are needed for a robotic design.

This force-sensing apparatus for harvesting fresh-market blackberries provided foundational data on harvesting force parameters essential in the design of a robotic gripper prototype. This project is only the first step to develop a soft robotic gripper for commercial use in harvesting fresh-market blackberries.

Recognizing and Managing Nematode Damage in Strawberries

Johan Desaeger, Assistant Professor of Entomology and Nematology, University of Florida, Institute of Food and Agricultural Services

Nematodes are one of the most underestimated agricultural pests, and this is no exception in strawberries. Particularly damaging and difficult to manage is the sting nematode (*Belonolaimus longicaudatus*, literally 'long-tailed arrow-like plague'). Sting nematodes are native to the sandy coastal plains of the southeastern U.S. and are very widespread in Florida strawberry fields. They are one of the largest plant-parasitic nematodes, measuring almost 1/10 inch long. They have a very long stylet, a hypodermic-like needle which is used to feed on strawberry roots, killing the root meristem and halting root growth. Lateral roots will develop, but the nematode will migrate to these lateral roots and damage them as well. This causes an abbreviated and stubby-looking root system (Photo 1). Sting nematodes have a strong preference for sandy soils and rarely cause problems in heavier and more organic soils. Other nematodes of importance are the northern root-knot nematode (*Meloidogyne hapla*, https://edis.ifas.ufl.edu/in1224), which causes knots or galls on the roots, and the northern lesion nematode (*Pratylenchus penetrans*), which causes dark lesions on the roots. As the common name implies, these nematodes are found mostly in northern regions and are more adapted to cooler temperatures. Both nematodes are endoparastic, which means they live inside the roots, and therefore can be spread via strawberry transplants. In Florida, they probably have been introduced with infected transplants from the northern U. S. and Canada, where most of Florida's strawberry plants are grown. Another nematode that can infect strawberries and can be spread with transplants are foliar or bud nematodes (*Aphelenchoides besseyi*, *A. ritzemabosi*, and *A. fragariae*). Foliar nematodes (*A. besseyi*, http://edis.ifas.ufl.edu/in1184) were found causing considerable damage in several strawberry farms in Florida in 2016-17. Although they have been reported from Florida since the early 1900's, the most recent infection likely originated in an out-of-state nursery. Foliar nematode symptoms on strawberry include deformation of buds, leaves, and flowers; undersized leaves with crinkled edges; tight crowns; reddened and stunted petioles; and few flowers and fruits (Photo 2). Those symptoms can be confused with mite or insect damage, which is why suspected plants are rarely diagnosed for nematode presence.

Photo 1 – Strawberry root damage/pruning caused by sting nematodes. Photo: J. Desaeger, University of Florida.

Both sting and root-knot nematodes can cause stunting of plants and reddening and yellowing of foliage (Photo 3). Sting nematodes tend to cause more damage earlier in the season, as soon as plants start producing fruit, whereas root-knot nematode damage more typically occurs

towards the end of the season when soils are cooler. Root-knot nematodes can cause late season collapse of strawberries, but yield loss at this time has less of an economic impact, unlike the early season damage caused by sting nematodes. However, yield loss can be severe when vegetable double-crops, such as melons, squash, or pepper, are planted following the strawberry crop, which is a common practice in Florida (Photo 4). In this case, it is recommended to apply a nematicide to help protect the double crop.
The northern root-knot nematode is the only root-knot nematode species that causes damage to strawberries. Other more common root-knot nematode species in the southern US, like the southern root-knot (*M. incognita*), the Javanese root-knot (*M. javanica*), and the peanut root-knot (*M. arenaria*) nematode, can cause considerable damage to vegetables and other crops but they do not seem to infect strawberries.

Young strawberry plants are much more susceptible to nematode damage, and it is key to minimize nematode damage right from the get-go. Once plants become damaged by nematodes, it is very difficult to remediate. Typically, nematode management is started before planting, in most cases by applying soil fumigants like 1,3-D (example product: Telone) and metam (example product: K-pam). These products should be applied when installing plastic-mulch beds, which can be anywhere from 3-6 weeks before planting. In severely infested fields, an additional deep-shank broadcast application of 1,3-D is recommended prior to bed formation. This will target nematodes that are hiding below the hardpan, which are not harmed by regular shank fumigation with 1,3-D, that mostly targets nematodes above the hardpan.

Photo 2 – Stunted strawberry plants and distorted leaves caused by foliar nematodes. Photo: J. Desaeger, University of Florida.

While fumigants have to be applied by specially licensed applicators and buffer zone and other restrictions have to be followed, this is not the case for two recently introduced non-fumigant nematicides: fluensulfone (Nimitz) and fluopyram (Velum). These products pose little risk for the applicators and can easily be applied through the drip irrigation system. Nimitz should be applied about 7 days before planting while Velum can be applied during the season as long as the maximum rate is not exceeded. Field trials in Florida have shown promising results, especially with a Nimitz-Velum program.

For organic growers, none of these options are available and other tools have to be used. Pre-plant treatments that avoid the use of chemicals, such as (bio-)solarization, steaming, and anaerobic soil disinfestation (ASD) can be effective; however, these treatments are not practical for large fields, and limited data is available on their efficacy in the southeast. Soil amendments, based on crustacean or mustard meal, are used by some growers, both as a natural fertilizer and to stimulate the soil microbiome. The soil microbial community contains many bacterial and fungal antagonists of nematodes and can contribute greatly to natural nematode suppression. A better understanding on how to stimulate these communities could provide opportunities for future non-chemical nematode management.

Photo 3 – Stunted strawberry plants and discoloration of leaves caused by sting nematodes. Photo: J. Desaeger, University of Florida.

One of the most practical tools for nematode management is the use of cover crops. Cover crops, such as velvet bean (*Mucuna pruriens*), sunn hemp (*Crotalaria juncea*), and sorghum-sudan grass, are all poor hosts to root-knot nematodes and good rotational crops for soil improvement and root-knot nematode management. However, while cover crops may be poor hosts to one type of nematode, they may increase other nematodes. For instance, sorghum-sudan will increase sting nematode populations, while both sorghum and Sunn hemp may increase lesion nematode populations. Planting cover crop mixtures could be one way to limit selection for one specific nematode and build a more diverse nematode population in the soil.

Several biological nematicides include compounds derived from either plants (thyme, mustard, neem and other plant oils; example products: Promax, Dazitol, and AzaGuard), or bacteria and fungi (example products: Majestene and DiTera). Others are nematode biocontrol agents, such as nematode-parasitic fungi (example product: MeloCon) or antagonistic fungi and bacteria. Biological products typically require multiple applications, and in the case of biological agents, which are live organisms, environmental conditions can significantly impact their performance. The lack of field research data on organic nematicides remains one of the main issues; if they are to become an effective part of organic management programs, this will require significantly more investment into research as to how to best use these products.

Nematodes only move short distances on their own; thus, spread mostly occurs through movement of infested soil and planting material. Prevention is therefore a key element of any nematode management program. Tools and equipment should only be shared with other farms after proper cleaning. Using clean planting material is especially important for strawberry transplants. Recent research at the University of Florida has shown that strawberry transplant steam treatments prior to planting can help to control nematodes inside nursery transplants. Host resistance is one of the best management tools for any pest or disease, but as of now, no nematode-resistant strawberry cultivars are available.

Nematodes are just one of many pests and diseases that strawberries growers in Florida have to deal with, but they may be the most difficult to manage. Nematodes can be very hard to detect, as they move to deeper soil layers or become dormant during the off season. This seems to be especially true for sting nematodes in strawberry fields. Prevention is key and recognizing and keeping track of problematic fields or areas within a field that are prone to nematode damage is the first step for successful management of these often-neglected pests.

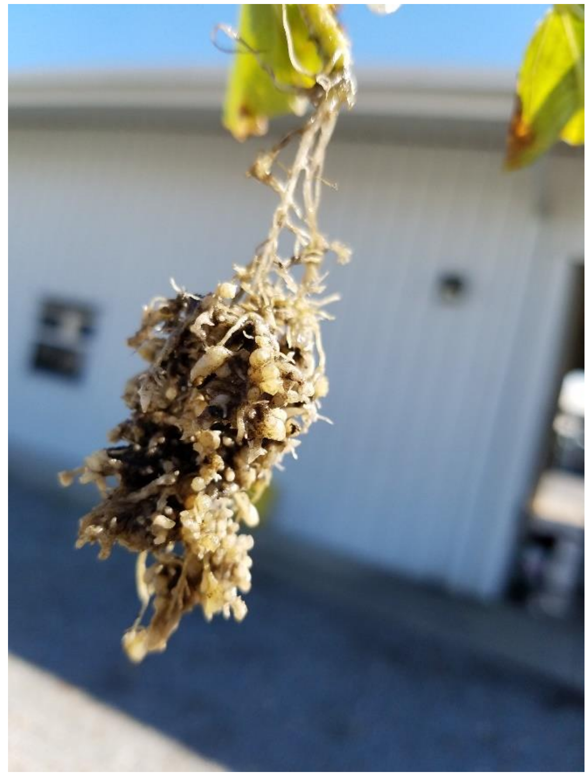


Photo 4 – Northern root-knot nematode damage on cantaloupe double-crop following strawberry. Photo: J. Desaeger, University of Florida.

Next issue of the Small Fruit News: April 2022

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