1999 Ohio IPM Block Grant Reports

1999 Evaluation Report and Future Recommendations Concerning the TOMCAST Network

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The purpose of this report is to review trends and evaluate the utility of the TOMCAST network to processing and fresh market tomato growers in Indiana, Michigan, and Ohio, over the past three years. With the loss of nearly 5,000 Heinz tomato acres in northwest Ohio in 1997 and other changes in the industry, revisiting the value of the network was seen as necessary.

Analysis of current TOMCAST sites cross-referenced with the 800-228-2905 DSV Hotline served as a primary indicator of network usage. These results, coupled with grower and cooperator surveys, weighed heavily in perceived adoption, success, and ultimate fate of the TOMCAST network.

Introduction

TOMCAST (tomato disease forecaster) has been a disease management model used initially by researchers and processing tomato growers in Indiana, Michigan, and Ohio since 1988. In the last 4 years the use of the network has been expanded to fresh market growers as well. Currently there are 14 Campbell Scientific dataloggers, also called stations, which compose the network (Figure 1). Two of these stations, Napoleon and Ottawa, are owned by Campbell Soup Company. We have an arrangement with Campbell's to run the stations for them if they pay for the phone charges. The function of these dataloggers is to record hourly air temperature and leaf wetness, converting them to Disease Severity Values on a 24 hour cycle. DSV represent disease development information which is passed onto growers primarily though a recorded answering machine message associated with an 800 number, called the DSV Hotline. Growers use DSV accumulation in their area to judge the rate of disease development. When the total DSV accumulation breaks a threshold, a fungicide spray is recommended.

The service component of the network described above was the focus of TOMCAST for during the initial years. In 1995, a need to investigate alternative forms of weather data collection and ultimately cheaper sources of DSV information fueled our research with SkyBit, a weather forecasting company. The research between TOMCAST and SkyBit has been very insightful, culminating in fungicide field trials treated according to the DSV accumulation of each system.

In the past, TOMCAST has kept itself viable through successfully obtaining competitive grant money from several sources such as USDA, Mid America Food Processor Association (MAFPA), Fremont Pickle and Tomato Growers Association, Ohio Small Fruit and Vegetable Research Program, and Ohio IPM mini-grants.

Currently, MAFPA and the Ohio IPM mini-grants support the service and research needs of the network. The network requires approximately $3000 to run each year solely for the phone charges incurred by the datalogger station cooperators and DSV Hotline usage. Yearly research efforts with SkyBit require an additional $1000-$3000 per season. There has been no funding available for equipment upgrades or general maintenance of the dataloggers for the past several years. The salary of the TOMCAST Coordinator has been provided by the Ohio IPM program since 1994.

Evaluation

The purpose of the evaluation was to determine the extent growers were using the TOMCAST network, and if Ohio IPM personnel would continue to operate the network. There were essentially three components that were factored into the evaluation; 1. DSV Hotline usage, 2. Cooperator network use surveys, 3. Major User's network use surveys.

All calls placed to the DSV Hotline are recorded on the long distance phone bill. Every call from 1997-99 was scanned into a spreadsheet and sorted by area code to determine how many calls were being placed from the same residence or business at various area codes throughout the network. The area codes in the tri-state area have changed dramatically in the past three years, making it tricky to track phone numbers and usage over time (Figure 2).

In general, the DSV Hotline has been averaging 900-1000 calls for the past five years (Table 1). The peak use of the network is June through August. Processing growers within the 419 area code of northwest Ohio continue to use the network the most, but recently, the fresh market growers of northeast Ohio have contributed substantially to the use. Grower use in the remaining areas is steady or declining. Based on the number of phone calls placed to the DSV Hotline and the location of each station, a yearly recommendation to keep or relocate each station was made. Six stations were on the remove / relocate list at least two of the last three years; Union City, IN, LaCrosse, IN, Racine, OH, Kokomo, IN, Tipp City, OH, and Petersburg, MI.

Any phone number that appeared 10 times or more during any season was assumed to be a "Major User" of the network (Tables 2-4). During 1997-1999, there were 51 total Major User's of the network. Fourteen of these 51 growers used the network two or more years. We attempted to contact as many of these growers as possible, using reverse lookup capabilities available on the Internet to get a street address from just a phone number. We identified addresses for 25 of the major users, and asked them to respond to our survey regarding their use of TOMCAST. We also sent a very similar survey to the datalogger station cooperators. The results of the surveys are at the end of this report.

In general the surveys revealed low levels of TOMCAST use and adoption, and higher levels of apathy toward the system than was previously thought. There was virtually no use of the content placed in DTN or web formats. There was no consensus among growers as to how the possibility of no longer having TOMCAST would affect their fungicide scheduling. The attitude toward funding TOMCAST another year received a luke warm response.

Recommendations

Based on the information collected, the following scenarios and options have been developed for the 2000 planting season. They are listed in order of severity, from least to most.

- Keep the network intact, but rearrange stations according to historical use patterns, concentrating them in NW and NE Ohio. MAFPA continues to fund program but at a *substantially* higher cost to cover both phone charges and Coordinator salary.

- Keep the network intact, do not operate or relocate the Union City, IN, LaCrosse, IN, Racine, OH, Kokomo, IN, Tipp City, OH, and Petersburg, MI stations. MAFPA continues to fund program but at a *substantially* higher cost to cover both phone charges and Coordinator salary.

- Recruit other personnel or graduate student to run network. Have them secure funding to run the network in either its current, rearranged, or truncated form.

- Decentralize network, teach willing cooperators how to run their own datalogger station.

- Dismantle TOMCAST network, notify pertinent parties.

Results of 1999 TOMCAST Use Survey Grower - Cooperators

N = 4 / 12

Please take a few moments to answer the following questions concerning your tomato operation. Thank you.

1. Approx. how many acres of **whole pack** tomatoes were grown this season?

    200 + 215 + 15 A whole pack
    18 A Paste
    2 A Fresh Market

2. What were the major varieties grown?

    401, 611, 696, 696, 401, 818, Celebrity, Mountain Pride, 696, TR12, others

3. In general, how would you rate this year's yields?

    a. Above last years (1) b. Below last years (2) c. Same as last years (1)

4. Could you estimate the avg. **whole pack** tonnage per acre harvested?

    43, 30 T/A **whole pack**
    47 T/A **Paste?**

5. In general, do you think disease pressure this year was...

    a. Greater than last years (1)
    b. Less than last years (1)
    c. About the same as last years (2)

6. How were fungicide sprays determined?

    Calendar 7,
    TOMCAST DSV & Calendar
    TOMCAST
    Calendar early / TOMCAST late

7. What, if any, **DSV threshold** do you try to use?

0, 15, 15, 15

8. In general, how would you rate your TOMCAST use this year compared to last year?

a. Used it more this year
b. Used it more last year (2)
c. About the same as last year (2)

9. How often did you obtain DSV information from TOMCAST this season?

a. Nearly daily
b. Every 3-4 days (1)
c. Weekly (1)
d. Every two weeks (1)
. DID not use (1)

10. What month is **most critical** for TOMCAST use?

Aug, July
Least critical? Sept.

11. Which of the following ways did you use to access DSV information?

a. Phone - Message machine tape recording (800-228-2905) (4)
b. Visited VegNet / TOMCAST home page using computer / internet (1)
c. Faxed / E-mailed copy of VegNet Newsletter
d. DTN or Farmdayta station broadcasts

12. If you accessed TOMCAST DSV's through DTN / Farmdayta, did you....(NO Responses)

a. Find the page layout (difficult / easy) to read
b. Find the information posted there (useful / not useful)
c. Think the page needs to be redesigned (yes / no)
d. What should be on the page________________________________

13. If you accessed information through the computer web site, did you...(NO Responses)

a. Like the completely redesigned web page (Yes / No)
b. Think it still needs work (Yes / No)
c. Find information posted timely (Yes / No)
d. Find the information there useful (Yes / No)
e. Want other information posted (Yes / No)
If yes, then what? ________________

14. How did you record DSV totals when you called the Hotline?

a. On lined paper (2)
b. Used data sheet in OH Veg. Prod. Guide
c. On computer
d. Made a mental note
e. Other method ________________________________

15. Do you know of other producers in the area who are using TOMCAST to time fungicide sprays?

(Yes - 1) (No - 1)

16. Do you know if they are satisfied with the results?

(Don't Know - 2)

17. If the TOMCAST system were NOT functioning next year, how would this impact your tomato operation...

a. Would not affect the way fungicides are currently applied (2)
b. Make a small difference when it came time to apply a fungicide
c. Make a large difference when it came time to apply a fungicide (1)
d. Other ____

18. Do you think TOMCAST is worth supporting over other research projects like breeding, ethral application timing, plant populations, varieties, etc.?

(Yes - 1) (No - 1)

19. If TOMCAST is funded in 2000, would you like to keep your host site status?

a. I would like the CR10 removed from my farm (1)
b. I would like to keep the CR10 on my farm (2)

20. There is a chance funding for the DSV Hotline (800-228-2905) may be eliminated. Would this make access to TOMCAST DSV's .... (Circle all that apply)

a. Very difficult
b. Inconvenient (1)
c. Unaffected (2)
d. Keep the 800 line

21. Any suggestions on how to improve service to you?

(No Suggestions)

Results of 1999 TOMCAST Use Survey Grower - Major User's

N = 9 / 25

Please take a few moments to answer the following questions concerning your tomato operation. Thank you.

Approx. how many acres of **whole pack** tomatoes were grown this season?

100 + 87+ 125 + 400 + 100 + 94 Acres **whole pack**
61Acres **Paste**
1.5Acres **Fresh market**

2. What were the major varieties grown? (up to 3)

Mountain spring, Mountain fresh, Aztec, 696, 401, 611, 8245, 696, 9704, 7983, TR12, 696, TR12 H9422, 696, 696, TR12, H9423, 7983, 8245, 696

3. In general, how would you rate this year's yields?

a. Above last years (2)
b. Below last years (4)
c. Same as last years (1)

Could you estimate the avg. **whole pack** tonnage per acre harvested?

25, 22, 38, 20, 27, 18, 4 T/A **whole pack**
38 T/A **Paste**
4 T/A **fresh market**

5. In general, do you think disease pressure this year was...

a. Greater than last years (3)
b. Less than last years (2)
c. About the same as last years (2)

6. How were fungicide sprays determined? (circle all that apply)

a. Used TOMCAST DSV(4)
b. Calendar (7, 10, 14 days)(4)
c. Skybit generated DSV
d. Other means_______________________________

7. What, if any, **DSV threshold** do you try to use?

0, 0, 18, 15, 15, 15, 16

8. In general, how would you rate your TOMCAST use this year compared to last year?

a. Used it more this year (1)
b. Used it more last year (1)
c. About the same as last year (4)

9. How often did you obtain DSV information from TOMCAST this season?

a. Nearly daily
b. Every 3-4 days (3)
c. Weekly (3)
d. Every two weeks
e. Never (1)

10. What month is **most critical** for TOMCAST use?

July (3), Aug (2)

Least critical?

Sept. (2), June (2)

11. Which of the following ways did you use to access DSV information?

a. Phone - Message machine tape recording (800-228-2905) (9)
b. Visited VegNet / TOMCAST home page using computer / Internet
c. Faxed/E-mailed copy of VegNet Newsletter
d. DTN or Farm,dayhta station broadcasts

12. If you accessed TOMCAST DSV's through DTN/Farmdayta, did you...(No Responses)

a. Find the page layout (difficult / easy) to read
b. Find the information posted there (useful / not useful)
c. Think the page needs to be redesigned (yes / no)
d. What else should be on the page______________________________

13. If you accessed information through the Internet web site, did you... (NO Responses)

a. Like the completely redesigned web page (Yes / No)
b. Think it still needs work (Yes / No)
c. Find information posted timely (Yes / No)
d. Find the information there useful (Yes / No)
e. Want other information posted (Yes / No)
If yes, then what? _______________

14. How did you record DSV totals when you called the Hotline?

a. On lined paper (3)
b. Used data sheet in OH Veg. Prod. Guide
c. On computer
d. Made a mental note
e. Other method ___Calendar (2)_____

15. Do you know of other producers in the area who are using TOMCAST to time fungicide sprays?

(Yes - 2) (No- 4)

16. Do you know if they are satisfied with the results?

(Yes-1) (No -1) (Don't know -3)

17. If the TOMCAST system were **NOT** functioning next year, how would this impact your tomato operation...

a. Would not affect the way fungicides are currently applied (1)
b. Make a small difference when it came time to apply a fungicide (1)
c. Make a large difference when it came time to apply a fungicide (4)
d. Other ____

18. Do you think TOMCAST is worth supporting over other research projects like breeding, ethral

application timing, plant populations, varieties, etc.?

(Yes -3)) (No-1) (No Opinion-2)

19. There is a chance funding for the DSV Hotline (800-228-2905) may be eliminated. Would this make access to TOMCAST DSV?s .... (Circle all that apply)

a. Very difficult
b. Inconvenient (1)
c. Unaffected (2)
d. Keep the 800 line(3)

20. Which station (s) did you use to obtain approximate DSV accumulation in your fields?

Union, Hobbs, Tipp, Pandora, Pandora, Claridon, Petersburg

21. For what crop do you use TOMCAST to help time fungicide applications?

A. tomatoes (4)
B. vegetables
C. both (1)
D. other ______________________

22. In your opinion, are bacterial diseases such as spot and speck (which are not predicted by TOMCAST) becoming more prevalent than the fungal diseases, such as early blight, anthracnose, and septoria?

(Yes 1) (No 3) (No Opinion 1)

23. Any suggestions on how to improve service to you? (No responses)

Comparison of TOMCAST and SkyBit Fungicide Spray Schedules on Fruit Quality in Fresh Market Tomatoes

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Abstract:

A fresh market tomato hybrid, Mountain Spring, was established in research plots at Hillsboro, Ohio as part of a fungicide trial. Each plot was sprayed based on weather related Disease Severity Value (DSV) accumulation, a measure of fungal pathogen development. Two different methods of generating DSV were tested; land based CR10 dataloggers and remote sense SkyBit weather forecasts. Spray thresholds of 13 and 18 DSV were used for both systems, plus a 7-10 day calendar program and an untreated check plot. Harvest yield and quality data for each treatment were compared in a two way ANOVA.

Objective:

1. To compare fruit quality and quantity differences in plots treated under SkyBit and CR10 generated DSV, along with calendar and unsprayed treatments.

Introduction:

Fresh market tomato growers face the challenge of controlling disease every year. Instead of applying fungicides on a scheduled or calendar basis, many are trying a different approach which focuses on timing the spray with the development of the disease. This biological approach to disease management is TOMCAST, TOMato disease foreCAST; a computer model which is driven by leaf wetness and temperature. These weather conditions are recorded by nearby dataloggers, which convert them to Disease Severity Values (DSV), a measure of how quickly fungal diseases are developing. When the DSV exceed a threshold, a fungicide spray is recommended. This system works well for growers within a certain distance from the units, but because of weather variation, can't be used reliably over 10-15 miles from the unit. To get this type of disease management information to those distant growers would require the purchase of another datalogger costing ca. $2500. The recent availability of site (farm) specific forecasted weather generated by satellite and NWS data, negates the need to purchase a datalogger in favor of a monthly subscription fee. No equipment other than a fax machine or e-mail account is needed to receive this information. We are evaluating fruit quality produced by fungicide spray schedules guided by forecasted disease pressure vs. locally observed disease conditions recorded by a datalogger.

A randomized complete block design fungicide trial was established at the Enterprise Center in Hillsboro, OH. A commonly used fresh market cultivar, Mountain Spring, was transplanted into single bed plots 5 feet wide by 20 feet long on June 5, 1999. The following treatments determined the timing of the fungicide application; SkyBit 13 DSV, SkyBit 18 DSV, CR10 13 DSV, CR10 18 DSV, Calendar and nonsprayed. There were four replications of each treatment.

The plots were harvested on September 14. All fruit from five feet of each plot was harvested and sorted according to grade and quality (Tables 1A & B). The categories were analyzed in a 2-way ANOVA and the means separated using a LSD test at 5% (AgStats2 software).

Table 1A. Fruit quality and yield of Hillsboro fresh market, SkyBit v. CR10 study, Mountain Spring cultivar, harvested September 14, 1999. The number of times each treatment was sprayed is listed in parentheses after the treatment label. UTC - Untreated Check

Treatments	Red Fruit avg. lbs./trt.	Red Fruit avg. # /trt.	Red Fruit wt. /fruit/plot	Salad Fruit avg. lbs./trt.	Salad Fruit avg. # /trt.	Salad Fruit wt. /fruit/plot
UTC (0)	9.09 a	21.25 a	0.40 a	3.50 a	18.25 a	0.19 a
Calendar (12)	14.73 a	32.50 a	0.41 a	4.39 a	20.25 a	0.21 a
SkyBit 13 DSV (6)	14.94 a	40.25 a	0.37 a	2.80 a	18.00 a	0.19 a
SkyBit 18 DSV (5)	8.32 a	21.75 a	0.37 a	3.80 a	19.00 a	0.19 a
CR10 13 DSV (5)	12.88 a	30.75 a	0.41 a	5.03 a	25.00 a	0.20 a
CR10 18 DSV (4)	8.1 a	19.50 a	0.32 a	4.14 a	25.25 a	0.17 a

Table 1B. Fungicide trial results on cull and diseased tomato fruit.

Treatments	Cull Fruit avg. lbs./trt.	Cull Fruit avg. #/trt.	Cull Fruit wt. /fruit/plot	Avg. Anthracnose /trt.	Avg.Total Disease/trt.
UTC (0)	2.63 a	13.75 a	0.19 a	4.26 a	5.05 a
Calendar (12)	3.89 a	15.00 a	0.28 a	4.65 a	5.28 a
SkyBit 13 DSV (6)	3.18 a	15.50 a	0.21 a	3.34 a	3.76 a
SkyBit 18 DSV (5)	3.21 a	12.50 a	0.23 a	4.17 a	5.31 a
CR10 13 DSV (5)	4.21 a	18.00 a	0.26 a	3.89 a	4.69 a
CR10 18 DSV (4)	2.75 a	21.75 a	0.15 a	2.22 a	3.29 a

Different letters in same category column represent significant difference between treatments. Fungicides applied when either SkyBit or CR10 systems accumulated DSV in excess of thresholds.

There were no significant differences among any of the treatments. It was a very dry year, with particularly droughty conditions in the area where the plots were. Fungal diseases prefer moist, warm conditions to develop, and with the lack of moisture, the tomatoes incurred very little fungal infection. Separating fungicide treatment effects under these conditions is difficult.

There are some interesting trends though. In general there did appear to be increased production of red fruit in those plots that were sprayed earlier and more often than the others. The SkyBit treatments tended to produce higher weights and more red fruit than the CR10 plots, but the CR10 treatments yielded more salad tomatoes. Both sets of treatments were relatively equal in the number of cull, Anthracnose, and total disease fruit. Even though the Calendar treatment was sprayed 2-3 times more often than the other plots, it did not produce the most red fruit, salad fruit, or cull fruit. The Calendar plots did have the most Anthracnose of any treatment, but not the most total disease.

If the results of the 5' x 5' plot harvests are scaled up to acre sized fields and the yields converted to 25 pound box equivalents, growers can be shown results that are more familiar and useful to them (Table 2).

Table 2. Select categories of average weight per plot converted to 25 pound boxes per acre.

Treatments	Red Fruit @ 25 lbs. /box/Acre	Salad Fruit @ 25 lbs. /box/Acre	Cull Fruit @ 25 lbs. /box/Acre	Anthracnose Fruit @ 25 lbs. /box/Acre
UTC (0)	634	244	183	297
Calendar (12)	1027	306	271	324
SkyBit 13 DSV (6)	1041	195	222	233
SkyBit 18 DSV (5)	580	265	224	291
CR10 13 DSV (5)	898	351	293	271
CR10 18 DSV (4)	565	289	192	155

Extension Implementation:

Based on the yields and quality of fruit produced by the SkyBit treatments, growers should be encouraged by the prospect of being able to utilize this new disease forecasting technology at moderate expense and risk. There should be some caution in openly recommending that growers use SkyBit over the majority of crop acres without first considering the potential for mishap. This is only the first year we have compared both CR10 and SkyBit in fresh market fungicide trials, and it was generally a season unfavorable to disease development. In a wetter year, the results may have been very different.

We plan to continue this type of research next year to see how the results compare in a more normal precipitation year.

This research will be published in the Ohio IPM Mini-grants reviews and also made available on the world wide web under the TOMCAST home page. The results will be presented informally at the Ohio Fruit and Vegetable Congress in Cincinnati, Ohio in February, 2000.

For further information contact Jim Jasinski Ohio State University Extension, Southwest District or the Ohio IPM Office.

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Development of Annual Medics as living mulches for Commercial Pumpkin Production.

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Introduction:

Cover crops are used in high-input agronomic and vegetable production systems to reduce soil erosion, fungicide use, plant disease, and weeds. Cover crops have also been shown to increase soil organic matter, nitrogen availability, and moisture. Traditional cover crops, such as hairy vetch (*Vicia villosa*) and winter rye (*Secale cereale*), widely used in tomato production have been used in pumpkin production with limited success. Traditional fall-sown cover crops, such as hairy vetch and winter rye, are typically killed by herbicide applications, mowing, and mechanical undercutting prior to spring planting. Pumpkin growers in Ohio have asked for alternative cover crops that could be spring or fall-sown and require less input than the traditional cover crops. Annual medics (*Medicago* spp.), native to Australia, have been studied as forage crops in the upper Midwest. Annual medics with their less invasive, dense, low growth habits and drought tolerance make them potential candidates as spring-sown living cover crops or fall-sown winter-killed cover crops in pumpkin production.

Objectives:

1. Selection of annual medics as living mulches with horticultural qualities suitable for use as cover crops for commercial pumpkin production.

Materials and Methods:

Plots in a randomized complete block design with 14 treatments (4 reps) were set up at two research farms in Columbus and Piketon, OH. The treatments included: no cover (control), rye, rye + hairy vetch, oat, oat + vetch, vetch, snail medic, burr medic, barrel medic, medic mix, 2 non-dormant alfalfas (Pioneer 5929 and WL711), medic + oat, and medic + vetch. Late May and early September seeding of 10' x 20' plots were done with a walk behind drill seeder and a hand-held broadcast seeder, respectively. Broadcasted seed was lightly incorporated with a rake. Since very little information is available spring seeded treatments included a high and low seeding rate for each. Spring high and low seeding rates were as follows: control, oat (90 and 60 lbs/A), oat + hairy vetch (50 lbs each/A and 25 lbs each/A), rye (90 lbs/A and 60 lbs/A), rye + hairy vetch (50 lbs each/A and 25 lbs each/A), hairy vetch (50 lbs/A and 30 lbs/A), snail medic (30 lbs/a and 20 lbs/A), burr medic (20 lbs/A and 12 lbs/A), non-dormant perennial alfalfa (WL711) (30 lbs/A and 20 lbs/A), non-dormant perennial alfalfa (Pioneer 5929) (30 lbs/A and 20 Lbs/A), medic mix (20 lbs each/A and 15 lbs each/A), medic + oat (25 lbs/A and 70 lbs/A), medic + oat (12.5 lbs/A and 40 lbs/A), medic + rye (25 lbs/A and 70 lbs/A), and medic + rye (12.5 lbs/A and 40 lbs/A). Cover crop height was measured at 3 and 6 weeks after spring planting to determine growth rates (table 1.1).

Results and Discussion:

Due to a very hot and dry summer cover crop growth was slow and weed pressure very high. A mid-July application of 2,4-DB @ 3 pts/A reduced weed populations as well as killed the rye, rye + vetch treatments. Due to the weed populations and lack of cover crop growth all spring-seeded treatments were mowed down. Interestingly, the *Medicago* spp. were unaffected by the herbicide application. This suggests that annual medics could be used in conjunction with an early 2,4-DB application (probably 2-3 weeks after cover crop seeding) and still act as a living cover crop if weed pressure is potentionally high. Weed control could then be obtained without having an effect on June pumpkin plantings. Observational data indicates medics may exhibit better growth potential under cooler temperatures. All low seeding rates for fall of 1999 were dropped because observational data suggested rates were much to low to produce adequate biomass and compete with weed pressure. Seeding rates were increased in some fall treatments for the same reasons (table 1.2). Fall-seeded cover crop treatments established much quicker and more uniformly than spring-seeded treatments. This was most likely due to reduced weed competition and cooler temperatures. Data from our preliminary study suggests that spring and fall-sown cover crops may be successfully incorporated in commercial pumpkin production. Fall cover crop treatments look very promising and new spring-sown cover crop plots will be established this coming April. Cover crop biomass will be collected from fall (1999) and spring-seeded (2000) cover crop treatments this summer at pumpkin planting and this fall at harvest. This data will give us a better understanding which of the fall and spring-sown cover crops are able to produce an adequate amount of biomass to last the entire pumpkin production season. The pumpkin cv. 'Magic Lantern' , a compact, bush-type variety will be seeded in cover crop treatments this summer and should give us a better understanding on how cover crops will affect soil water / plant relations, fruit quality, and fruit disease development.

Table 1.1 Seeding rates and cover crop heights at 3 and 6 weeks after planting (WAP) of spring-sown cover crops in 1999 at Waterman Horticultural and Natural Resources Laboratory, Columbus, OH.

		Height	Height
		(cm)	(cm)
Scientific Names	Seeding Rate (lbs/A)	3 WAP	6 WAP
Control	none		
Avena sativa	90	2.8	7.2
Avena sativa / *Vicia villosa*	50 & 50	2.4 / 1.6	7.2 / 2.8
Secale cereale 'Amor' / *Vicia villosa*	50 & 50	2.2 / 1.5	2.8 / 2.0
Vicia villosa	50	1.8	2.4
Medicago scutellata - Snail Medic	30	1.2	3.2
Medicago polymorpha - Burr Medic	20	0.8	2.4

Medicago truncalata - Barrel Medic	20	0.84	1.6
Medicago sativa Pioneer 5929	30	1.5	2.6
Medicago sativa 'WL711'	30	1.5	2.8
M. scutellata, polymorpha, truncalata	20	~1.0	~2.0
M. scutellata / Avena sativa	25 & 70	1.1 / 2.6	2.8 / 8.0
Secale cereale 'Amor'	90	2.3	3.6
M. scutellata / Secale cereale	25 & 70	1.1 / 2.5	2.4 / 3.2

Table 1.2 Cover crop seeding rates for fall of 1999 at Waterman Horticulture and Natural Resources Laboratory, Columbus, OH.

Treatment	Scientific Names	lb/A
UTC		none
Oat	*Avena sativa*	90
Oat/Vetch	*Avena sativa / Vicia villosa*	50 & 50
Rye/Vetch	*Secale cereale* 'Amor' / *Vicia villosa*	50 & 50
Vetch	*Vicia villosa*	50
Medic- Snail	*Medicago scutellata*	50
Medic -Burr	*Medicago polymorpha*	40
Medic - barrel	*Medicago truncalata*	40
ND Alfalfa	*Medicago sativa* Pioneer 5929	40
ND Alfalfa	*Medicago sativa* 'WL711'	40
3 Medics	*M. scutellata, polymorpha, truncalata*	20 ea.
Medic/Oat	*M. scutellata / Avena sativa*	40 & 70
Rye	*Secale cereale* 'Amor'	90
Medic/Rye	*M. scutellata / Secale cereale*	40 & 70

For further information contact Richard M. Riedel , Professor, Dept. of Horticulture & Crop Science, The Ohio State University or the Ohio IPM Office.

Evaluating Effects of Insect and Disease Damage on TopCross High Oil Corn Production

Principal Investigator:

Peter Thomison, Horticulture and Crop Science
Pat Lipps, Plant Pathology

ABSTRACT:

High oil corn acreage in the U.S. has increased from less than 50,000 acres in 1992 to over one million acres in 1999. High oil corn is attractive as a livestock feed because it has greater energy value than normal yellow dent corn and can replace more expensive dietary sources of fats and proteins. The **TopCross®** grain production system is rapidly gaining popularity as the preferred method of producing high oil corn and involves planting a blend (a **TC-Blend®**) of two different types of seed corn mixed together in the same bag. TopCross corn production may be more vulnerable to certain pest problems, including those that result in defoliation and silk clipping, than normal corn. Widely publicized yield losses in TopCross corn fields near West Liberty, Ohio in 1997, associated with insect injury and unfavorable growing conditions, have slowed adoption of this new seed technology. The objectives of this research include the following: 1) to evaluate defoliation effects on the nutrient composition of **TopCross** and normal corn grain and 2) to compare the effects of varying levels of defoliation at different stages of corn development on the agronomic performance of pollinator and male sterile grain parent plants, as well as their normal (and fertile) grain parent checks. Results of this project will serve as a basis for predicting grain quality and yield losses associated with leaf destruction of TopCross corn by insect feeding, and/or foliar diseases.

Three field experiments were performed to determine the impact of defoliation injury on TopCross high oil corn production. In Experiment 1 effects of early season plant injury on TopCross grain production were determined. In Experiment 2 effects of defoliation during grain fill were evaluated. In Experiment 3 effects of foliar fungicides were determined. The three experiments were established at the OSU Farm Science Review near London, the OSU Waterman Research Farm in Columbus, and the OSU-ATI farm in Wooster.

Experiment 1: A high oil TC Blend (Pfister SuperKernoil 2652-19) and its normal grain parent check (Pfister 2652) were evaluated. Early season plant injury was created using different levels of defoliation. Defoliation treatments were as follow: no defoliation, 100% leaf removal at V4 (or the 4-collar leaf stage), and 50 and 100% leaf blade removal at the V13 stage of development. The distal half of all leaves at the collar was removed to accomplish the 50% defoliation treatment. The 100% defoliation treatment entailed cutting at the collar all fully developed leaves on the plant.

Experiment 2: This experiment used the same high oil TC Blend and normal grain parent evaluated in

Experiment 1. Defoliation treatments were as follows: no defoliation, and 50 and 100% leaf blade removal at the tassel emergence (VT), milk (R3), and full dent (R5) stage of development. The leaf removal protocol was the same as that described for Experiment 1.

Experiment 3 : Sixteen foliar fungicide treatments, including varying rates and application dates of Tilt and Quadris fungicides, were evaluated using the high oil TC Blend Dekalb DK 595TC.

In Experiments 1 and 2, treatments were replicated three times in a randomized complete block field design with treatments in a split plot layout. The TC Blend and grain parent check were assigned to main plots and the defoliation treatments to subplots, four rows 30 inches apart and 17.5 feet in length. Plots were planted at seeding rates of 30,800 seeds/A.

Final plant stand, numbers of plants stalk lodged (stalk breakage below the ear), and barren or with nubbin ears were recorded at maturity prior to harvest. At harvest, the center two rows of each plot were hand harvested to determine grain yield, ear moisture, and kernel weight. Ears of the TC Blend pollinator plants (SK2652 pollinator 19) and TC Blend male sterile grain parent plants were separated to distinguish effects of defoliation on these different plant types in Experiments 1 and 2. Sampled ears from the three experiments were shelled and a sub sample of grain from each plot was analyzed for grain quality composition.

To minimize possible pollen contamination from the neighboring male fertile grain parent check as well as any nearby normal corn, the TC Blend plots in experiments 1 and 2 were planted in isolation at least 100 feet from normal corn hybrids. This 100-foot buffer was planted with male sterile seed to minimize foreign pollen contamination. Plots were also planted with this TC Blend seed as border (20-50 feet) on all sides of the isolation field.

In Experiment 1, defoliation did not change the timing of pollen shed by the pollinator relative to silk emergence by the male sterile grain parents. Complete defoliation at V4 delayed pollen shed and silk emergence by 7 to 10 days. Defoliation at V13 had little effect of the timing of silk emegence and pollen shed compared to nondefoliated check. Defoliation resulted in more nubbin ears and greater stalk lodging in the TC Blend pollinator than in the TC Blend grain parent. Grain yields of the non defoliated grain parent check were not significantly different from the TC Blend. The TC Blend and Its normal counterpart exhibited similar yield response to complete defoliation at V4 and 100% and 50% defoliation at V13. Grain oil content and metabolizable energy were significantly higher in grain from the TC Blend than the grain parent check but grain nutrient composition was not affected by defoliation.

In Experiment 2, agronomic performance of the grain parent check and TC Blend were similarly affected by defoliation treatments. Yields of the nondefoliated grain parent check and TC Blend did not differ significantly. Defoliation (50 and 100 %) reduced yields in all treatments but 100% defoliation treatment at VT resulted in the greatest yield reduction whereas 50% defoliation at R5 resulted in no significant least yield loss. Effects of 50% defoliation on yield at VT and R3 were comparable. Yield losses from defoliation were greatest at anthesis and during early kernel development. Defoliated pollinators were characterized by a much higher percentage of barrenness and nubbin ears than the male sterile grain parents. For those pollinator plants that did produce normal ears, grain/plant, and ear weight appeared less affected by defoliation than the grain parent plants. Grain yield of pollinator plants was reduced by 50% and 100% defoliation at VT and 100% defoliation at R3, whereas all the defoliation treatments reduced yields of TC Blend grain parent plants. However kernel size of pollinators was reduced by all defoliation treatments except the 50% defoliation at VT, a response similar to the grain parent.

The oil content of grain from the male sterileTC Blend grain parent averaged 3.1 percentage points more than that of the fertile grain parent. Grain oil content was generally reduced by defoliation treatments, whereas protein content was increased. The reduction in oil content was more severe with greater defoliation at the earlier kernel development stage The oil content of the grain parent check was reduced by three of the defoliation treatments (50% and 100% defoliation at R3 and 100% defoliation at R5) with oil levels lowered by 10 -25%. The grain oil content of the TC Blend grain parent was reduced by all defoliation treatments except the 50% defoliation at VT. Decreases in oil content ranged from 5 % for 50% defoliation at R5 to 30% for complete defoliation at R3. Complete defoliation of the TC Blend grain parent at R3 and R5 reduced oil levels by 30% and 20% respectively; whereas 50% defoliation reduced grain oil levels at VT, R3, and R5 by 6%, 10%, and 5%, respectively.

In Experiment 3, there were small but significant increases in grain yield associated with certain fungicide treatments that were related to reduced disease injury. However. effects of the foliar fungicides on grain oil, protein, starch, and lysine were not significant.

Since premiums for contract production of high oil corn are based on grain oil content, the lower grain oil levels associated with late season defoliation would result in reduced premiums. Moreover, with grain yield reduced by defoliation, oil yield/A would be reduced. Additional study is needed to assess the efficacy of fungicides on kernel composition when disease pressure is more severe.

EXTENSION PROGRAM IMPLEMENTATION:

Results from these experiments will be summarized in an Ohio State University Extension Fact sheet as well as in the OSU C.O.R.N. (Crop Observation and Recommendation Network) Newsletter. Results will also be presented at grower and ag industry meetings, including field days and plot tours. Data collected will be used in developing guidelines for assessing yield and grain quality losses associated with leaf blade destruction by insect feeding and foliar diseases in TopCross corn fields.

For further information contact Peter R. Thomison , Associate Professor, Dept. of Horticulture & Crop Science, The Ohio State University or the Ohio IPM Office.

Evaluation and Demonstration of Site Specific Data Logging to Aid in Disease Control in Commercial Fruit and Vegetable Production

Principal Investigator:

Ron Becker, OSU Extension, Wayne Co.

Abstract:

Commercial production of fresh market horticultural crops has increased significantly in the Wayne and Holmes County areas during the last 10 years. Disease control in these crops has depended on the use of fungicide applications on a scheduled basis in combination with cultural controls. These scheduled applications have been season long for some crops (ex.-scab control in apples), or waiting until the first indications of disease infestation before starting chemical control efforts in others (ex.-early blight in tomato). Growers have recently expressed an interest in using monitoring equipment to determine infection periods for these diseases, allowing them to apply fungicides more on an "as needed/preventative" basis rather than on a schedule, as well as being able to control the infestation before it becomes evident. While monitoring stations are already in place for tom-cast in other areas of the state, the concern is whether or not the infection periods in those areas correspond to the many micro-climates in our area as well. The fact that the cost of monitoring equipment is now considerably less than in the past is also allowing growers to consider the use of monitors on their own farms, rather than relying on the results of monitors that are centrally located.

The objectives of this project were to 1) determine the variance in weather conditions and resulting occurrence of disease infestations on a site to site basis within a given area ; and 2) to determine the accuracy of the monitoring units.

Data loggers used were the leaf wetness/temperature logger from Spectrum Technologies and the watchdog data logger. Sites selected were based on crop, geographical location and topography. Sites included and their distance from the central site at the OARDC [ ] were: 1) an apple orchard in a low lying area in southern Wayne Co.[5 mi.], 2) a tomato field in an elevated area in southern Wayne Co.[8 mi.], 3) a tomato field in a low lying area in Summit Co.[28 mi], 4) an apple orchard in an elevated area in northern Wayne Co.[16 mi.], and 5) in a vineyard planting on flat terrain at the OARDC Snyder farm in central Wayne Co. While all sites were monitored for leaf wetness and temperature, these last two sites were also monitored for relative humidity and rainfall as well. Data was pulled 1-2 times per week, depending on weather conditions. The computer used for pulling the data was an IBM 755C Thinkpad.

Software and hardware problems during the first part of the summer did not allow for a full season of data collection as intended. Software problems ranged from the program using the wrong date when compiling data, to incompatibility with the IBM Thinkpad. The main hardware problem was rapid depletion of the

battery (2-3 days) due to a short in one of the units. Software problems were solved by mid-July.

The unit in the vineyard at the OARDC had a Campbell CR21 monitoring unit within several feet of it, already placed there by Plant Pathology. In comparing the data between the two units from August 16th through October, the daily lows and averages were within one-half degree C of each other. The daily highs were normally within 1 degree C of each other, but varied as much as 3 degrees C on several occasions. Rainfall amounts were also very similar overall, but did vary up to 10 mm on one occasion. The leaf wetness hours varied considerably - as many as 15 hours per day on some days. Though the effort was made to put the Watchdog leaf wetness sensor in a similar canopy as that of the CR21, it is felt that placement caused the difference rather than fault of the unit.

In comparing apple scab infection periods between the two orchards, the Mills scale, having values from 0 (no infection) to 3 (heavy infection), was used. From July 8th through October 10th, 24 infection periods of 1 or greater were recorded in the southern orchard. In the same period of time, only 17 periods were recorded in the northern orchard. Using an infection period of 2 or greater as a threshold and an assumed 7 day period of protection after application, the southern orchard would have required 7 fungicide applications during this period to protect the crop from infection. The northern orchard would have required only 5 fungicide applications. Scab pressure was very low for the season, making evaluation of the crop for disease infestation impractical.

In apples, the data recorder was also used for determining the proper spray date for codling moth control. Biofix dates were determined by trapping and scouting the orchards for the first sustained flight. Degree day (DD) reports were then tracked to determine the proper spray date. For codling moth, this is 250 DD (base 50) after the biofix. The southern orchard had heavy flights of codling moth throughout the summer, and therefore subsequent sprays were applied 200 DD after moths were again found in the traps. By using this method, fruit damage was kept to a minimum. Unsprayed trees in the area sustained heavy fruit damage. The northern orchard had very low infestations of codling moth, and required only one pesticide application for control.

In comparing the tomato fields for early blight, Tom-cast, with a cumulative DSV value of 16 as the threshold, was used. From July 14th through September 2nd the Wayne County location accumulated 62 DSV's and required 4 fungicide applications. During the same period, the Summit County location accumulated 50 DSV's and required 3 fungicide applications. Early blight infestations were light in both plots, with harvest continuing 2-3 weeks longer than normal. However, due to the dry weather, disease pressure was also light even in unsprayed plots.

The data from the tomato plots was also compared to a Campbell CR10 unit based in Fremont. For the period from July 14th through August 22, DSV's accumlated were 65 in Fremont, 43 in Summit Co. and 61 in Wayne County.

Extension Program Implementation:

Results of this project were used in a display for the Wayne County Farm and Foliage tour, proving of interest to growers and non-growers alike. A summary of the findings will also be shared at fruit and vegetable grower meetings and pesticide updates in Wayne and Holmes Counties this winter. The growers involved with this project continue to be very interested in it's use and it's ability to provide them with timely disease and insect development information. Their hopes are to use this information to reduce pesticide application while retaining good fruit quality. Because of the limited amount of data that was able to collected this year as well as the drier than normal conditions, it is felt that any determination as to the need for monitoring of each farms micro-climate for disease development is unable to be made at this point.

Therefore, this project is to be continued into year 2000. With software problems now solved, a full season of data, starting April 1st, is expected to be collected.

For further information contact Ron Becker , Program Assistant, Ohio State University Extension, Wayne County or the Ohio IPM Office.

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1999 Evaluation of Bt-Corn and Non-Bt Isolines in Ohio

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During the past three years, trials including multiple hybrids of Bt-corn and comparable isolines have been conducted at the Western and Northwestern Branch Stations to evaluate yield benefits that may be attributed to the use of corn that has been genetically modified to prevent losses due to annual infestations of European corn borer (ECB). Results of trials conducted during the 1999 growing season are presented in Table 1.

Table 1 - Comparison of Bt-Corn Hybrids and Non-Bt Isolines at the Western and Northwestern Branch Stations, 1999.

Treatment	Properties	Stand per	ECB Obs. / Plant		Yield
		100 Row Ft	Cavities	Larvae	Bu./ Ac.
Western Branch Station, Clark County					
Asgrow 730	Non-Bt Isoline	98.50 b	0.20	0.20	145.9
Asgrow 730 Bt	Yieldgard	93.75 b	0.00	0.00	137.6
DeKalb 647	Non-Bt Isoline	105.75 ab	0.70	0.55	156.2
DeKalb 647 Bt	Yieldgard	98.25 b	0.00	0.00	137.6
Garst 8481	Non-Bt Isoline	93.75 b	0.75	0.55	133.4
Garst 8481 Bt	Starlink	116.75 a	0.00	0.00	144.8
Northwestern Branch Station, Wood County					
Asgrow RX601	Non-Bt Isoline	130.9 a	1.10	0.75	166.0
Asgrow RX601YG	Yieldgard	131.3 a	0.00	0.00	163.7
DeKalb 595	Non-Bt Isoline	128.4 ab	0.90	0.60	171.7
DeKalb 595 Bty	Yieldgard	124.1 b	0.00	0.06	161.3
Garst 8481	Non-Bt Isoline	128.8 a	1.25	0.95	168.7
Garst 8481 Bt	Starlink	128.3 ab	0.00	0.00	163.6
Means in a column followed by the same letter are not significantly different @ P = 0.05.					

- Bt-corn hybrid suppressed ECB injury to minimal levels. However, ECB infestations observed in non-Bt corn isolines at both the Western and Northwestern Branch Station trials were marginal in regard to causing economic losses.
- At the Western Branch, stand loss due to cutworm infestation was prevented by the Garst 8481 Bt hybrid, which includes the Starlink trait. This is the first case of significant prevention of a natural infestation of black cutworm injury documented in a Ohio replicated field trial (and possibly within the mid-west region).
- Differences in yield observed between Bt-corn hybrids and non-Bt corn isolines evaluated were not significant.

A summary of results observed in three years of field evaluations of Bt-corn hybrids and equivalent non-Bt isolines conducted at both the Western and Northwestern Branch stations is presented in Table 2.

Table 2 - Evaluation of Stand, Corn Borer Infestation and Yield of Bt-Corn Hybrids and Non-Bt Isolines At Two OARDC Research Stations from 1997 to 1999.

Year of	No. Hybrids	Stand per	ECB Obs. per Plant		Yield
Trial	Evaluated	100 Row Ft.	Cavities	Larvae	Bu. per Ac.
Western Branch Station, Clark County					
1997	4 Bt-Corn	137.7	0.15	0.01	156.5
	4 Isolines	135.6	0.91	0.26	152.2
1998	3 Bt-Corn	136.1	0.02	0.00	131.5
	3 Isolines	130.0	0.15	0.11	130.2
1999	3 Bt-Corn	102.9	0.00	0.00	140.0
	3 Isolines	99.3	0.55	0.43	145.2
3 Yr. Avg.	Bt-Corn	125.6	0.06	0.00	142.7
	Isolines	121.6	0.54	0.27	144.5
Northwestern Branch Station, Wood County					
1997	4 Bt-Corn	116.4	0.20	0.08	176.1
	4 Isolines	114.7	1.66	0.45	175.5
1998	3 Bt-Corn	123.5	0.00	0.00	174.9
	3 Isolines	114.5	0.07	0.12	163.8
1999	3 Bt-Corn	127.9	0.00	0.02	162.9
	3 Isolines	129.4	1.08	0.77	168.8

3 Yr. Avg.	Bt-Corn	122.6	0.07	0.03	171.3
	Isolines	119.5	0.94	0.45	169.4

- The bottom line of the results presented in the preceding table is that the corn yields of Bt-Corn hybrids and their non-Bt isolines evaluated at two locations in Ohio over a three year time period are equal.
- Exceptions may exist, but the results demonstrate that corn borer impact over time on Ohio corn is not significant and that the benefit derived from an investment in Bt-Corn may not be warranted under Ohio growing conditions.

Acknowledgements:

Extension personnel responsible for providing significant assistance on projects reported include: B. Eisley, Research Associate, Dept. of Entomology; J. Jasinski, IPM Extension Associate, Southwest District; C. Young, Extension Associate, Northwest District; and A. Ba, Research Associate, Dept. of Entomology.

Ohio Integrated Pest Management

THE OHIO STATE UNIVERSITY EXTENSION

Refining Disease Prediction Systems for North Central Ohio Apple Orchards

Principal Investigator:

Ted W. Gastier, Huron County Agricultural Agent

ABSTRACT:

Twenty-four apple growers in ten Ohio counties, including five of the top ten apple producing counties, plus eight Extension Agents received daily apple disease prediction products by e-mail. These products were supplemented with weekly orchard visits to twenty-seven production blocks. The objectives of this project were; 1). To monitor temperatures and leaf-wetness at ten locations, 2). To compare two weather monitoring methods at eight locations, 3). To utilize predictive computer software and weather products for managing apple scab and fire blight based on weather observations, 4). To utilize weather products for managing sooty blotch and fly speck, and 5). To deliver timely disease management information to County Agents, other Extension personnel, and industry leaders including growers.

METHODS:

Disease products for apple scab, fire blight, and sooty blotch were purchased from SkyBit, Inc. of Bellefonte, PA for six orchard locations which were representative of ten apple producing counties. The six orchards were located in Lucas, Erie, Geauga, Wayne, Columbiana, and Licking counties. The products were received through daily e-mail by the Huron County Extension office and forwarded to growers and agents by 8:00 a.m. each morning during the growing season. This information was presented in condensed form as a portion of the weekly (in-season) Ohio Fruit ICM News and delivered to approximately 180 addresses by surface and e-mail. The format allowed for a review of the month's infection periods and forecasts of expected infections during the following seven days in five districts of the state designated as West, North-Central, Northeast, Eastern Highlands, and Central.

Four temperature/leaf-wetness Spectrum Technologies monitors where positioned at eye-level within the apple tree canopies at four locations. The apple scab computer Specware, based on the Modified Mills Chart (available from Spectrum Technologies of Plainfield, IL) was utilized to indicate expected apple scab infection periods. Although expected, SpecWare for fire blight and sooty blotch were not yet available for the 1999 season. In addition, daily temperature and precipitation data from eight Ohio weather stations were recorded to collaborate wetting periods . Fruit quality was checked for disease-caused blemishes as apples were placed into storage at eighteen locations.

RESULTS & DISCUSSION:

After encountering severe apple scab infections during the 1998 growing season, growers experienced less disease pressures for 1999. Also growers, after suffering heavy losses in some cases, were more diligent in their management of scab, fire blight, and sooty blotch this year. Never-the-less, this project allowed some growers to reduce fungicide cover sprays by one or two applications with fruit quality maintained at an adequately high level.

The following table compares SkyBit and SpecWare Apple Scab Prediction Products:

	Days of Apple Scab Infection Indicated and Level of Pressure (where shown)						
Source	**SkyBit**	**SpecWare**	**SkyBit**	**SpecWare**	**SkyBit**	**SkyBit**	**SkyBit**
Month	**North Central**	**North Central**	**Eastern Highlands**	**Eastern Highlands**	**Western**	**Central**	**North East**
April 1999	6	4 (light)	NA	NA	NA	NA	NA
May	11	6 (medium)	11	NA	8	11	10
June	7	10 (medium)	9	NA	12	5	9
July	13	13 (medium)	11	NA	11	15	14
August	18	17 (heavy)	21	16 (heavy)	16	18	17
September	NA	NA	NA	12 (medium)	NA	NA	NA
April 1998	14	7 (medium)	NA	NA	15	NA	NA
May	13	21 (heavy)	NA	NA	13	NA	NA
June	15	11 (heavy	NA	NA	15	NA	NA
July	11	15 (heavy)	NA	NA	NA	NA	NA
August	15	15 (heavy)	NA	NA	NA	NA	NA
September	NA	8 (medium)	NA	NA	NA	NA	NA

NA=not available (SpecWare - equipment failure, SkyBit - not purchased)

Differences between prediction methods appear to be related to duration of wetness periods associated with actual rainfall as indicated by climatological data and wetness monitors rather than SkyBit observations. However, the SkyBit delivery system is convenient and possesses an adequate level of accuracy when actual rainfall is recorded. In no case was a possible infection period missed by SkyBit. The SpecWare Scab Product is easy to use and adjust for sensitivity, and is based on the widely accepted modified Mills Chart with options for the Cornell and Washington State methodologies. However, the present reliability and user-friendliness of the monitoring devices has created incomplete records as well as the need for timely downloading. The addition of a backup unit in an orchard would increase the reliability of the leaf wetness/temperature monitors..

EXTENSION PROGRAM IMPLEMENTATION

These results will be shared through the Ohio Fruit ICM News as well as personal contacts with apple producers. The Ohio Fruit and Vegetable Congress, to be held in February 2000, will provide additional opportunities for sharing and improving grower awareness of these management tools which can help maintain the judicious use of disease control materials.

For further information contact Ted Gastier , Ohio State University Extension, Huron County or the Ohio IPM Office.

Stink bug management in tomatoes and squash

Principal Investigator:

Celeste Welty (OSU Department of Entomology)

Background:

Tomato fruits produced for the fresh market or the whole-pack market are usually culled if injured by stink bugs, due to yellow blotches on the fruit surface and white corky tissue beneath the peel. Growers have requested information on how to manage this pest because stink bug injury has been increasing during the past few years, but little information is available on their biology and management. Stink bugs (Heteroptera: Pentatomidae) are not known as a pest of squash or gourds, although the squash bug (Heteroptera: Coreidae) is a pest of those crops. Squash and gourd growers believe that bug feeding on fruit is associated with recent problems from bacterial diseases of fruit. Recent discussions with growers indicate that stink bug, not squash bug, is the problem, and that stink bugs can be readily found in the field only at night. This project was done to address some of these questions.

Summary of project activities:

1) tomato field trial: A trial was conducted to evaluate two tentative thresholds and several insecticides for control of stink bugs in tomatoes. In tomatoes planted next to wheat at OARDC/Fremont, 32 plots were scouted weekly with 10 fruit per sample and 10 samples per plot. Stink bug injury was first detected on 6 July. When the low threshold (0.5% of fruit injured) was exceeded on 3 August, six replicated insecticide treatments were applied: Warrior, Thiodan, Penncap-M, Baythroid, and 2 rates of experimental Actara. When the high threshold (1.0% of fruit injured) was exceeded on 23 August, one insecticide (Warrior) was applied as a seventh treatment. An untreated check was also evaluated as an eighth treatment. Fruit was evaluated at harvest on 1 September for yield and stink bug injury. The percentage of red fruit injured by stink bug was 15.3% in the untreated check which was significantly ($P = 0.06$) higher than where treated with Penncap-M (1.6%) or Actara (3.3% with low rate; 3.2% with high rate). There was no significant difference when Warrior was applied twice starting at a low threshold (9.5% of red fruit injured) versus once at a high threshold (5.3% of red fruit injured).

2) behavior observations in tomato field: We had planned to observe stink bugs in a planting of unsprayed tomatoes at OARDC/Fremont to determine the movement patterns of stink bugs within the tomato canopy, to better understand when injury occurs and how bugs might be avoiding contact with insecticides. However, because damage and bugs were detected more readily than usual in the daytime in the threshold study plots, we decided not to make these observations. Sticky tile traps were tested as a tool for monitoring nocturnal activity of stink bugs, but they were found ineffective; they were placed on the ground in late day and checked in the morning.

3) behavior observations on tomato in lab: Observations were made to characterize damage to green and red tomato fruit by the one-spotted stink bug, *Euschistus variolarius*, in each of its development stages. From lab colonies of *E. variolarius*, individual young nymphs were placed in a container with an excised green and red tomato fruit, and held at 24^{o}C with 16 h light, 8 h dark. Three to six nymphs from each of six egg masses were used; a total of 31 nymphs were started of which 21 bugs completed development to adults. Bugs were observed once per day until they reached adulthood. Fruit were replaced every 4 days, and held until ripe when damage was characterized by evaluating the percentage of fruit surface injured and the depth of injury into tomato flesh. Data is being analyzed to test the hypothesis that damage is significantly greater on green fruit than on red fruit.

4) field scouting of gourds and butternut squash: To determine the number, type, and timing of squash or gourd samples to take to detect bug infestations, and to determine seasonal trends in insect and disease incidence with emphasis on fruit injury, four commercial fields were scouted once per week. The sample unit was one mid-canopy mature leaf, one stem, one flower, and one fruit, and 50 samples were taken per field. In squash and gourd fields in central Sandusky County, no fruit problems were detected, squash bug was never found on sampled plants although eggs were noted once on a non-sampled plant; only cucumber beetles were found on leaves from 25 June to 18 August and in flowers from 7 July to 7 September. In squash and gourd fields in western Sandusky County, no fruit problems were detected, squash bug was found from 8 July until 25 August; stink bug was found once in gourds (adult on 8 July) and 3 times in squash (adult on 8 July, 28 July; nymph on 12 August); cucumber beetles were found on leaves from 3 June to 5 August and in flowers from 8 July to 25 August. Of 50 samples examined per field per week, squash bug was found on 0 to 9 samples (0 to 18% of samples). During the 8 week period that squash bug was found in the western squash field, the number of positive samples per 50 samples was 1 to 5 for leaf samples, 0 to 5 for stem samples, and 0 to 1 for fruit samples. The range in total number of squash bugs on one sample was: on leaf sample, 0 to 1 adults, 0 to 1 egg masses, 0 to 17 nymphs; on stem sample, 0 to 10 nymphs; on fruit sample, 0 to 1 nymphs. Based on the variability between fields, the sample size of 50 per field seems appropriate as a minimum for large fields. Scouting both leaves and stems is needed for best detection of squash bug. To supplement scouting, one pheromone trap was placed in each field to monitor squash vine borer; adults were found in all 4 fields with a peak catch ranging from 9 to 22 moths per trap per week.

5) field trial with bugs and bacteria on gourds: To determine whether feeding by squash bug or stink bugs predisposes gourd fruit to bacterial diseases, a field experiment was conducted with caged fruit.

Methods: Six replicates of 9 treatments were evaluated. The treatments were combinations of 3 bacteria (Xanthomonas or Pseudomonas or buffer with no bacteria) and 3 injuries (bug or pinprick or none). Seeds of 'Nest Egg' gourds were planted at Waterman Farm in Columbus, after treating seed with Clorox. Plants were trained to climb on a trellis. Gourd fruit were enclosed in fine-mesh bags as soon as the flower petals wilted. Experiments were initiated when fruit had been bagged for an average of one week with range 3 days to 3 weeks. Bacterial leaf spot (*Xanthomonas campestris* pv *cucurbitae*) and angular leaf spot (*Pseudomonas lacrymans*) were obtained from USDA and kept in culture. Bacteria were mixed with buffered water and sprayed on fruit for artificial inoculation. Lab colonies were established using stink bug adults collected from alfalfa in April and squash bug eggs collected from zucchini in early July. The experiment was set up on 26 July with stink bug and on 26 August with squash bug. One adult female bug was used per fruit. Bugs were placed on fruit for 24 hours before bacteria was inoculated.

Results: In the first trial (with stink bug), which was initiated during a period of unusually hot weather, water-soaked lesions typical of bacterial diseases developed on only three of 54 fruit tested: two fruit treated with bug and no bacteria, and one fruit treated with no bug and no bacteria; apparently weather conditions during the trial were not conducive to disease development. In the second trial (with squash bug), water-soaked lesions typical of bacterial diseases developed on only five of 54 fruit tested: two fruit treated with bug and Pseudomonas, one fruit treated with bug and Xanthomonas, one fruit treated with bug and no bacteria, and one fruit treated with Xanthomonas and no bug. Damage from Pseudomonas appeared somewhat more severe when squash bug was present than when a pinprick or no injury was present.

Extension program implementation: The tomato field trial was featured in two field tours on 20 July and 5 August 1999, and conclusions on scouting and thresholds are being incorporated into a stink bug fact sheet that has been drafted. Results from the squash and gourd work will be featured in a talk at the Ohio vegetable growers' congress on 12 February 2000.

For further information contact Celeste Welty , Associate Professor, Dept. of Entomology, The Ohio State University or the Ohio IPM Office.

Ohio Integrated Pest Management

The Ohio State University Extension

The Flowering Sequence of Plants and Degree-Day Models as Tools for Predicting Insect Activity in Lake County Nurseries.

Principal Investigators:

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Abstract:

Several hundred taxa of woody ornamental plants are produced in Ohio's nurseries. This tremendous diversity of crops, each with it's own complement of insect pests, creates tremendous logistical challenges to implementing IPM programs. Many pests are difficult for growers to detect and monitor, especially insects such as scales and borers that are only vulnerable to pesticides during specific stages. Consequently, frequent "insurance" pesticide applications are made, often scheduled on a calendar-basis.

A phenological sequence of the blooming periods of ornamental plants can provide a user-friendly approach to predicting insect activity. Phenology is the study of recurring biological phenomena and their relationship to weather. Because the development of both plants and insects is temperature dependent, plants can accurately track the environmental factors that affect insect development. Plant phenology is easier for nursery managers to monitor than are difficult to detect insects, and can be used to predict the order and time pests reach vulnerable stages. This would greatly simplify the logistics of managing a great diversity of pests.

A five-year study conducted by Herms in Michigan demonstrated that a plant phenological sequence can be used effectively as a biological calendar to accurately predict insect activity, and that even one year of phenological data can be very useful because within a region there is little year-to-year variation in patterns of plant and insect phenology, even when there is substantial variation in degree-day accumulation. However, evaluation of the Michigan sequence in Ohio shows that phenological indicators developed in one geographic region are not always accurate when applied in another region, making it necessary to develop a phenological sequence for Ohio.

The objectives of this project were to (1) identify a phenological sequence of flowering ornamental plants that can be used as a "biological calendar" for timing the seasonal appearance of key insect and mite pests in Ohio nurseries, (2) to quantify degree-day accumulation for each insect and plant phenological event, and (3) provide scouting and monitoring data and training to growers.

The phenology of 86 plant species and/or cultivars and 40 species of arthropod pests were monitored. Plants were chosen to represent a range of blooming times from early March through late July. This time period corresponds with the activity of most of the important insect pests of ornamental plants. Four individuals of

each species or cultivar were monitored at least three times each week, and the dates of "first bloom" and "full bloom" recorded, with "first bloom" defined as the date on which the first flower bud on the plant opens revealing pistils and/or stamens, and "full bloom" as the date on which 95% of the flower buds have opened. These phenological events can be identified and recorded with precision by multiple observers.

The 40 insect and mite species monitored represent diverse feeding guilds including defoliators, scales and other sucking insects, gall formers, wood borers, leafminers, and root feeders. As opposed to methods used to monitor plant phenology, which were designed to minimize variation in order to increase predictive power, sampling protocols for insects were designed to characterize the phenology of the entire population. Key phenological events such as egg hatch and adult emergence were monitored using techniques appropriate for each species, including pheromone traps, visual monitoring, sticky cards, light traps, and beating methods. Cumulative degree-days were calculated from daily maximum and minimum temperatures for each phenological event using the double sine wave method from daily maximum and minimum temperature data using a base temperature of 50° F and a starting date of 1 January.

The easily monitored blooming sequence used as a "biological calendar" to predict the order and time pests reach vulnerable stages should facilitate implementation of IPM by increasing the efficiency of monitoring programs and improving timing of pesticide applications. The net effect will be to decrease the number of pesticide applications, and increase acceptance of short-residual biorational products. For example, we found that when common lilac was in full bloom (1) crawler emergence of pine needle scale was well underway and that sprays were appropriate at that time, (2) pheromone traps for lilac borer should have been deployed promptly, and (3) there was still time to plan for bronze birch borer. A useful attribute of the phenological sequence is that they can be readily expanded and customized. Once the basic sequence is in place, any new plants or pests can be added as the need occurs. For example, if a pest manager has made a particularly successful treatment, any plants in bloom at the time can be noted, added to the sequence, and used to duplicate the timing in future years.

Extension Program Implementation:

Extension objectives were to provide real time phenological data and scouting reports to Lake County growers based on data collected in this project, and to provide onsite training in scouting procedures to cooperating growers. These objectives were met through two formats: scouting data from this study was disseminated to growers in real time through two outlets: the weekly Buckeye Yard And Garden Line (BYGL), and bi-weekly meetings of the Lake County Growers IPM Program. The meetings, hosted at rotating nurseries, were also used as an opportunity to train growers in monitoring techniques such as the use of pheromone traps. Data from this project was also presented at the State Master Gardener's Conference in Springfield in September and the Professional Grounds Maintenance Society meeting in Cincinnati in November.

For further information contact Daniel Herms , Department of Entomology, OSU/OARDC or the Ohio IPM Office.
