2019 Vegetable Extension and Research Report

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2019 University of Georgia Vegetable Extension and Research Report

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2019 University of Georgia Vegetable Extension and Research Report

Varying Irrigation Rates on Peppers to Evaluate Changes in Quality, Yield, and Water Savings

G.L. Hawkins

Introduction

In 2004, the Georgia General Assembly passed the Comprehensive Statewide Water Management Plan (Georgia O.C.G.A. Secs. 12-5-520 et seq.), which included the creation of 10 Regional Water Planning Councils (RWC). The councils were to and have developed regional water plans for all areas of Georgia. The plans include information on current water uses and projected water uses for four sectors of Georgia with Agriculture being one. Also included in the plans are management practices for agriculture and the other sectors. Two of the practices listed for the south Georgia RWCs are efficiency education and research (DCAR 5) and understanding optimum application methods (DCAR 6). Based on these management practices, this research focused on these two management practices to determine whether there can be water savings while also producing quality and yield in bell peppers (*Capsicum annuum* L.) and jalapeno peppers (*Capsicum annuum*) being irrigated with drip irrigation.

Materials and methods

The research was conducted at the Tifton Vegetable Park on the University of Georgia Tifton campus, where loamy sand is the predominate soil type. Irrigation for this research followed that recommended by the UGA vegetable specialist. The peppers were grown on plastic with three application treatments randomized across nine beds as shown in Figure 1. Within each treatment, four groups of five bell peppers and jalapeno peppers were sampled for yield. As can be seen in Figure 1, bell peppers were grown on one end of each bed and Jalapenos were on the opposite end of the bed. Water and nutrients were supplied trough drip tape with emitter application rates of 0.25, 0.48, 1.0 gph per 100 ft. Emitter spacing was 12 in (31 cm) for the 0.25 and 0.48 gph tape and 6 in (15 cm) for the 1.0 gph tape. Two experiments were conducted simultaneously with tape being placed at 2 in (5 cm) below the plastic in one experiment and 8 in (20 cm) in the second. The experiments were conducted on two separate sets of beds. Within each experiment, application times were 30 minutes twice daily. With the different emitters in the tape, running the system for 30 minutes allowed the different treatments to be conducted simultaneously while still providing standard (1X), half (0.5X), and double (2X) rates for the same watering period. Each group of bell peppers and jalapenos were sampled weekly and weighed for yield.

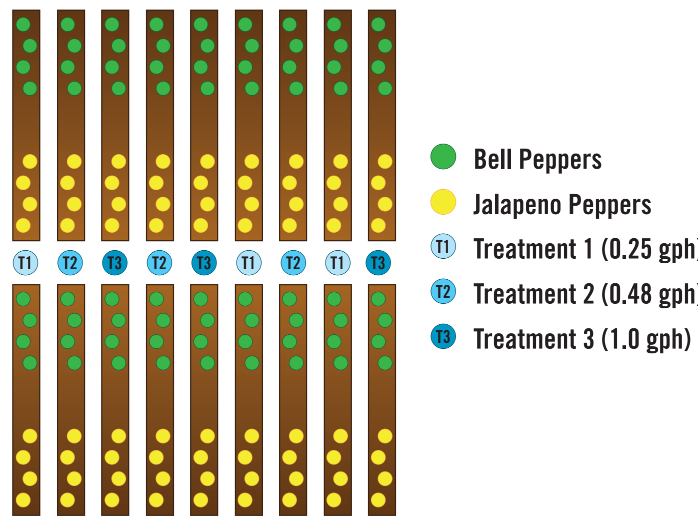

Figure 1. Plot layout with both the 2 in (5 cm) and 8 in (20 cm) depths of drip tape. T1 is Treatment 1 at 0.25 gph drip, T2 is Treatment 2 at 0.48 gph drip, and T3 is Treatment 3 at 1.0 gph drip.

Results

As can be seen in Figure 2, there is no difference in the yield from the 0.5X rate at either the 2 or 8 in (5 or 20 cm) placement of the drip tape when compared to the 2 in (5 cm) (normal) placement of the tape and standard recommended (1X) application rate of water. A higher yield was observed for bell peppers when drip tape was placed at the 8 in (20 cm) depth at the 1X application rate. The application rate of 1.0 gph (2X rate) had very low yield at both tape depths. This is good to see from a water management aspect, in that over application reduces the yield and waste water by leaching below the root zone. Looking at the jalapenos (Right set of bars in Figure 2), there was no difference in the 1X rate of irrigation application rate and that of a half rate application. Like the bell peppers, yields dramatically dropped when the application was doubled from the 1X rate.

One other measure used to analyze peppers is the Brix value. Data on the average Brix from each treatment can be seen in Figure 3. The Brix values for the bell peppers was not different when comparing the 0.5X rate at both depths or the 1X rate at 2 in (5 cm) depth. The data indicates that at a 2X rate and 8 in (20 cm)

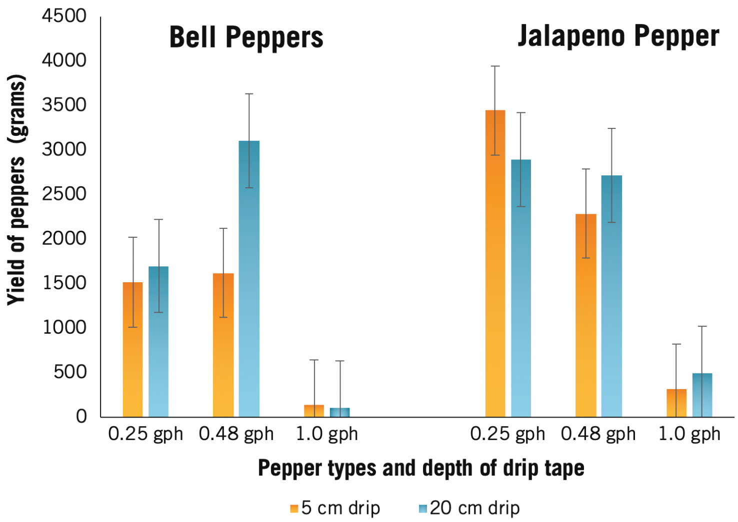

Figure 2. Yield for both bell and jalapeno peppers grown under different application rates of irrigation with drip tape placed at either 2 or 8 in (5 or 20 cm).

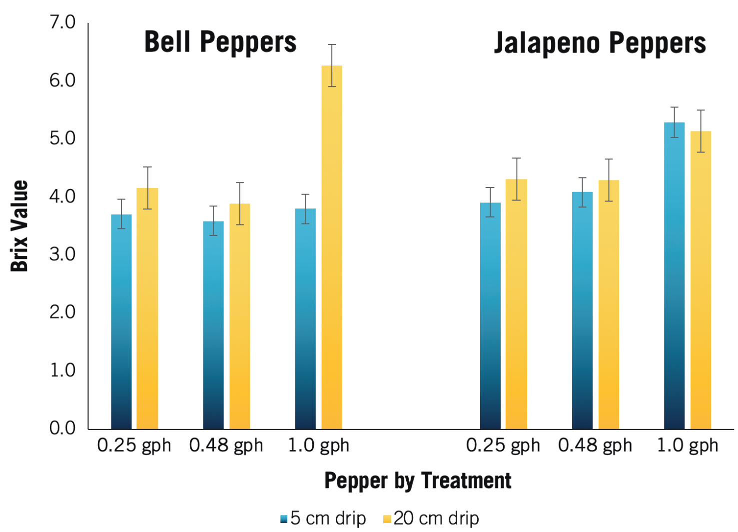

Figure 3. Brix values for both bell and jalapeno peppers grown under different application rates of irrigation with drip tape placed at either 2 or 8 in (5 or 20 cm).

depth of drip tape, bell peppers have a higher Brix and are sweeter. The Brix for the 0.5X and 1X rates at either tape depth were the same. At the 2X rate the Brix indicated a sweeter pepper. Even though both peppers tested indicated a higher Brix when grown at a 2X rate of water application, the yield is low as compared to the 0.5X and 1X application rates.

Conclusion

The research here was used to measure the yield and quality of both bell peppers (*Capsicum annuum L.*) and jalapeno peppers (*Capsicum annuum*) grown under various application rates of water at two different depths of drip tape placement. The research also was used as a means of implementing the two management practices of Efficiency Education and Research (DCAR 5) and Understanding Optimum Application Methods (DCAR 6) both of which were accomplished.

Results indicate that there is a higher yield if the standard recommended (1X) rate of water is applied and the tape is placed 8 in (20 cm) below the plastic. No difference in yield was observed at 1X or 0.5X application rate and tape placed at either 2 or 8 in (5 or 20 cm). Yield suffered when the application rate was doubled at either tape placement depth. There was no difference in the Brix value at either the 0.5X or 1X application rate for either bell or jalapeno peppers. Brix were higher at the 2X rate, but the yield suffered as mentioned above.

Overall, the results of this research indicated there was no yield or quality (as measured by Brix) difference if the application rates were cut in half. However, doubling the application rates did affect the yield. The results from this study are based on a one-year study in and on a research park using a recommended rate of water application with that rate being halved or doubled. The next step in this research would be to water the 1X rate treatment using soil moisture sensors keeping the soil moisture profile at field capacity and then halving and doubling that rate at both the tape placement of 2 and 8 in (5 and 20 cm).

Evaluation of Fungicides for Managing Alternaria Leaf Blight on Carrot

B. Dutta, W.M. Donahoo, and M.J. Foster

Introduction

Carrots have an annual farm gate value of more than $35.5 million in Georgia. While productions are concentrated in the south portion of the state, the region is also favorable for disease incidence. Particularly, the Alternaria leaf blight (*Alternaria dauci*) in carrot fields increased recently, and have been a concern for Georgia growers. Thus, the objective of this study was to evaluate the effect of different fungicides on Alternaria leaf blight for carrot.

Materials and methods

The experiment was conducted at the University of Georgia Blackshank Farm in Tifton. Carrot (cv. Bolero) was direct seeded into six-row beds on December 12, 2018. 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 in a randomized complete block design with four replications. Plots were overhead irrigated weekly as necessary using a pivot-irrigation system. Fertility and insecticide treatments were applied according to the University of Georgia 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: January 8, January 22, February 5, February 19, March 5, March 19, and April 2. Plots not treated with fungicides served as the non-treated check. Disease severity was assessed on February 16, March 2, March 16, and April 6 as percent leaf area with necrosis per plot and area under disease progress curve was calculated for each treatment. 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 at $P=0.05$. The mean rainfall received during December 2018 and April 2019 was 2.8 in and 5.2 in, respectively. The average high and low temperatures for the month of December 2018 were 54 °F and 40 °F, respectively, and for the month of April 2019 were 71 °F and 53 °F, respectively.

Results and discussion

Alternaria leaf blight was first observed on February 16 with 35% 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 the other treatments. Disease progressed gradually over the next seven weeks, and the final disease severity ratings were recorded on April 6. Based on disease ratings on April 6, treatments comprised of Merivon and Penncozeb (38.5%); Luna Sensation and Penncozeb (36.2%); and Pristine and Penncozeb (42.5%) had significantly lower disease severity compared to the 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; however, both of these treatments had significantly lower disease severity compared to the non-treated check. AUDPC values followed the same trend as that of final disease severity rating (April 6). Merivon or Luna Sensation or Pristine or Switch 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 fungicide treatments on disease severity and the area under disease progression curve.

Treatment and rate per acre	Fungicide applications[z]	Disease severity (%)[y]		AUDPC[x]
		February 16	April 6	
Merivon 5.5 fl oz	1,3,5	9.5 bw	57.5 b	1082.4 b
Pristine 10.5 fl oz	1,3,5	10.2 b	60.5 b	1128.5 b
Luna Sensation 7.6 fl oz	1,3,5	8.4 b	50.5 b	1105.2 b
Switch 11 fl oz	1,3,5	6.5 b	54.2 b	1150.5 b
Merivon 5.5 fl oz Penncozeb 2 lb	1,3,5 2,4,6	5.0 b	38.5 c	1445.5 c
Luna Sensation 7.6 fl oz Penncozeb 2 lb	1,3,5 2,4,6	8.2 b	36.2 c	1380.2 c
Pristine 10.5 fl oz Penncozeb 2 lb	1,3,5 2,4,6	6.5 b	42.5 c	1484.2 c
Switch 11 fl oz Penncozeb 2 lb	1,3,5 2,4,6	2.8 b	41.5 c	1472.2 c
Non-treated	N/A	35.0 a	72.5 a	3215.5 a

[z]Spray dates were: 1 = January 8; 2 = January 22; 3 = February 5; 4 = February 19; 5 = March 5; and 6 = April 2.

[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 February 16, March 2, March 16, and April 6.

[x]AUDPC was calculated from ratings taken on February 16, March 2, March 16, and April 6.

[w]Means followed by the same letter in each column are not significantly different according to the Waller-Duncan test at $P<0.05$.

Controlling Nutsedge with Vapam Drip Injections in Plasticulture

S. Culpepper and J. Vance

Introduction

Nutsedge species continue to be the number one weedy pest in vegetables produced on plasticulture in Georgia. Although growers can fumigate to effectively control the pest for the first crop, it becomes increasingly more difficult to manage when growing two, three, or more additional crops on that mulch. Herbicides, such as glyphosate, are available for applications between crops but they rarely provide adequate control of this problematic weed species. Another option for improving weed control on second or third (etc.) crop mulch is an injection of metam sodium (Vapam, others) through the drip tape. Historically, a drip injection of Vapam using a single drip tape is marginally effective. Thus, an experiment was conducted to better understand the effectiveness of injecting Vapam through a single drip tape as influenced by rate and the amount of time water is run after the injection.

Materials and methods

Tifton loamy sandy soil within the experimental area was tilled to remove all plant debris and within two weeks, raised beds (32 wide, 8 inch tall) were formed using a combination bedder shaper and a plastic mulch layer. Beds were formed without applying fumigants as the study objective required a heavy nutsedge population be present at time of treatment. A single drip tape was inserted 2 inches below the soil surface and then covered with standard low density polyethylene mulch. Nutsedge was allowed to emerge, penetrate the mulch, and reproduce until little to no mulch was visible. Once nutsedge populations were severe, Vapam treatments were injected according to the treatment list provided in Table 1.

Results and discussion

Vapam rate was the dominant factor influencing nutsedge control with increased control noted as rate increased. Both the level of visual control and the distance from the drip tape in which nutsedge was eliminated was greatest with Vapam at 75 gal/A broadcast rate (Table 1). When applying Vapam at 75 GPA, watering between 30 or 60 minutes after injection appeared to be ideal for the best results in this study. Also, when measuring parts per million of metam sodium in the bed after injection, greatest values were detected with the high rate followed by watering for 30 to 60 minutes.

Conclusion

Numerous studies have evaluated the benefit of adding adjuvants with Vapam for improved movement across the bed without any success. This study showed the greatest method to improve control and increase control distance from the drip tape is to increase rate (up to the max label rate). Additionally, over watering after injection may hamper control as influenced by soil type. Even with the highest label use rate (75 GPA), metam sodium injections alone will not provide adequate control of significant nutsedge populations and a holistic approach to management will be required for long-term success in controlling this weed.

Table 1. Yellow and purple nutsedge response to metam sodium (Vapam) drip injected.*

Vapam rate per broadcast acre	Interval water ran after injection	Parts per million metam detected one day after injection**	Nutsedge control at 16 days	Distance (inches) nutsedge was controlled from drip line
25 gal	30 min	16 de	48 e	10 c
25 gal	60 min	17 de	48 e	10 c
25 gal	120 min	9 ef	45 e	9 d
50 gal	30 min	48 b	71 cd	11 b
50 gal	60 min	46 b	68 d	11 b
50 gal	120 min	30 cd	70 cd	10 c
75 gal	30 min	64 a	82 a	12 a
75 gal	60 min	69 a	80 ab	12 a
75 gal	120 min	40 bc	75 bc	11 b

*All values within a column followed by the same letter are not different.

**Values obtained using the Mini-rae 3000.

Evaluation of GMO Cowpea as a Trap for the Control of Cowpea Curculio in Snap Beans

D.G. Riley

Introduction

Snap beans, *Phaseolus vulgaris* L., can be attacked by cowpea curculio (Figure 1), causing some feeding damage to the pods and beans. However, we have observed that damage and reproduction of the curculio is much more severe on its preferred host crop, cowpea. This preference is the main reason for researching the use cowpea as a trap crop for this pest in snap beans. Snap beans are an important crop in Georgia with an acreage of 8,787 with a farm gate value of ~$24 million. Cowpea or southern pea, V*igna unguiculata* L., is planted on 3,457 acres and is valued at ~$5 million for fresh-frozen food consumption (Wolfe and Stubbs, 2018). What is less well known is that cowpea acreage peaked in Georgia at three quarter million acres in 1937 (Anon., 1957). The collapse of acreage in Georgia was due in part to the cowpea curculio, *Chalcodermus aeneus* Boheman (Riley and Sparks 2019). Losses due to cowpea curculio have been so severe in recent decades that some commercial contract growers have been moving their operations out of southern Georgia (CT Harvey, personal communication). Thus, even though the cowpea crop may draw curculios away from snap bean, the curculio reproduction on cowpea continues to increase curculio populations, increasing the pest problem. So, what is the solution to curculio reproduction on cowpea?

Figure 1. Cowpea curculio adult (left) on cowpea bean with a feeding scar (top right side of the bean) visible.

In recent years, a GMO cowpea was developed by T.J. Higgins in CSIRO Australia based on a high amylase inhibitor genetically modified genotype ('AAI-1 cowpea', Higgins *et al*., 2013). This GMO cowpea has the same gene that occurs naturally in snap bean that provides protection against curculio reproduction in the pods. This gene has been reported to reduce reproduction by cowpea weevil, *Callosobruchus maculatus* (Fabricius), on cowpea seed (Lüthi *et al*., 2013). If it does the same for cowpea curculio, then you could theoretically still get the attraction of curculios away from snap beans to cowpea, but with reduced curculio reproduction. Starved, over-wintering curculio populations must feed and oviposit as quickly as possible in the spring and are strongly attacked to cowpeas (Arant, 1938).

We proposed to use a GMO cowpea that will attract the curculio for oviposition in the spring, but will not allow for grubs and adults to develop from that trap crop. The first step in this project was to evaluate the GMO cowpea for its ability to inhibit curculio reproduction. We secured a Biotechnology Regulatory Service permit Notification No. 17-270-102n (CPS09252017) to import the GMO cowpea seed from Australia and tested them for their ability to reduce reproduction in a no-choice test.

Materials and methods

The test was set up in a quarantine greenhouse facility at the UGA Tifton campus (NESPAL greenhouse), using 1.5-by-1.5-by-3-ft cages for each treatment arranged in a randomized complete block design (Figure 2). We tested the GMO cowpea line with the AAI gene against its parent, non-transformed cowpea IT86D-1010 compared to the snap bean line that is a natural genetic source of the new GMO trait. Six adult weevils were introduced into each cage (ca. 50% female) and were allowed to reproduce in a no-choice setting, that is, they were forced to feed on the plant offered. The plants were grown to maturity and pods were harvest as they matured and held for curculio grub emergence. The number of fallen pods were also recorded as a measure of damage.

Results and discussion

The results of the greenhouse test showed that the GMO trait reduces curculio emergence by 71% and presumably survival in the pods in a no-choice test

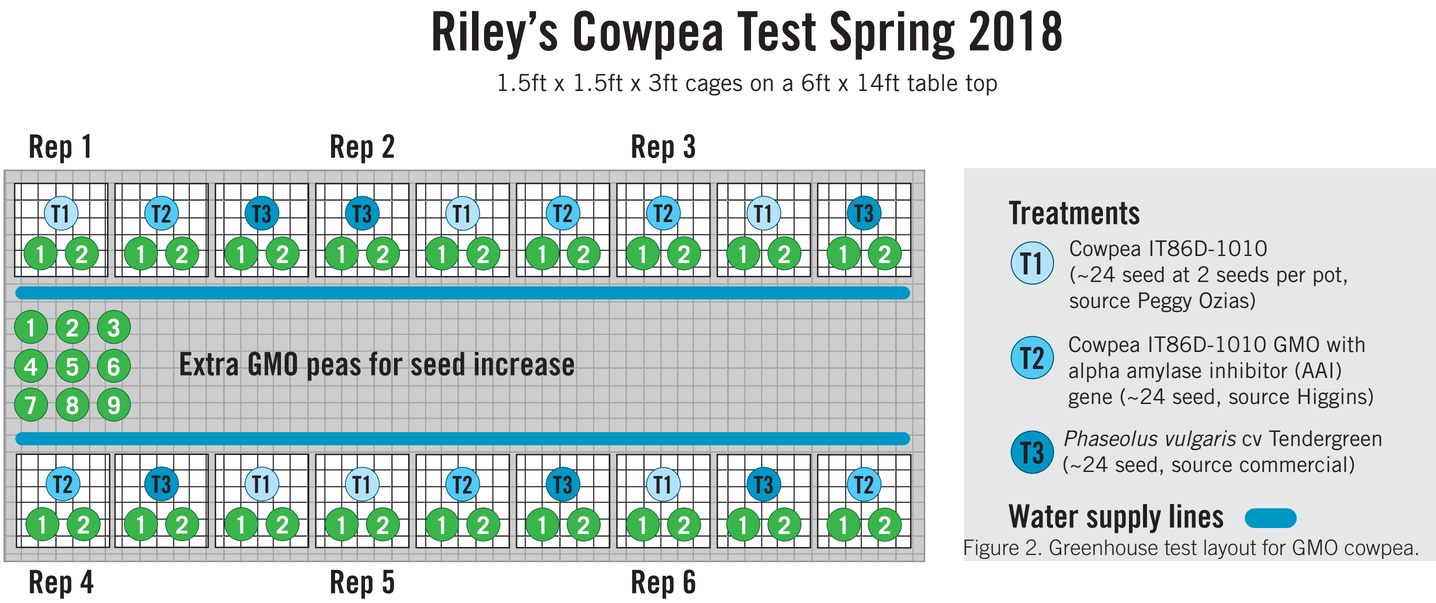

Figure 2. Greenhouse test layout for GMO cowpea.

(Figure 3). This test also confirmed that even though curculios can be observed feeding on snap bean pods causing cosmetic damage, the number of weevils that survive to grub emergence was zero in this test. Thus, snap beans is a poor reproductive host plant for cowpea curculio and likely does not contribute to regional outbreaks in Georgia. Cowpea curculio damage did result in some fallen pods in snap bean, but not as much as either the susceptible cowpea or the GMO resistant cowpea (Figure 4). Interestingly, both the resistant and susceptible cowpea had about the same number of fallen pods, so it is not clear if the resistant trait would reduce the immediate damage caused by the curculio. The resistant trait would only reduce the number of curculios surviving and hopefully lead to a reduction of the overall curculio population. In order to test for this and the overall strength of the resistance trait, we would need to conduct the test under field conditions with greater curculio pressure to determine if this resistance holds up under Georgia growing conditions.

Conclusion

A new AAI transformed cowpea line IT86D-1010 developed in Australia has been shown to potentially reduce the survival of cowpea curculio in cowpea. This is the first host plant resistance material to show this strong a reduction in the survival of this pest. It does not appear that this pea is any less attractive to the curculio, so there is the possibility of using this for a trap crop to protect snap beans from damage and not greatly increase the pest population.

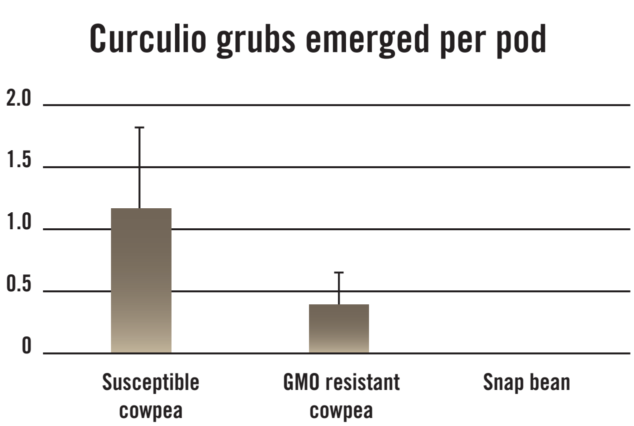

Figure 3. Cowpea curculio grub emergence from pods of cowpea and snap beans (note zero emergence from snap beans).

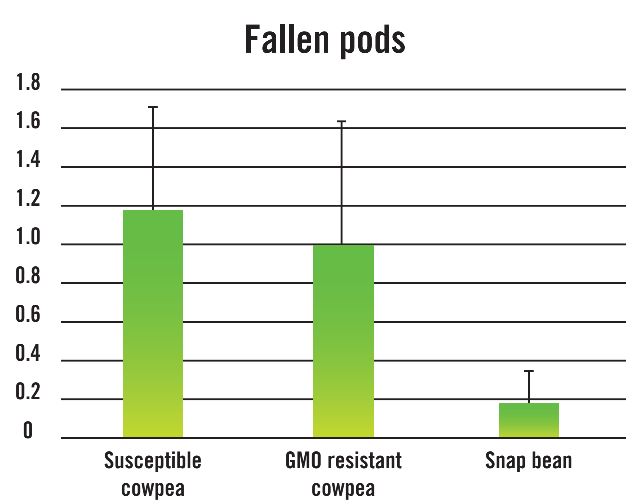

Figure 4. The number of fallen pods per cage.

Insecticide Resistance Monitoring in the Diamondback Moth, *Plutella xyllostella*, and Field Evaluation of Nuclear Polyhedrosis Virus as a Chemical Alternative for Control

D. G. Riley

Introduction

The diamondback moth (DBM), *Plutella xylostella* (Linnaeus), (Figure 1) is a severe insect pest of Brassicaceae crops, including broccoli, cabbage, collards, kale, mustards, kohlrabi, cauliflower, Brussels sprouts, radish, turnips, and watercress. It is a major pest in Georgia vegetable production due to its ability to become resistant to any new insecticide to which it is exposed, regardless of the mode of action (MOA) of the insecticide. Studies have shown that the DBM now has resistance to over 95 insecticides, over two times more than the next closest lepidopteran pest (www.pesticideresistance.org), making the DBM one of the most insecticide resistant insects in the world. We have been monitoring resistance levels of DBM to multiple insecticides in southern Georgia using a critical dose technique.

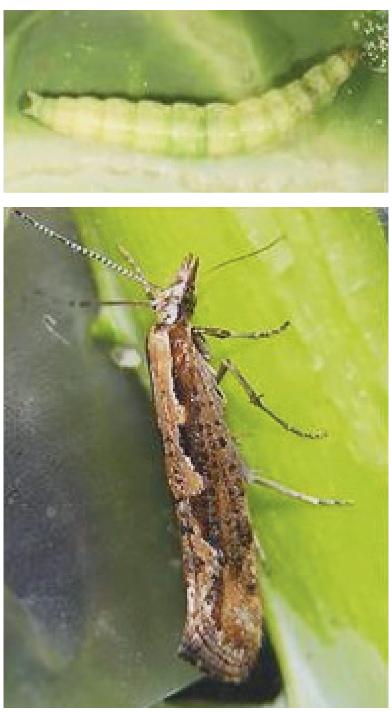

Figure 1. Diamondback moth larva (top) and adult (bottom).

We also have been looking at natural products for control as an alternative to synthetic chemical insecticides, such as the nuclear polyhedrosis virus (NPV), part of the family of baculoviruses that attacks predominantly moths. In this report, we present the findings for the 2018 studies conducted at UGA's Coastal Plain Experiment Station.

Materials and methods

DBM monitoring. A cabbage leaf dip assay of DBM larva was used, mixing the high labeled rate for individual insecticides representing different MOAs in the equivalent of a 100 gallon per acre spray volume as a critical dose (i.e., should be greater than 90% control of a susceptible DBM population). We used twelve commercial insecticide products representing different Insecticide Resistance Action Committee (IRAC) mode of action groups for the DBM critical dose bioassay. The insecticides and high labeled rate used were bifenthrin (Brigade® 2EC, FMC Corporation) at 6.4 fl oz/a, novaluron (Rimon® 0.83EC, Arysta LifeScience North America LLC) at 12 fl oz/a, lambda-cyhalothrin (Karate® 2.08 CS with Zeon™ Technology, Syngenta Crop Protection LLC) at 1.92 fl oz/a, chlorantraniliprole (Coragen® Insect Control 1.67 SC, FMC Corporation) at 5 fl oz/a, methomyl (Lannate® 2.4 LV Insecticide DuPont Crop Protection) at 3 pt/a, indoxacarb (Avaunt® 30WDG, FMC Corporation) at 3.5 oz/a, spinetoram (Radiant® 1SC, Dow AgroSciences LLC) at 10 fl oz/a, *Bacillus thuringiensis* (XenTari®, Valent U.S.A. LLC Agricultural Products) at 1.5 lb/a, cyantraniliprole (Exirel® 0.83SC, FMC Corporation) at 13.5 fl oz/a, emamectin benzoate (Proclaim 5WDG, Syngenta Crop Protection, LLC) at 4.8 oz/a, naled (Dibrom® 8 Emulsive (RUP), Amvac Chemical Corporation) at 2 pt/a, and cyclaniliprole (Harvanta™ 50SL Insecticide, Summit Agro USA, LLC) at 16.4 fl oz/a. This was to determine which products/MOAs demonstrate efficacy against specific field populations of DBM, typically those field where control problems had been reported.

NPV testing. The nuclear polyhedrosis virus (NPV) commercial product tested was Plutex® from Andermatt Biocontrol AG, 6146 Grossdietwil, Switzerland along with their *Beauvaria bassianna* (an entomopathogenic fungus) product Bb Protec. We also tested low rates of the growth regulator, Knack®, combined with the *Bacillus thuringiensis* product Xentari®. Cabbage, hyb. Cheers, was transplanted into two rows per 6-ft beds on March 7 and maintained with standard cultural practices at the Lang Farm at Tifton's Coastal Plain Experiment Station. A total of 500 lbs of 10-10-10 was applied to Tift pebbly clay loam field plots initially followed by 150 lbs of 10-10-10 at first side dressing and 150 lbs of ammonia nitrate at second side dressing. Irrigation was overhead as needed, but the spring was quite rainy. Scouting of

10 plants per plot was initiated on March 21 and continued weekly with a break from May 14 to 29 due to rainy weather, until a final damage rating on May 30 at harvest time. Foliar applications of insecticide were made on March 27, April 3, 10, 19, and 24, and May 5 and 8, with Kinetic adjuvant @ 0.25% v/v except treatment 7 (Table 1). The damage rating and harvest sample size was ten heads per plot. Ratings were based on a 0=no damage to 5=maximum damage scale. Insect counts were analyzed averaged over all sample dates. Harvest was based on a single harvest and marketable head weight was estimated as heads with less than a "2" damage rating, only slight damage to the wrapper leaves.

Results and discussion

DBM monitoring. The average kill rate for DBM larvae from samples taken primarily from Tift and Colquitt counties indicated that only the products above Avaunt (Figure 2) were providing significantly better control than the water check on the average. Knack significantly reduced pupation, but very little larval death. Lannate, Coragen, Karate, Rimon, and Brigade were no better than spraying water, on the average, suggesting severe levels of DBM resistance to these products in 2018.

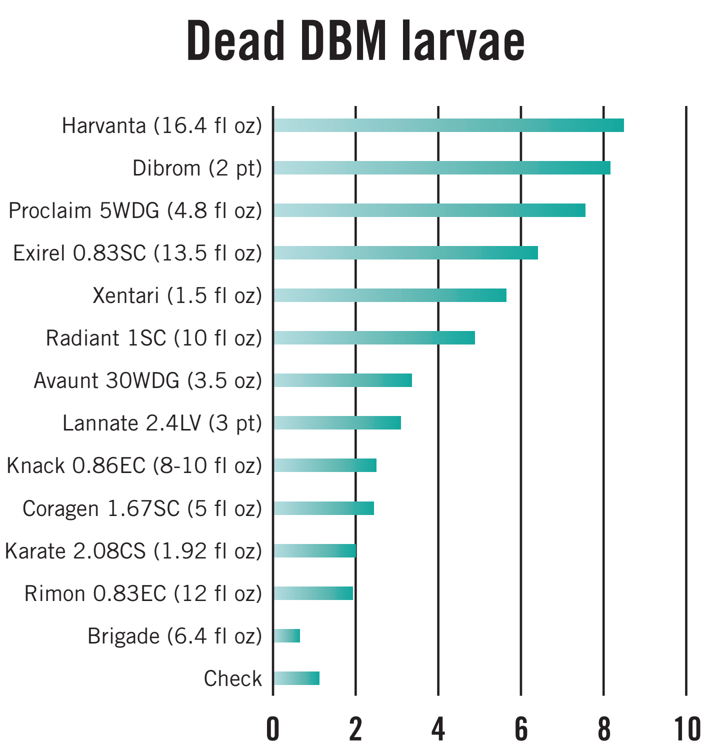

Figure 2. Average dead larvae out of 10 for field bioassays conducted in 2018.

NPV testing. Plutex provided some DBM control, but Radiant, Xentari and even Coragen provided significant DBM control in this test (Table 2).

Conclusion

It is important to keep searching for new products for DBM control and perhaps products like Plutex can help reduce the selection for resistance by providing a completely different mode of action. However, it will be just as important to keep up the resistance monitoring program to see what is working to control DBM in individual growers' fields.

Table 1. Average effect on DBM, Lepidoptera larvae (over all dates) and final cabbage damage/yield at the UGA Coastal Plain Experiment Station in Tifton, Georgia, spring 2018.

Treatment rate per acre	DBM all stages	All Lep. larvae combined	Average leaf damage	Average head damage	Sum marketable lbs per 10 heads	Percent of Marketable heads
1. Untreated check	2.28ba	4.33a	2.95a	2.33ba	10.9d	20.3e
2. Radiant 8 fl oz/a	0.60edf	0.85e	2.23b	1.65bc	53.3a	73.3a
3. Xentari DF 1.5 lbs prod/a	0.65edf	1.03ed	2.78a	1.85bac	25.7bdc	40.0bdec
4. Coragen SC 7.5 fl oz/a	0.20f	0.43e	2.15b	1.35c	30.2bdc	56.2bdac
5. Bb-Protec 600 g/ha or 9 oz/a	2.30a	4.10ba	2.83a	1.68bc	40.5bac	61.4ba
6. Plutex 1.7 fl oz/a	1.15edc	2.50c	2.98a	2.15ba	19.9dc	28.9bdec
7. Plutex (no adjuvant) 3.4 fl oz/a	1.95bac	3.50bac	2.95a	2.03bac	21.0bdc	28.8dec
8. Plutex 3.4 fl oz/a	1.78bac	3.05bac	2.95a	2.48a	15.0d	25.2de
9. Plutex 3.4 fl oz/a	1.48bc	3.15bac	2.95a	2.18ba	10.4d	20.6e
10. Plutex 6.8 fl oz/a	1.33dc	2.93bc	3.00a	2.30ba	9.0d	16.2e
11. Bb-Protec 600 g/ha or 9 oz/a Plutex 3.4 fl oz/a	1.23edc	2.35dc	2.95a	2.18ba	13.3d	20.5e
12. Knack 5 oz per 2 weeks + Xentari DF 1.5 lbs weekly	0.45ef	0.65e	2.23b	1.45c	41.8ba	59.2bac

*Means within columns followed by a same letter are not significantly different (LSD, P<0.05)

Evaluation of Fungicides and Mulching in Managing Phytophthora Fruit Rot in Pepper

B. Dutta and M. Foster

Introduction

Bell pepper is annually cultivated in 5,548 acres in Georgia, with the majority of this acreage planted in plastic mulching systems in the southwest portion of the state. Phytophthora fruit rot (*Phytophthora capsici*) is the major disease that challenge bell pepper growers, and effective fungicide programs are required to maintain yield. Therefore, the objective of this study was to evaluate the effect of different fungicides and mulching systems on Phytophthora fruit rot for bell pepper production.

Materials and methods

Fungicides were evaluated for their efficacy to manage Phytophthora fruit rot, caused by *P. 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 with 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 was served 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 UGA 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 °F and 74 °F, respectively. On June 20, fruit from each plot were harvested and incubated under standard room temperature (78 °F) for 48 hours. Ratings for fruit rot incidence were assessed on June 22 as percentage of fruits with visible symptoms typical of *P. capsici*. Data were analyzed using the software ARM (Gylling Data Management, Brookings, SD), analysis of variance (ANOVA) and the Waller- Duncan test to separate means.

Results and discussion

P. capsici fruit rot was not observed in field for any of the treatments including non-treated check. Hence, post-harvest evaluation was conducted. Post-harvest ratings for Phytophthora fruit rot were taken on June 22. 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 Jun
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 protected LSD test at $P \leq 0.05$.

Evaluation of New Non-Fumigant Nematicides Against Root-Knot Nematodes in a Cucumber-Eggplant Double Cropping System

A. Hajihassani

Introduction

Georgia's humid, hot environment, mild winters, and sandy soils are ideal for growing vegetables, but the conditions also favor the development of plant-parasitic nematodes. The nematodes that growers are most aware of and concerned about are root-knot nematodes (*Meloidogyne* spp.) that attack a wide range of crops and induce galls on roots (Hajihassani, 2018b). In Georgia, two to four crops are grown on a single application of plastic mulch, but this multi-cropping system buildups the root-knot populations. Vegetable growers apply soil fumigants like 1,3-Dichloropropene (trade name: Telone II) prior to laying the plastic mulch and this offers effective nematode control for the first crop (Hajihassani, 2018b). However, control of nematodes on subsequent crops grown on the same plastic mulch depends on the application of non-fumigant nematicides. For decades, only one non-fumigant nematicide, Oxamyl (Vydate), was available for use by growers. Some new non-fumigants currently available for use in vegetable production include fluopyram (Velum Prime) and fluensulfone (Nimitz). Salibro is one another formulation with nematicidal activity that has not yet been registered. Limited information is available on the nematicidal efficacy of these products for control of nematodes in vegetables in Georgia. The aim of this study was to evaluate the potential efficacy of Vydate, Nimitz, Velum Prime, and Salibro on root-knot nematodes and plant vigor and yield of cucumber and eggplant. The efficacy of these products was compared with metam sodium (Vapam) treatment.

Materials and methods

A double-crop field experiment was conducted at the UGA Black Shank Farm in Tifton, Georgia, in 2018. Cucumber (cv. Mongoose) and eggplant (Purple Shine) were planted in spring and fall seasons, respectively. The experiment site has a history of infestation with southern root-knot nematode, *M. incognita*. Mean soil nematode counts prior to nematicides application was 1 nematode/100 cc (cm^3) of soil. Plots were 15 ft long by 6 ft wide, with 6-ft separation between rows. A single line of drip tape per bed was placed 1-2 inches below the bed tops, and beds were covered with white low- density polyethylene mulch. Vydate at 64 fl oz/acre, Velum Prime at 6.5 fl oz/acre, Nimitz at 5 pt/acre, Salibro at 30.7 fl oz/acre, and Vapam (70 gal/acre) were applied using a CO2 pressurized tank based on instruction on the labels of products. Vydate, Velum prime and Salibro were applied one day prior to transplanting, whereas Vapam and Nimitz were applied 15 and 7 days before transplanting, respectively. The study was done as a randomized complete block with five replicates.

Crop vigor was measured at mid-season using a handheld crop sensor (GreenSeeker, Trimble). Plant phytotoxicity was assessed visually one week after nematicide application. Root systems were assessed for galling caused by root-knot nematode based on a gall index (0 = no galls seen, 5= roots completely covered in galls) (Hussey and Janssen, 2002). Soil nematode counts were determined by collecting five soil cores from root zones in each plot and then pooled to create a single composite sample from which 100 cc of soil was used for nematode extraction using the sieving floatation technique.

Results and discussion

None of the nematicides was phytotoxic to cucumber and eggplant one week after application. In both spring and fall seasons, all nematicide treatments reduced nematode numbers in the soil compared to untreated control; however, there was no difference among nematicides in reducing nematode populations (Figure 1).

At harvest, all nematicides significantly reduced root gall index compared to untreated control. Cucumber plots treated with Nimitz, Salibro, Velum Prime and Vapam had lower gall index than those treated with Vydate. In eggplant plots, application of Nimitz performed better in reducing root galling in comparison with other nematicides. Although no difference in gall index was observed among Salibro, Velum Prime and Vapam, these nematicides performed better than Vydate in reducing gall severity in eggplant (Figure 2).

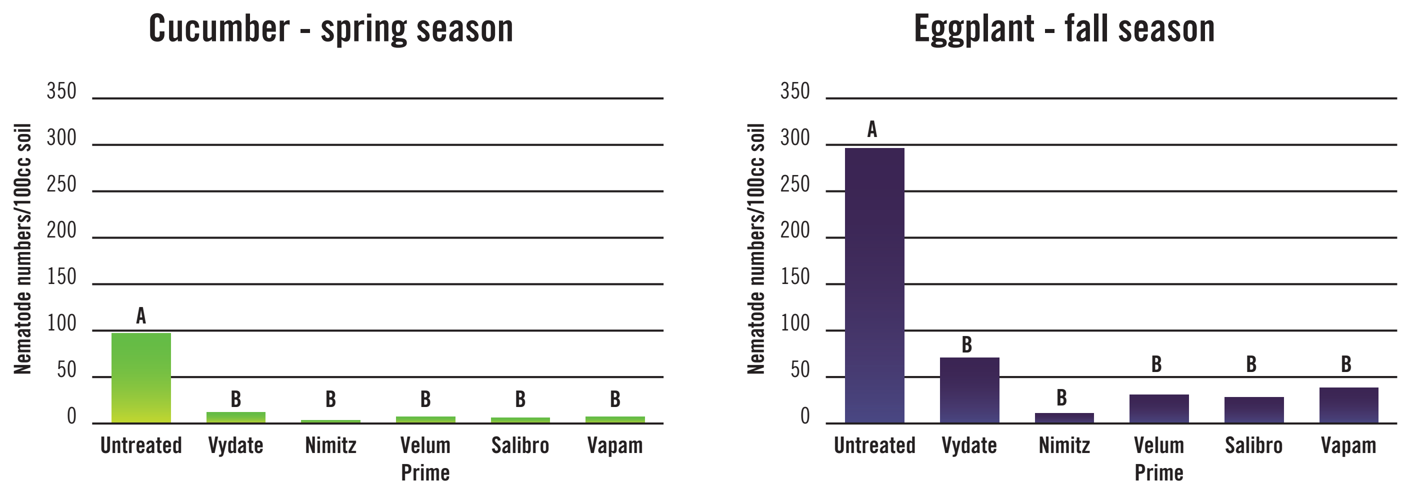

Figure 1. Effect of drip-applied nematicides on soil populations of root-knot nematode at harvest of cucumber and eggplant crops.

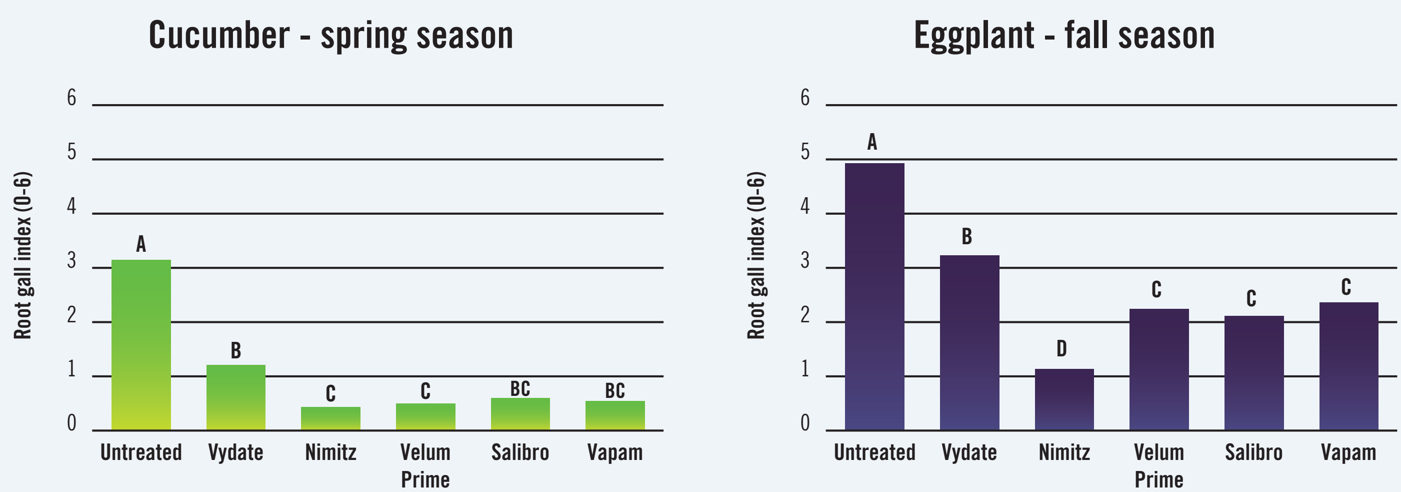

Figure 2. Effect of drip-applied nematicides on root gall severity caused by root-knot nematode.
Rot gall index was measured using a 0 to 5 scale, where 0 = no galls, and 5 = 100% of roots galled.

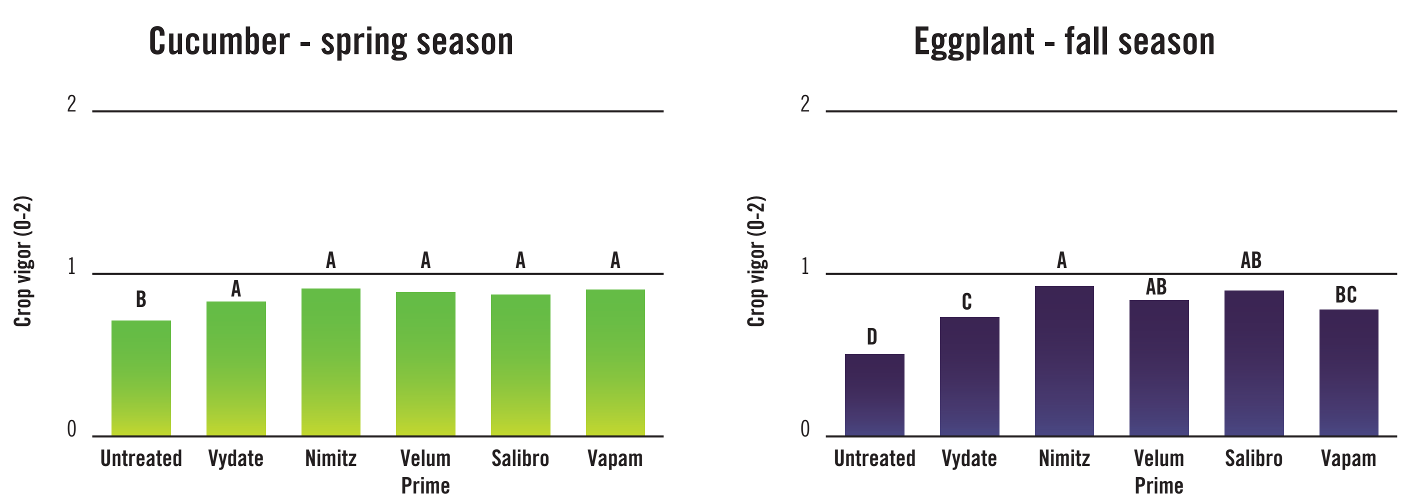

Figure 3. Effect of drip-applied nematicides on crop vigor of cucumber and eggplant. A crop vigor rating of 1 indicates best growth.

There was no significant difference in cucumber vigor (growth) among nematicides treatments; however, cucumber growth was greater in plots treated with all nematicides compared to untreated control. Eggplant plots treated with Nimitz, Salibro and Velum Prime had greater crop vigor compared to other nematicides and untreated control (Figure 3). Cucumber yield was not different among treated and untreated plots (data not shown). No data was collected for eggplant yield, due to delayed planting in the fall and cold weather.

Conclusion

The results indicated that Vydate, Velum Prime, Nimitz, Salibro, and Vapam had better benefits in control of root-knot nematodes in the spring when nematode numbers in the soil was low (1 nematode/100 cc of soil). Conversely, the effectiveness of these nematicides varied on eggplant in the fall when the nematode pressure was moderate to high. Therefore, soil sampling is important for growers to determine the population levels of nematodes in a field and to understand the needs for chemical control. Overall, this research showed that Nimitz had a greater impact in reducing root galling and nematode populations than other nematicides tested. Velum Prime and Salibro also showed great nematicidal efficacy; however, further research is required to understand their potential in root-knot nematode control, particularly when a long-season crop (e.g. fruiting vegetables) is grown in the fall.

Cucumber Tolerance to Liberty Applied Before Transplanting or After Seeding in Bareground Production

T. Randell, J. Vance, S. Culpepper

Introduction

Georgia vegetable growers produce over 20% of the nation's fresh-market cucumbers; over half of that uses bare-ground production systems. Fields must be weed-free at planting to maximize yield and profit; thus, effective burndown herbicides are critical. Limitations with current options entice academic, industry, and USDA partners to search for new options to help growers. Liberty, one possibility for the future, is an effective burndown tool. However, its influence from residual activity to vegetables planted before or after application is not understood.

Materials and methods

Two different studies were conducted twice between 2017 and 2019 to determine transplant cucumber tolerance to preplant applications of Liberty focusing on rate, influence of irrigation after application and before planting, and interval between application and planting. Liberty applied at 16, 32, 48, and 80 oz/A the day before transplanting cucumber caused 13 to 52% injury on sandy, low organic matter soils (Figure 1).

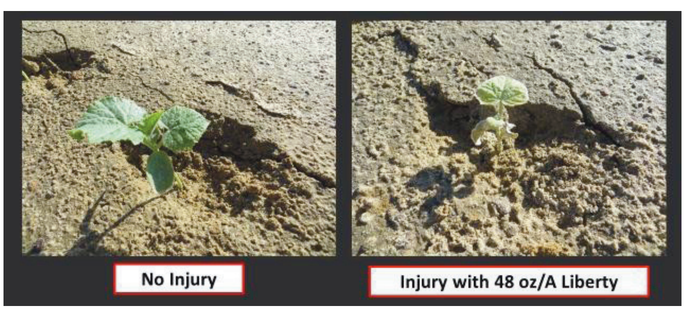

Figure 1. Transplant cucumber response to Liberty applied before planting.

The addition of irrigation (0.3 inch) after application but before transplanting significantly reduced injury by 38 to 62%. Cucumber vine lengths were reduced 11 to 33% with the three highest Liberty rates, while plant biomass was reduced 36 to 55% with the two highest rates; irrigation eliminated damage except at 80 oz/A. Early- season yield (harvests 1-4) noted a 31 to 60% yield loss from Liberty at 48 to 80 oz/A, with irrigation eliminating yield loss. Total marketable yield (11-13 harvests) followed similar trends. Extending the interval between Liberty applications and planting from 1 to 4 days was not beneficial; further extending the interval to 7 days significantly reduced injury at one of two locations (Figure 2). Residual activity of Liberty significantly damaged cucumber at all locations; thus, additional research is needed to determine if greater irrigation amounts and/or intervals between application and planting would improve transplant cucumber tolerance to Liberty preplant.

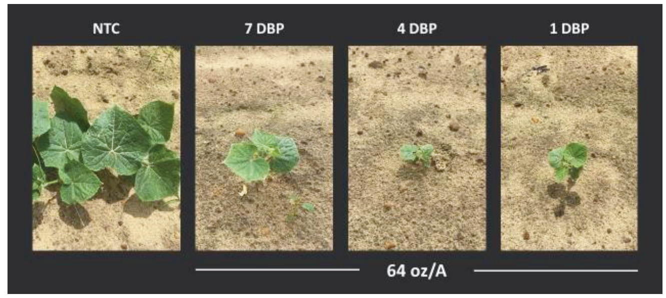

Figure 2. Transplant cucumber response to Liberty applied one, four, or seven days before planting.

Results and discussion

A study conducted at four locations between 2017 and 2019 determined seeded cucumber tolerance to Liberty applied immediately after seeding, as influenced by rate and irrigation following application. Liberty applied at 16, 32, 48, and 80 oz/A injured cucumber 8% or less on sandy, low organic matter soils. Liberty at only 80 oz/A reduced vine growth at one of four locations; the addition of irrigation (0.3 inch applied after seeding but prior to crop emergence) eliminated vine growth reductions. Early season biomass, early-season marketable fruit weight and number, and full-season marketable fruit weight and number were not influenced by Liberty.

Conclusion

Liberty is an effective burndown herbicide for numerous troublesome weeds. However, the belief that Liberty is a contact non- residual herbicide is simply not true. Our research proves that residual activity from Liberty can be damaging to vegetables. As IR-4, Georgia Department of Agriculture, the U.S. EPA and manufacturers move forward with cucurbit and fruiting vegetable registrations of glufosinate (active ingredient in Liberty), labels will be written very specifically to guide growers on how to use the herbicide in each crop and with each production practice to avoid crop injury. Liberty is not currently registered for use in cucurbits or fruiting vegetables and must not be used at this time.

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

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

Introduction

Whiteflies and virus incidences in 2018 were substantially high in squash, snap bean and tomato. Numerous grower fields were completely lost due to these incidences in the fall before hurricane swept through last fall. Whitefly populations were typically high in the fall season of 2018. Both yellow and zucchini squash were infected with cucurbit leaf crumple virus (CuLCrV) and cucurbit yellow stunting disorder virus (CYSDV), and almost always as mixed infection. Our laboratory experiments confirmed that there were synergistic interactions leading to more severe symptoms. We are currently researching the effects of such infections on interactions with whiteflies, and subsequent effects on epidemics. CuLCrV also infects beans. In addition, for the first time in Georgia, we identified another whitefly-transmitted virus, sida golden mosaic virus (SiGMV) infecting beans often times as mixed infection with CuLCrV in 2018. A commonly found weed host, prickly sida, was also found infected with this virus, suggesting that the virus has already established in Georgia. In 2019, we often found mixed infections of CuLCrV and SiGMV. This has complicated management efforts for CuLCrV in beans. Initial screening in 2018 revealed that a number of snap bean cultivars that were actually tolerant/resistant to CuLCrV. However, in 2019, those cultivars were actually susceptible to SiGMV, rendering the cultivars originally perceived as tolerant/resistant as susceptible. Research is ongoing in our laboratory to examine SiGMV host range, interactions with whiteflies, and virus transmission.

Whitefly cryptic species and population explosion

Whiteflies actually form the cryptic species complex. Research in our lab is aimed at monitoring whitefly cryptic species using molecular markers. Research thus far reveals that *Bemisia tabaci*, MEAM 1 is the predominant cryptic species in crops. We are exploring host-associated relationships and population differences within MEAM I across farmscapes in Georgia. This information is essential to assess relative contributions of host associations to virus epidemics. Whitefly populations in 2018 (albeit slightly lower than in 2017) were explosive in nature towards the middle of the growing season. Besides transmitting viruses, whiteflies by their sheer numbers, were actually posing a direct threat to the crop. Which was very obvious in the amount of silvering observed in numerous squash fields.

Figure 1. (A) Entire row of squash seedlings infected with CuLCrV and CYSDV; (B) bean plants infected with CuLCrV and SiGMV; and (C) prickly sida (weed) infected with SiGMV.

Figure 2. (A) Heavy infestation of whiteflies on squash plants; and (B) squash plants displaying silvering due to heavy infestation of whiteflies.

Results and discussion

A substantial amount of our research is geared towards basic and applied aspects of virus transmission prevention. Here, I will briefly describe some of the results of field trials that were obtained in 2018. The field trials focused 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. In addition, greenhouse trials were conducted. The trials were all conducted in Tifton in collaboration with Bhabesh Dutta, Tim Coolong, and Andre da Silva. For the sake of brevity, I will only describe the results of the mulch trial as well as the insecticide trial.

Mulch effects

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. This experiment was conducted at the TVP farm in Tifton.

At the end of the season, almost every plant was infected. However, the timing of infection and infection severity had a bigger effect on yield. For instance, plants under silver mulch got infected later than standard mulch, and infection severity was less. This translated to increased yields under silver mulch.

Insecticide effects

A number or insecticides were evaluated against whiteflies in squash using the same experimental design indicated above.

Figure 3. Differences shown between usage of row cover (A) and a standard insecticide treatment (B). Row covers were removed at flowering.

Table 1. Whitefly adult counts taken at three time intervals clearly show that whitefly infestation was more on standard white mulch when compared with silver and live mulch during peak infestation sampling.

September 21			September 28			October 3		
LS - means with the same letter are not significantly different			LS - means with the same letter are not significantly different			LS - means with the same letter are not significantly different		
Treatment	Estimate		Treatment	Estimate		Treatment	Estimate	
Standard	97.8000	A	Standard	72.6500	A	Standard	53.7750	A
					A			
Live	63.5250	B	Live	71.0750	A	Live	21.4250	B
		B						B
Silver	34.1250	B	Silver	29.4500	B	Silver	16.6000	B

Table 2. Virus severity rating and whitefly feeding-induced silvering were higher on standard white mulch when compared with silver and/or live mulch. Consequently, yields measured as fancy and medium fruits per plot were higher in the case of silver mulch than other mulch.

Severity			Silvering			Fancy			Medium		
LS - means with the same letter are not significantly different			LS - means with the same letter are not significantly different			LS - means with the same letter are not significantly different			LS - means with the same letter are not significantly different		
Treatment	Estimate		Treatment	Estimate		Treatment	Estimate		Treatment	Estimate	
Standard	4.5000	A	Standard	4.2500	A	Silver	12.7500	A	Standard	19.7500	A
		A			A						
Live	4.0000	A	Live	3.5000	B A	Standard	5.5959	B	Live	7.7500	B
					B			B			B
Silver	2.7500	B	Silver	2.2500	B	Live	5.2500	B	Standard	5.8255	B

Table 3. Whitefly counts, virus-induced severity, whitefly feeding-induced silvering, and number of fancy fruits harvested following row cover and various insecticide application.

September 21			Severity			Silvering			Fancy		
LS - means with the same letter are not significantly different.			LS - means with the same letter are not significantly different			LS - means with the same letter are not significantly different			LS - means with the same letter are not significantly different		
Treatment	Estimate		Treatment	Estimate		Treatment	Estimate		Treatment	Estimate	
Untreated Ck	74.0750	A	Admire Pro	4.2500	A	Untreated Ck	2.5000	A	Row cover	37.7500	A
		A			A			A			
Grandevo	58.0750	B A	Untreated Ck	4.0000	A	Admire Pro	2.2500	A	Untreated Ck	5.5000	B
		B A			A			A			B
Admire Pro	51.5000	B A C	Grandevo	3.7500	A	Requiem	1.5000	A	Crop oil	4.5000	B
		B A C			A			A			B
Exirel	45.1250	B A C	Exirel	3.7500	A	Crop oil	1.0000	A	Requiem	3.5000	B
		B C			A			A			B
Requiem	40.1500	B C	Sivanto	3.7500	A	Exirel	1.0000	A	Sivanto	3.2500	B
		B C			A			A			B
Crop oil	36.0250	B C	Crop oil	3.5000	A	Sivanto	1.0000	A	Grandevo	3.0000	B
		C			A			A			B
Sivanto	24.5250	D C	Requiem	3.5000	A	Grandevo	1.0000	A	Admire Pro	2.5000	B
		D						A			B
Row cover	1.18E-12	D	Row cover	1.0000	B	Row cover	1.0000	A	Exirel	0.7500	B

Conclusion

Ongoing research indicates that a number of cultural and chemical tactics can be effectively used to suppress whiteflies and viruses in the absence of host resistance. These tactics can play a pivotal role in risk mitigation, and enhancing sustainability, and profitability.

Pepper Weevil Control in Pepper and Eggplant

D. Riley and A. Sparks

Introduction

The pepper weevil, *Anthonomus eugenii* (Figure 1), has been a severe problem in commercial pepper in southern Georgia over the last several years. We began looking at insecticide efficacy to see if we were experiencing reduced levels of control and initially found tolerance to pyrethroids insecticides. Since pepper weevil is the most devastating pest of pepper (Riley and Sparks, 1995) where it occurs in Georgia and susceptible pepper and eggplant are some of our top ranked vegetable commodities in the State, it was imperative to develop effective control strategies for this pest in both crops. Pepper weevils can move between pepper and eggplant fields, but preliminary data suggested that pepper pods are a much better reproductive host than blossoms or fruit of eggplant. An important problem for insecticide control is that pepper weevil grubs develop inside of the pepper pods or in the fleshy flowers of eggplant, so the grubs are protected from foliar sprays of insecticides. Thus, the susceptibility of the adults to insecticides is the most critical measure of potential control of this pest. This study (1) compared pepper and eggplant in terms of susceptibility to damage caused by similar pepper weevil pressure and (2) provided insecticide efficacy based on a bioassay of adults collected from a commercial pepper field.

Figure 1. Pepper weevil adult on pepper flower bud (left) and eggplant flower (right).

Materials and methods

The pepper-eggplant field study was conducted at the Lang-Rigdon Farm of the Coastal Plain Experiment Station in Tifton, Georgia, in late summer 2018, but the test plots were rendered useless by Hurricane Michael. We retested in summer 2019. We used a split-plot design experiment with the treated and untreated block as the main plots and the different host plant resistant plants Bell pepper, Jalapeno pepper and eggplant as the subplots. Berdegue, *et al.* (1994), had already identified that hot peppers are more pepper weevil-resistant than bell peppers, and we suspected that eggplants are more resistant to pepper weevil than bell peppers. This gave us a range of susceptibility to the weevil to see how these compare with and without an insecticide spray program (Vydate rotated with Actara).

This also gave us the opportunity to see if there was an interaction between plant resistance and insecticide treatment, hopefully positive and additive relative to weevil damage control. We established a double row of jalapeno evenly infested with pepper weevil down the length of the experimental plots to give each block similar access to invading pepper weevils from the source rows. We only made a single harvest when the bell pepper was just large enough to pick since this was the most stressed of the three crops. The jalapeno and eggplant crop were at a normal stage for picking of the fruit weights were in line with commercial standards. The bell pepper fruits weights were too low for commercial standards, but we were afraid of losing the crop all together if we did not harvest at that time. For this reason, we focused on fruit numbers and changes in percent fruit weight to assess impacts of weevils on harvest.

For the insecticide efficacy study, weevils collected from commercial peppers infested with weevils and exposed to pepper pod slices dipped in the high rates of the better products for weevil control based on previously reported information. Weevils in fallen pods were collected and brought back to the Vegetable Entomology Research Lab for the bioassay. Pods were held for adult weevil emergence to begin testing. Organically grown pepper pods were sliced in eighths and dipped into insecticide solutions equivalent to the highest labeled rate mixed in a 100 gallons per acre, then allowed to air dry before placing into a vented petri dish. Five pepper weevil adults were introduced into the dishes and sealed with a clip. Mortality was observed at 48 and 120 hours plus. The treatments tested are listed in table 2.

Results and discussion

Even though the bell pepper-jalapeno pepper-eggplant plot yields were relatively low due to fertilizer injection issues, over all three crops, the sprays for pepper weevil significantly increased marketable fruit number by 2.3-fold based on this single harvest. There was a significant interaction between the spray treatment and crop relative to marketable fruit, suggesting that each crop responded differently to pepper weevil control (Figure 2). The main difference was that jalapeno pepper responded the strongest to sprays, much stronger than either bell pepper or eggplant in terms of increased marketable fruit produced. Coincidentally, there was also significantly reduced weevil contamination in the harvested fruit of jalapeno pepper (Figure 2). As observed in previous studies, eggplant fruit did not harbor weevils inside the fruit but jalapeno clearly is a source for pepper weevil production (Table 1).

The bell peppers performed the poorest in this trial with fruit weights (0.1 lb/fruit) well below commercial standards, but jalapeno and eggplant fruit weights were normal (0.06 lb and 0.67 lb per fruit, respectively). We knew from the onset that this experiment was a bit like comparing "apples and oranges" when it comes to pepper weevil control across different crops. However, it was important from a landscape pest management approach to understand how these crops interact with this severe pest in terms of how they respond to similar pest pressure and how they contribute to the on-going pepper weevil problem. From Table 1, we can observe that eggplant produced 3½ times the fruit per plot as bell pepper and jalapeno produced 5.7 times the fruit in the same row space as bell pepper. Interestingly, jalapeno produced 5.6 times as many pepper weevil as bell pepper in the same row space. On the other hand, eggplant fruit contributed no increase in weevils which is consistent with previous studies where we demonstrated that pepper weevils in eggplant reproduce almost exclusively in the flower buds. The increase in marketable fruit number with insecticidal control, given similar weevil infestation levels, was greatest with jalapeno peppers (Figure 2).

Similarly, greatest reduction in pepper weevil in fruit occurred with insecticidal control in jalapeno. So, what does this mean for pepper weevil management? Jalapeno peppers are likely a greater source for pepper weevil reproduction on farms where all three crops are grown. Since weevil numbers appear to parallel pepper fruit numbers, we suspect that all small pepper fruit varieties with high fruit numbers need to be managed more intensively for pepper weevil control. This study needs to be repeated to better assess the impact of weevils on bell pepper.

In the second part of this study, we were able to evaluate a number of insecticides for pepper weevil control (Table 2). As in previous bioassays in Georgia, Vydate and Actara provided strong mortality at 5 days post-treatment, with a new unregistered product, EXP, providing a similar level of control. In the next grouping, providing significant control was Belay, Cormoran, Assail, Exirel and a combination of Torac plus Exponent, a PBO synergist. Unfortunately, this syngergist did not help the pyrethroid insecticide Hero (Table 2).

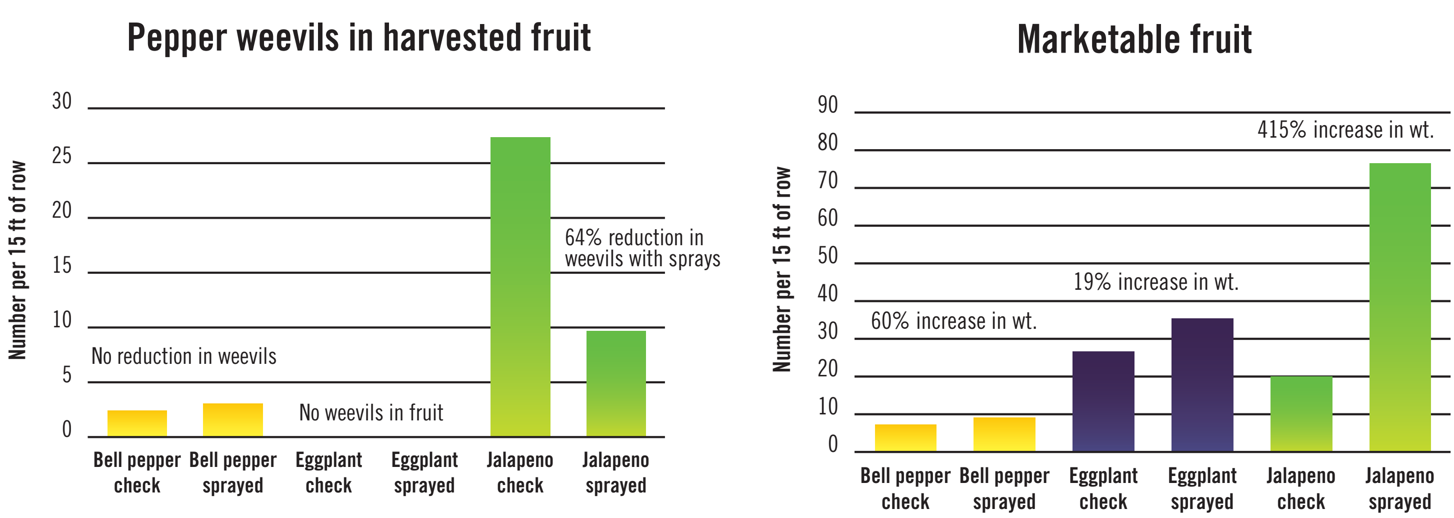

Figure 2. Response of the crop and pepper weevil fruit contamination to insecticide treatment.

Table 1. Number of fruit and pepper weevils produced per 15 feet of row in a single harvest.

Crop	Market fruit	Market weight	Weevils
Jalapeno	48.4a	2.8b	18.4a
Eggplant	29.5ab	19.7a	0.0b
Bell pepper	8.5b	0.8b	3.3b

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

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

Treatments (rate per acre)	Dead at 48 hours	Live at 48 hours	Dead at 120+ hours
Vydate L 4 pt/a	4.2a	0.4e	4.8a
EXP 6.85 fl oz/a	3.2ab	0.2e	3.8ab
Actara 25WDG 5.5 oz/a	2.0bc	1.2de	3.4ab
Belay 2.13SC 4 fl oz/a	1.8cd	0.6e	2.6bc
Cormoran 9 fl oz/a	1.6cd	2.8abc	2.6bc
Assail 30SG 4 oz/a	1.2cde	1.4cde	2.4bc
Torac 1.29EC 21 fl oz/a Plus Exponent 8 fl oz/a	2.0bc	1.6cde	2.4bc
Exirel 13.5 fl oz/a	0.6de	3.2ab	2.2bc
Minecto Pro 1.37SC 10 fl oz/a	0.2e	4.2a	1.6cd
Torac 1.29EC 21 fl oz/a	1.2cde	2.6bcd	1.4cd
Hero 1.24EC 10.3 fl oz/a Plus Exponent 8 fl oz/a	1.6cd	1.6cde	1.2cd
Untreated Check	0.0e	3.8ab	0.0d

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

Conclusion

Pepper weevil is one of the most devastating insect pests of peppers where it occurs. We have found that small fruit peppers like jalapeno contributes more to weevil reproduction than bell pepper in the field. Jalapeno pepper also exhibited the strongest yield response to pepper weevil control as compared to bell pepper and eggplant. Eggplant fruit do not significantly contribute to pepper weevil reproduction. The top treatments for pepper weevil control are still Vydate and Actara, but we have several products that provide significant mortality of pepper weevil adults. Since the grubs in the plant fruiting structure are protected from sprays, efficacy against adult weevils is our best indicator of control potential for commercial insecticides.

Prediction of Bacterial Leaf Spot in Pepper Using Models Developed from Soil Mineral Composition

B. Dutta

Introduction

Pepper is an important vegetable crop in the U.S. for both processing and fresh-market consumption. Georgia ranks in the top four states in the nation in pepper production, and in terms of dollar value to Georgia pepper ranks 2nd, behind only Vidalia onions. Pepper production has been negatively impacted by pests and diseases such as bacterial leaf spot of pepper (BLS), caused by the bacterium *Xanthomonas campestris* pv. *vesicatoria*. BLS has caused millions of dollars in losses annually, and is the most widespread and serious disease affecting pepper in Georgia. BLS is usually spread by infected seed and transplants. Like most bacterial diseases, it is extremely difficult to manage, and is responsible for severe losses when there is either abundant rain or when overhead irrigation is employed. To control this disease, growers apply multiple applications of copper plus mancozeb as frequently as twice a week. However, the disease is not effectively controlled when environmental conditions are optimum for disease development. Furthermore, control is hampered by the development of copper-tolerant bacterial strains. Since BLS is difficult to manage with current control strategies and because the primary existing control strategy is based on copper sprays, alternatives such as the plant activator, acibenzolar-S-methyl (Actigard), which shown some promise. Despite its effectiveness against BLS the response has been variable.

Cation concentrations in soil and plants were reported to affect disease severity on many pathosystems. We investigated if cation concentrations in pepper plants affect BLS severity. Based on mineral analysis of pepper tissues, several significant BLS severity models were developed. These models are comprised of Cu, Fe, Mn or Zn as major contributors alone or in different ratios. These cations also act as cofactors for superoxide dismutase (SOD) enzymes that detoxify reactive oxygen species produced in plants upon pathogen attack. As a result, hydrogen peroxide is formed, which acts as precursor for salicylic acid (SA) formation. SA has been proposed as the signal molecule to initiate the systemic acquired resistance (SAR) pathway.

Using GACCV funds, we previously found evidence of SOD involvement in these models as seen by the effects of increased levels of Cu, Fe or Zn on the relative gene expression for the three major classes of SODs (Cu-Zn SOD, MnSOD and FeSOD) in pepper tissues. We also observed that increased levels of SA and MnSOD activity in plants showing less BLS severity than plants with severe BLS symptoms, thereby providing evidence of a SAR response. This phenomenon was also observed with *Nicotiana tabacum* when challenged with tomato spotted wilt (TSW) virus. Tobacco plants with low TSW severity ratings were high in MnSOD activity (data not shown). Moreover, highly significant and predictive TSW models were developed using Cu, Fe, Mn or Zn cations alone or in combination with one another. One of the models was validated when we predicted TSW severity in a field study (2014). Based on a survey of soil micronutrients at the Bowen Farm on the UGA Tifton campus, we predicted TSW severity (percentage) by plugging concentrations of key micronutrients in predictive TSW model. Based on model predictions, field plots were designated as high and low disease risk areas prior to transplanting tobacco. By chance, the high risk and low risk sites were within 100 m of one another. When plants were rated for disease severity, TSW ratings in the low risk site were 4.5% compared to 33.1% in the high risk site. In an earlier study, tobacco TSW levels in the field significantly fit a gradient increasing from north to south. Levels of increasing copper levels and decreasing iron levels in the soil also ran from north to south and significantly fit the disease gradient. These data validated our model in terms of explaining the patterns of disease variation in the field. Such disease predictions should also be evaluated for BLS severity in pepper using models developed from soil mineral analysis. Preliminary data indicate that such predictions are possible. The objective of this study was to predict high risk and low risk sites in pepper fields using the disease models developed from the correlation of mineral levels and base cation saturation ratios with disease severity.

Materials and methods

Soil samples from two experimental sites (BSF1 and TVP1) were collected and sent to the UGA Plant and Soil Analysis Laboratory for analysis. The sites were at the UGA Tifton campus. Data were fit to predictive BLS models developed earlier. A total of 20 soil samples per field site were taken and they were assigned a plot number. Fields/sites of high risk or low risk for BLS severity on pepper were identified. Pepper transplants were planted in randomized complete block design in both the high risk and low risk areas for these sites. Plots were not inoculated and were evaluated after the incidence of natural BLS outbreak. Disease ratings were taken at two-week intervals until harvest maturity and an area under the disease progress curve (AUDPC) for BLS was constructed.

Results and discussion

Based on the predictive BLS model developed earlier, cation concentrations alone or in ratio to one another were substituted in the model. After substitution, predictive BLS severity for two experimental sites were determined. Later, a total of six plots (three high risk and three low risk) per site were chosen. In BSF1, the predictive BLS for three high risk plots were 328, 248 and 215 and the actual AUDPC for the same plots were observed to be 285, 202, and 182 respectively. The percent accuracy of prediction for these plots ranged from 77.3 to 81.9% (Table 1). For the low risk sites, total BLS for three plots were predicted to be 174, 154 and 145, and the actual AUDPC for the same plots were observed to be 110, 105 and 92, respectively (Table 1). The percent accuracy of prediction for these plots ranged from 41.8 to 57.6% (Table 1).

For TVP1, the predicted BLS levels for three plots were 264, 245, and 225 with actual AUDPC values of 212, 198, and 172, respectively (Table 1). The percent accuracy of model prediction ranged from 69.2 to 76.2%. For the same site, the predicted BLS levels for the low risk sites were 162, 138, and 128 with actual AUDPC values of 105, 86, and 98, respectively (Table 1). The percent accuracy of model prediction ranged from 45.7 to 69.4% (Table 1).

Conclusion

The results from this investigation indicate that BLS severity can be predicted based on models developed from soil and tissue cation concentrations. Our preliminary results suggest that BLS severity for BSF1 and TVP1 were successful in predicting the high risk sites compared to the low risk. The exact reason for this observation is not clear, but future field trials should focus on understanding this discrepancy. Overall, these observations indicate that cation concentrations in soil can potentially predict high risk sites in fields.

Table 1. Predictive and actual area under disease progress curve (AUDPC) for two experimental sites.

Site	Predictive BLS	Site designation[1]	Actual AUDPC for BLS	Percent accuracy (%)[2]
BSF1	248	High risk	202	77.3
BSF1	215	High risk	182	81.8
BSF1	328	High risk	285	84.9
BSF1	174	Low risk	110	41.8
BSF1	154	Low risk	105	53.3
BSF1	145	Low risk	92	57.6
TVP1	245	High risk	198	76.2
TVP1	264	High risk	212	75.4
TVP1	225	High risk	172	69.2
TVP1	138	Low risk	86	60.4
TVP1	162	Low risk	105	45.7

[1] Sites were designated as high risk or low risk sites based on the BLS model developed earlier.
[2] Percent accuracy was calculated as 100% error. Percent error was calculated as [predictive BLS-actual AUDPC/actual AUDPC × 100].

Monitoring Resistance Development in *Phytophthora capsici* Populations to Several Fungicides

P. Ji

Introduction

Phytophthora blight, caused by *Phytophthora apsica*, is a devastating disease that dramatically reduces yield and quality of squash, peppers, and several other vegetable crops. Infected vegetable crops may develop crown rot, root rot, leaf blight, fruit rot, or become wilted quickly. Favored by rainfall and humid weather conditions, this disease is extremely damaging in Georgia and many other vegetable production areas.

Application of fungicides continues to be a significant component in developing effective programs for managing Phytophthora blight. A challenge in managing the disease is that *P. apsica* has a remarkable ability to develop resistance to chemical fungicides. Studies conducted in our lab at University of Georgia in recent years indicated that *P. apsica* isolates from vegetable fields in Georgia developed resistance to mefenoxam (e.g., Ridomil Gold) and cyazofamid (e.g., Ranman). Other fungicides are being used for managing Phytophthora blight, including mandipropamid (e.g., Revus), dimethomorph and ametoctradin (e.g., Zampro), ethaboxam (e.g., Elumin), oxathiapiprolin (e.g., Orondis), and fluopicolide (e.g., Presidio). Some of the fungicides have been used for disease management in Georgia for a few years. The objective of the study was to evaluate if resistance has developed in populations of *P. apsica* to fungicides commonly used for managing Phytophthora blight, including fluopicolide, mandipropamid, oxathiapiprolin, ethaboxam, dimethomorph and ametoctradin

Materials and methods

Experiments were conducted at University of Georgia Coastal Plain Experiment Station in Tifton, Georgia. Isolates of *P. apsica* were collected from vegetable fields at different locations in Georgia in 2018 and 2019. More than 100 isolates were identified by morphological characteristics and molecular identification. The isolates were used to determine potential resistance to fluopicolide, mandipropamid, oxathiapiprolin, ethaboxam, dimethomorph and ametoctradin An agar plug taken from the edge of an actively growing colony was placed at the center of V8 agar plate amended with each of the fungicides at final concentrations of 1 and 10 mg/liter. The plates were incubated at 25 °C and colony diameters were measured in two perpendicular directions 5 days after incubation and averaged for analysis. The relative growth rate of *P. apsica* on fungicide amended and non-amended control plates was used to determine resistance to the fungicide (sensitive: <30% of the control, that is, colony diameter on fungicide amended plates is less than 30% of colony diameter on non-amended control plates; intermediately sensitive: 30 to 90% of the control; resistant: >90% of the control). The experiments were conducted twice under similar conditions and percentage of resistant and sensitive isolates was calculated.

Isolates determined in the above-mentioned study as resistant to fluopicolide were used to evaluate resistance to higher concentrations of the fungicide. V8 agar plates were amended with the fungicide at different concentrations ranging from 25 to 500 mg/liter active ingredient. An agar plug taken from the edge of an actively growing colony was placed at the center of the plates and growth of the pathogen was measured as described above. Additionally, effects of the fungicide on sporangial production and zoospore germination of *P. apsica* isolates determined to be resistant by mycelial growth were evaluated. Mycelial plugs were placed in petri dishes containing sterile distilled water amended with each of the fungicides at concentrations ranging from 0 to 500 mg/liter. The petri dishes were placed under light for 3 days and numbers of sporangia were counted under a microscope. For zoospore germination, suspensions of zoospores were spread plated on V8 agar plates amended with the fungicide and incubated as mentioned above. Percent germination of the spores was calculated by viewing 100 spores on each plate four hours after incubation.

Results and discussion

All isolates of *P. apsica* tested were sensitive to oxathiapiprolin, mandipropamid, dimethomorph and ametoctradin at 1 mg/liter or higher concentrations based on mycelial growth. However, most of the isolates were resistant to fluopicolide at 1 mg/liter

(Figure 1). About half of the isolates were sensitive to ethaboxam and the other half were intermediately sensitive to the compound at 1 mg/liter. More than 40% of the isolates were resistant to fluopicolide at 10 mg/liter or higher concentrations based on mycelial growth (Figure 2). All isolates resistant to fluopicolide based on mycelial growth were identified to be resistant based on sporangial production and zoospore germination with EC50 > 100 mg/liter.

Conclusion

Large numbers of isolates of *P. apsica* from commercial vegetable fields in Georgia have developed resistance to Presidio (a.i., fluopicolide). This fungicide should not be used for control of Phytophthora blight in vegetable production in Georgia. Reduced sensitivity to Elumin (a.i., ethaboxam) was observed in populations of *P. apsica*, and continuous monitoring of potential resistance development to this fungicide is highly desirable. No isolates were found to be resistant to Orondis (a.i., oxathiapiprolin), Zampro (a.i., dimethomorph and ametoctradin) and Revus (a.i., mandipropamid).

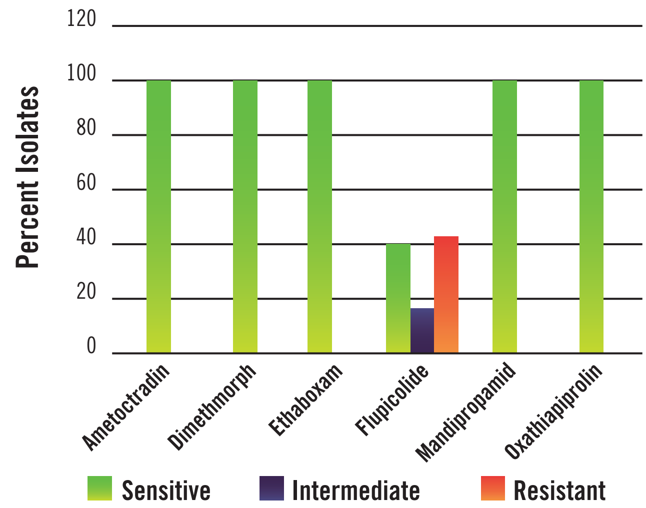

Figure 1. Percentage of sensitive, intermediately sensitive, and resistant isolates of P. capsici from vegetable fields in Georgia to chemical fungicides (1 mg/liter).

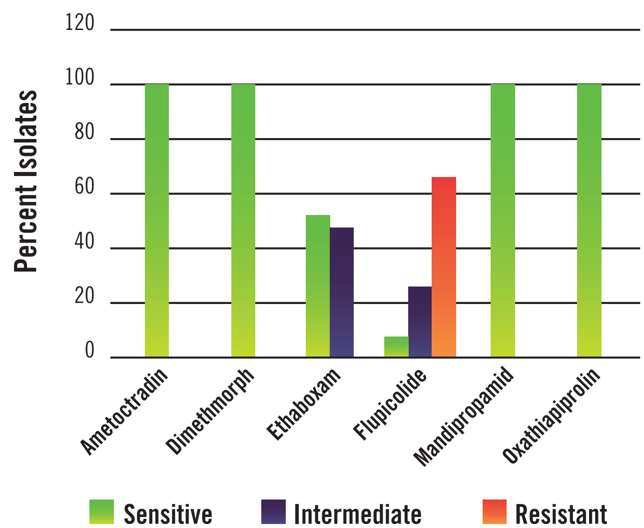

Figure 2. Percentage of sensitive, intermediately sensitive, and resistant isolates of P. capsici from vegetable fields in Georgia to chemical fungicides (100 mg/liter).

Support of Silverleaf Whitefly Management Research and Pest Management in Sweet Potato

A. Sparks

Introduction

Silverleaf whitefly is a key pest of many vegetable crops produced in the fall in southern Georgia. While UGA scientists are examining many aspects of this pest's biology and researching multiple approaches to management of both the pest and the viruses they transmit, insecticides are the first line of defense. New insecticides with potential efficacy need to be evaluated under field conditions and older insecticides require monitoring for potential resistance. Multiple field efficacy trials were conducted for these reasons.

Sweet potato pests consist primarily of soil insects and soil applied insecticides are typically used to manage these pests with varying degrees of success. Insecticide application timing is based primarily on crop stage (pre-plant incorporated and lay-by incorporated applications). A study was conducted to look at planting date effects on efficacy of these treatments.

Materials and methods

Nine small plots, replicated trials were conducted at the UGA Tifton campus to evaluate the efficacy of various insecticides and insecticide rotations against whiteflies in cucurbit crops and snap beans. Squash serves as an "acid test" for any insecticide targeting whitefly, as silverleaf symptoms appear in yellow squash at very low population densities. Thus, trials conducted in squash typically highlight the strongest insecticides for whitefly management. Cucumbers were used in other tests as they do not react readily to whitefly feeding, support large populations of whitefly, and provide insights into products with good activity that may appear inadequate in squash. Snap beans were also used in some tests, as past experience has indicated potential crop-insecticide interactions that may render some insecticides less efficacious in snap beans.

A small plot, replicated trial was conducted in sweet potato to investigate the effects of planting dates on the efficacy of pre-plant and side-dress insecticide applications for management of damage by soil insects. Sweet potatoes were planted on three dates (approximately three weeks apart) with four insecticide treatments: no insecticide; chlorpyrifos pre-plant incorporated; bifenthrin lay-by incorporated; both pre-plant and lay-by applications.

Results and discussion

Selected results are shown for the whitefly trials.

Insecticide drench treatments in squash, cucumbers and snap beans:

In the squash test, Admire Pro failed to provide any suppression of silverleaf symptoms. This is of concern as previous occurrence of insecticide resistance to the neonicotinoids appeared with Admire first.

The other insecticides suppressed silverleaf for about three weeks, which is similar to recent years.

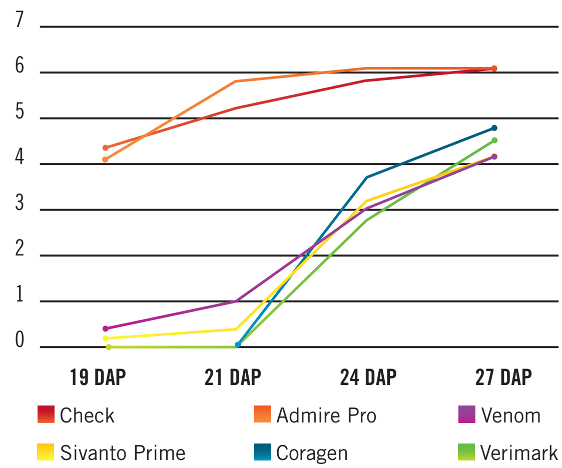

Figure 1. Squash drench silverleaf ratings, 2018. Squash, cucumber, snap bean test.

In the cucumber test, both Admire Pro and Coragen failed to suppress nymph populations. Issues with Admire Pro were discussed above. Coragen has been reported to be inconsistent in other parts of the country, which is not so for Georgia; however, this may signal a shift in efficacy with this chemistry. Verimark and Venom provided good control through 25 days after treatment.

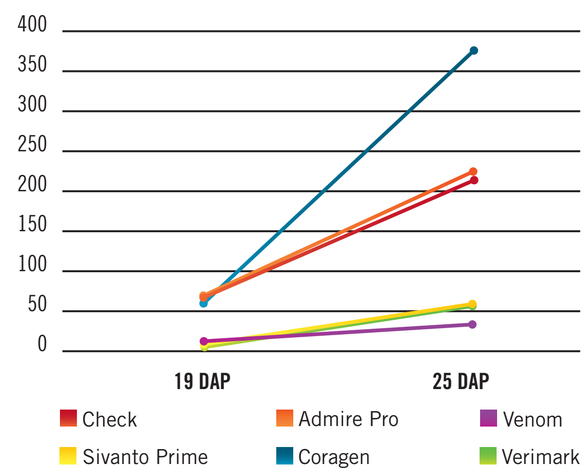

Figure 2. Cucumber drench nymphs per sample, 2018. Squash, cucumber, snap bean test.

In snap beans, Admire Pro and Sivanto Prime provided intermediate control. The group 4 insecticides have shown reduced efficacy on snap beans in the past (although Venom performed well in this test). Both Coragen and Verimark provided good control through 26 days after planting.

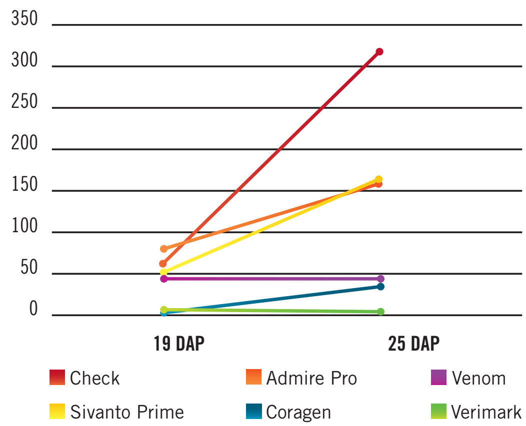

Figure 3. Snap beans drench nymphs per sample, 2018. Squash, cucumber, snap bean test.

Foliar application tests in squash, cucumbers and snap beans:

In squash, Actara (which is closely related to Admire Pro) and Venom performed poorly. Sivanto Prime and Coragen were intermediate, and Exirel provided the best suppression. However, none of the treatments applied on a 7 day schedule were adequate to prevent silverleaf. This test was started slightly late and demonstrates the importance of not getting behind in management of silverleaf whitefly.

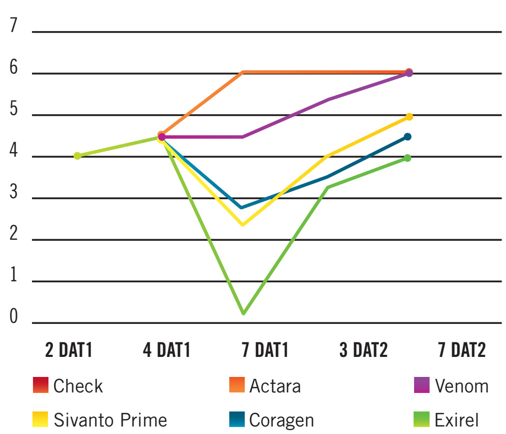

Figure 4. Squash foliar silverleaf ratings, 2018. Squash, cucumber, snap bean test.

In the cucumber trial, Actara and Coragen performed poorly. Sivanto Prime, Venom and Exirel performed very well, with Exirel providing the greatest suppression of nymph populations.

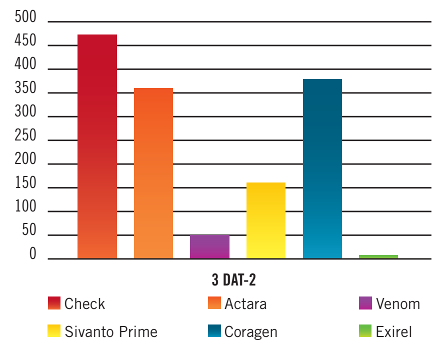

Figure 5. Cucumber foliar nymphs per sample, 2018. Squash, cucumber, snap bean test.

In the snap bean trial, only Exirel provided good control of the whitefly nymphs. The poor performance of the Group 4 insecticides has been noted in snap beans before. The poor performance of Coragen is unusual and may signal a potential shift in efficacy of this product.

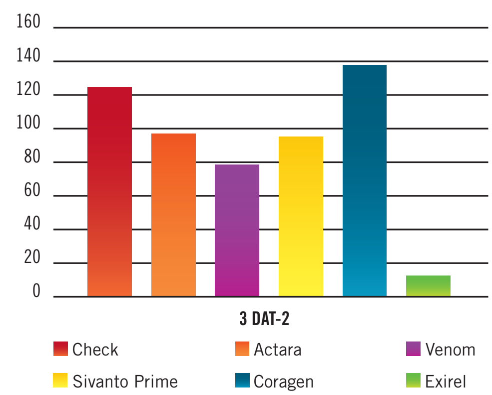

Figure 6. Snap beans foliar nymphs per sample, 2018. Squash, cucumber, snap bean test.

Conclusions of the squash, cucumber and snap bean trails:

Admire Pro showed reduced efficacy across all trials. This is of concern as prior insecticide resistance issues with the Group 4 insecticides appeared with Admire first. Also of concern is the inconsistent performance of Coragen. This has been reported in other parts of the US, but Coragen has served as a standard product for whitefly control in Georgia since its registration. This may signal a shift in the efficacy of Coragen in Georgia and possibly a shift in susceptibility to the Group 28 insecticides; however, both Verimark and Exirel (Group 28) provided the best control in most tests in 2018. The potential reduced efficacy of the Group 4 insecticides in snap beans has been noted before. These insecticides till provide suppression in snap beans, but often not at the level expected from experiences in cucurbit crops.

Insecticide rotations for management of silverleaf whitefly:
A weekly rotation of Sefina or Sivanto Prime in rotation with Knack provided good suppression of whitefly nymph populations. Knack, Movento, Courier and Sefina, in rotation with Exirel provided excellent control of nymphs.

Alternate insecticide modes of action are encouraged to help manage insecticide resistance. This data suggests they can be incorporated without reducing control.

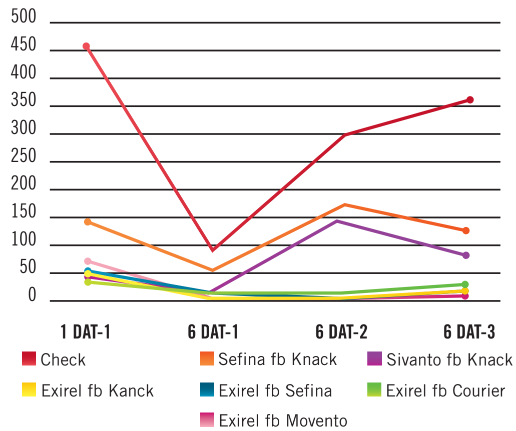

Figure 7. Insecticide rotations for SLWF control cucumber test.

Sweet potato soil insect management:
In the earliest planting, the pre-plant insecticide and side-dress provided some suppression of root damage and the combination only slightly improved this protection.

In the middle planting, pest pressure was higher. Both the pre-plant and side-dress again suppressed damage similarly, but the combination increased damage suppression.

In the third planting, pest pressure was decreased and none of the insecticide applications suppressed damage.

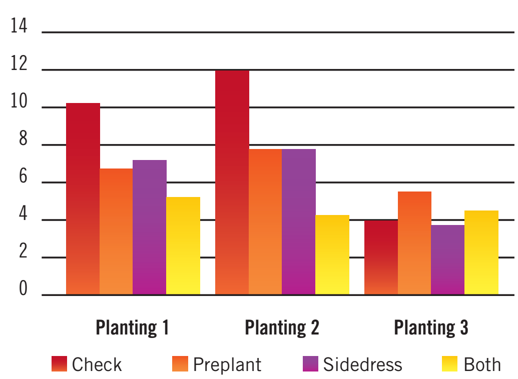

Figure 8. Sweet potato soil insect management, planting date effects, 2018.

While this data could be interpreted in a variety of ways, it does suggest that planting date does influence the need and efficacy of insecticide applications for management of soil insects. This is likely the result of the current timing of applications based on plant development (pre-plant, and side-dress applied just prior to vining to prevent damage by the mechanical incorporation). A more appropriate approach would likely be application timing based on the pest cycling within a field, particularly for the side-dress application which serves more as a shallow barrier to infestation. If applied too early, the residual activity could be lost before the pests appear. If applied too late, the pest may already be below the treatment zone and escape exposure.

Evaluation of Sweet Potato Varieties for the Vidalia and Tifton Areas

G. Boyhan, T. Coolong, C. McGregor, A. da Silva, A. Shirley, C. Tyson, J. Edenfield, R. Hill, M. Brannon

Introduction

Sweet potato were an important crop in Georgia in past years. In 1965 there were 10,000 acres of sweet potatoes produced. This production fell off to under 1,000 acres because of the sweet potato weevil which resulted in a statewide quarantine. In recent years, production has grown to 4,000-5,000 acres thus again becoming an important crop in the state.

Sweet potatoes are a warm, long season crop in the Morning Glory family. They are propagated asexually from slips or cuttings. This is one of the few vegetables that are propagated in this fashion. They are generally planted in May and harvested in September. Sweet potatoes are often called yams especially when canned; however, the true yam is completely different related to lilies and grasses. This study was to evaluate sweet potato varieties for their yield and graded yield.

Materials and methods

Two different experiments were conducted, one on the UGA campus in Tifton, Georgia. The other at the Vidalia Onion and Vegetable Research Center in Lyons, Georgia. Transplant slips were acquired from North Carolina State University and Louisiana State University for these trials.

Soil at both locations was prepared according to University of Georgia Cooperative Extension Service recommendations. Slips were transplanted in June 2018 at both locations. Typical production practices include applying 800 lbs/acre of 5-10-15, Valor herbicide applied at 2.5 oz/acre, and 2 qts/acre of Lorsban applied prior to transplanting.

In Tifton plots were a single row with a 12 inch in-row spacing and 3 ft between rows. Each plot was 20 ft long resulting in 60 sq ft per plot. At the Vidalia farm plots had a 12 inch in-row spacing and 3 ft between rows. Plots were 50 ft long resulting 150 sq ft per plot.

Plots at both locations were harvested in October and total field weight was recorded per plot. Approximately two weeks after harvest the sweet potatoes were graded into size classes of Number 1 petite, Number 1, Number 2, Jumbo, and Culls based on USDA recommendations.

The experimental design was a randomized complete block design with 4 replications. Data were analyzed with Stata 15.1. An analysis of variance was used for the Tifton data and an analysis of covariance with the Vidalia Farm data using the stand count as the co-variate.

Results and discussion

There were seven entries evaluated at the Vidalia Farm with ‘Beauregard’ from LSU having the highest total yield at 35,792 lbs/acre (Table 1). This was significantly better than ‘Evangeline’ or any other variety with yields less than 29,732 lbs/acre.

There were no differences in the graded yields for No. 1 petite or No. 1 in the Vidalia trial. There are numerical differences in the yield for these two grades; however, there was no statistically significant difference among the entries. This usually occurs with widely differing yields as with the No. 1 data because of wide differences in yields between replications within a particular variety or because of missing data.

Entry ‘Beauregard’ also had the greatest amount of jumbo sweet potatoes with 15,137 lbs/acre, which was significantly greater than ‘Evangeline’ with 6,425 lbs/acre or any other entry with less than 10,611 lbs/acre.

At the Tifton location there were no differences between any of the entries for either harvested, total, or graded yields (Table 2). There were differences; however, between the number of culls with ‘Beauregard’ having the fewest culls. ‘Beauregard’ had fewer culls than any of the other entries with the exception of ‘Bellevue’ or ‘Orleans’.

Table 1. Sweet potato variety trial results, Vidalia Farm, Lyons, Georgia, 2018.

Entry	Source[y]	Graded yield[z]			
		Total yield (lbs/acre)	No. 1 Petite	No. 1	Jumbos
Covington	NC State	13,721	3,449	5,808	3,231
Beauregard	LSU	35,792	6,425	10,019	15,137
Bayou Belle	LSU	33,832	5,590	10,781	14,447
Bellevue	LSU	14,084	5,372	3,884	1,779
Evangeline	LSU	22,615	5,046	8,458	6,425
Orleans	LSU	33,396	7,599	11,180	11,422
Burgundy	LSU	14,593	6,534	6,026	1,089
Coefficient of variation		16%	24%	33%	37%
Fisher's Protected LSD (P≤0.05)		NSx	NS	NS	NS

[z]No. 1 petite (diameter ≥1.25 & ≤2.25 inches, length ≥3 &≤7 inches); No. 1: (diameter: ≥1.75 & ≤3 inches, length: ≥3 & ≤9 inches), Jumbo: (diameter >3.5 & >9 inches).

[y]NC State = North Carolina State University, LSU = Louisiana State University

[x]NS = Not significant

Table 2. Sweet potato variety trial results, Tifton, Georgia, 2018.

Entry	Source[x]	Graded yield[z]						
		Harvest yield (lbs/acre)	Total yield[y]	No. 1 Petite	No. 1	No. 2	Jumbos	Culls
Averee	NC State	15,055	13,232	2,505	5,862	1,452	236	3,176
Covington	NC State	14,275	12,633	3,049	5,826	1,162	345	2,251
Beauregard	LSU	16,855	15,367	3,775	7,163	1,839	1839	750
Bayou Belle	LSU	22,470	21,151	6,050	9,559	1,597	1670	2,275
Bellevue	LSU	18,305	15,900	3,176	9,003	1,180	926	1,615
13-84	LSU	21,726	19,457	4,429	8,839	1,924	563	3,703
Evangeline	LSU	11,562	10,255	3,049	4,737	309	0	2,160
Orleans	LSU	14,439	12,705	3,648	6,806	309	0	1,942
CV		37%	39%	44%	52%	114%	171%	38%
Fisher's Test (P≤0.05)		NS[w]	NS	NS	NS	NS	NS	NS

[z]No. 1 petite (diameter ≥1.25 & ≤2.25 inches, length ≥3 &≤7 inches); No. 1: (diameter: ≥1.75 & ≤3 inches, length: ≥3 & ≤9 inches), No. 2: (≥1.5 inches & <36 oz. somewhat misshaped), Jumbo: (diameter >3.5 & >9 inches).

[y]Total yield includes No. 1 petite, No. 1, No. 2, Jumbos, and culls

[x]NC State = North Carolina State University, LSU = Louisiana State University

[w]NS = Not significant

The coefficient of variation is a unit independent measure of how well the experiment did or how well it fits the model. A lower value is considered better. Field research with CVs in the 30-40% range are typical. Values above 100% indicate that the reported means have no real meaning because the variation between plots is so high.

There were problems with these trials. The entries from NC State arrived a week earlier than those from LSU and were consequently planted a week earlier than the LSU entries. In addition, the condition of many of the slips were poor when they were brought to the Vidalia Farm. In addition, there was a tremendous amount of deer pressure at the Tifton site, which delayed harvest and probably reduced yields. This should be noted by growers that deer can become a serious problem and may require they take remedial steps such as fencing, deer repellents, and herd culling.

In conclusion, caution should be exercised in interpreting these results. 'Covington' a common variety grown commercially did not do very well. Promising varieties include 'Bayou Belle', 'Orleans', and 'Beauregard', which growers may wish to consider.

Screening Germplasm for Resistance to Whitefly Transmitted Viruses Cucurbit Leaf Crumple, Tomato Yellow Leaf Curl, and Cucurbit Yellow Stunting

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Introduction

Whitefly transmitted viruses, specifically Cucurbit leaf crumple, tomato yellow leaf curl, and cucurbit yellow stunting viruses have been devastating to fall-grown vegetable crops in 2016 and 2017. The cucurbit leaf crumple virus specifically can be devastating to yellow squash, zucchini, pumpkin, watermelon, and snap beans. Tomato yellow leaf curl virus has been problematic to Georgia growers in the fall for a number of years, and although there are resistant varieties available, the high virus pressure encountered in some fields in 2016 and 2017 overcame this resistance and crops were negatively impacted. These whitefly transmitted viruses currently are the largest impediments to fall vegetable production in Georgia.

Materials and methods

Trials were conducted in spring and fall 2018 on tomatoes and squash. All crops were grown on plastic mulch (black in spring and white in fall). Soils were fumigated with Pic-Chlor 60 at the time of plastic laying. Crops were fertigated weekly through harvest. In spring and fall 2018 there were 18 entries of tomato. Approximately half of the entries had some level of resistance to tomato yellow leaf curl virus. While the spring tomato trial was harvested successfully, the fall trial was destroyed by hurricane Michael and yields could not be determined. The squash were grown in fall 2018 using standard practices for yellow and zucchini squash on plastic mulch. Squash were rated for virus and harvested every 2 days for a total of 13 harvests.

Results and discussion

Because tomatoes were damaged by Hurricane Michael, only spring data was available (Table 1). The top 8 varieties were not significantly different from each other, although several varieties with tomato yellow leaf curl virus resistance performed well. This suggests that there are virus resistant varieties that are available that can yield well even if virus is not present. Therefore growers can choose resistant varieties for fall production with confidence that yields can be maintained even if whitefly populations and virus incidence are low.

Squash did not get notable levels of cucurbit leaf crumple virus in fall 2018. Whitefly populations were lower than in 2016 and 2017 growing seasons. Therefore yields were not reflective of virus resistance, but only performance without disease. For this reason data are not presented. Nonetheless, varieties such as ‘Respect’ (zucchini) and ‘Gold Prize’ (yellow) performed well.

Conclusion

Our data suggest that tomato yellow leaf curl virus resistant tomatoes are do not necessarily have significantly lower yields than their non-resistant counterparts and therefore should be included in any fall production system in Georgia. Squash results were inconsistent with previous fall trials. In fall seasons when cucurbit leaf crumple virus levels are high, the varieties ‘Lioness’ and ‘SV6009’ and ‘SV0914’ have performed well.

Table 1. Total season-long yield for tomato varieties grown in spring 2018 in Tifton, Georgia.

Variety	Boxes/Acre[z]								Percent[y]	
	Total		X-Large		Large		Medium		Cull	
2255	2,750	a[a]	2610	a	130	gh	10	de	5.9	c
Roadster	2,680	ab	2350	abc	310	b-e	20	cde	6.5	bc
Red Bounty	2,600	abc	2280	a-d	290	b-f	30	b-e	6.1	bc
2263	2,590	abc	2520	ab	70	h	5	e	5.6	c
Camaro	2,550	a-d	2280	a-d	230	d-g	30	b-e	10.3	a
SV7631	2,470	a-d	2200	b-e	250	c-g	20	cde	7.7	abc
42	2,440	a-d	2030	c-f	380	bc	20	cde	6.1	c
Quincy	2,430	a-d	1760	fg	560	a	100	a	5.4	c
Grand Marshall	2,360	b-e	1920	d-g	370	bcd	50	bc	8.3	abc
3040	2,350	b-e	2190	b-e	150	fgh	5	e	5.7	c
Skyway	2,320	b-e	2200	b-e	110	gh	10	de	8.3	abc
Everglade	2,310	cde	2140	b-f	150	fgh	20	de	8.4	abc
Dixie Red	2,300	cde	2080	c-f	190	e-h	30	b-e	5.4	c
Resolute	2,210	de	1840	efg	330	b-e	30	b-e	7.1	abc
B3096	2,010	ef	1560	gh	390	b	60	b	6.0	c
SV4676	1,790	fg	1610	gh	160	fgh	10	de	8.7	abc
SV2310	1,560	g	1260	g	250	c-g	40	bcd	9.8	ab
	(boxes/ac)[z]								**Percent[y]**	
	Total		**1.25 in dia.**		**1.5 in dia.**		**1.75 in dia.**		**Cull**	
2117[w]	**2640**		**310**		**810**		**1540**		**1.0**	

[z]Based on a 25-lb box.

[y]Size categories according to USDA grade standards for fresh market tomatoes. Percent based on number of fruit picked in each category.

[x]Values within the same column followed the same letter(s) are not significantly different according to Fisher's protected least significant difference test ($P<0.05$)

[w]Roma type, not compared to red round types. Sizes classed based on shoulder diameter (1.25, 1.5 and 1.75 inches).

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