2020 Vegetable Extension and Research Report

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2020 University of Georgia Vegetable Extension and Research Report

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2020 University of Georgia Vegetable Extension and Research Report

Effects of Multiple Crop Plastic Mulching on Georgia Vegetable Production

A. da Silva, F. Krupek, S. Carlson, M. de Barros

Introduction

In Georgia, plastic mulch is used in about 33% of vegetable production, and the benefits of first crop plastic will enhance crop development and increase crop yields. The cost of installing a plastic bed can be as high as $2,000/acre depending on the material and fumigation used, which is relatively expensive for growers. Therefore, vegetable crops are typically planted over the same plastic for three seasons in Georgia. Growers adopt multiple crop plastics to reduce costs with plastic, drip tape, labor, pesticides, and others. However, the impacts of multiple crop seasons in the same plastic have not been investigated yet. Multiple crop plastics may increase soil compaction, reduce soil pH, decrease soil water and nutrient availability, induce low root distribution, and favor weed pressure, hence, crop yield is penalized over time. There is a need to identify at which point the reuse of plastic mulching for multiple crop seasons stop being beneficial for Georgia vegetable production and start to reduce yield. Thus, the objective of the study was to evaluate the effect of using the same plastic mulching in three vegetable growing seasons in Georgia. The goal was to identify the point when plastic mulching is no longer beneficial for crop production.

Materials and methods

On-farm field experiments to evaluate the effectiveness of the use of three crop plastics were conducted by two growers in southwest Georgia during the spring growing season of 2019. Squash and zucchini areas with first, second, and third crop plastic were selected in each farm and crop management practices followed the regular growers' activities.

In each crop plastic (i.e., farm 1 – first crop plastic, or farm 2 – third crop plastic), a total of four beds (50-ft long) were randomly selected for data collection during crop development. Therefore, the experiment was treated as a completely randomized block design, in which farm was considered the block but four locations in each farm were sampled, with a total of eight replications per treatment.

Data for soil compaction and soil moisture distribution along the growing beds were sampled in the 0-12 in. soil depth layer at 30 locations in each bed at 0, 20 and 40 days after transplanting (DAT) using the Field Scout SC 900 compaction meter and the Field Scout TDR 350 moisture sensor (Spectrum Technologies Inc., Aurora, IL). A GPS was attached to the soil compaction meter and soil moisture sensor to identify each single location and maps for each sampling time were plotted. In addition, biomass accumulation were monitored at 20, 30, and 40 DAT, in which 2 representative plants per plot were sampled, dried at 150 °F until constant weight and dry matter weight measured. Squash and Zucchini fruit were harvested over 12 picks. Fruit were harvests three times a week starting at 35 DAT and classified in Fancy, Medium, and Culls according to USDA standards.

Statistical analysis was performed using the software RStudio Version 1.0.136 (RStudio Team, 2016). Analysis of variance (ANOVA) followed by a least square means comparisons were performed using the Fisher's least significant test adjusted at *p-value* of 0.05.

Results

Soil compaction was higher with second and third plastic crop compared to first plastic crop, regardless of sampling date (Figure 1). At 40 DAT, soil compaction was maximized at 7 in. of soil depth in the first plastic crop, but at 4 in. of soil depth for second and third plastic crop (Figure 2). Although there were no significant differences between second and third plastic crop on the overall soil compaction, figure 3 shows the continuing increase in the spatial distribution of soil compaction with first, second, and

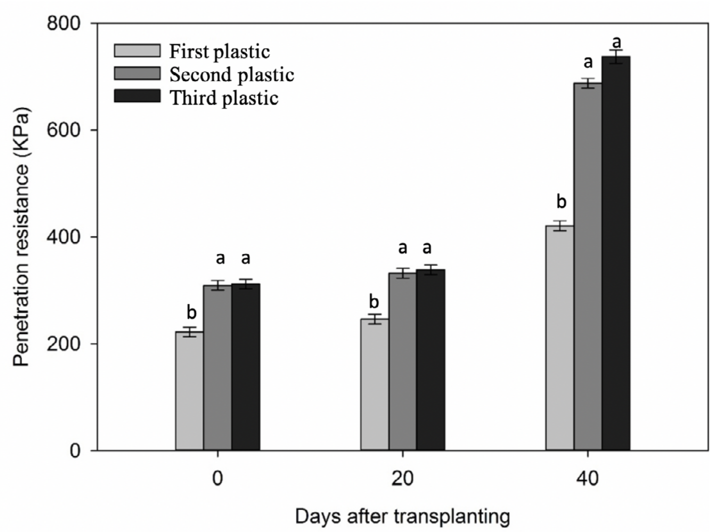


Figure 1. Effect of first, second, and third crop plastic on penetration resistance at 0, 20, and 40 days after yellow squash and zucchini transplanting.

third plastic crop. This distribution had a direct impact in the soil volumetric water content, which was higher for first plastic but similar between second and third plastic (Figure 4).

While soil compaction explains the soil volumetric water content, both soil characteristics explain the difference in the yellow squash and zucchini biomass accumulation (Table 1) and ultimate crop yields (Table 2). Total yield was higher in the first plastic (1,820 box/acre) compared to second (1,661 box/acre) and third (1,624 box/acre) plastic for yellow squash, however, there was a gradual increase in total yield for zucchini with first (2,374 box/acre), second (1,869 box/acre), and third (1,679 box/acre) plastic crop.

Conclusion

There was an increase in the spatial distribution of soil compaction with first, second, and third plastic crop that reduced the soil volumetric water content. Soil compaction was lower with first plastic crop compared to second and third plastic crop. Consequently, first plastic crop presented the highest total yields for yellow squash and zucchini; however, there were no significant differences on total yield between first and second crop for zucchini, indicating that a grower using second or more should grow zucchini instead yellow squash to avoid yield loss. The effect of multi-cropping plastic should be evaluated in additional vegetable crops to identify ideal crop rotation.

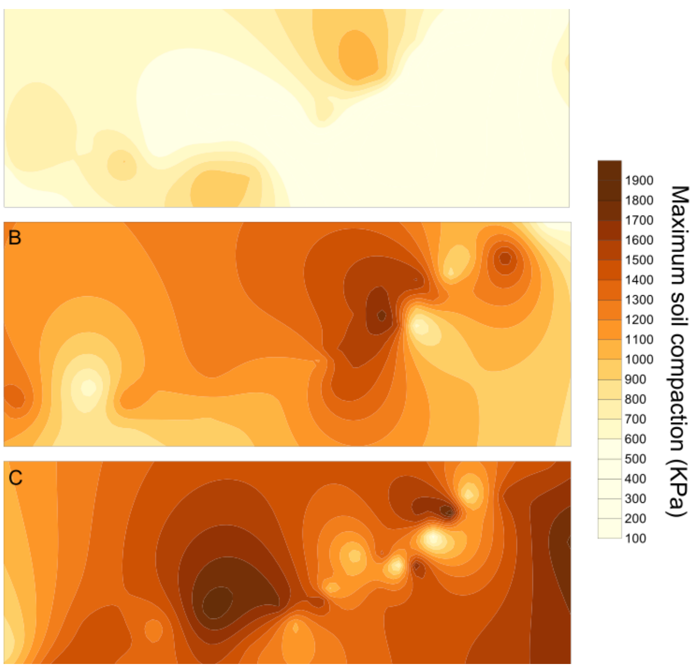


Figure 2. Effect of first (A), second (B), and third (C) plastic crop on soil compaction (6 in. of soil depth) at 40 days after yellow squash and zucchini transplanting.

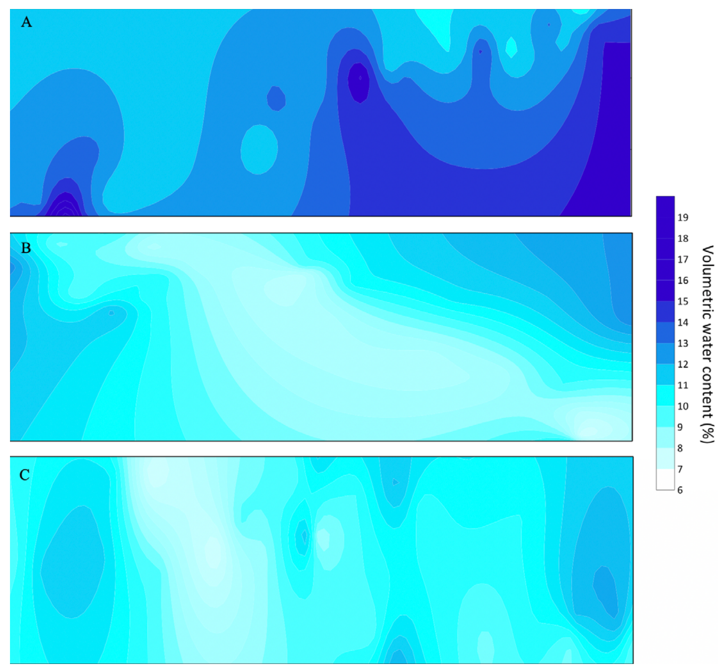


Figure 3. Effect of first (A), second (B), and third (C) plastic crop on soil volumetric water content (0-8 in. soil depth layer) at 40 days after yellow squash and zucchini transplanting.

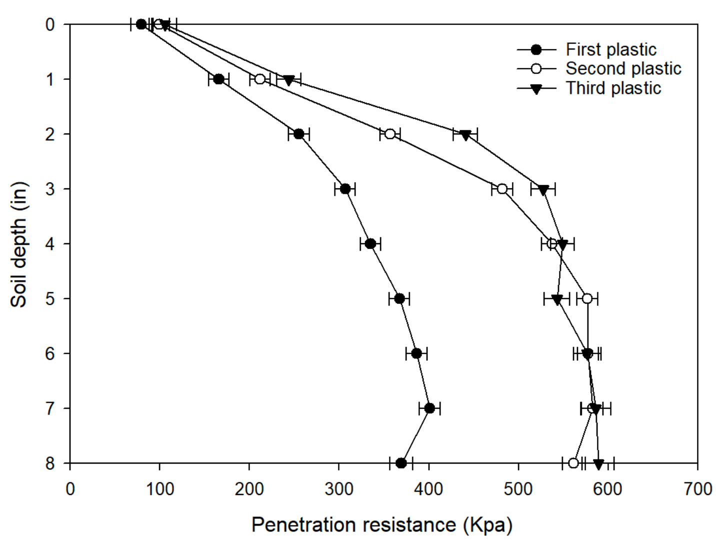


Figure 4. Effect of first, second, third plastic crop on penetration resistance at 0-8 in. soil depth layers at 40 DAT. Within each depth error bars denote standard error of the mean.

Table 1. Effect of first, second, and third plastic crop on yellow squash and zucchini aboveground dry biomass at 20, 30, and 40 days after transplanting.

	Days after transplanting (DAT)					
	20 DAT	30 DAT	40 DAT	20 DAT	30 DAT	40 DAT
	Yellow squash biomass (g/plant)			Zucchini biomass (g/plant)		
First plastic	1.5	49.0 a*	64.5 a	3.6 a	59.4 a	83.7 a
Second plastic	1.2	14.0 b	33.0 b	2.1 ab	19.1 b	52.3 b
Third plastic	1.3	21.2 b	33.2 b	1.1 b	26.0 b	44.0 b

*Values followed by similar letters indicate no significant differences ($p < 0.05$) among plastic treatments within each sampling date according to Holm-Tukey adjust.

Table 2. Effect of first, second, and third plastic crop on total and yield quality of yellow squash and zucchini.

Season of Plastic mulching	Total yield	Fancy	Medium	Cull
	½ bushel box/acre			
Yellow squash				
First plastic	1820 a*	965 a	688 a	167 a
Second plastic	1661 b	972 a	561 b	128 a
Third plastic	1624 b	951 a	508 b	166 a
Zucchini				
First plastic	2374 a	1116 a	1129 a	129 a
Second plastic	1869 ab	992 ab	772 b	104 a
Third plastic	1679 b	896 b	664 b	118 a

*Values followed by similar letters indicate no significant differences ($p < 0.05$) among plastic treatments within each yield parameter according to Holm-Tukey adjust.

Insecticides Update, 2019

A. Sparks

Silverleaf whitefly efficacy tests

The efficacy of selected insecticides against silverleaf whitefly was evaluated in studies conducted in collards, squash, tomato, and cucumbers. Of greatest importance was the identification of the relatively high efficacy of PQZ, a new insecticide, against adults of the silverleaf whitefly. Relatively few insecticides are efficacious against adults and this product provides high efficacy with a seldom used mode-of-action, which should aid in management of both the insect and potential insecticide resistance. Studies conducted not included in this report included an efficacy test with biorational products (results were inconclusive) and an insecticide rotation study to for suppression of virus vectored by whiteflies (no virus appeared in this study).

Insecticide rotation studies were conducted in cucumbers (two tests) and squash. In all three studies, various insecticides were applied on a weekly rotation with Sivanto.

In squash, all treatments were performed similarly, with none of the treatments suppressing silverleaf symptoms once they starting progressing. This highlights the need to initiate treatments early in infestations and the fact that squash are extremely sensitive to whitefly feeding.

Populations of nymphs were suppressed in cucumbers with all of the insecticide rotations, including a rotation without a secondary insecticide. While this might suggest that a longer application interval is possible, experience with this pest in southern Georgia suggest otherwise. These data do suggest that many insecticides have the potential to be effective rotation partners in whitefly management. Adult counts in all three trials show efficacy of Sivanto and PQZ against adult whiteflies.

Evaluation of soil applications of systemic insecticides in squash showed continued efficacy of Verimark, Venom, Sivanto, and Coragen for suppression of silverleaf. Residual activity of these products was a little under three weeks in 2019. Of note, Admire Pro did not provide suppression of silverleaf in 2019.

An efficacy study conducted in tomato did show good efficacy with a new pre-mix product, Senstar. Senstar contains the active ingredients found in both Knack and Movento.

Management of soil insects in sweet potato

Two tests were conducted, with each test repeated on two planting dates. Both tests evaluated insecticides for reduction of damage to roots by soil insects. In both tests, pre-plant incorporated treatments were applied as a broadcast spray in 20 gpa and incorporated with a rolling cultivator. Side-dress applications were applied with a water-wagon equipped with a 5-ft boom. Side-dress applications

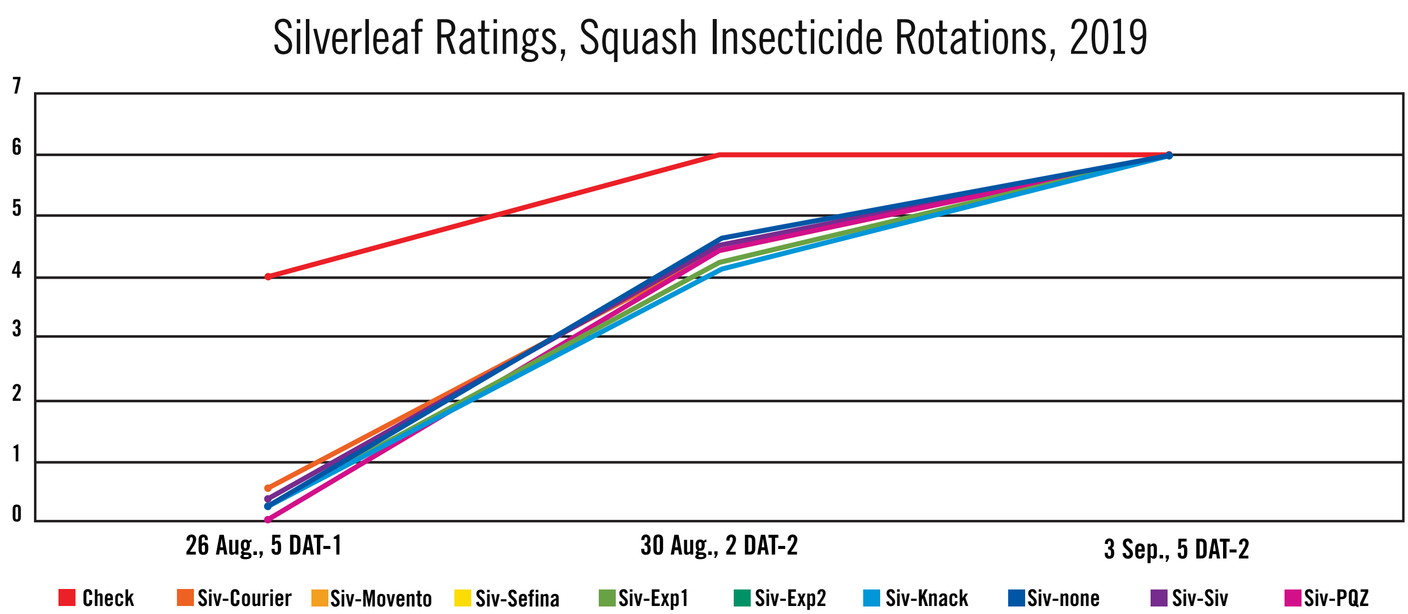


Figure 1. Silverleaf ratings, insecticide rotation treatments in squash. (0 = no silverleaf, 6 = entire plot with severe silverleaf).

were made in a total of 3960 gpa (4 passes at 990 gpa) to simulate a chemigation side-dress application. The first test evaluated the efficacy of pre-plant incorporated insecticides (Lorsban at 4 pints per acre; Belay at 12 fl oz per acre) with and without a side-dress application of bifenthrin (9.6 fl oz per acre applied at 21 days after planting). Results were variable with few statistically significant results. The trends do suggest that Lorsban provided more consistent suppression of damage, while Belay performed similar to Lorsban in the first planting (June 6) but performed poorly in the second planting (July 11). The addition of the bifenthrin side-dress generally did not aid control in this test.

The second test evaluated single and split applications of bifenthrin (all applications at 9.6 fl oz per acre) following a PPI application of Lorsban (4 pints per acre). All bifenthrin applications were applied with the water-wagon to simulate chemigation. Damage in both plantings was relatively light and only minor statistical differences were detected and trends were not consistent. The light pest pressure and variable results make any conclusions questionable.

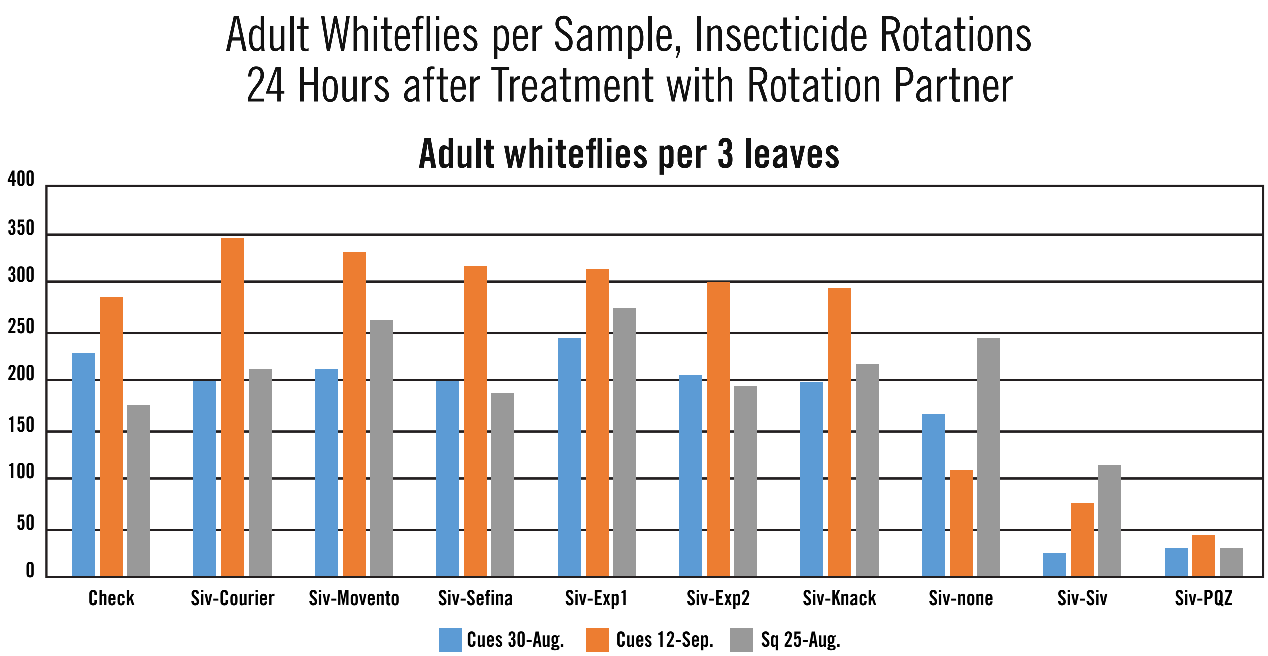


Figure 2. Adult whitefly counts at 24 hours after treatment with the insecticide rotation partner.

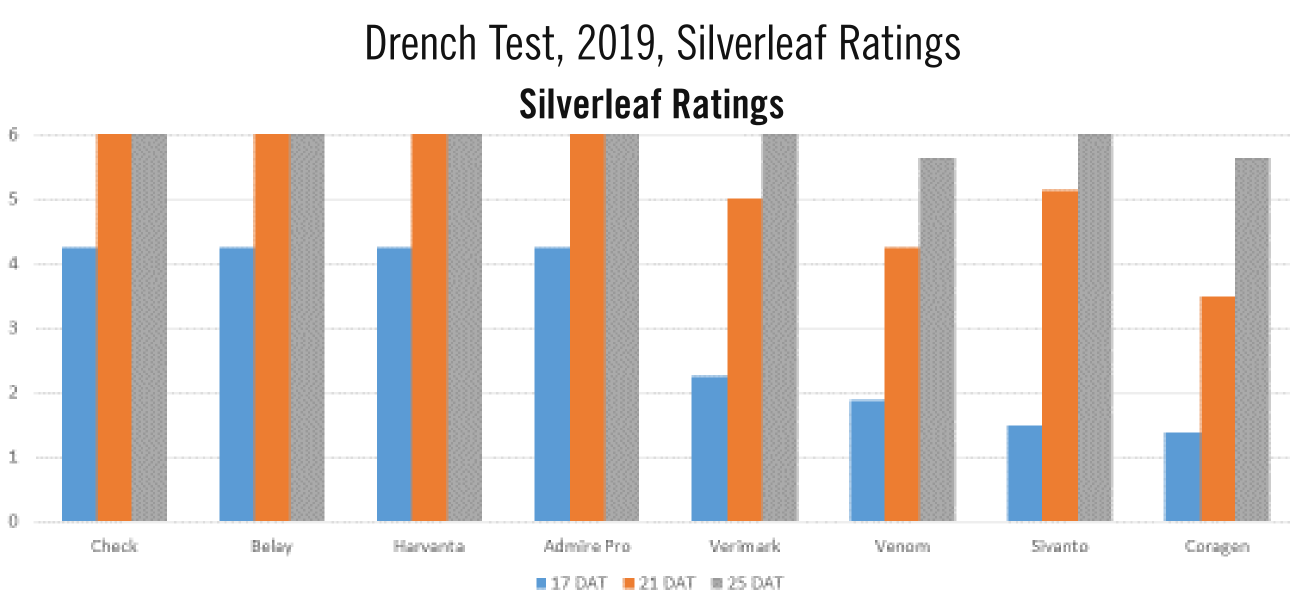


Figure 3. Silverleaf ratings, soil applied insecticide test. 0 = no silverleaf, 6 = entire plot with severe silverleaf.

Tomato – Large Nymphs per Sample

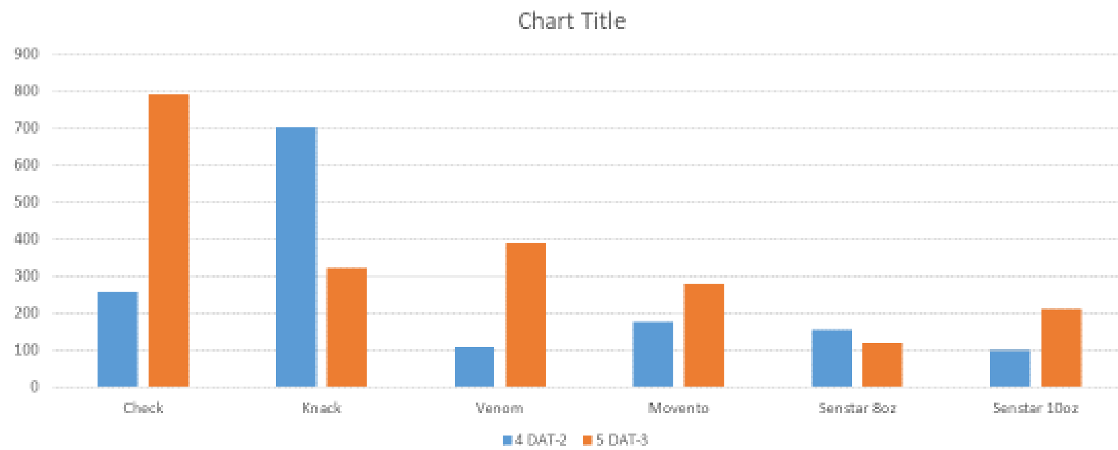


Figure 4. Large nymph densities, insecticide efficacy test in tomatoes.

Pre-plant Incorporated Insecticides for Soil Insects

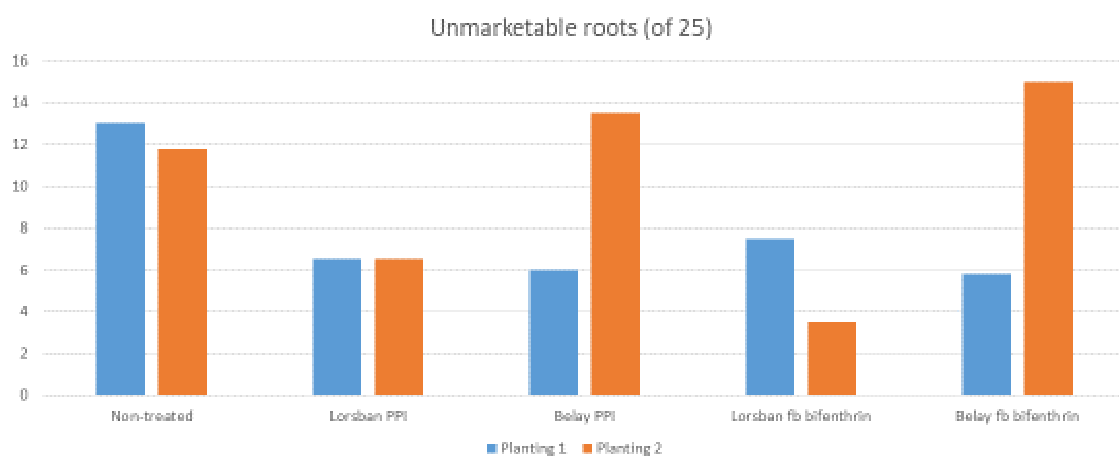


Figure 5. Number of unmarketable sweet potato roots (of 25 harvested) following treatments with pre-plant incorporated insecticides.

Timing of Bifenthrin Side-Dress Applications for Soil insects

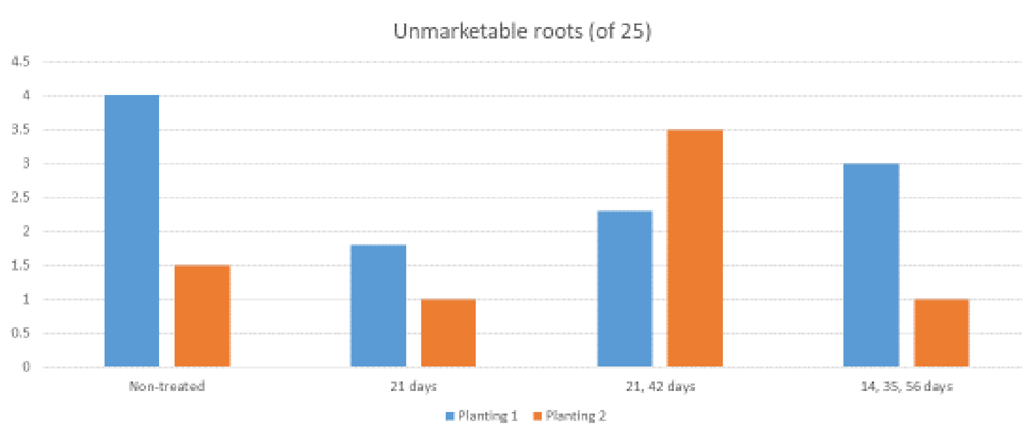


Figure 6. Number of unmarketable sweet potato roots (of 25 harvested) in plots treated with bifenthrin as a simulated chemigation application at indicated days after transplanting.

Evaluation of Fungicides for Managing Alternaria Leaf Blight on Carrot in Georgia, 2020

A. Sparks

Experiment overview

The experiment was conducted at the University of Georgia Blackshank Farm in Tifton. Carrot (cv. Bolero) was direct seeded into six-row beds on Dec. 10, 2019. Beds were on 6-ft centers with 1-in. plant spacing within rows. Plots were 15-ft long with 10-ft unplanted breaks between plots within the row. The treatments were arranged with four replications. Plots were overhead irrigated weekly as necessary using a pivot-irrigation system. Fertility and insecticide treatments were applied according to UGA Extension recommendations. The field has a history of Alternaria leaf blight infection since 2015, hence, natural infection was relied upon for this trial. Fungicide treatments were applied with a backpack sprayer calibrated to deliver 40 GPA at 80 psi through TX-18 hollow cone nozzles. Fungicide applications were made on 14-day intervals: Jan. 13, Jan. 27, Feb. 10, Feb. 24, Mar. 9, and Mar. 23. Plots not treated with fungicides served as non-treated check. Disease severity was assessed on Feb. 20, Mar. 5, Mar. 19, and Apr. 2 as percent leaf area with necrosis per plot and area under disease progress curve was calculated for each treatment. The mean rainfall received during Dec. 2019 and Apr. 2020 was 4.2 in. and 8.4 in., respectively. The average high and low temperatures for the month of Dec. 2019 were 58 °F and 44 °F, respectively, and for the month of Apr. 2020 were 82 °F and 63 °F, respectively.

Alternaria leaf blight was first observed on Feb. 20 with 28.8% disease severity in the non-treated check. During the same disease assessment period, disease severity was significantly higher in the non-treated check compared to other treatments. Among the treatments, fungicides alternated with Penncozeb had significant lower disease severity compared with the same fungicides sprayed without Penncozeb.

Disease progressed gradually over the next 7 weeks, and the final disease severity ratings were recorded on Apr. 2. Based on disease ratings on Apr. 2, treatments comprised of Merivon and Penncozeb (35.5%) or Luna Sensation and Penncozeb (39.2%) or Pristine and Penncozeb (41.8%) or Switch and Penncozeb (40.4%) or Miravis Primer and Penncozeb (38.5%)had significantly lower disease severity compared with other treatments and the non-treated check. Alternaria leaf blight severity was not significantly different for treatments with solo application of either Merivon or Pristine or Luna Sensation or Switch or Miravis Prime; however, both of these treatments had significantly lower disease severity compared to the non-treated check. AUDPC values followed same trend as that of final disease severity ratings on Apr. 2. Merivon or Luna Sensation or Pristine or Switch or Miravis Prime in a program with Penncozeb had significantly lower AUDPC values compared to other treatments and the non-treated control. Phytotoxicity was not observed.

Table 1. Effect of first, second, and third plastic crop on yellow squash and zucchini aboveground dry biomass at 20, 30, and 40 days after transplanting.

Treatment and rate per acre	Fungicide applications[z]	Disease severity (%)[y]		
		20 Feb	2 Apr	AUDPC[x]
Merivon 5.5 fl oz	1,3,5	17.5 bw	47.2 b	782.8 b
Pristine 10.5 fl oz	1,3,5	19.2 b	52.8 b	728.2 b
Luna Sensation 7.6 fl oz	1,3,5	16.5 b	54.5 b	705.5 b
Switch 11 fl oz	1,3,5	15.2 b	51.2 b	650.2 b
Miravis Prime 9.2 fl oz	1,3,5	14.8 b	55.0 b	798.8 b
Merivon 5.5 fl oz Penncozeb 2 lb	1,3,5 2,4,6	9.8 c	35.5 c	348.2 c
Luna Sensation 7.6 fl oz Penncozeb 2 lb	1,3,5 2,4,6	10.2 c	39.2 c	265.8 c
Pristine 10.5 fl oz Penncozeb 2 lb	1,3,5 2,4,6	7.2 c	41.8 c	382.2 c
Switch 11 fl oz Penncozeb 2 lb	1,3,5 2,4,6	4.8 c	40.4 c	278.5 c
Miravis Prime 9.2 fl oz Penncozeb 2 lb	1,3,5 2,4,6	3.2 c	38.5 c	245.5 c
Non-treated	N/A	28.8 a	64.5 a	1245.2 a

[z]Spray dates were: 1 = 13 Jan; 2 = 27 Jan; 3 = 10 Feb; 4 = 24 Feb; 5 = 9 Mar; and 6 = 23 Mar.

[y]Alternaria leaf blight severity was rated on a 0-100 scale where 0=0% leaf area affected and 100=100% leaf area affected on 20 Feb, 5 Mar, 19 Mar, and 2 Apr.

[x]AUDPC was calculated from ratings taken on 20 Feb, 5 Mar, 19 Mar, and 2 Apr.

[w]Means followed by the same letter in each column are not significantly different at $p \leq 0.05$.

Molecular Method Developed for Real-Time Detection of Cucurbit Leaf Crumple Virus on Squash

E. Ali, P. Ji, S. Waliullah, T. Stackhouse

Introduction

Cucurbit leaf crumple virus (CuLCrV) is a begomovirus virus that is able to infect most cucurbits, including cucumber, cantaloupe, squash (yellow, zucchini, and winter squash), pumpkin, watermelon, and beans. Symptoms of CuLCrV include yellow chlorotic spots (abnormally pale due to insufficient chlorophyll), interveinal yellowing, mosaic, and leaf curling and crumpling. In the case of severe infection, stunting and growth distortion are observed. These symptoms can also resemble those caused by other closely related whitefly-transmitted begomoviruses. Squash leaf curl virus (SLCV), the closest begomovirus to CuLCrV, also causes severe leaf chlorosis, leaf crumpling, curl symptoms, and stunting of squash and melon plants, which cannot be easily distinguished from CuLCrV on the basis of symptoms alone. Therefore, a proper identification method is needed to detect this pathogen especially in early infection stage. Loop-mediated isothermal amplification (LAMP) assay is a novel technique that can effectively address the limitations of traditional detection methods. It is a straightforward, rapid, highly sensitive, specific, cost-effective method that can be used for early diagnosis and in-situ testing of crop pathogens. The objective of this study was to develop a LAMP assay for rapid and efficient detection of CuLCrV in cucurbits. This assay should supplement and enhance existing procedures for detecting the pathogen.

Materials and methods

CuLCrV-infected leaves were sampled from commercial fields of vegetables including yellow squash, zucchini, watermelon and cucumber in Tift and Lowndes counties, Georgia. Other begomovirus-infected samples were collected by vegetable laboratories in USDA-ARS, Charleston, South Carolina, and the Department of Plant Pathology at the University of Georgia for specificity tests. The published CuLCrV DNA sequence was used to design LAMP primers. LAMP conditions were optimized to detect CuLCrV infection. Comparative sensitivity of LAMP was checked with other published methods.

Results and discussion

The optimal temperature and reaction time for the LAMP assay were determined for CuLCrV detection from infected samples (Figure 1). DNA extracted from CuLCrV and closely related begomoviruses were tested for LAMP assay specificity. Only the CuLCrV-infected sample could be detected (Figure 2). DNA was serial diluted to test for sensitivity, which was found to be extremely high compared to previously existing methods which has the field use potential.

Conclusion

Whitefly-transmitted CuLCrV poses a threat to cucurbit production in the southeastern United States and causes enormous financial losses. Therefore, early diagnosis of this virus is crucial to prevent further loss. The LAMP assay described here is a more rapid, accurate, specific, sensitive, simple, and portable diagnosis method, which can be utilized in laboratory and field conditions for timely detection of this virus. The LAMP assay could detect virus infection from infected samples in as little as 15 minutes. The LAMP assay could detect the virus from symptomatic and asymptomatic plants (Table 1). Although compared to LAMP, qPCR was more sensitive for detection of virus infection, it is not applicable for field detection of infection as the assay requires expensive equipment and expert technicians. In conclusion, the LAMP assay developed in this study is an efficient, reliable and sensitive method for specific and rapid detection of CuLCrV from infected squash and other cucurbit leaf samples. This new assay allows a diagnostician to do on-site, sensitive identification on symptomatic and asymptomatic tissues, allowing for faster control measure implementation.

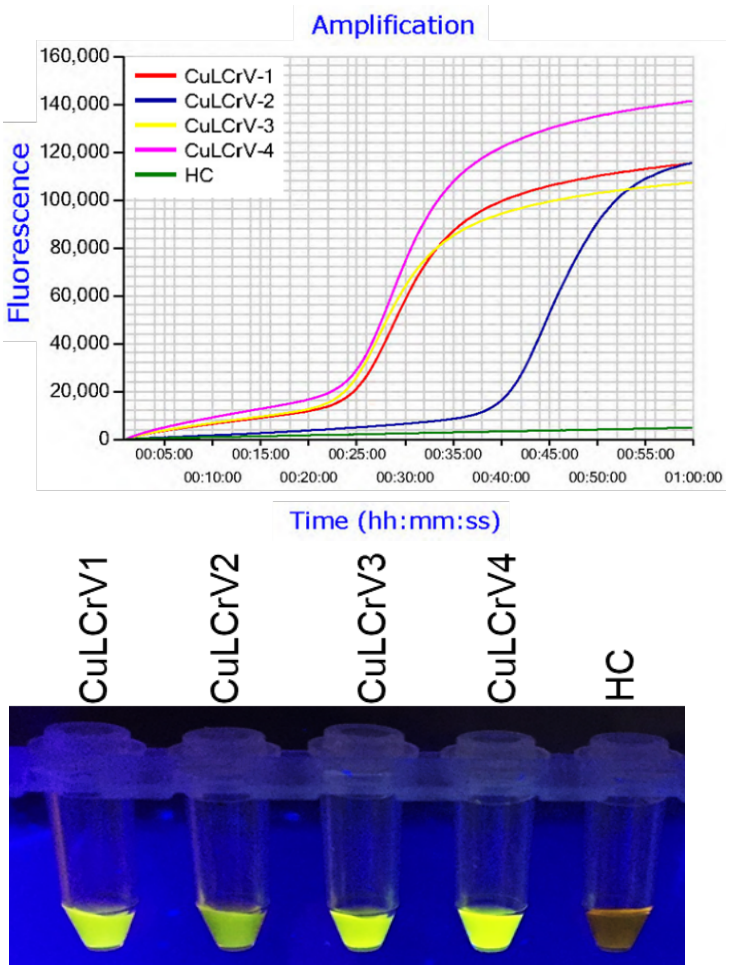


Figure 1. LAMP graphical results for a healthy control (green) and four CuLCrV samples (all other colors) samples. LAMP colorimetric results with four CuLCrV samples and a healthy control. There is a colorimetric change in positives from red to fluorescent yellow.

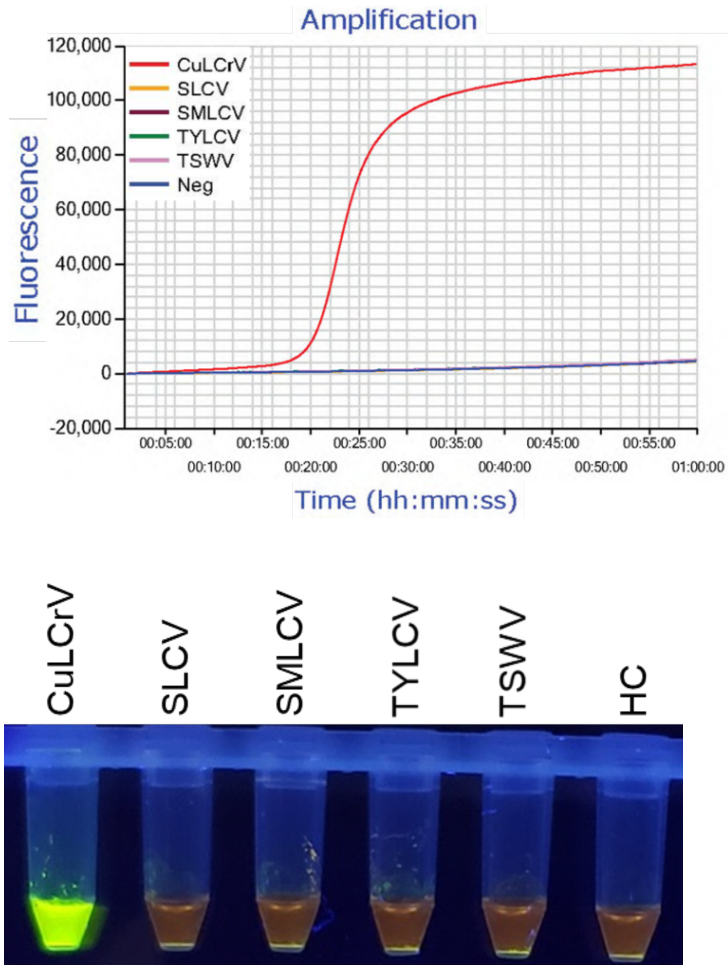


Figure 2. LAMP graphical results for one CuLCrV sample (red) four other begomoviruses (all other colors), and a healthy control (blue). LAMP colorimetric results with one CuLCrV sample, four other begomoviruses, and a healthy control. There is a colorimetric change in positives from red to fluorescent yellow.

Table 2. Pepper weevil fruit dip bioassay results in terms of dead and live adults at 48 and 120 hours.

Sample	Geographic Location	Symptomatic/ Asymptomatic	No. of samples tested	Detected by LAMP
Winter Squash	Tift County	Symptomatic	10	10
		Asymptomatic	10	6
	Lowndes County	Symptomatic	10	9
		Asymptomatic	10	5

*Means within columns are not significantly different (LSD, $p < 0.05$).

Soil Fumigation for Control of Root-Knot Nematodes in Bell Pepper

C. Nnamdi, A. Hajihassani

Introduction

Almost all vegetable crops grown in Georgia are susceptible to damage by plant-parasitic nematodes (Hajihassani, 2018a). Using a comprehensive survey conducted in 2018, we have documented that root-knot nematodes, *Meloidogyne* spp., are the No. 1 nematode pest in vegetable crops in Georgia, infecting 67% of the fields surveyed. Pre-plant soil fumigation is an important component of vegetable production for effective control of nematodes. Without fumigation, vegetable fields mainly in the southern part of the state would be greatly infested with root-knot nematodes (Hajihassani, 2018b). Fumigants are applied 2-3 weeks before seeding/transplanting to prevent the risk of crop injury. They are applied to the raised beds followed by covering beds with plastic mulches to trap the active ingredients in soil, thus increasing their efficacy.

Prior to 2005, chemical control options for nematode diseases were limited to methyl bromide. Following the methyl bromide phaseout in the U.S., attention has focused on the application of alternative chemical products for treating soils before planting vegetables crops. In Georgia, 1,3-dichloropropene (Telone II), chloropicrin, mixtures of 1,3-dichloropropene and chloropicrin (e.g., Pic-Clor 60), metam sodium (Vapam) and dimethyl disulfide (Paladin) have been the common fumigants for the control of soilborne pathogens, weeds and nematodes in vegetable-production systems (Hajihassani, 2018b). A better understanding of efficacy of these fumigants on root-knot nematodes is desired to improve management practices. In this project we compared the efficacy of chisel-injected application of different fumigants on root-knot nematode population density and yield of bell pepper.

Materials and methods

The study was conducted in summer 2019 in a field with the history of high infestation with the southern root-knot nematode (*Meloidogyne incognita*). All fumigants were applied according to label recommendations for vegetable crops. The trial used four replicates per treatment. The plot size was 150 ft of a 2.5 ft wide raised bed. Treatments included Telone II (125 pounds per acre), Dominus (250 pounds per acre), Pic-Clor 60 (175 pounds per acre), Paladin (167 pounds per acre) and a *M. incognita*-resistant pepper cultivar 'Carolina Wonder'. Fumigants were injected with a three-shank fumigation rig at a 12-in. depth in a bed. Totally impermeable film mulch was placed over beds immediately after fumigation.

Soil samples for nematode analysis in each plot were collected prior to fumigation, at mid-season, and at termination of trials. Soil cores were combined and nematodes were recovered from a 100-cm^3 subsample by the sieving-centrifugation method, and counted under a microscope. Root gall index was rated using a 0-5 scale, where 0 = no galls, 1 = trace of nematode with few galls on roots, 2 = ≤ 25% root galling, 3 = 26-50%, 4 = 51-75%, 5 = 76-100% galling (Hussey and Janssen, 2002). Pepper fruits were harvested and weighed. Experimental data were subjected to analysis of variance for statistical significance between treatments.

Results

At the termination of the trial (end of the season), the numbers of root-knot nematode in the soil were only significantly lower than the untreated check in the resistant pepper treatment. In addition, Paladin followed by Telone II and Pic-Clor 60 numerically reduced the nematode populations in the soil (Figure 1A). All soil fumigants and the resistant pepper cultivar reduced root galling compared to the untreated check at harvest.

Pic-Clor 60 had numerically better control of root galling compared to the other fumigants. Among the fumigant treatments, Paladin had numerically lower nematode numbers in comparison with the other fumigants. We also found that Pic-Clor 60 and the resistant cultivar had the highest and lowest pepper fruit yield, respectively (Figure 1B). We also found that Pic-Clor 60 and the resistant cultivar had the highest and lowest marketable fruit yield, respectively (Figure 2).

Based on our data, treatments with Dominus and the resistant variety had the highest weed density. Plots treated with Pic-Clor 60 had the lowest weed density. There was no difference in weed density among Paladin, Telone II and the untreated check. The weed population in the Dominus treatment was higher than the check plot (data not shown). Soil fumigation with Pic-Clor 60 reduced southern blight disease, caused by the fungus *Athelia rolfsii*, as compared to other treatments (data not shown).

Conclusion

Paladin, though effective in suppressing nematode juveniles in the soil, was withdrawn from the market in 2019, further restricting the already limited number of tools for managing nematodes. Pic-Clor 60 is likely an ideal fumigant for control of root-knot nematodes and other soilborne pathogens in multi-cropping systems of vegetables. However, root-knot nematode population densities in plots treated with Pic-Clor 60 were increased by the end of the growing season. This may suggest that combined use of fumigants and at- or post-plant nonfumigant nematicides through drip irrigation systems could provide enough root protection against high pressure of root-knot nematodes in the first and subsequent crops grown on the same plastic mulch, which need further investigation.

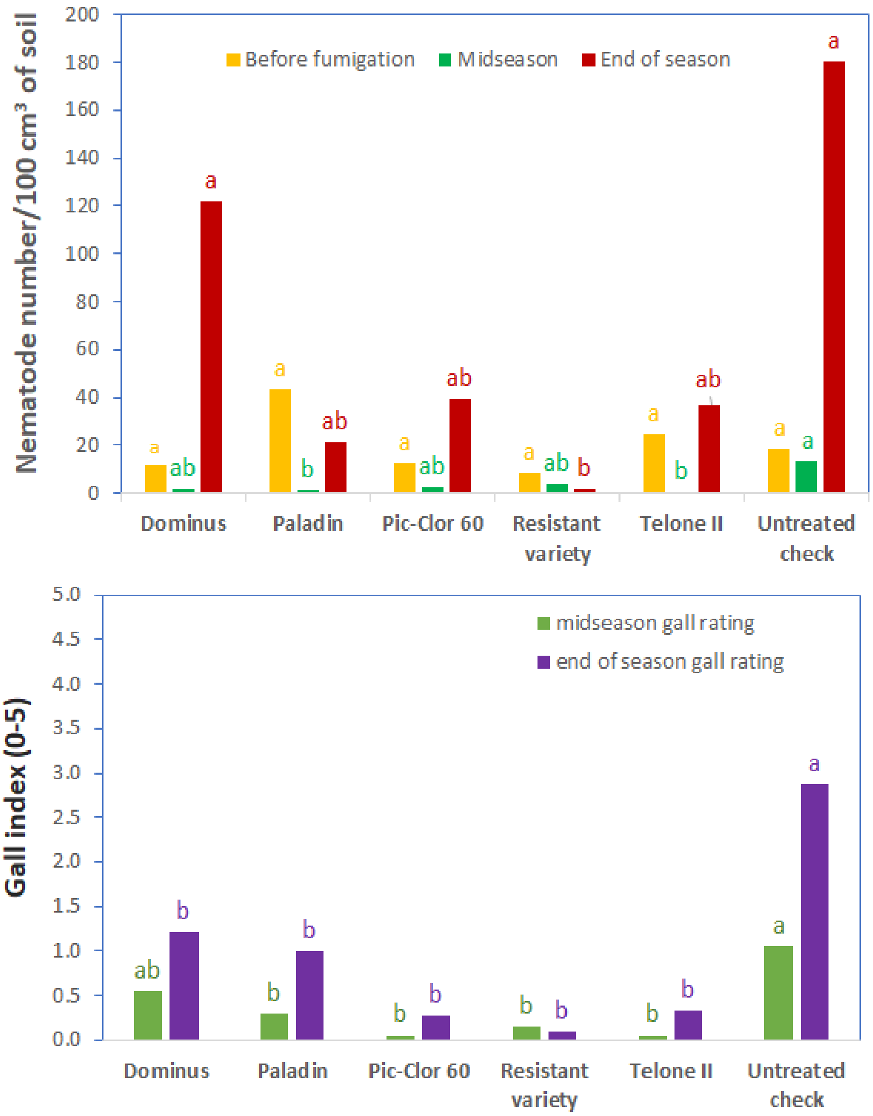


Figure 1. Effect of different chemical fumigants on nematode population density (A) and root gall severity (B) caused by the southern root-knot nematode (*Meloidogyne incognita*) on bell pepper.

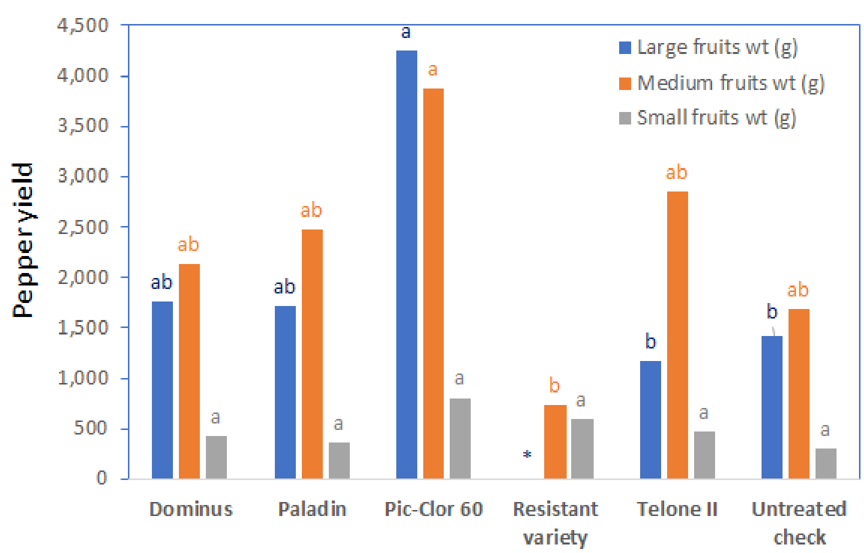


Figure 2. Effect of soil fumigants on bell pepper yield in the field infested with the root-knot nematode.

Field Evaluation of GMO Cowpea and Snap Beans for Their Susceptibility to Cowpea Curculio Damage

D. Riley

Need/justification for research in Georgia

The 2019 season test experienced heavy cowpea curculio, *Chalcodermus aeneus* Boheman (Figure 1) damage to blackeyed pea, *Vigna unguiculata* L. lines except the GMO line. We also observed that snapbeans, *Phaseolus vulgaris* L., did experience damage from curculio, but not as much as susceptible cowpea. Snap beans, an important crop in Georgia with a farm gate value of <$27 million (Wolfe and Stubbs, 2015), is attacked cowpea curculio, causing feeding damage to the pods and beans. Since diapaused, overwintering curculio populations must feed and oviposit as quickly as possible in the spring, we believe that the spring crop is more heavily affected than the fall crop. We also think that diapausing weevils in the fall inflict less damage than in the spring because they are laying less eggs. We documented this in a publication in 2019. We propose to field test the GMO weevil-resistant cowpea developed by T.J. Higgins in CSIRO Australia (based on a high-amylase-inhibitor genotype 'AAI-1 cowpea', Higgins *et al.*, 2013; Lüthi *et al.*, 2013) against susceptible cowpeas and snap beans in replicated field blocks planted in the spring and in the fall. We propose to split each plot and treat half with Vydate to reduce the curculio and measure curculio damage response in each season.

Potential benefit

This research will provide a more stable insect management program that eliminates the sole reliance on insecticide control that has continued to fail for cowpea curculio since the 1950s could provide even longer-term benefits to this important legume cropping system for the Southeast U.S. by utilizing GMO resistance to the curculio.

Study objectives

1. To field test a genetically modified AAI-1 cowpea vs. susceptible cowpea lines vs. snap bean in terms of the plant's ability to attract cowpea curculio for oviposition, but then prevent the development of grubs in the pods while protecting beans from damage.

2. To test these lines in the spring and fall growing seasons in treated and untreated plots to see how these are adapted to Georgia growing conditions and our levels of cowpea curculio.

Figure 1. Cowpea curculio (top), damage to cowpea (middle), and snap beans (bottom)

Procedures and locations of research

The proposed studies will be conducted at the Lang-Rigdon Farm of the Coastal Plain Experiment Station in Tifton, Georgia. Seeds from each cultivar will be planted manually in two 60 ft x 6 ft plots replicated four times. The cultivars to be tested include 'Tendergreen snap beans, the GMO cowpea, a standard blackeyed pea variety and a pinkeyed purple hull variety. One of the randomly selected plots will be treated weekly with oxamyl (Vydate) during flowering to reduce curculio pressure. We will rely on a natural infestation of cowpea curculio, *Chalcodermus aeneus*, for feeding, oviposition, and development of this insect on transformed, non-transformed cowpeas, and snapbeans for damage evaluation. There will be two plantings to coincide pod maturity with availability of cowpea curculio adults in the field based on known generation times (Riley *et al.,* 2015). The proposed planting dates are Apr. 15 and Aug. 15. Only seed will be collected and cold stored for possible future work. All other plant material from the test will be destroyed. All regrowth will be monitored and destroyed into the following year. Regression analysis will be used to relate curculio damage in terms of percentage of "stung" seeds to yield by cultivar to determine the response of each cultivar to curculio damage under field conditions in the spring and fall seasons.

Evaluation of Fungicides and Mulching in Managing Phytophthora Fruit Rot in Pepper, Tift County, 2019

B. Dutta, M. Foster

Experiment overview

Fungicides were evaluated for their efficacy to manage Phytophthora fruit rot, caused by *Phytophthora capsici*. The experiment was conducted in a field plot at the UGA Tifton campus that had a history of epidemics of Phytophthora fruit rot. Pepper 'Aristotle' were transplanted onto two row beds covered with 18-in. black plastic mulch on 1 Apr. Beds were on 6-ft centers with 1-ft plant spacing within rows. Plots were 20-ft long and used 5-ft planted borders between plot ends. Treatment-plots that received mulching, a thick layer of hay was applied at either end. The trial was arranged in a split-plot design with fungicide program being a main plot and mulching a sub-plot. Four plots with 10 plants per plot were used for each treatment. Plots were drip irrigated weekly and as necessary using a drip tape irrigation system. Fertility and insecticide treatments were applied according to the University of Georgia Extension recommendations. Natural infection was relied upon for initial inoculum. Fungicide treatments were applied using a John Deere 6155 sprayer calibrated to deliver 40 GPA at 125 psi through TX-10 hollow cone nozzles. The mean rainfall received during April and June was 1.5 in. and 5.2 in., respectively. The average high and low temperatures for the month of April were 85 °F and 63 °F, respectively, and for the month of June were 91° and 74 °F, respectively. On 20 June, fruit from each plot were harvested and incubated under standard room temperature (78 °F) for 48-h. Ratings for fruit rot incidence were assessed on 22 June as percentage of fruits with visible symptoms typical of *P. capsici*.

Phytophthora capsisi fruit rot was not observed in field for any of the treatments including non-treated check. Hence, post-harvest evaluation were conducted. Post-harvest ratings for Phytophthora fruit rot were taken on 22 June. The fruit rot incidence for fruits from the non-treated check plots with (28.2%) and without (32.5%) mulching was not significantly different; however, numerically non-treated mulched plots had lower disease incidence compared to non-mulched plots. Both non-treated checks (with and without mulch) had significantly higher fruit rot incidence compared to fruits from fungicide treated plots. Among the treatments, fungicide programs with mulch had significantly lower disease incidence compared to their non-mulch counterparts. The fruit rot incidence was significantly lower for the fungicide program that comprised of Presidio, Orondis Ultra and K-Phite (2.8%) along with mulching compared to other fungicide programs. Fungicide program comprised of Presidio, Orondis Ultra and Elumin (8.5%) along with mulching had significantly lower disease incidence compared to the same fungicide program but without mulching (14.8%). Phytotoxicity was not observed with any of the treatments.

Table 1. Effect of fungicide treatments application on fruit rot incidence in pepper.

Treatment and rate per acre	Application timing[z]	Fruit rot incidence (%)[y]
		22 June
No mulch		
Presidio 4 fl oz	1, 3	6.8 c[x]
Orondis Ultra 8 fl oz	2, 4	
K-PHITE 4 qt	1-5	
Mulch		
Presidio 4 fl oz	1, 4	2.8 d
Orondis Ultra 8 fl oz	2, 5	
K-PHITE 4 qt	3, 6	
No mulch		
Actigard 0.75 fl oz	1, 4	14.8 b
Elumin 8 fl oz	2, 5	
Presidio 4 fl oz	3, 6	
Mulch		
Actigard 0.75 fl oz	1, 3	8.5 c
Elumin 8 fl oz	2,4	
Presidio 4 fl oz	1-5	
Non-treated check (No mulch)		**32.5 a**
Non-treated check (Mulch)		**28.2 a**

[z]Application dates were: 1=May 20, 2=May 27, 3=June 3, 4=June 10, and 5=June 17.

[y]Disease incidence was rated on a 0 to 100 scale where 0=0% of fruit in a plot affected and 100=100% of fruit in a plot affected.

[x]Means followed by the same letter within each column are not significantly different according to Fisher's LSD test at p ≤ 0.05.

Roundup Application Before Transplanting Vegetables

S. Culpepper, T. Randell, J. Vance

Introduction

Georgia vegetable growers rely heavily on Roundup to assist in preparing a weed-free planting environment for over 35 different fresh-market vegetable crops. Past labels and research in other areas have suggested that the herbicide provides little to no residual soil activity thereby eliminating plant-back or rotational concerns. However, over the past few years, farmers have asked UGA Extension personnel whether previous researchers evaluated the use of this herbicide in transplant vegetable production scenarios on sandy soils. Thus, the objective of these experiments was to determine if glyphosate applied prior to transplanting poses harm to produce through residual activity and, if so, what approaches can be used to avoid damage.

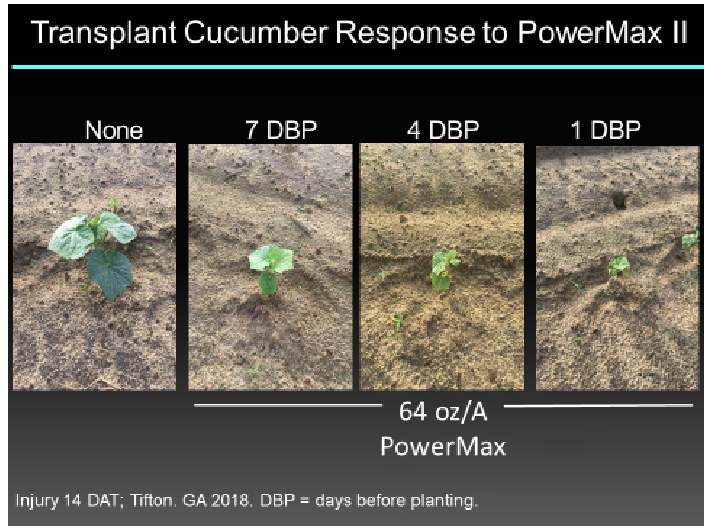
Materials and methods

Four different experiments were conducted to determine the impact of glyphosate applied prior to transplanting a multitude of vegetables. Common cultivars were transplanted into bareground production after applying glyphosate preplant as noted with each study below. Crops were grown following standard production practices with each treatment replicated four times. Soils were over 90% sand with less than 0.5% organic matter. *Rates of glyphosate discussed below include 1.1, 2.2, 3.3 or 4.4 lb ae/A which would equal Roundup PowerMaxII rates of 32, 64, 96, or 128 oz/A, respectively. These rates were for research purposes; use labeled rates only.*

Results

Cucumber experiment: Glyphosate at 1.1, 2.2, or 3.3 lb/A was applied 7, 4, or 1 day before transplanting. With no rainfall occurring between application and planting, maximum injury ranged from 5 to 8, 14 to 31, and 27 to 52% with 1.1, 2.2 or 3.3 lb/A, respectively, with higher injury levels noted with applications closer to planting. Only 1.1 lb/A applied 7 days preplant did not reduce plant biomass. After harvesting 11 to 13 times, pounds of marketable fruit were reduced by all glyphosate applications except for 1.1 lb/A applied 7, 4, or 1 days preplant and with 2.2 lb/A applied 7 days preplant.

Squash experiment: Treatments were identical to that



provided for the cucumber experiment. Maximum injury ranged from 0 to 13, 3 to 22, and 13 to 48% with glyphosate at 1.1, 2.2 or 3.3 lb/A, respectively, with higher injury levels noted with applications closer to planting. Glyphosate reduced plant heights, preharvest biomass, and pounds of marketable fruit except when glyphosate was applied at 1.1 lb/A at 7 or 4 days prior to planting.

Seedless watermelon experiment: Glyphosate at 0 or 2.2 lb/A was applied 1 day prior to transplanting with herbicide treatments either receiving no irrigation or 0.5 in. of irrigation after spraying but before planting. Maximum watermelon injury was 5% with irrigation and 30% without irrigation, respectively. Glyphosate preplant without irrigation reduced runner lengths 27% at 6 weeks, preharvest plant biomass 56%, and pounds of fruit harvested 25% when compared to no glyphosate. The addition of irrigation was beneficial, but glyphosate still reduced runner lengths by 12 % and pounds of fruit harvested 16%.

Bell pepper, cantaloupe, cucumber, eggplant, summer yellow squash, tomato, and seedless watermelon experiment: Glyphosate was applied at 0, 2.2, or 4.4 lb/A 3 days prior to transplanting. Rainfall or irrigation did not occur between application and transplanting.

Visual injury: At 21 days after treatment, glyphosate at 2.2 or 4.4 lb/A injured bell pepper (53 or 79%), cantaloupe (43 or 69%), cucumber (69 or 91%), eggplant (51 or 72%), squash (55 or 89%), tomato (55 or 89%), and watermelon (49 or 79%), respectively.

Plant biomass: At 43 days after treatment, glyphosate at 2.2 or 4.4 lb/A reduced plant biomass of bell pepper (80 or 96%), cantaloupe (59 or 78%), cucumber (77 or 97%), eggplant (58 or 92%), squash (61 or 87%), tomato (80 or 97%), and watermelon (32 or 73%), respectively.

Crop Stand: Glyphosate did not influence cantaloupe, eggplant or pepper stand. Stand loss was observed for squash, tomato, and watermelon but only with glyphosate at the 4.4 lb/A rate while both glyphosate rates reduced stand in cucumber.

Conclusion

Glyphosate is a critical tool for Georgia agriculture. Vegetable growers, however, need to closely evaluate their use of this herbicide active ingredient prior to planting vegetables. In response to the research provided herein, a new Roundup PowerMax II label has been develop in cooperation with Bayer CropScience to guide growers on how to use the product effectively without causing crop damage and is provided below.

Of importance, the label addresses fruiting vegetables and cucurbits. However, as our research expands into Cole crops and other vegetables, we would encourage growers to follow these more restrictive recommendations in contrast to current product labeling.

Additional information

Recommendations Prior to Transplanting Cucurbits and Fruiting Vegetables in Sandy Soils EPA Reg. No. 524-537

FIFRA 2(ee) Recommendation

FOR DISTRIBUTION AND USE ONLY IN THE STATES OF ALABAMA, FLORIDA AND GEORGIA

FIFRA Section 2(ee) Recommendation: This recommendation is made as permitted under FIFRA Section 2(ee) and has not been submitted to or accepted by the U.S. Environmental Protection Agency. This product bulletin is not product labeling, but is issued to clearly describe use recommendations as permitted under FIFRA Section 2(ee). Always read and follow label directions. The applicable labeling for this product must be in the possession of the user at the time of application.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

Read the product labeling affixed to the container of Roundup PowerMAX II Herbicide before applying. Use of Roundup PowerMAX II Herbicide according to this product bulletin is subject to the use precautions and limitations imposed by the labeling affixed to the container.

CROPS: Cantaloupe, Casaba melon, Crenshaw melon, Cucumber, Gherkin, Gourds, Honeydew melon, Honey ball melon, Mango melon, Melons (all), Muskmelon, Persian melon, Pumpkin, Squash (summer, winter), Watermelon, Eggplant, Groundcherry, Okra, Pepino, Pepper (includes bell pepper, chili pepper, cooking pepper, pimento, sweet pepper), Tomatillo, Tomato.

When applying Roundup PowerMAX II Herbicide prior to transplanting these crops in BARE GROUND production soil with over 85% sand and/or less than 0.5% organic matter, if the soil is not tilled after application and before planting, apply no more than 32 fluid ounces of this product per acre in a single application, and allow for a minimum accumulation of 0.5 in. of rainfall or overhead irrigation and wait 7 or more days between application and transplanting. Make no more than 1 application of this product within 2 weeks before transplanting.

When applying Roundup PowerMAX II Herbicide prior to transplanting these crops in MULCH production where soil is over 85% sand and/or less than 0.5% organic matter, wait 3 or more days before transplanting following a single application of this product up to 32 fluid ounces per acre, or wait 10 or more days following a single application between 32 and 64 fluid ounces per acre, AND allow for a single rainfall or irrigation event of at least 0.5 in. between application of this product at any rate and transplanting. Punch new transplant holes and place plants a minimum of 3 in. from old holes or torn mulch.

Single Application Rate of Roundup PowerMAX II Herbicide	Interval Between Application and Transplanting	Rainfall/Irrigation Before Transplanting
Up to 32 fluid ounces	3 or more days before transplanting	0.5 in. or more
32 to 64 fluid ounces	10 or more days before transplanting	0.5 in. or more

Advanced molecular detection of *Phytophthora capsici* on squash and bell pepper

E. Ali, P. Ji, S. Waliullah, O. Hudson, T. Stackhouse

Introduction

Phytophthora blight is one of the most devastating diseases of solanaceous and cucurbit crops. The disease, caused by the oomycete pathogen *Phytophthora capsici*, is extremely damaging on squash and bell pepper. Typical symptoms include root rot, crown rot, and fruit rot. *Phytophthora capsici* causes permanent wilt suddenly due to root infection following rain or irrigation and whole plants or vines collapse quickly. The pathogen affects not only in the field, but also during post-harvest stages. Healthy-looking fruit is harvested, but fruit rot developed after shipping can make harvests inedible. In addition to *P. capsici*, there are various other pathogens that can cause similar symptoms on squash and peppers. A sensitive and quick diagnosis tool for identifying the disease is highly needed. Molecular diagnosis exists for this pathogen; however, current methods are time-consuming, requires sophisticated and bulky laboratory equipment.

Loop-mediated isothermal amplification (LAMP) is a DNA-based method with potential to overcome many of the limitations of traditional assays. The sensitivity of LAMP can be 1,000 times higher than other common methods and testing can be carried out rapidly (often 30 min) with minimal equipment (a water bath or heated block). The objective of this study was to develop a LAMP assay for rapid, sensitive, and efficient detection of *P. capsici* on squash and bell pepper under laboratory and field conditions. The new detection method allows researchers and extension agents to easily detect the presence of *P. capsici* in less than two hours. The assay is proven to be more sensitive than previous methods and was validated against other pathogens. This detection method will allow growers to detect the pathogen from infected vegetables like squash and bell pepper to prevent devastating outbreaks and economic losses.

Materials and methods

A novel loop-mediated isothermal amplification (LAMP) assay was developed to amplify *P. capsici*. The assay conditions were optimized for best equipment settings (temperatures, concentrations, and time), sensitivity, and specificity. This assay was also used testing field samples.

Results

The resulting assay successfully identified *Phytophthora capsici* samples (Figure 1). The samples were tested with extremely low concentrations of DNA for sensitivity and against various closely related oomycetes for specificity. It was shown to specifically amplify DNA of *P. capsici* and was 100-fold more sensitive than the reported sensitivity of the conventional PCR method (Figure 2). There were several ways to detect the results, including graphs and color changes. Isolates of *P. capsici* were taken from Tennessee, Florida, and Georgia and were submitted to the same protocol described in the methods. All samples of *P. capsici* isolates were amplified successfully in all runs of the assay.

Conclusions

Traditional diagnosis of *P. capsici* based on morphological microscopic observation and conventional molecular methods is time-consuming and requires specialized techniques and knowledge. The LAMP assay developed represents a sensitive, specific and rapid diagnostic method for *P. capsici* detection. *P. capsici*-infected samples on squash and bell pepper can be identified in the early stages of infection, and management measures can be designed before the infection becomes epidemic.

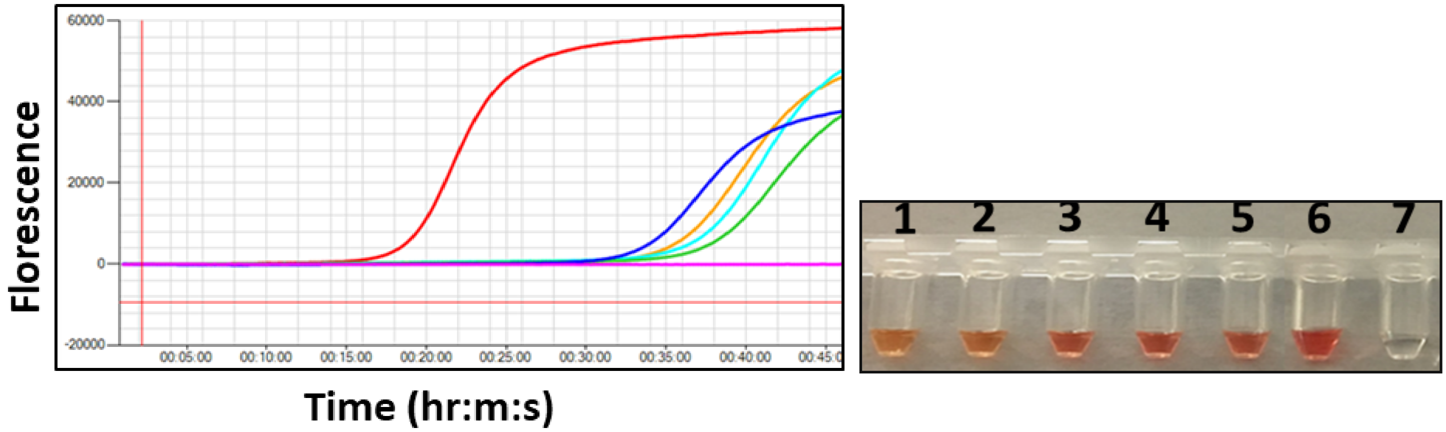


Figure 1. LAMP graphical results for a healthy control control (green) and four CuLCrV samples (all other colors) samples. LAMP colorimetric results with four CuLCrV samples and a healthy control. There is a colorimetric change in positives from red to fluorescent yellow.

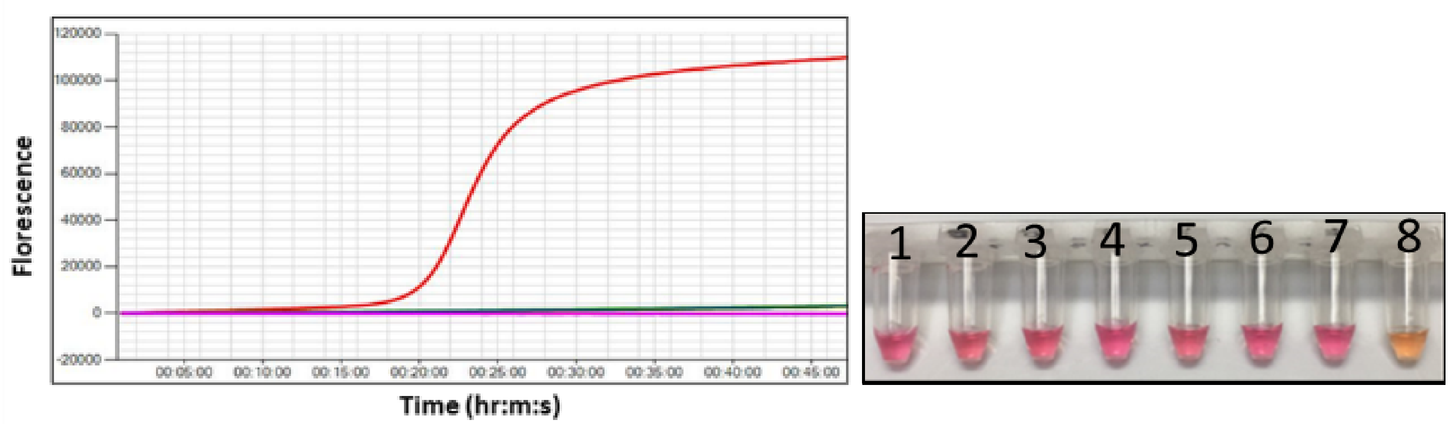


Figure 2. Left: LAMP graphical results with one *P. capsici* sample (red) and seven closely related oomycete samples (all other colors). Right) LAMP colorimetric results for six *P. capsici* (1-6) samples and a negative control (N). Right: LAMP colorimetric results with seven closely related oomycete samples (1-7) and one *P. capsici* sample (8). There is a colorimetric change in positives from red to yellow/orange.

Management of Whitefly-Transmitted Viral Diseases and Maximization of Fruit Yield and Quality in Zucchini Squash by Utilizing Colored Plastic Mulches and Particle Clay Applications

J. Díaz-Pérez, S. Bag

Introduction

Squash (*Cucurbita pepo* L.) is susceptible to viral diseases transmitted by whiteflies that result in significant reductions in plant growth and fruit yield. Plastic mulch color has been found to affect plant growth and fruit yield and be influence insect pests populations in various crops. Particle clay has also been reported to reduce plant heat stress and to repel insects (such as whiteflies) that transmit viral diseases. There is limited information on the use of colored plastic mulches and particle clay for improvement of plant health and management of whiteflies in Georgia.

Objectives

To determine the effects of colored plastic mulches alone or combined with particle clay on whiteflies populations and fruit yield and quality in zucchini squash.

Materials and methods

Zucchini ('Spineless Beauty') was planted at the UGA Tifton Campus in the fall of 2019, following the recommendations of UGA Extension Service, including the use of plastic film mulch and drip irrigation. Experimental design was a randomized complete block, with four replications and six treatments [three plastic mulches (white, black, and gray) and two particle clay treatments (with or without particle clay)] (Figure 1). Particle clay (Surround®) was applied every week or as needed, depending on rainfall.

Leaf temperature was measured with an infrared thermometer. Plant dry weight was determined at the end of the season. The populations of whiteflies were estimated using a visual rating scale (1 = None; 2 = Low; 3 = Medium; 4 = High; 5 = Very High). Fruit were harvested and graded according to the USDA grading standards as marketable and cull.

Figure 1. Zucchini squash ('Spineless Beauty') on colored plastic film mulches. Tifton, Georgia, fall of 2019.

Plants were monitored for the presence of virus symptoms on weekly intervals and the disease severity was recorded.

Results

Plant growth and whiteflies rating: Plant growth was unaffected by both, mulch and particle clay treatments (Table 1).

Leaf temperature: similar among plastic film mulches. Leaf temperature, however, was significantly reduced with particle clay applications (Figure 2).

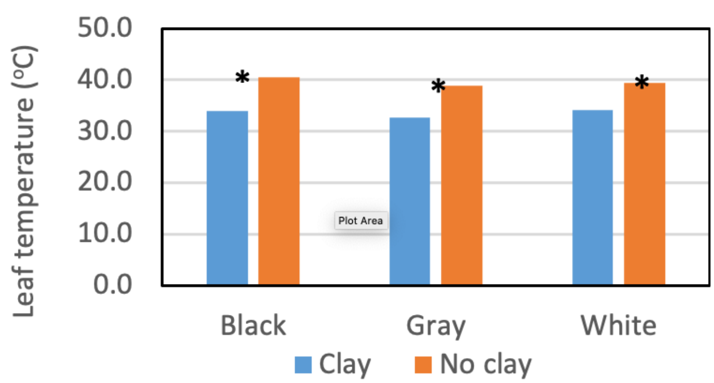


Figure 2. Effect of plastic mulch color and particle clay applications on midday leaf temperature in zucchini ('Spineless Beauty'). Tifton, Georgia, fall of 2019.

Whiteflies rating: (visual estimation of whiteflies population) were unaffected by mulch treatments (Table 1). Whiteflies visual ratings, however, were reduced with particle clay applications.

Table 1. Effect of plastic mulch color and particle clay applications on plant growth, whiteflies rating, and zucchini fruit yield. Tifton, Georgia, fall of 2019.

Treatment	Plant dry wt (g)	Whiteflies rating[z]	Marketable (1000/ha)	Marketable (t/ha)	Fruit wt (g/fruit)
Mulch					
Black	61.6	2.64	52.6 b	11.9 b	227
Gray	61.4	2.75	68.7 a	16.4 a	237
White	59.7	2.63	68.6 a	14.9 ab	217
Particle clay					
No	59.5	2.90	58.0 b	13.0 b	225
Yes	62.4	2.44	67.2 a	15.4 a	228
Significance					
Mulch (M)	0.799	0.605	0.007	0.018	0.468
Particle clay (C)	0.311	0.0001	0.032	0.035	0.645
M x C	0.964	0.878	0.335	0.069	0.092

Figure. 3 Zucchini squash ('Spineless Beauty') on colored plastic film mulches showed no symptoms of viral disease. Tifton, Georgia, fall of 2019.

Fruit number and yield: The number and yield of marketable fruit were reduced on black mulch compared to gray and white mulches. Fruit number and weight were increased with particle clay treatment. The weight of individual fruit was unaffected by both, plastic mulch and particle clay treatments.

Virus disease incidence: No foliar symptoms associated with viruses were observed in the experimental plots (Figure 3).

Conclusions

Particle clay (Surround) applications resulted in reduced leaf temperatures and whiteflies ratings and increased zucchini fruit yields. Further studies on Surround® as a tool for management of whiteflies and for improving plant health are recommended.

Black plastic mulch was associated with reduced zucchini fruit yields. Thus, black mulch is not recommended for fall zucchini production in Tifton, Georgia.

Managing Whiteflies and Whitefly-Transmitted Viruses in Important Vegetable Crops of Georgia

R. Srinivasan, B. Dutta, T. Coolong, A. Sparks

Whitefly and virus incidence in 2019

By now, it is rather clear that whiteflies and whitefly-transmitted viruses have become established in our state and have become chronic issues. What drives their intensities each year still need to be clearly worked out. Nevertheless, their intensities fluctuate yearly. 2019 was a -moderate year for whiteflies and viruses, with a few sporadic high intensity spots. The viruses commonly found in 2019 included the tomato yellow leaf curl virus (TYLCV) and tomato chlorosis virus (ToCV) in tomato, cucurbit leaf crumple virus (CuLCrV) and cucurbit yellow stunting disorder virus (CYSDV) in squash, and CuLCrV and sida golden mosaic virus (SiGMV) in beans. CuLCrV and CYSDV were more often than not seen as mixed infections in squash. Similarly, CuLCrV and SiGMV were found as mixed infections in beans. In fact, the frequency of SiGMV was much more prevalent in 2019 than in 2018. The mixed infected plants were much more symptomatic than plants infected with one or no virus, consequently suffered more yield losses. Our laboratory is now fully committed to studying interactions between viruses, hosts, and whiteflies to comprehensively understand how these viruses are transmitted, how the virus inoculum is maintained year-after-year, and how best to use the information obtained towards management both in short-term and long-term.

Understanding the problem

Our laboratory continues to spend considerable amount of time and resources to understand how these viruses are transmitted, what are their inoculum sources, and what are the whitefly reservoirs. This is painstaking mainly due to the fact that each of these questions requires a multitude of experiments to be precisely addressed. The general theme (at least for the viruses evaluated thus far) is that horizontal or whitefly-to-whitely transmission of these viruses is almost non-existent, and virus epidemics seem to be initiated by alternate or weed hosts that are present in the farmscape/landscape each year. Two of our recent publications on this front offer more details (Gadhave *et al.,* 2020; Legarrea *et al.,* 2020). The other row crops that are reservoirs of the vector (whiteflies) seem to be also involved.

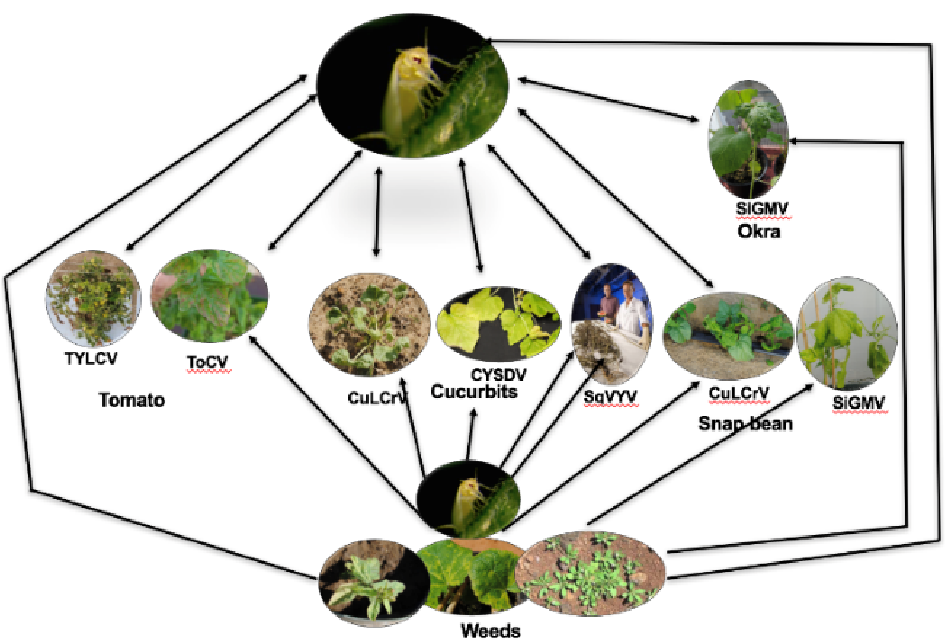


Figure 1. The virus-whitefly web cartoon depicting the complexity of vegetable hosts and whitefly-transmitted viruses infecting them. This web structure seems to be getting more elaborate with the addition of new viruses and hosts affected by them.

Whitefly cryptic species and populations in vegetable crops

Whiteflies actually form a cryptic species complex. There are numerous cryptic species depending upon the method in which the molecular analyses are conducted. But suffice to say that in Georgia, the *Bemisia tabaci* (Gennadius), Middle East Asia Minor 1 (MEAM 1) is the predominant cryptic species across vegetable and row crops, and this scenario has not changed recently. Whitefly populations were somewhat moderate in 2019 (albeit slightly lower than in 2018). The prevalence of a single cryptic species throughout our landscape indicates that whiteflies could move from one host to the other especially when fall vegetables are planted. Therefore, successful whiteflies and virus management would have to rely on a landscape-level strategy.

Besides transmitting viruses, whiteflies also actually pose a direct threat to the crop. Feeding related damages in vegetables include silvering of leaves in the case of squash, sooty mold in leaves and flowering structures in tomato, irregular ripening of fruits in tomato, and yield reduction.

Figure 2. Silvering in squash plants (top) in a crop planted in fall 2019 due to heavy infestation of whiteflies (bottom).

Management of whiteflies and viruses

Our research is aimed at understanding basic aspects of virus transmission prevention and use the knowledge gained to develop short and long-term management. The long-term management aspects include using RNAi approaches and host plant resistance. Some research on those fronts have already begun in collaboration with Dr. Bhabesh Dutta, Dr. Cecilia McGregor, and Dr. Andre da Silva, and currently transcriptomics research is ongoing to lay the foundation for RNAi based management. In the short term, field research on screening for resistance, insecticide effects, and cultural tactics such as reflective and live mulch as well as row covers for management of whiteflies and viruses in squash are being conducted. In addition, greenhouse experiments are also being conducted. Here, I will only describe the results of the greenhouse trial, the mulch trial as well as the insecticide trial with squash.

Greenhouse treatments

Greenhouse seedlings could also be susceptible to whiteflies and viruses even before planting in the field. Therefore, it becomes essential to limit the infection percentage at the beginning. A few treatments were examined in 2019, and their results are included below. The take home message in this exercise is that protection physically and with chemicals would be ideal and reduce the amount of inoculum being planted in the beginning of the growing season.

Table 1. Effects of insecticides and a growth regulator on whitefly infestation evaluated with and without protective netting.

Treatments	Mean whitefly counts
Not-protected	
Verimark (13.5 fl oz/A)	0.9 bc
Requeim (2 qt/A)	0.2 c
Actigard (0.25 fl oz/A)	1.2 b
Non-treated check	4.1 a
Protected	
Verimark (13.5 fl oz/A)	0.0 b
Requeim (2 qt/A)	0.0 b
Actigard (0.25 fl oz/A)	0.0 b
Non-treated check	0.2 a

Overall, a 2% incidence of CuLCrV was observed under non-protected (no netting) scenario. While this 2% is probably small, planting seedlings with 2% virus incidence in the field could very soon progress to a very high percentage of virus incidence.

Mulch treatments

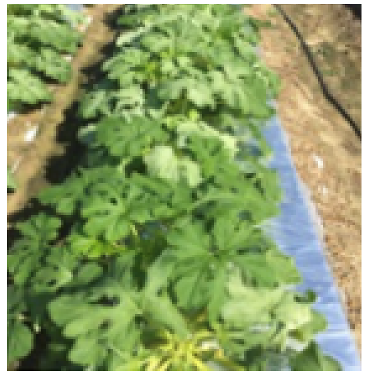
In 2019, the mulch trial was conducted at the TVP farm in Tifton. Three kinds of mulch were evaluated: white plastic, reflective, and live (buckwheat) mulch were evaluated in a randomized complete design with at least four replications for each treatment.

Table 2. Effects of different mulch types on whitefly incidence, 2019.

Eggs

Tukey-Kramer Grouping for Treatment Least Squares Means (Alpha=0.05) LS-means with the same letter are not significantly different.	
Treatment	Estimate
Silver Mulch	200.00 A A
Live Mulch (Buckwheat)	184.20 B A B
Standard White	156.60 B

Nymphs



Tukey Grouping for Treatment Least Squares Means (Alpha=0.05) LS-means with the same letter are not significantly different.	
Treatment	Estimate
Standard White	190.70 A A
Live Mulch (Buckwheat)	189.65 A
Silver Mulch	126.45 B

Adults

Tukey Grouping for Treatment Least Squares Means (Alpha=0.05) LS-means with the same letter are not significantly different.	
Treatment	Estimate
Silver Mulch	205.33 A A
Standard White	136.33 A A
Live Mulch	69.3333A

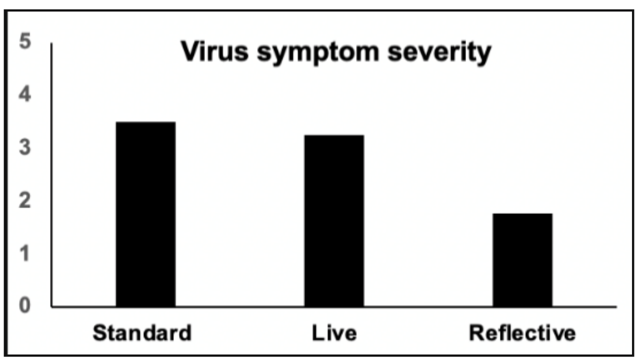


Figure 3. Effects of mulch on virus symptom severity.

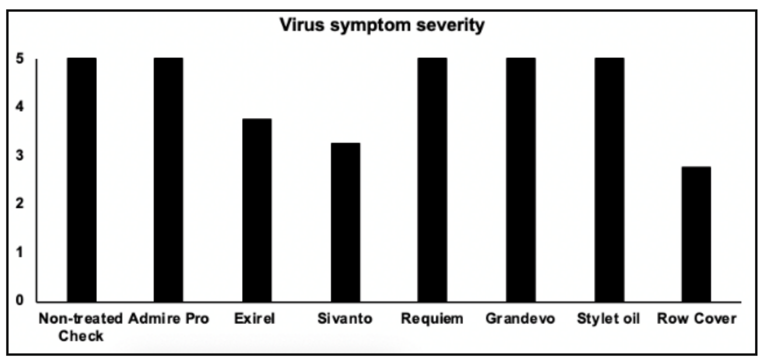


Figure 5. Effects of various insecticide treatments on virus symptom severity.

Figure 4. The photos on the right show differences in squash following insecticide applications. The photo on the left represents a non-treated row and the photo on the right shows an effective insecticide treatment.

Results revealed that silver mulch suppressed whitefly infestation on squash plants and reduced virus symptom severity. Given that most plants in all treatments were infected, silver mulch-based reduction in symptom severity and whitefly suppression translated to modest yield benefits.

Insecticide treatments

Several insecticides were evaluated in 2019 against whiteflies in squash.

Application of insecticides did not prevent virus transmission completely, but rather suppressed whitefly feeding on squash plants. Consequently, the symptom severity was reduced, and yields increased. The row cover and Sivanto applications were better than all other insecticide treatments.

Conclusions

Our research indicates that in the absence of a 'silver-bullet' option, stacking management options such as cultural and chemical could help reduce some losses in the short-term until more sustainable long-term management options become available. The short-term goal is to emphasize on the additive nature of these management options, and how they could be readily useful to growers.

Table 3. The table on the left is a snapshot of whitefly adult counts on squash treated with various insecticides and row cover.

09/05/19 Tukey-Kramer Grouping for Treatment Least Squares Means (Alpha=0.05) LS-means with the same letter are not significantly different	
Treatment	**Estimate**
Stylet Oil	126.27 A A
Exirel	121.87 A A
Sivanto	110.35 A A
Untreated Check	99.3000 A
Requiem	99.0000 A A
Admire Pro	96.9250 A A
Grandevo	89.8250 A
Row Cover	4.6E-12 B

Table 4. Effects of various insecticide treatments on squash yield.

Yield Tukey Grouping for Treatment Least Squares Means (Alpha=0.05) LS-means with the same letter are not significantly different	
Treatment	**Estimate**
Row cover	55.2500 A A
Sivanto	47.7500 A A
Exirel	41.5000 B A B
Admire Pro	7.7500 B C C
Requiem	3.5000 C C
Grandevo	2.7500 C C
Stylet Oil	2.5000 C C
Untreated Check	2.5000 C

Monitoring insecticide resistance in *Plutella xylostella*, the diamondback moth, in Cole crops and developing more genetic analysis tools to identify mechanisms

D. Riley

Background of research in Georgia

By now, it is rather clear that whiteflies and whitefly-transmitted viruses have become established in our state and have become chronic issues. What drives their intensities each year still need to be clearly worked out. Nevertheless, their intensities fluctuate yearly. 2019 was a -moderate year for whiteflies and viruses, with a few sporadic high intensity spots. The viruses commonly found in 2019 included the tomato yellow leaf curl virus (TYLCV) and tomato chlorosis virus (ToCV) in tomato, cucurbit leaf crumple virus (CuLCrV) and cucurbit yellow stunting disorder virus (CYSDV) in squash, and CuLCrV and sida golden mosaic virus (SiGMV) in beans. CuLCrV and CYSDV were more often than not seen as mixed infections in squash. Similarly, CuLCrV and SiGMV were found as mixed infections in beans. In fact, the frequency of SiGMV was much more prevalent in 2019 than in 2018. The mixed infected plants were much more symptomatic than plants infected with one or no virus, consequently suffered more yield losses. Our laboratory is now fully committed to studying interactions between viruses, hosts, and whiteflies to comprehensively understand how these viruses are transmitted, how the virus inoculum is maintained year-after-year, and how best to use the information obtained towards management both in short-term and long-term.

Proposed DBM bioassay and field resistance management methodology

The proposed bioassay method will be the leaf dip assay of DBM larvae used last year a high labeled rate for individual products (last year's Appendix) to ascertain which of the IRAC Groups of insecticide demonstrate efficacy against a specific population of DBM. It takes ~3 hours to set up an 11-treatment (10 + check) bioassay run for one or more locations. Agents and students will collect larvae to load in the dishes and the graduate

Figure 1. Diamondback moth adult (inset) and leaf damage caused by feeding larva.

student will read the 24 h – 72 h mortality results and place them into a descriptive graph along with a recommended IRAC Group rotation sheet (non-specific for commercial products) provided by D. Riley. These will be done in any county where we are called by the agents reporting a DBM outbreak.

Following the insecticide bioassays, surviving larvae will be preserved in RNAlater and stored at -80o until RNA and DNA extraction can be performed. Total RNA will be extracted with a Direct-zol RNA miniprep kit (Zymo Research) according to the manufacturer's protocol, after which first-strand cDNA will be generated using SuperScript VILO master mix (Invitrogen). Genomic DNA will be extracted using an E.Z.N.A. Insect DNA Kit (Omega Bio-tek). cDNA and genomic DNA will be stored at -80o until assayed. Standard PCR will be used initially to screen for known mutations conferring target-site resistance. Specific mutations are described above for each class of insecticide. Primers will be designed to amplify only wild-type (susceptible) targets, so failure to amplify the target will imply a mutation relative to the wild-type sequence. The specific mutation will be identified by amplifying and sequencing (in both directions) a region of ~600 bp around the suspected mutation site. Various PCR machines (including a MJ Research PTC-200 nad an Eppendorf MasterCycler Gradient machine) are available for this work. Amplifications will use Phusion Taq (New England Biolabs), a proofreading Taq polymerase, to minimize chances of PCR-induced errors. The specific tests that indicate resistance to specific modes of action will be summarized for regional use and presented at the Southeast Regional Fruit and Vegetable Conference.

Screening of Novel New Crops for Georgia Vegetable Growers

T. Coolong, A. da Silva

Introduction

Diversification is a way for Georgia vegetable farmers to reduce risk and possibly increase revenue. Many crops that were once considered novel (broccoli, kale, cauliflower) are now produced on commercial acreage in Georgia. For a number of years, growers have looked at lettuce as a potential market. However, nearly all lettuce sold on the wholesale market is grown in California and Arizona and most varieties are bred with those locations and climates in mind. Therefore, we chose to trial lettuces (multiple types) in Georgia in fall 2019 to determine the best performing varieties that growers may look to trial on their own farms. In addition, we wanted to determine if we could obtain commercially acceptable yields for lettuce in Georgia.

Materials and methods

A total of 30 Varieties of lettuce were grown as supplied by Johnny's Seeds. Lettuce were seeded on 16 Sept. 2019 into 200-cell trays (Speedling type tray) and transplanted on 18 October 2019 into white-on-black plastic mulch raised beds. Beds were spaced approximately 6-ft center to center and were approximately 34 in. across the top and 4-6 in. tall. Lettuce seedlings were planted into double rows spaced approximately 16 in. apart with 12-in. row spacing (14,520 plants per acre) (Figure 1). The mini-gem types of lettuce were planted on a 6-in. in row spacing (29,040 plants per acre).

Approximately 500 lbs/acre of 10-10-10 fertilizer was applied preplant. Plants were irrigated regularly upon establishment, but rarely irrigated beginning in November as rains fell more frequently. Plants were fertilized once after planting through the drip irrigation with approximately 15 lbs/nitrogen/acre using a 20-10-20 fertilizer. Lettuce was harvested when plants visually appeared to be mature and the centers (when applicable) were filled out, but prior to bolting. All plots of a given variety were harvested on the same day, but within a given type of lettuce (eg. Salanova) harvests may have occurred over several weeks. Harvests began on 25 Nov. and concluded on 6 Jan. All heads in a plot were harvested, weighed, and tasted with notes taken. Bolting ratings were conducted at harvest, but no plants had initiated bolting.

Figure 1. Visual appearance of cultivars evaluated.

Results

Yields overall were good (Table 1). 'Dragoon' was the first variety harvested, while 'Cherokee', 'Coastal Star', 'Salvius', and 'Monte Carlo' were the last. As expected, most romaine varieties had the highest yields, with 'Coastal Star' averaging nearly 40 oz/head. Given weather conditions in Georgia it is unexpected to have yields for most romaine types exceeded 1 lb/head, with the exception of 'Thurinus'. 'Green Sweet Crisp' had a very high yield for Salanova types. Upon cutting, the head was extremely dense with yields more than 16 oz per head. Most other Salanova types had head weights in the 6-7 oz. range. 'Red Cross' produced a great flavor with a firm head and was well received by most that viewed it.

Conclusion

All varieties performed well overall, which was likely due to the mid-fall planting window. Although spacing was wide, commercially acceptable head weights of romaine types were obtained. A study evaluating spacing on second crop plastic would help determine if we can have a fall-market for lettuce in Georgia. In addition, the specialty types performed very well and may be a potential market for some growers as well. Row covers were used on some nights when temperatures dropped below 30 °F, but it is unlikely that they truly were necessary for production during this time period.

Table 1. Yield results from Fall 2019 lettuce trial. Watkinsville, Georgia. All plants grown at a population of 14,520/acre except mini-romaine types that were grown at a population of 29,040/acre.

Type	Variety	Yield (lb/100 ft)		Avg. Head Wt. (oz)		Days to Harvest	Flavor Notes
Butterhead							
	Alkindus	189	a*	15.1	a	69	Sweet internally, bitter outside
	Red Cross	132	b	10.6	b	53	Succulent, low bitterness, good bite
	Skyphos	114	b	9.1	b	53	Sweet, succulent, crunchy
Leaf/Lollo							
	Ruby Sky	178	a	14.2	a	53	Mild sweet, crunchy
	Ilema	102	b	8.1	b	49	
	Antonet	82b	b	6.5	b	53	Lite bitterness, sharp flavor
Oak Leaf							
	Rouxai	66	-	5.3		53	
Mini-Romaine							
	Breen	240	a	9.6	a	69	Very crunchy/crisp
	Truchas	143	b	5.7	b	54	Mild bitterness, crunchy texture
	Dragoon	140	b	5.6	b	38	Crisp, mild flavor
	Ezbruke	103	c	4.1	c	69	Very crunchy, very bitter
Romaine							
	Coastal Star	498	a	39.8	a	80	Sweet and bitter, crunchy
	Salvius	447	a	35.8	a	80	Bitter, very green flavored
	Sparx	376	ab	30.0	ab	69	Very crisp, clean-flavor
	Fusion	284	bc	22.7	bc	59	Very crunchy, no bitterness
	Monte Carlo	258	bc	20.6	bcd	80	Very sweet, crisp
	Green Forest	227	cd	18.1	cd	69	Fleshier, green flavor, mild
	Thurinus	120	d	9.6	d	69	Fleshy bite, good flavor
Salanova							
	Green Sweet Crisp	203	a	16.2	a	49	
	Green Butter	91	b	7.3	b	55	Sweet, mild flavor
	Green Oakleafleaf	91	b	7.3	b	52	
	Red Sweet Crisp	87	bc	7.0	bc	59	Mild sweetness, good texture
	Green Incise	77	bcd	6.1	bcd	52	Bitter and green flavor
	Red Butter	75	cd	6.0	cd	69	Great flavor and texture
	Red Incise	71	d	5.6	d	52	Bitter and green flavor, crisp
	Red Oak	65	d	5.2	d	52	Slight bitterness, crisp
Summer Crisp							
	Cherokee	246	a	19.6	a	80	
	Magenta	192	b	15.3	b	69	Sweet, lots of water, mild flavor
	Muir	147	c	11.7	c	49	
	Nevada	124	c	9.9	c	52	Crisp and sweet

*Values followed by the same numbers within a given type of lettuce (e.g., Romaine) are not significantly different ($p < 0.05$). Varieties in different types of lettuce were not compared.

Determining Irrigation Scheduling for Vegetable Crops Using the Blue Dye Test

S. Hollifield, J. Candian, A. da Silva

Introduction

In Brooks County, Georgia producers annually grow approximately 6,250 acres of commercial vegetables. The vast majority of the vegetables produced are grown in commercial fields consisting of sandy loam and sandy soil types, but commercial vegetable production can be challenging in these soils. Sand particles are large and coarse, which allows water to both enter and drain away quickly. Due to the shallow root system of vegetable crops, it is challenging for growers to monitor and maintain adequate moisture and nutrients.

Depending on air temperatures and other environmental factors, vegetable crops grown in sandy soils are likely to become dry soon after an irrigation or rainfall event. In addition, vegetables produced in sandy soils often times exhibit nutrient deficiencies due to the high levels of nutrients leached when irrigation is not properly managed. In general, vegetable growers must closely manage fertility programs with timing of irrigation events and rainfall occurrences to avoid plants stresses and yield reductions.

During the 2019 production season, Brooks County Extension conducted a blue-dye field test to address commercial grower concerns related to irrigation questions for bell pepper production and movement of the water throughout the soil profile after irrigation events. The blue-dye field test is a practical method to visualize water movement in the soil. The test consists in the injection of a water-soluble dye through the drip irrigation system that will provide a visual report of water movement in the root zone. Thus, in collaboration with a bell pepper grower the first blue-dye commercial field test in Georgia was conducted with the objective to determine irrigation scheduling for bell pepper production in sandy soils. Sandy and loamy sand soils have low water holding capacities and require frequent irrigation events to potentiate yield. Proper scheduling of irrigation events in vegetable fields, with drip irrigation, can be simply identified using a blue-dye indicator, which is injected in the irrigation water to color the soil. The objective of this educational demonstration project was to assist and educate a bell pepper grower, in the scheduling of irrigation events, with an introduction and demonstration of the blue dye test.

Materials and methods

Conducted in a 42-acre field located in Brooks County, Georgia, the blue-dye test evaluated six treatments representing irrigation timings at 15, 20, 25, 30, 40, and 60 minutes. Irrigation was applied at 500 gpm and 60 psi, while blue-dye indicator was injected after system pressurization. Treatments were replicated 4 times in a complete randomize design. Replications were considered a bed 100-ft in length. After irrigation, trenches were open along the soil profile and measurements of the wet zone were made. Soil measurements recorded included the depth between bed surface and deepest dye observation, maximum wetted width located in wet zone, and greatest distance between sides of wetted zone below an emitter.

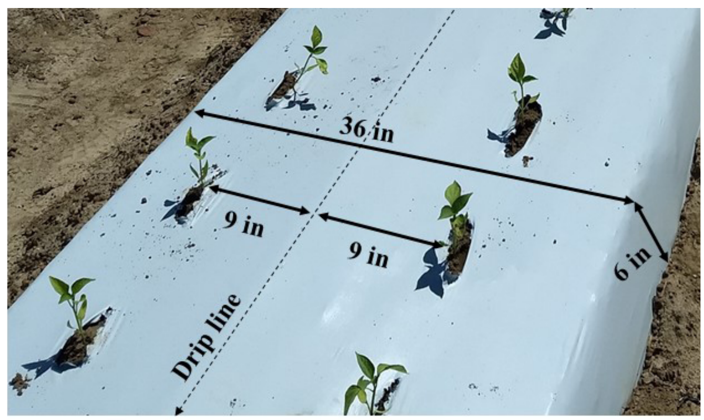


Figure 1. Dimensions of a typical vegetable crop bed with plastic mulching planted with bell peppers.

Results

Downward soil water movement linearly increased with irrigation timing. After 40 and 60 minutes of irrigation, blue-dye indicator was measured at 12.5 in. and 15 in. of soil depth, respectively. This indicates water was moving below bell pepper root zone (12 in. of soil depth), under 60 minutes of irrigation. Bell pepper plants are typically planted in double-rows 9 in. of distance from the drip line each. Lateral soil water movement had a plateau at 9.5 in. from the drip line at 40 minutes of irrigation. Therefore, irrigation events exceeding 40 minutes only represented downward water movement. Most important topic for growers. An easy and simple presentation of results will call their attention.

Figure 2. Effect of the blue dye on the distance between bed surface and deepest dye observation (D), maximum wetted width found in wet zone (W), and distance from bed surface down to measured width (DHW). This photo was taken right after the 15 minutes irrigation treatment.

Conclusion

Typical observation of irrigation events provides qualitative information, but quantitative measures provided by the blue-dye test are needed to improve irrigation management. The detailed data analysis and results obtained from this field test, provided the grower with the precise information needed for improved irrigation management. An additional result of the blue-dye test data was that the grower has decreased his fall bell pepper plant row spacing, from 9 in. off the drip line to 8 in. from the drip line. The grower decided to make this management decision to optimize irrigation scheduling, because our data revealed that lateral water movement plateaued at 9.5 in. from the drip line. By demonstrating to the grower, the depth and width of water movement in the plant bed, and the amount of water that can be held in the root zone, the grower can more effectively determine how to manage and split irrigation events. In addition, this soil profile information assists growers in finding the balance between irrigating and fertigating, to provide necessary plant moisture and nutrients, and decreasing off-site water movement. Overall, the improvement of irrigation management practices in vegetable production saves water usage and reduces production costs. All vegetable crops can be successfully grown in sandy soils, but irrigation management is critical. The blue-dye field study provides a simple and practical method to visualize water movement throughout the soil profile.

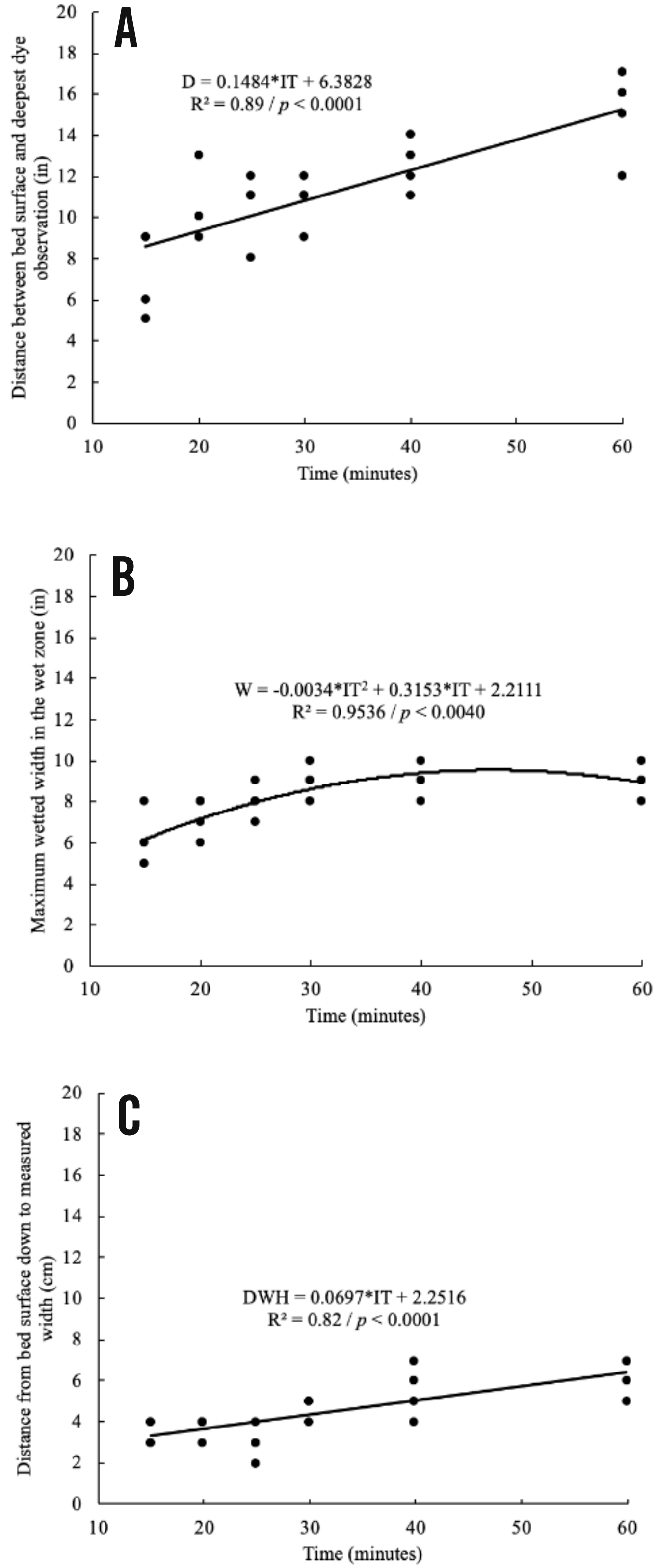


Figure 3. Regression analysis for the distance between bed surface and deepest dye observation (A), maximum wetted width in the wet zone (B), and distance from bed surface down to measured width (C). Note: D means distance between bed surface and deepest dye observation, W means maximum wetted width in the wet zone, DWH means distance from bed surface down to measured width, and IT means irrigation time.

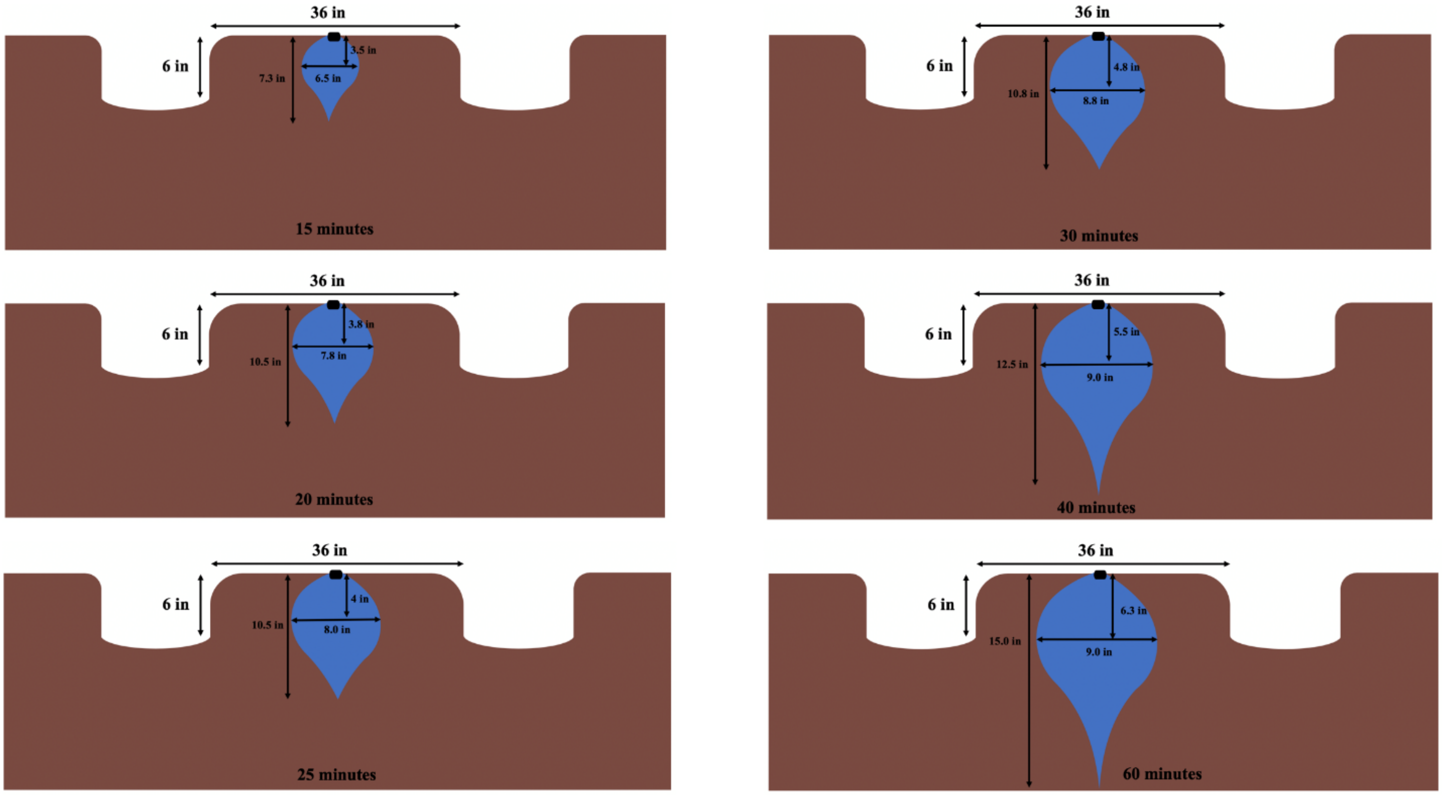


Figure 4. Distance between the bed surface and deepest dye observation (D), maximum wetted width in the wet zone (W), and distance from bed surface down to measured width (DHW) for 15 (A), 20 (B), 25 (C), 30 (D), 40 (E), and 60 minutes (F) of irrigation.

Evaluation of Fungicides for Managing Phytophthora Fruit Rot in Watermelon

S. Hollifield, B. Dutta

Introduction

Brooks County commercial watermelon production equates to over $1,300,000 in farm gate value and annually places Brooks County in the top 20 counties for watermelon production in Georgia. However, each year watermelon producers in Brooks County and throughout Georgia face potential challenges with their disease management programs and profitability margins, from the threat and development of Phytophthora fruit rot. Disease outbreaks of Phytophthora fruit rot in watermelon are caused by the organism *Phytophthora capsici* (*P. capsici*), and even under the most intensive fungicide management programs, this organism can cause extensive losses during favorable weather conditions. Weather conditions that favor Phytophthora fruit rot include warm, rainy days. Also, due to the fact that the *P. capsici* is carried with water movement in soil, rainfall resulting in water that may stand in pools within a field, favors rapid spread of the disease. Due to the potential movement of the organism, through contaminated soil adhering to farm equipment and field labor, plentiful soil moisture may result in widespread problems throughout a farming operation. Also, since the infected watermelon crop is inedible, the resulting crop loss and income can be devastating for watermelon producers. In addition, watermelon producers affected by Phytophthora fruit rot may incur additional costs of production, due to a delay in apparent symptoms of the disease. When managing watermelons infected with *P. capsici* the possibility exist, that even after producers have their watermelon crop picked, packed, and stored, with no signs of Phytophthora fruit rot, the symptoms may appear after shipment. In these cases, the producer doesn't only not get paid for the watermelons, but is still responsible for the shipping costs to the locations and for the disposal of the infected watermelons. For these reasons, the objectives for this watermelon applied research trial was twofold: 1. Evaluate fungicides for their efficacy in management of Phytophthora fruit rot, throughout the growing season for watermelons and 2. Evaluate post-harvest product applications for the suppression of Phytophthora fruit rot symptoms on watermelons.

Materials and methods

Phytophthora fruit rot, fungicide evaluation commercial field trial - Conducted in commercial watermelon field in a randomized complete block design with four replications, each replication was 20 feet in length and with 5 feet planted borders between each plot end. On March 22nd, watermelon (cv. Troubadour) plants were transplanted on to single row beds covered with 18-in. black plastic mulch. Plots were drip irrigated as necessary each week, using a drip tape irrigation system. The grower followed fertility and insecticide treatments according to University of Georgia Extension recommendations. Natural infection of *P. capsici* was relied upon, no inoculation of the organism was conducted. Application of fungicide spray programs began when fruit was present and large enough to apply fungicides to the fruit surface. Fungicide spray applications were made with John Deere 6155 weekly for six weeks. The sprayer was calibrated to deliver 40 GPA at 125 psi, through TX-10 hollow cone nozzles.

At harvest, twenty-three watermelons were harvested from each replicated treatment. The watermelons were stored in individual shipping boxes and incubated at packing shed, under standard room temperature (78 °F), for 48 hours. After this time period, the the watermelons were processed and visually rated for Phytophthora fruit rot. Data were analyzed in the software ARM (Gylling Data Management, Brookings, SD) using analysis of variance (ANOVA) and the Waller-Duncan test to separate means.

Phytophthora fruit rot, post-harvest product evaluation trial: Post-harvest evaluated the effectiveness of three different treatments applied for suppression of *P.capsici* and Phytophthora fruit rot symptoms. The watermelons were harvested from a commercial field infected with *P. capsici*, specifically areas of the field exhibiting Phytophthora fruit rot symptoms. Three treatments were applied to harvested watermelons including 65 watermelons per replication. The treatments were replicated three times for a total of 585 watermelons included in post-harvest study. Treatments included an untreated, as well as Presidio and Oxidate applied treatments. Presidio and Oxidate products were applied to watermelons post-harvest by dipping cloth wipe into product pre-mix and rubbing treated cloth onto the fruit surface. Presidio was pre-mixed into 2 gallons of water at a 2 ounce rate

(1 oz./gallon). Oxidate was pre-mixed into 2 gallons of water at a 12 ounce rate (6 oz./gallon). The treated watermelons were stored in nine individual labeled shipping boxes (three treatments, replicated three times) and incubated at packing shed under standard room temperature (78 degrees Fahrenheit) for 48 hours. After 48 hours, the watermelons were processed through grading procedures, to visually evaluate for the presence of Phytophthora fruit rot symptoms. 48-hour evaluation numerical data was collected for each replicated treatment indicating the presence and occurrences of infected fruit. After initial evaluation, the Phytophthora fruit rot watermelons were removed from the treatments and the remaining unaffected watermelons were stored in original shipping boxes for a second evaluation to be conducted. Prior to second evaluation, the watermelons were incubated under standard room temperature (78 °F), for an additional seventy two hours. After seventy two hour incubation period, the watermelons were processed through grading procedures, for a second visual evaluation for symptom progression and/or additional *P. capsici* infected fruit. Seventy two hour evaluation numerical data was collected for each replication to reference the presence and occurrences of infected fruit.

Results

Phytophthora fruit rot, fungicide evaluation commercial field trial: The disease incidence was significantly higher for the fungicide program that was comprised of Actigard, Elumin, and Presidio (7.6%) compared to other fungicide programs. Fungicide programs comprised of Actigard, Orondis Ultra, and Presidio (1.2%) and Presidio, Orondis Ultra, and Elumin (2.2%) were not significantly different from each other. Phytophthora fruit rot symptoms were not observed for a fungicide program that was comprised of Presidio, Orondis Ultra and Reveille (Potassium Phosphite). No phytotoxicity was observed with any of the fungicide treatments.

Phytophthora fruit rot, post-harvest product evaluation trial: At the first post-harvest evaluation (48 hour incubation) the disease incidence for the Untreated and Presidio treated watermelons was 7.7%. Oxidate treated watermelons displayed a slightly higher infection rate at 8.2%. The total average percentage of the three treatments was 7.9%, for Phytophthora fruit rot watermelons exhibiting symptoms, 2 days after harvest from a *P. capsici* infected field.

The second visual evaluation (additional 72 hour incubation) revealed a continuation of *P. capsici* infection with Untreated at 8.2%, Presidio at 11.1%, and Oxidate at 10.3%. The total average percentage of the three treatments was 9.8%, for Phytophthora fruit rot watermelons exhibiting symptoms, 5 days after harvest from a *P. capsici* infected field.

Conclusion

Phytophthora fruit rot, fungicide evaluation commercial field trial: Although, the commercial field in which this trial was placed had a history of *P. capsici*, the infection rate from *P. capsici* and disease pressure remained suppressed, with producer's closely managed fungicide programs. The Brooks County commercial field trial results, demonstrated that fungicide combinations, which included Orondis Ultra, Presidio, and Reveille (potassium phosphite), were most effective in managing Phytophthora fruit rot in watermelons. However, for producers to effectively manage Phytophthora fruit rot, it is essential that fungicides with different modes of action be rotated. In order to prevent the buildup of fungicide resistance in *P. capsici*, producers should implement a good fungicide resistance management tool, which includes; alternating fungicide modes of action or FRAC (Fungicide Resistance Action Committee) codes applied and/or tank-mixing a systemic fungicide with a contact fungicide.

Phytophthora fruit rot, post-harvest product evaluation trial: There were increased incidences of Phytophthora fruit rot, resulting from high rate of infection from *P. capsici*, in the commercial watermelon field utilized for the harvest of the fruit, used in post-harvest study. The post-harvest evaluation clearly demonstrated that products applied post-harvest to suppress the infection, occurrence, and/or symptoms of Phytophthora fruit rot, on watermelons harvested from *P. capsici* field, will not prevent continued infection throughout the grading, packing, and shipping process.

Table 1. Phytophthora fruit rot incidence according to treatment.

Treatment and rate per acre		App code[y]	Disease incidence (%)[x] 22 June
Presidio	4 fl oz	1, 3	0.0 c
Orondis Ultra	8 fl oz	2, 4	
Reveille	6 pt	1-5	
Actigard	0.75 fl oz	1, 4	1.2 b
Orondis Ultra	8 fl oz	2, 5	
Presidio	4 fl oz	3, 6	
Actigard	0.75 fl oz	1, 4	7.6 a
Elumin	8 fl oz	2, 5	
Presidio	4 fl oz	3, 6	
Presidio	4 fl oz	1, 3	2.2 b
Orondis Ultra	8 fl oz	2, 4	
Elumin	8 fl oz	1-5	

[y]Application dates were: 1=14 May, 2=21 May, 3=26 May, 4=1 June, 5= 19 June, and 6=15 June.

[x]Disease incidence was rated on a 0 to 100 scale where 0=0% of fruit in a plot affected and 100=100% of fruit in a plot affected.

[w]Means followed by the same letter(s) within each column are not significantly different according to Fisher's protected LSD test at $p \leq 0.05$.

Hidden hosts: Identification and monitoring of Weeds as Reservoirs for Cucurbit Leaf Crumple Virus

E. Ali, P. Ji, S. Waliullah, T. Stackhouse

Introduction

Cucurbit leaf crumple virus (CuLCrV) is a begomovirus that was first reported in snap bean in south Georgia in 2009. As with other begomoviruses, this virus is transmitted by various biotypes of whiteflies including the silverleaf whitefly (*Bemisia tabaci*). It can infect most cucurbits as well as snap bean. Typical symptoms of CuLCrV include chlorotic leaf spots and terminal buds, leaf curling and crumpling, and interveinal yellowing. In addition, plants may be stunted, resulting in severe or complete yield loss. Weeds may serve as a host of CuLCrV. While studies regarding weed hosts of CuLCrV are limited, many weed species are known hosts of other viruses including weeds in the families Amaranthaceae, Ascleridaceae, Chenopodiaceae, Convolvulaceae, Euphor-biaceae, Solanaceae, Compositae, Malvaceae, Plantaginaceae, Leguminosae, and Umbelliferae. Weeds infected by CuLCrV may not show disease symptoms. However, weeds that harbor CuLCrV can serve as reservoirs of the virus even during non-crop grown seasons, which potentially influences epidemiology and spread of CuLCrV. During crop grown seasons, the virus can be transmitted from infected weeds to crop plants by whiteflies. To manage this notorious viral disease effectively, knowledge about weed hosts of the virus needs to be generated in a year-round monitoring program so appropriate management actions can be taken. In this project, we conducted a statewide survey to investigate the presence and prevalence of CuLCrV in different weed species within and around CuLCrV -infected vegetable fields.

Materials and methods

In May through August 2019, a total of 200 weed samples were collected from vegetable fields in 6 counties in Georgia (Figure 1). Samples were tested for the presence of CuLCrV using molecular PCR-based assay at the Molecular Diagnostic Laboratory in Tifton.

Results and discussion

Collected weed samples belong to 17 plant families (Table 1). Based on our survey results, only two weed samples, wild cucumber (Cucurbitaceae) and wild radish (Brassicaceae), were detected as positive for the CuLCrV. Cucurbitaceae family plants are well known host for begomoviruses; however, brassicaceae family plants are not common for this group of viruses. Further research will be beneficial to conduct detailed pathogenicity study to confirm wild radish acts as a reservoir for this virus.

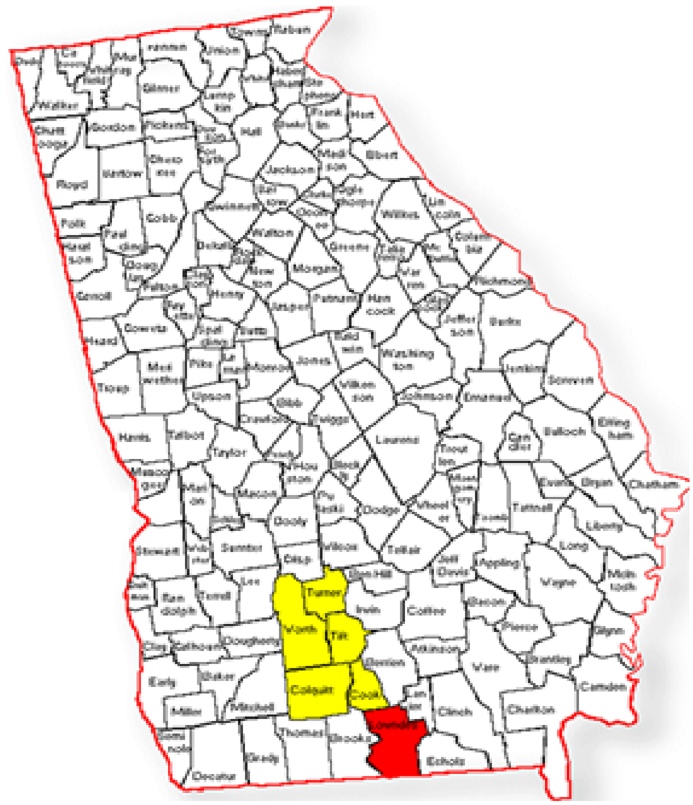


Figure 1. Highlighted counties were surveyed for Cucurbit leaf crumple virus in weeds. Yellow counties were not found to have CuLCrV in weeds, while the red county had positives.

Conclusions

Recently damage caused by whitefly-transmitted viruses increased in Georgia. The presence of CuLCrV in weeds has great importance for virus management. Our current findings are further evidence of the importance of weeds acting as reservoirs for the whitefly-transmitted viruses in cucurbit crops. Therefore, management of weeds is an essential component for the overall management plans for CuLCrV.

Table 1. Detection of Cucurbit leaf crumple virus (CuLCrV) in weeds in Georgia.

Family	Local Name	Species	# samples	CuLCrV detection
Amaranthaceae	Pigweed	*Amaranthus* spp.	6	Negative
	Palmer amaranth	*Amaranthus palmeri*	3	Negative
Asteraceae	Common ragweed	*Ambrosia artemisiifolia*	5	Negative
	Cudweed	*Gamochaeta purpurea*	5	Negative
	Dogfennel	*Eupatorium capillifolium*	6	Negative
	Prickly lettuce	*Lactuca serriola*	6	Negative
	Smartweed	*Persicaria* spp.	5	Negative
	Dogfennel	*Eupatorium capillifolium*	5	Negative
	Cocklebur	*Xanthium strumarium*	6	Negative
	Eclipta	*Eclipta prostrata*	3	Negative
	Canada goldenrod	*Solidago canadensis*	4	Negative
Brassicaceae	Wild radish	*Raphanus raphanistrum*	1	Positive
Commelinaceae	Dayflower	*Commelina* spp.	5	Negative
	Benghal dayflower	*Commelina benghalensis*	6	Negative
Convolvulaceae	Ivy-leafed morning glory	*Ipomoea hederacea*	3	Negative
	Smallflower morningglory	*Jacquemontia tamnifolia*	4	Negative
Cucurbitaceae	Wild cucumber	*Cucumis* spp.	2	Positive: 1 Negative: 1
Cyperaceae	Purple nutsedge	*Cyperus rotundus*	6	Negative
	Yellow nutsedge	*Cyperus esculentus*	1	Negative
Euphorbiaceae	Spotted spurge	*Chamaesyce maculata*	6	Negative
	Chamberbitter	*Phyllanthus urinaria*	5	Negative
	Nodding spurge	*Chamaesyce nutans*	5	Negative
Fabaceae	Florida beggarweed	*Desmodium tortuosum*	6	Negative
	Wild peanut	*Arachis hypogaea*	4	Negative
	Sicklepod	*Senna obtusifolia*	3	Negative
	Kudzu	*Pueraria montana*	6	Negative
Malvaceae	Arrowleaf sida	*Sida rhombifolia*	1	Negative
Molluginaceae	Carpetweed	*Mollugo verticillata*	5	Negative
Oxalidaceae	Yellow woodsorrel	*Oxalis stricta*	4	Negative
Poaceae	Large crabgrass	*Digitaria sanguinalis*	6	Negative
	India lovegrass	*Eragrostis pilosa*	6	Negative
	Goosegrass	*Eleusine indica*	4	Negative
	Texas millet	*Urochloa texana*	5	Negative
	Crowfoot grass	*Dactyloctenium aegyptium*	5	Negative
	Bermudagrass	*Cynodon dactylon*	5	Negative
	Barnyardgrass	*Echinochloa crus-galli*	5	Negative
Polygonaceae	Curly dock	*Rumex crispus*	4	Negative
Portulacaceae	Pink purslane	*Portulaca pilosa*	4	Negative
	Common purslane	*Portulaca oleracea*	6	Negative
Rubiaceae	Florida pusley	*Richardia scabra*	5	Negative
	Virginia Buttonweed	*Diodia virginiana*	6	Negative

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