Sustainable Anthracnose Management for Watermelon and Cucumber Growers in the Eastern U.S.

Accomplishment Summary 2024-2025

Award Number: 2023-51181-41156

USDA NIFA

United States Department of Agriculture
National Institute of Food and Agriculture

CUCURBIT ANTHRACNOSE
USDA-NIFA-SCRI

Specialty Crop Research Initiative

Table of Contents

Georgia State Accomplishment Summary (Kaur/Dutta; GA)

1. Commercial field survey: A total of 329 isolates were collected from 14 commercial fields in 2025 (Figure 1). One hundred eighty-two isolates were collected from seven cucumber fields; one hundred twenty-two isolates were collected from six watermelon fields and twenty-five isolates from muskmelon from one field in Georgia (Table 1). Isolates were characterized morphologically and using newly developed *C. orbiculare*-specific-PCR assay. In case of cucumber, the detection frequence ranged from 96 to 100% (mean = 98%) while it was 38 to 100% in case of watermelon (mean= 80%).

2. *Colletotrichum orbiculare* specific primers screened in seven states: Conventional PCR primer developed for detecting *C. orbiculare* was shared with co-PIs for screening their isolates. Of the six states that screened and tested the specificity of *C. orbiculare* specific primers, it was found to be specific across five states in detecting *C. orbiculare* except one of the species, *C. sojae* where it was also shown to cross react with this primer set from Virginia isolates collection.

Table 1. *Colletotrichum* spp. isolates collected from commercial field surveys from cucurbits in Georgia.

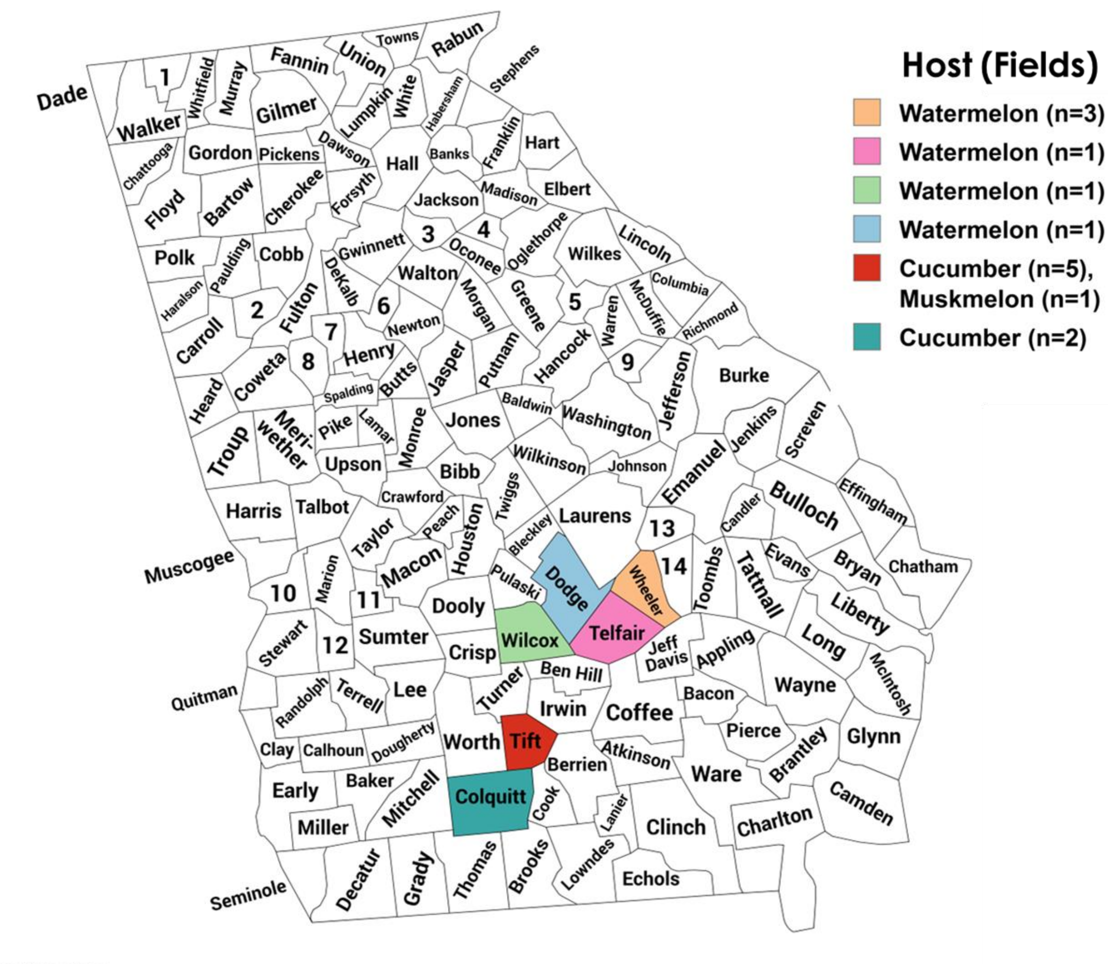
Year	Host	Location of fields	Number of isolates collected	Number of isolates detected as *C. orbiculare**
2025	Cucumber	Tift Co. (Field-1)	29	28
		Tift Co. (Field-2)	28	27
		Tift Co. (Field-3)	25	25
		Tift Co. (Field-4)	28	28
		Tift Co. (Field-5)	26	26
		Colquitt Co. (Field-1)	25	25
		Colquitt Co. (Field-2)	17	17
	Watermelon	Telfair	22	19
		Wheeler Co. (Field-1)	25	19

	Wheeler Co. (Field-2)	13	5
	Wheeler Co. (Field-3)	18	15
	Wilcox Co.	22	19
	Dodge Co.	23	22
Muskmelon	Tift Co.	25	20

*****PCR confirmation with newly designed *C. orbiculare* specific primers

Grand total number of isolates (*n*=329): watermelon (*n*=122; 6 fields), cucumber (*n*=182; 7 fields) and muskmelon (*n*=25; 1 field).

Figure 1. Map of commercial field surveys from cucurbits infected with anthracnose in Georgia.



3. Evaluation of conventional and organic fungicides: Four separate field trials were conducted to evaluate the efficacy of conventional and organic products on anthracnose severity in cucumber and watermelon in Georgia in 2025. All the trials were inoculated with an aggressive isolate of *C. orbiculare* from GA. In the watermelon conventional fungicide trial, except for Miravis Prime and Proline none of the tested fungicides (Bravo, Manzate, Topsin, Cabrio, Tebuconazole, Cevya and Switch) were able to reduce AUDPC values significantly compared to the non-treated plots. Interestingly in case of cucumbers, except for Manzate and Proline none of the fungicides (Bravo, Topsin, Miravis Prime, Cabrio, Tebuconazole, Cevya and Switch) were able to reduce AUDPC values significantly compared to the non-treated plots. A panel of OMRI-listed fungicides (Guarda, Oxidate, Howler, LifeGard, Microthiol Disperss, OSO, and Timorex ACT) were also evaluated in watermelon and cucumber against *C. orbiculare* foliar severity. Similar to last year, none of the OMRI-listed fungicides were able to reduce foliar anthracnose severity in watermelon and cucumber. In both the trials, Bravo performed significantly better than the OMRI-listed products.

Characterization of *C. orbiculare* isolates and marker development (Brewer, UGA)

Our goal is to understand the causal species of cucurbit anthracnose, the population genetic structure of *C. orbiculare*, and the development of fungicide resistance across populations. To identify species, we used multilocus sequencing and sequenced nine *C. orbiculare* isolates from watermelon (4), cucumber (3), and cantaloupe (2) using GAPDH, GS, and H3 genes. Only GAPDH showed differences among hosts. Watermelon isolates had one SNP, while cucumber and cantaloupe were identical. GS and H3 did not vary within *C. orbiculare* but GS distinguished *C. orbiculare* from other *Colletotrichum* species like *C. spisosum*. For fungicide resistance analysis, a QoI sensitivity assay was conducted on 51 isolates collected from 2021 to 2024 in Georgia. It showed watermelon isolates were more sensitive (mean EC_{50} = 0.28 µg/mL) than cucumber (1.39 µg/mL) and cantaloupe (1.01 µg/mL). Tests with 2025 isolates are ongoing. We developed *cytb*-based PCR primers and confirmed that all watermelon isolates were wild type, whereas cucumber and cantaloupe isolates carried the F129L mutation linked to partial QoI resistance. A PCR-based CAPS marker using the BstNI enzyme was developed to distinguish the F129L alleles. Wild-type isolates produced a ~400 bp digested fragment, while mutant isolates remained undigested (~550 bp). About 30 isolates were validated through *cytb* sequencing and marker confirmation. We are currently conducting DMI fungicide sensitivity assays, and preliminary results indicate that the 2025 watermelon isolates from Georgia are less sensitive than the 2021 watermelon isolates and less sensitive than the cucumber and cantaloupe isolates from Georgia.

To produce high quality reference genomes, we generated PacBio HiFi assemblies for one watermelon and one cucumber isolate. Synteny analysis indicated extensive genome-wide collinearity alongside numerous structural variants and intrachromosomal exchanges. We then constructed a graph pangenome, trimmed Illumina reads from 96 *C. orbiculare* isolates collected from four cucurbit hosts across five states, and aligned them to the pangenome for variant calling. Phylogenic, Principal component and ADMIXTURE analyses revealed structure associated with both host and geography. All Georgia cucumber isolates and four cantaloupe isolates formed one cluster, whereas all watermelon isolates from Georgia, Florida, South Carolina, and Delaware formed a second cluster, although the single Delaware watermelon isolate was quite divergent. New York isolates were genetically distinct and grouped into four clusters (three watermelon isolates; four cucumber isolates; two watermelon isolates plus one gourd isolate; two cucumber isolates). We plan to sequence and add to the population genetic analyses 96 additional isolates from cucurbit hosts across the eastern U.S. isolates to better understand population structure of *C. orbiculare*.

Seed Pathology Aspects (Walcott, Oakley; UGA)

It has long been suggested that *Colletotrichum orbiculare* (the fungus causing anthracnose on cucurbits) is seedborne and transmissible from seeds-to-seedlings. However, there is no available literature to support these claims. As part of the SCRI-SAM project, the Walcott Lab is investigating the seedborne nature of *C. orbiculare* and testing naturally infested seedlots from the eastern U.S. for the pathogen. To do this, we developed a seed DNA extraction method that is simple, rapid and does not involve expensive equipment. DNA was tested by a PCR assay using a species-specific primer set designed by Dr. Navjot Kaur. The method was validated by extracting DNA from 10 independent seed samples (n = 25-30 seeds) artificially infested with 1.0 x 10^6 conidia/mL from isolate Wa L-21 BE-11. This validation was done with watermelon (cv. 'Crimson Sweet) and cucumber (cv. 'Marketer') seeds. Using this method, we tested more than 80 watermelon and cucumber seedlots. The tested seedlots were collected from New York and Georgia and of the 84 seedlots tested thus far (79 = Wa; 5 = Cu), the pathogen was detected in 27.38% (23/84). Using sequencing data, the identity of the pathogen was confirmed to be *C. orbiculare*.

The Walcott Lab also explored how the fungus might infect seeds. In Spring/Summer 2025, 64 watermelon seedlings were transplanted into a field (UGA Horticulture Farm, Athens, GA) and maintained until blossom formation. 56 female watermelon blossoms were inoculated with 10 μL of 1.0 x 10^8 conidia/mL (Wa L-21 BE-11); 8 female blossoms were inoculated with sterile deionized water to act as negative controls. At harvest maturity, fruits (8) were collected, and seeds were manually extracted, maintaining seeds from each fruit as a separate seedlot. Out of the 8 seedlots recovered from inoculated female blossoms, 5 tested positive for *C. orbiculare*. This result suggests that the pathogen may enter seeds through the floral organs of watermelon. To confirm the result, DNA was extracted independently from the same 8 seedlots and used as template for the *C. orbiculare*-specific PCR assay. The 5 seedlots tested positive for *C. orbiculare*, as well as an additional seedlot that was previously tested negative. PCR products from both the initial and subsequent DNA extractions have been sent off for sequencing. We will repeat this field experiment in Summer 2026.

These data provide that *C. orbiculare* can infect the seed and be detected by PCR. However, it is not clear if the pathogen can transmit disease from seeds-to-seedlings. The Walcott Lab has observed anthracnose-like symptoms in watermelon and cucumber seedlings that developed from artificially infested seeds, but efforts to recover and re-isolate the pathogen are ongoing. Efforts will continue to determine if infested cucurbit seeds can transmit anthracnose under controlled conditions.

Effects of Irrigation and Variety trials on Anthracnose Severity (Coolong; GA)

Year 2 of the irrigation timing objective has been completed. This data will be combined with other locations, and publication will be forthcoming.

A large (26 variety) trial for cucumber screening for susceptibility to *Anthracnose* was conducted in the Athens location using commercial varieties. Field slicing and parthenocarpic varieties were included. Yield and disease incidence were recorded. In addition, fruit was stored to evaluate the impact of anthracnose in storage. Fruit was also analyzed for wax content to determine if wax content is correlated to disease resistance. This trial will be repeated in 2026. Additional work is now being conducted in the greenhouse with several varieties of cucumbers from the field trial to determine spread of anthracnose on inoculated fruit.

A field trial was also conducted evaluating fruit load on watermelon plants and susceptibility to anthracnose. Watermelon plants were allowed to pollinate and fruit set as normal; fruit were removed for a period of 10 and 20 days and all fruit was removed from 2 varieties of watermelon to determine at what stage of fruit set were plants most susceptible to infection. All plants were inoculated with anthracnose and disease incidence tracked. We conducted this trial to determine if there was an optimal time for anthracnose infection during fruit set and to pair potential fungicide applications with that time. Further, changes in plant nutrient status were tracked during fruit set so that we could correlate any nutrient deficiencies with the potential for infection. This trial will be repeated in 2026.

Anthracnose Phenotyping of Watermelon Core Collection (McGregor; GA)

This study aimed to identify potential resistance to Race 2 of *Colletotrichum orbiculare* (Anthracnose) in the watermelon core collection. The field trial was conducted in Summer 2025 at the University of Georgia's Durham Horticulture Farm (Watkinsville, GA), and included 292 genotypes, each with three replicates of six plants per plot. Four susceptible differentials (Charleston Gray, Sugar Baby, Crimson Sweet, Black Diamond) and one resistant control (PI 189225) were included.

The two central plants per plot were inoculated with isolate WA-L-21-BE-11 at a concentration of 1×10^5 spores/mL, three weeks post-transplanting. Disease data were collected weekly for five weeks, starting three weeks after inoculation for anthracnose severity and incidence (0 - 100 scale). AUDPC values for anthracnose severity were calculated across all reps. Statistical analysis identified 20 *Citrullus amarus* genotypes with significantly lower AUDPC than Sugar Baby. Among them, UGA1081 and PI 596671 showed significantly lower AUDPC than all susceptible controls.

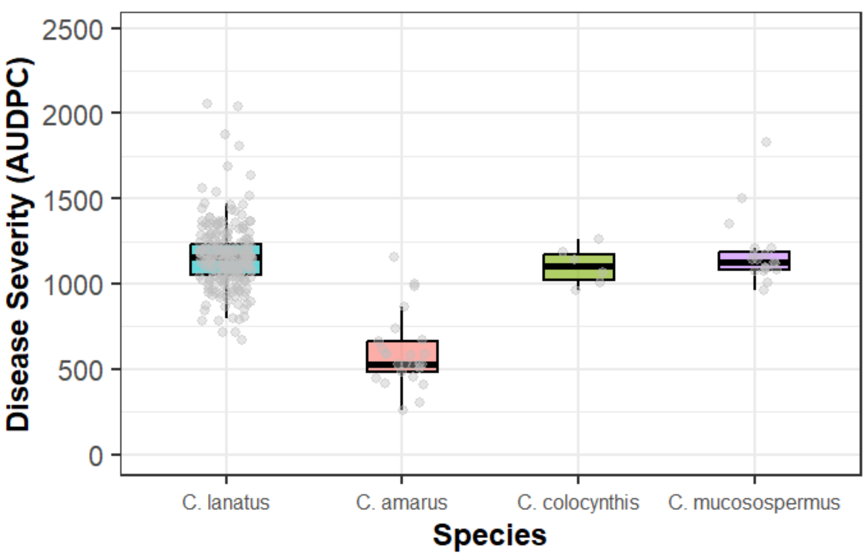
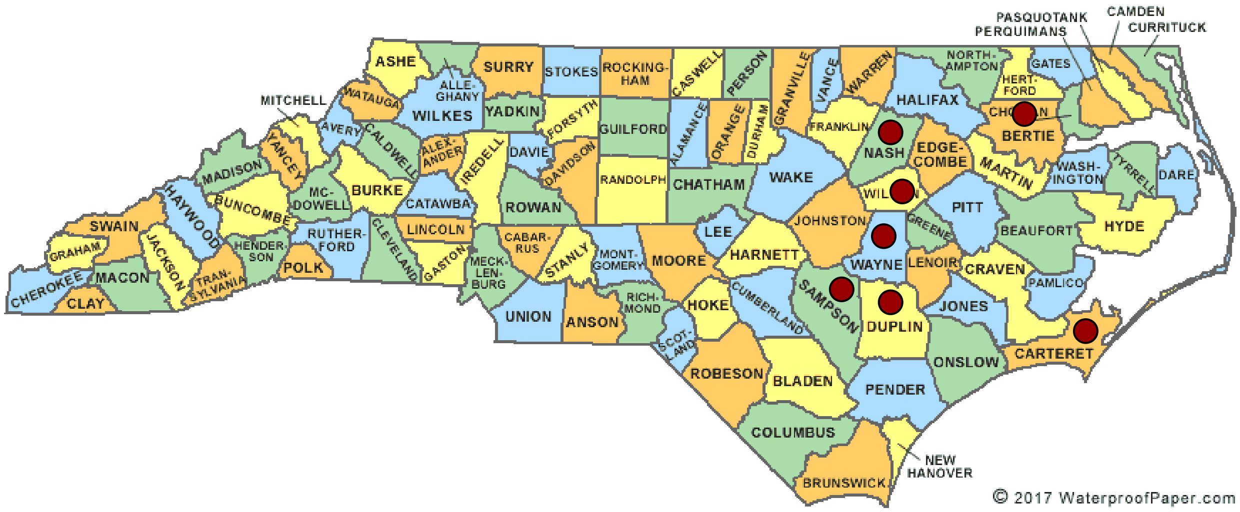


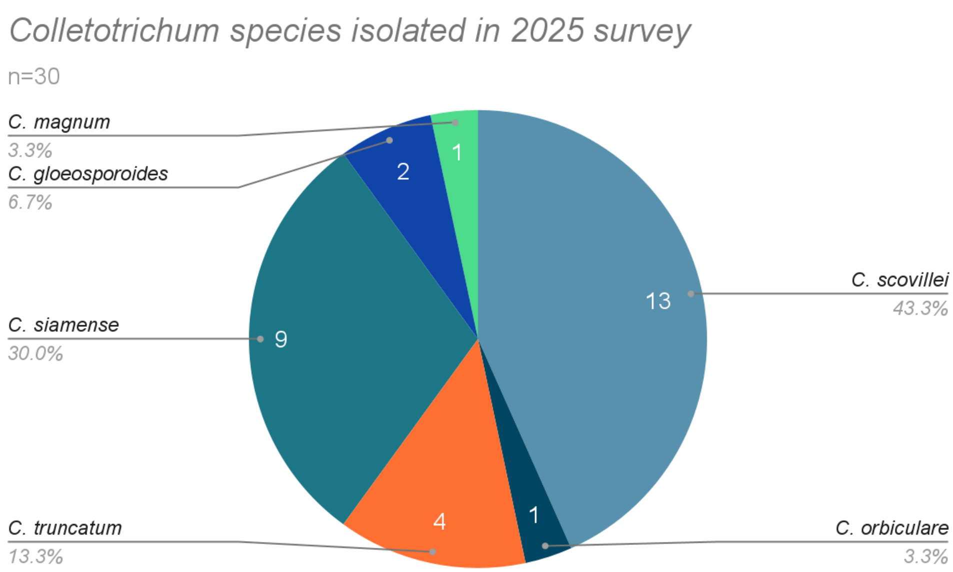
Fig.1 Anthracnose disease severity in the watermelon core collection, grouped by species.

North Carolina State Accomplishment Summary (Quesada-Ocampo; NC)

2025 Survey

15 grower farms were sampled across 7 NC counties. 201 isolates were obtained and are currently being sequenced for molecular identification. Most isolates were obtained from pepper (n=82) due to the recent outbreak of pepper anthracnose but were also sampled from cucumber (n=38), cantaloupe (n=13), and watermelon (n=66). Out of the 200 isolates obtained, 33 have been sequenced, and 30 out of 33 have been identified as *Colletotrichum*.

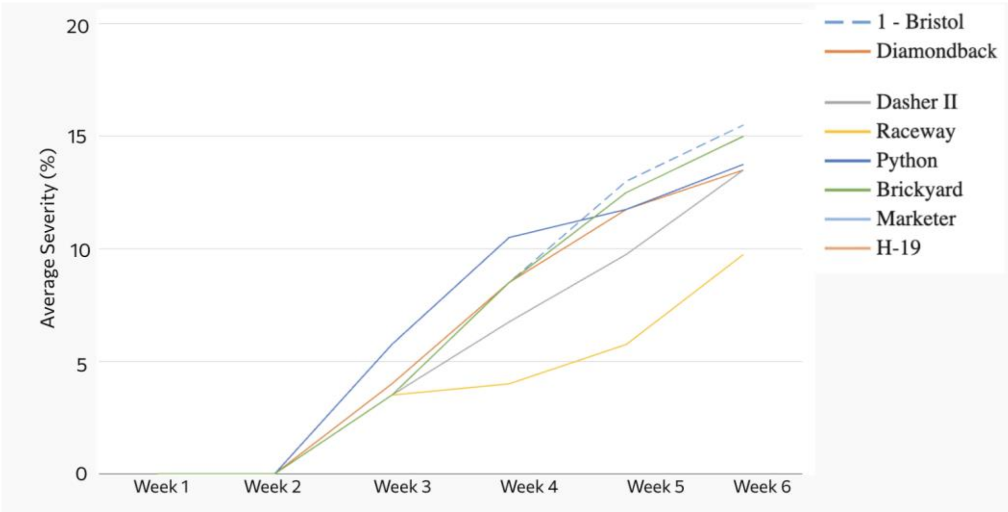




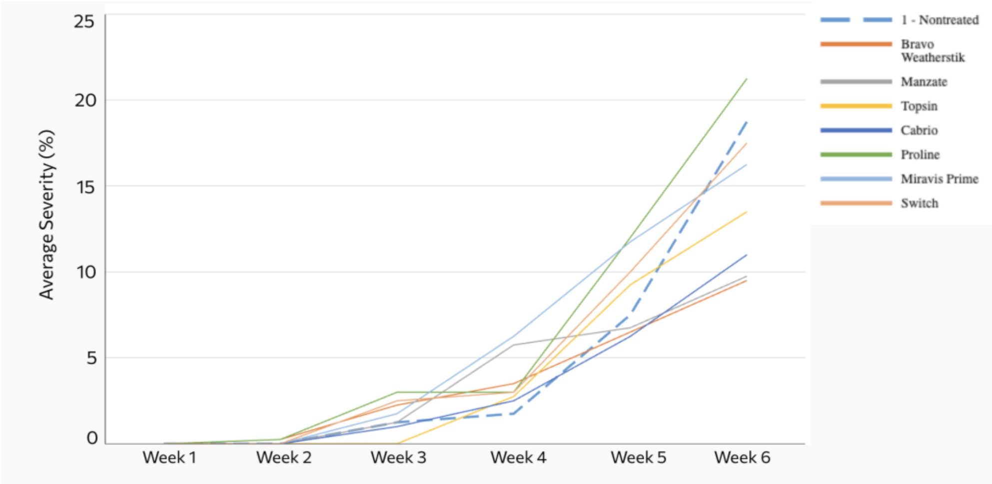
2025 Field Trials

Below are the preliminary results from the variety and fungicide trials conducted by NC State University at the Cherry Farm Research Station in Goldsboro, NC. Plots were inoculated weekly with NC *Colletotrichum* isolates according to the established SAM SCRI protocol, two days before fungicide applications. Trial results are being evaluated for significance, but briefly Bristol and Brickyard were the varieties with the most disease, while Raceway had the lowest disease severity across the entire experiment. The Bravo Weather Stik, Manzate, and Cabrio plots had the lowest end-of-trial disease severity and Proline had the highest end-of-trial disease severity.

Variety Trial Preliminary Results



Fungicide Trial Preliminary Results



Extension and Dissemination

Our results from this effort have been presented at 1 symposium (Summer Undergraduate Research & Creativity Symposium, Raleigh, NC, July 2025), 1 conference (Pickle Packers International, Charlotte, NC, October 2025), and will be presented at an upcoming vegetable expo in Myrtle Beach, South Carolina. We have published disease announcements for the recent discovery of *Colletotrichum scovillei* in North Carolina and have updated information on the Anthracnose of Pepper and Anthracnose of Cucurbits Disease Fact Sheets on the NC State Extension Vegetable Pathology Factsheets website.

Florida State Accomplishment Summary (Meru, Roberts, Vallad, McVay, Kaur; FL)

Objective 1

i. Survey & Isolate Collection

The Florida culture collection comprises 49 *Colletotrichum* isolates collected from eight counties (Charlotte, Collier, Desoto, Gilchrist, Hendry, Hillsborough, Levy, and Osceola). Most isolates (90%) originated from watermelon, and the remainder (10%) were from cucumber. Among the watermelon isolates, 49% were obtained from fruit tissue and 51% from leaves. Anthracnose incidence was low this year, with only four new isolates recovered from a field in Hendry County. Additional surveys are ongoing.

All isolates have been stored on filter paper or in MicroBank tubes. The 24 Florida isolates selected by Dr. Brewer's lab for whole-genome sequencing and race typing were single-spored prior to storage.

ii. Species identification

Molecular characterization using universal *Colletotrichum* primers and a *C. lagenarium*–specific primer set was completed for the 24 Florida isolates selected by Dr. Brewer's laboratory, of which 18 were confirmed as *Colletotrichum*. From the complete collection, 24 isolates were examined using the *C. orbiculare* primer set developed by Dr. Dutta's laboratory. Of these, 23 were sent to Eurofins for Sanger sequencing of the GAPDH region. BLAST analysis of the resulting sequences identified 21 isolates as *C. orbiculare*, one as *C. truncatum*, and one as *C. brevisporum*.

iii. Race Typing

All 25 Georgia isolates have been race-typed in duplicate. Isolates from watermelon consistently corresponded to race 2, whereas those from cucumber corresponded to race 1. Future work will evaluate these isolates on an expanded differential panel to further assess host specificity. Race-typing and host-specificity assays for the Florida isolates are scheduled to begin in 2026.

Additionally, three non-*orbiculare* isolates from North Carolina (*C. siamense*, *C. scovillei*, and one unidentified *Colletotrichum* sp.) and three industry race-typing controls from Virginia were received. The Virginia controls confirmed the expected phenotypes for race 1 and race 2.

v. Commercial Varieties Across Seven Locations

v. Evaluate host response in varietal selections and core PI collection of watermelon and cucumber lines.

v.a. Phenotyping the core collections of watermelon and cucumber:
Three hundred accessions of watermelon from the Dr. Kousik group at the USDA Charleston lab have been received. The field trial to evaluate resistance to anthracnose race 2 is currently underway (fall 2025) at UF/IFAS TREC (Homestead, FL).

v.b. Commercial variety trials across seven locations.

Between fall 2024 and spring 2025, we conducted field trials to evaluate anthracnose (*Colletotrichum orbiculare*) resistance in eight commercial cultivars of cucumber and watermelon, using race 1 and race 2 isolates, respectively. Disease progression was measured using AUDPC, and yields were categorized into marketable and unmarketable portions. In cucumber, H19, mamba (MB), and raceway (RW) consistently delivered the best results, characterized by high marketable yields paired with low disease severity across both seasons. On the other hand, marketers (MK) and python (PY) were the most vulnerable, showing greater disease impact and reduced marketable yield. Overall cucumber yield was higher in spring 2025 than in fall 2024. In the spring 2025 trial, watermelon showed significant differences in disease severity among cultivars. Troubadour (TR) showed the highest severity, followed by captivation (CP), while Charleston Grey (CG) had the lowest disease levels. Tukey's test identified TR as the most susceptible cultivar, and fascination (FS) recorded the lowest yield. Importantly, none of the watermelon cultivars exhibited full resistance to race 2. A second round of watermelon screening is planned for 2026, incorporating additional commercial cultivars to search for stronger resistance to race 2.

Objective 2

i. Fungicide Field Trials

Two field trials were conducted in spring 2025 to evaluate conventional fungicide programs on watermelon and cucumber. In the cucumber trial, the most effective treatments were Topsin, Cabrio, and Proline. In the watermelon trial, severe downy mildew developed early and obscured foliar anthracnose symptoms, preventing reliable disease severity assessments among treatments. Consequently, AUDPC and final severity data from this trial were excluded from analysis. Postharvest evaluations of watermelon fruit were conducted to assess anthracnose disease incidence.

Delaware State Accomplishment Summary (Betts, Mullin; DE)

In 2025 we saw environmental conditions conducive to anthracnose that led to moderate disease pressure for watermelon across the region.

Objective 1:
Due to wet environmental conditions some grower samples were received mid-season (July) with anthracnose infection. Sampling efforts mostly took place in August/September with some pumpkin sampling extending until October. Tissue samples were collected from a total of 13 sampling sites (Delaware=11, Maryland=2), these included watermelon and pumpkin. These sampling efforts yielded 133 cucurbit isolates, 67 of which morphologically resemble *Colletotrichum.* Isolates are being placed in long term storage and PCR confirmation will be underway shortly. Pure cultures are being obtained and once all DNA is extracted sequencing will be performed with GAPDH and HIS3 primers. Though isolate identities have not yet been confirmed, morphology indicates a number of different species present.

A host panel was also planted and inoculated to better understand the pathogenicity of *C. magnum*. Hosts included watermelon, cucumber, cantaloupe, butternut squash, acorn squash, and pumpkin. Disease progression photos were taken on a 5 day schedule. Lesions were excised and brought to the lab for reisolation to confirm pathogenicity of *C. magnum*. A follow-up panel will be conducted in growth chambers in the upcoming months.

Objective 2:
A fungicide efficacy trial including fourteen treatments, 10 traditional fungicides, 3 nontraditional fungicides, and one control was conducted in 2025. Fungicides included: Bravo weatherstik, Dithane F-45, Topsin, Cabrio, Tebuzol, Rhyme, Proline, Cevya, Miravis Prime, Switch, Howler EVO, Oxidate 5.0, and Guarda. Spray rates used were based on manufacturer recommendations found on product labels. There were a total of six weekly spray applications that began in early-July and ended in mid-August. This year plots were inoculated with a local *C. magnum* isolate collected in the 2024 growing season the day after the first fungicide application. Plots were inoculated with a 1.0×10^5 conidia/mL using a hand-held pump sprayer. Each plot was inoculated until leaf wetness was reached (visible droplets on leaf surface). Plant vigor and disease severity ratings were also conducted three separate times on August 8, 15, and 22. For these ratings, plots were rated on a 1-9 scale based on the general health of the plants in the plot and severity was rated between 0-100% based on total area of plant surface with visible disease symptoms. Harvest data was collected once on August 12, and a final melon count was done on August 28 as there were not enough viable melons to necessitate a second harvest. At harvest, data was collected on the number and weight of healthy and unhealthy melons.

South Carolina State Accomplishment Summary (Keinath, Last, Zardus, Mothersbaugh, Riddle; SC)

Objective 1.i. Survey of commercial watermelon and cucumber crops for *Colletotrichum* spp.
Diseased leaves were collected in 3 watermelon fields. Two fields (SC13 and SC14) had no symptoms of anthracnose. Symptoms were observed on 70% of leaves in a third field (SC12), and 5 isolates of *Colletotrichum* were preserved. In addition, 1 isolate of *C. orbiculare* was collected from naturally infected watermelon at Clemson Coastal REC, and 1 isolate of *C. magnum* was collected from a watermelon plant in the USDA USVL greenhouse, Charleston.

Objective 1. iii. Host specificity of *Colletotrichum* spp.
Pumpkin cultivars susceptible to anthracnose fruit rot, 2 cultivars each of *Cucurbita pepo* and *C. maxima*, and bottle gourd (*Lagenaria siceraria*) were grown in the field in spring and fall. Immature fruit of three different sizes (ages) were harvested and surface disinfested. Discs cut from fruit were wounded (1 mm deep) or not wounded and inoculated with *Colletotrichum magnum* and *C. orbiculare*. Fruit periderm differed in resistance to penetration as measured by a penetrometer. Disease incidence and lesion diameters are still being analyzed.

Objective 2.ii. Field trials: Conventional fungicides on watermelon ‘Sugar Baby’

Treatment (FRAC)	DS (%)	*P*=0.01	Treatment (FRAC)	DS (%)	*P*=0.01
Water	33.8	a	Miravis Prime (7+12)	12.0	cd
Water	30.1	ab	Manzate Pro-Stick (M3)	3.0	de
Rhyme (3)	18.5	abc	Cabrio (11)	1.7	e
Tebuconazole (3)	17.9	abc	Bravo Weatherstik (M5)	1.7	e
Switch (9+12)	15.2	bc	Topsin (1)	1.7	e
Cevya (3)	13.5	bcd	Proline (3)	1.0	e

Fungicide treatments were applied 5 times. Anthracnose developed from naturally occurring inoculum. Proline, Topsin, Bravo, and Cabrio were more effective than all other treatments except Manzate. Miravis Prime also reduced severity compared to water. Yield did not differ.

Objective 2.iii. Field trials: Drip vs. overhead irrigation on watermelon cv. Crimson Sweet
Mini-wobbler sprinkler heads were used to mist 3 of 4 treatments for 15 minutes per day; all treatments received drip irrigation. Severity of foliar anthracnose on 6/16/25, 80 days after transplanting, and AUDPC did not differ among treatments.

Time	Severity %
06:00 PM	38.6
12:00 PM	28.4
06:00 AM	20.1
No misting	15.8

Objective 5. Extension activities

Keinath, A. P. 2025. 2025 Updates on diseases on watermelons and other cucurbits. 2025 Watermelon Field Day Edisto REC, Blackville, SC, July 10, 2025. 112 attendees.

Keinath, A. P. 2025. Why reusing watermelon plastic for watermelon is a very bad idea and other plant pathology horror stories. SC Grower blog. 7/22/2025

New York State Accomplishment Summary (Pethybridge, Khmelnitsky, Murphy, Cornell, NY)

In Year 2 of the SCRI-SAM project, NY conducted repeats of the OMRI-listed product efficacy trial, conventional product efficacy trial, and cultivar resistance screening trial. Additionally, NY conducted a crop residue trial, and an irrigation trial for the first time. All inoculated trials in Year 2 were inoculated with the same three local NY *C. orbiculare* isolates as the year prior. Inoculated trials included OMRI-listed and conventional fungicide product efficacy, cultivar resistance, and irrigation trials. In the OMRI-listed and conventional product trials, the first treatments were applied 24 hours before inoculation and applied weekly for a total of four applications. The products tested in the OMRI-listed trial were Howler, LifeGard, Oso, Kocide 3000-O, Double Nickel, and three rates of Gotablanca from Clear Leaf Agro (27 fl oz./A,44 fl oz./A, and 55 fl oz./A). Kocide 3000-O, Oso and Gotablanca (44 fl.oz./A) provided effective anthracnose control. In the conventional product trial, the products tested were: Dithane, Topsin, Cabrio, Tebuzol, Rhyme, Proline, Cevya, Miravis Prime, Switch and Bravo Weatherstik. Bravo Weatherstik, Topsin and Cabrio also provided effective anthracnose control. The cultivar resistance trial included eight cultivars: Valor, Excursion, Charleston Gray, Black Diamond, Sugar Baby, Embasy, Fascination and Troubadour. Sugar Baby and Black Diamond were the most susceptible to anthracnose, differing significantly from all other cultivars in all variables measured.

The irrigation trial tested four different leaf wetness scenarios by applying either low mist (2 hours of overhead irrigation), high mist (4 hours of overhead irrigation), natural rainfall or rain shelter (complete exclusion from any overhead irrigation). The crop residue trial, which was established in October 2024, tested the effect of five residue treatments including sanitation, propane burning, tillage, leaving residue on the soil surface, and applying granular urea fertilizer. Sanitation and propane burning the residue were the only treatments to significantly reduce anthracnose severity compared to tillage plots which had significantly higher anthracnose severity. Bulk soil samples were taken from the residue areas at two times (pre-planting and pre-harvest) for future microbiome (bacterial and fungal composition and abundance) analysis. The repeat of the crop residue trial was established in early October 2025. All trials have also been harvested, and the fruit has been sorted into marketable and unmarketable. Marketable fruit from the product efficacy trials were stored in cold storage for 1 week to evaluate post-harvest losses. Afterwards, seeds were extracted from the symptomatic fruit and sent to collaborators in UGA. We have also reached out to ~15 farms and have surveyed 7 commercial fields and isolated a total of ~20 isolates.

Virginia State Accomplishment Summary (Higgins, Langston; VA)

Fungicide Efficacy Field Trial. Fungicide field trials on watermelon were conducted in 2024 and 2025 in Painter, VA. Disease pressure was high in both years (>83% severity in untreated plots). Manzate, Bravo, and Quadris Top consistently resulted in among the lowest disease severity across years. In 2025, Cabrio, Topsin, and Proline were similar to Manzate (the numerically lowest treatment both years). Switch and Miravis Prime had higher disease incidence than Manzate but lower than Tebuzol and Cevya in both years. Tebuzol and Cevya were either less effective than the other fungicides or did not provide adequate disease control.

Cultivar Field Trial. A cultivar field trial was also completed in 2024 and 2025 in Painter, VA. Despite differences in disease progression, all cultivars were highly susceptible to anthracnose, with final disease severity exceeding 90%.

Isolate Collection. In 2024, Virginia collected 101 isolates from 4 commercial watermelon fields. Of these, 84 isolates have been identified using ITS, TUB2, GAPDH, HIS3, and ACT; identification of the remaining 17 isolates is ongoing. From the 2024 collection, 66 isolates were *C. orbiculare* and 22 were *C. sojae*. All *C. sojae* isolates originated from a single field experiencing an active anthracnose outbreak. Koch's postulates are in progress for *C. sojae*, as this species is not typically associated with watermelon anthracnose. In 2025, Virginia collected an additional 184 isolates from watermelon and volunteer soybean plants; identification is currently underway.

Fungicide Assays. EC_{50} values for difenoconazole were obtained from two experimental runs for all 2024 isolates. Although no baseline sensitivity dataset exists for comparison, the frequency distribution of *C. orbiculare* isolates was skewed, suggesting potential fungicide resistance in the population. Additional monitoring is required. The difenoconazole EC_{50} distribution for *C. sojae* isolates was narrower and more difficult to interpret. EC_{50} values for thiophanate-methyl are currently being evaluated.

Race-typing. Virginia established a race-typing protocol to determine *C. orbiculare* races associated with watermelon anthracnose, using a differential panel of cultivars (Marketer', 'H-19', 'Black Diamond', 'Charleston Gray', 'Taybelle', 'Athena', and 'Birdhouse'). The characterization of races from VA (n= 50), NY (n=50), DE (n=25) isolates is in progress. Preliminary results indicate that 8 Virginia isolates collected from watermelon were all Race 2. For NY, 2 isolates collected from cucumber and 2 isolates collected from watermelon were Race 1.

Debris Management (Sintim, UGA; Pethybridge, NY)

This Working Group assesses debris management for anthracnose control, and the subsequent impact on crop productivity, soil carbon sequestration, and overall soil health. From a regenerative agricultural management perspective, it is recommended to leave crop debris to serve as mulch. The practice protects the soil surface against wind and water erosion and slows evaporation and decomposition of organic matter. However, such management practice may not be a viable option for cucurbit production in the southern United States because of the frequent outbreak of anthracnose disease. Anthracnose is a fungal disease caused by a soilborne pathogen, *Colletotrichum spp*. The pathogen can overwinter in soil and crop debris, resulting in the outbreak of anthracnose disease in susceptible crops. Anthracnose disease have been found to be less severe in more intensive tillage systems. Nonetheless, intensive tillage systems have a long history of disrupting soil health indicators, prompting the need to consider a sanitation control (crop debris removal), as a compromise between the two extreme systems (retention of crop in the field vs. incorporation of crop debris via tillage).

To assess the role of crop debris management on anthracnose control, field studies were initiated to assess three crop debris management systems: (a) crop debris left on the soil surface (D-Left); (b) crop debris incorporated via tillage after harvest (D-Incorporated); and (c) crop debris completely removed after harvest (D-Removed). The treatments were arranged in a randomized complete block design with four replications, and each treatment plot had three beds to ensure adequate buffer. Cucumber and watermelon were used as the test crop, and all sampling and data collection were made from the middle bed.

Anthracnose infestation in both crops was not significantly different between treatments, with average disease rating in cucumber being 8.3% on June 18; 37.9% on June 24; and 85.8% on July 3; and that in watermelon being 0.6% on June 18; 21.7% on June 24; 51.7% on July 3; and 79.4% on July 9. First harvest in cucumber was on June 18, after disease rating, and that in watermelon was on July 24 after disease rating, highlighting disease severity increased after harvest. Yield was also not significantly affected by treatments, with average marketable and unmarketable yield of cucumber being 12.6 and 5.8 tons/ac, respectively, and that of watermelon being 12.5 and 8.0 tons/ac, respectively. The results highlight marginal effects of debris management on anthracnose severity in cucumber and watermelon.


June 18
D-Left
D-Incorp.
D-Remov.
June 24
D-Left
D-Incorp.
D-Remov.
July 3
D-Left
D-Incorp.
D-Remov.
June 18
D-Left
D-Incorp.
D-Remov.
June 24
D-Left
D-Incorp.
D-Remov.
July 3
D-Left
D-Incorp.
D-Remov.
July 9
D-Left
D-Incorp.
D-Remov.

Economics Accomplishment Summary (Colson; GA)

Economic Evaluation of Multi-State Cucumber and Watermelon Trials

As part of a coordinated, multi-state research effort, an economic analysis was conducted to assess the profitability and production implications of cucumber and watermelon cultivar trials across Florida, Georgia, New York, and Virginia in 2024. The objective was to quantify how cultivar selection, plant spacing, irrigation timing, and disease susceptibility influence farm-level returns and inform management decisions for growers in the eastern United States.

Data and Approach

Each site conducted replicated field experiments under varying production conditions, using randomized block plot designs. Economic assessments were based on regional price and yield data compiled from USDA Market Reports, land-grant enterprise budgets, and university Extension specialists. For each treatment, estimated gross revenue per acre was calculated to reflect realistic market performance under local growing conditions.

Key Findings

- **Florida (Cucumber Spacing Trial):**
  Evaluated eight cultivars under three plant spacings (3 ft, 1 ft, 0.5 ft) and elevated anthracnose pressure. Results demonstrated a strong economic benefit from denser planting: revenues increased from roughly $936/acre (3 ft) to $5,663/acre (0.5 ft), with some high-performing cultivars exceeding $9,000/acre. Average revenue across treatments was $3,142/acre, emphasizing the yield and revenue gains achievable through optimized spacing.

- **Georgia (Cucumber and Watermelon Trials):**
  Among eight cucumber varieties, estimated revenue ranged from $6,387–$12,006/acre (average $8,848/acre). Watermelon varieties generated $3,454–$5,704/acre (average $4,686/acre). Irrigation timing trials revealed that morning watering (6:00 AM) maximized returns ($3,542/acre) compared to mid-day ($2,725/acre), highlighting the importance of irrigation scheduling on yield and profitability.

- **New York (Watermelon Variety Trial):**
  Nine cultivars were evaluated under regional conditions. Despite two non-productive varieties, the top performer achieved $10,413/acre, with an overall average of $6,789/acre, illustrating the strong influence of cultivar adaptability on revenue potential.

- **Virginia (Anthracnose Susceptibility Trial):**
  Ten watermelon cultivars were tested for disease tolerance under deliberate inoculation. Unmarketable fruit ranged from 84–100%, resulting in estimated revenue losses of $7,722–$9,215/acre (average $8,616/acre). These findings underscore the substantial economic cost of disease outbreaks and the value of resistant cultivars.

Phenotyping watermelon germplasm for resistance to anthracnose (Kousik; USDA)

Two hundred and eighty-six (286) belonging to the core watermelon germplasm were evaluated for resistance to anthracnose at the USDA-ARS, U.S. Vegetable Laboratory farm in Charleston, SC, during fall of 2025. The collection included four species: *Citrullus amarus, C. colocynthis***,** *C. mucosospermus*, and *C. lanatus*, along with several commercial cultivated checks. Four-week-old seedlings were transplanted onto 36-inch-wide raised plastic mulched beds. Each germplasm accession had two replications. Natural anthracnose infection occurred across the field due to heavy and consistent rains in late September and early October. Disease developed naturally during the season, and four ratings were recorded at weekly intervals in October. Disease severity was recorded on a 0–10 scale of increasing disease severity for each plot and converted to percentage (%) scale. Area under disease progress curve (AUDPC) values were calculated for each accession based on the four ratings. *C. amarus* accessions showed the lowest disease severity, with many accessions maintaining low disease severity levels throughout the rating period. *C. mucosospermus* exhibited intermediate responses, with several PIs showing moderate to low AUDPC, indicating presence of resistance genes for anthracnose within this species. In contrast, the cultivated watermelon accessions (*C. lanatus*), which included cultivars Black Diamond, Charleston Gray, Crimson Sweet, *and* Sugar Baby, showed high susceptibility to anthracnose. However, some *C. lanatus* accessions displayed varying levels of resistance. All *C. colocynthis* accessions were susceptible. Severe anthracnose infection was also observed on fruit of some accessions. The citron (*C. amarus*) PI 189225 and the Egusi type (*C. mucosospermus*) PI 560023 were some of the most resistant accessions. Gummy stem blight was also observed in the field which made it challenging to rate some of the plots. The pathogen causing anthracnose naturally in the field has been isolated for further studies. Accessions that displayed resistance will be evaluated again under controlled conditions and in the field in 2026.

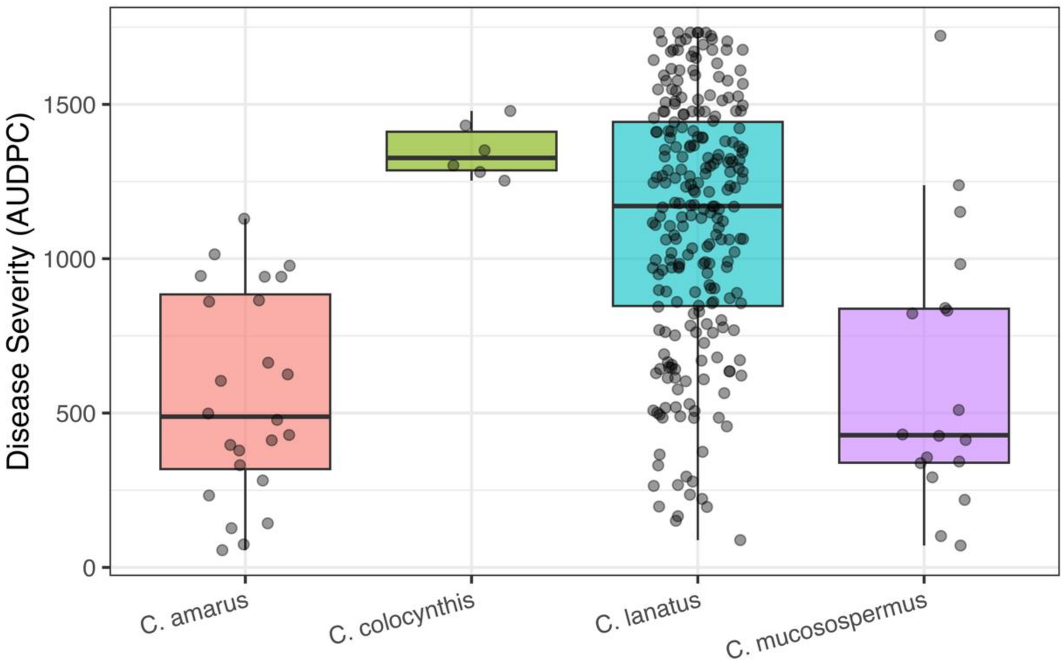


Figure: Anthracnose disease severity (AUDPC) across *Citrullus* species under natural infection in the field at Charleston, SC.

Watermelon & Cucumber Variety Trials, GA (McAvoy and Kumari; UGA)

Objective: To evaluate watermelon and cucumber varieties for anthracnose resistance, yield, and fruit quality.

Methodology: Trials were conducted in spring 2025 at Hort Hill, UGA Tifton, using a randomized block design with four replications. Eight watermelon and eight cucumber varieties were grown under uniform irrigation, fertilization, and pest management. Anthracnose ratings were collected on 14 May, 20 May, 28 May, 03 June, and 09 June 2025 to generate AUDPC values. The data analysis was performed using the One-Way ANOVA model in JMP Pro 17.

Results:

1. SAM- Anthracnose Watermelon Variety Trial

Table 1: AUDPC.

Variety	AUDPC[i]
Black Diamond	133.8 a
Captivation	111.5 ab
Charleston Grey	85.4 ab
Embassy	102.6 ab
Excursion	111.5 ab
Fascination	69.8 b
Troubadour	95.0 ab
Valor	73.9 ab
P Value	**0.0411***

[ii]Means followed by the same letter are not significantly different based on Tukey's honest significant difference test at 95%.

2. SAM- Anthracnose Cucumber Variety Trial

Table 2. AUDPC.

Variety	AUDPC[i]
Brickyard	697.3 a
Bristol	695.3 a
Diamondback	820.8 a
H-19	579.5 a
Mamba	641.0 a
Marketer	543.5 a
Python	621.0 a
Raceway	601.0 a
P value	**0.2791**

[ii]Means followed by the same letter are not significantly different based on Tukey's honest significant difference test at 95%.