Pickle

Tuesday morning 9:00 am

Where: Grand Gallery Room A (lower level)

Summary: Growers can learn how to fine tune and diversify their pest control practices in this session. Information about brining will be provided to growers and processors.

Recertification credits: 1 (Private, 1A, 1B)

CCA Credits: IPM(0.5) CM(1.5)

Moderator: Bruce MacKellar, Van Burnen Co. MSU Extension

9:00 a.m. Weed Control in Pickling Cucumbers

- Bernard H. Zandstra, Michigan State University

9:20 a.m. Developments in Phytophthora Control

- Mary K. Hausbeck, Michigan State University

9:40 a.m. Use of Modified spacing and Cover Crops in Pickle Production

- Mathieu Ngouajio, Michigan State University

10:00 a.m. Bulk Storage of Brined Vegetables: History, Technology, Sourcing.

- Henry Fleming, NC State Univ and USDA (Ret.)

Weed control in pickling cucumbers

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Department of Horticulture, Michigan State University

Pickling cucumber trials were established at the MSU Horticulture Farm and at the MSU Muck Farm during 2003. The Hort Farm study was on a sandy loam soil, and the Muck Farm study was on a deep muck soil.

Our objectives in general are to test new herbicides for use on cucumbers, and to find more effective ways to use currently available herbicides. Two herbicides have been registrerd for cucumber use during the past 2 years: Strategy, a premix of ethalfluralin (Curbit) and clomazone (Command), and Sandea (halosulfuron).

Curbit alone at 1.13 lb ai/a (3 pints) on sandy loam soil may be considered the standard weed control treatment for cucumber. If watered in with 0.25-0.5 inch rain or irrigation, it will give about 4 weeks control of most annual grasses and broadleaves. It does not control weeds in the mustard family, composite family, or nightshades very well. If we reduce the Curbit rate to 0.75 lb (2 pints) and add Command 0.25 lb (11 fl oz.) we can improve both broadleaf and grass control. This tank mix does not control redroot pigweed well.

Strategy 1.05 lb (4 pints) is equivalent to 2 pints of Curbit plus 0.67 pint Command 3 ME, and gives similar weed control. However Strategy costs $10/pint, or $40.00/acre. The tank mix of 2 pint Curbit and .7 pt Command costs $18.75 per application. That will normally be sufficient weed control for machine-harvested pickles. In very weedy fields, it may be profitable to apply Sandea preemergence at a cost of $20.50 per acre, in addition to the Strategy or Curbit.

If broadleaves emerge, Sandea 0.5 oz (0.023 lb ai) plus NIS 1 pint per acre may be applied postemergence, at a cost of $22.75 per acre. If grasses emerge, 1 pint of Poast plus 1 qt of COC may be applied at a cost of $9.75 per acre.

Yields in our plot on mineral soil were somewhat irregular because of difficulty keeping enough moisture on the plots. There was essentially no difference in yields between the treatments: Curbit 3 pt preemergence, Curbit 2 pt plus Command 0.7 pint pre, Strategy 4 pt plus Sandea 0.5 oz pre, Strategy 4 pt pre followed by Sandea 0.5 pt post, Prefar 6 lb pre followed by Sandea plus 1 pt NIS post, and Command 0.7 pt pre followed by Sandea 0.5 pt plus Poast 1 pt plus 1 pt NIS post.

At this time it appears that on light to moderately weedy soils, Curbit 2-3 pt is the most inexpensive weed control program. Using 2 pt Curbit plus 0.7 pt Command costs about the same and gives a broader spectrum of weed control.

For handpicked pickles that grow in the field for 60 days or longer a post emergence application will probably be needed. If Curbit and Command are applied preemergence ($18.75) followed by Sandea 0.5 oz plus Poast 1 pt plus NIS 1 pt postemergence ($38.75), the total expense is $57.50. While this is expensive, it is probably cheaper than hand hoeing @ $8.00/hr.

On muck soil, Strategy 5 pt plus Sandea 1 oz preemergence, Strategy 5 pt followed by Sandea 0.5 oz postemergence, and Command 0.8 pt preemergence followed by Sandea 0.5 oz plus Poast 1 pt plus NIS postemergence gave similar yield. Weed control on muck in general was not as good as on mineral soil.

Developments in *Phytophthora* Control

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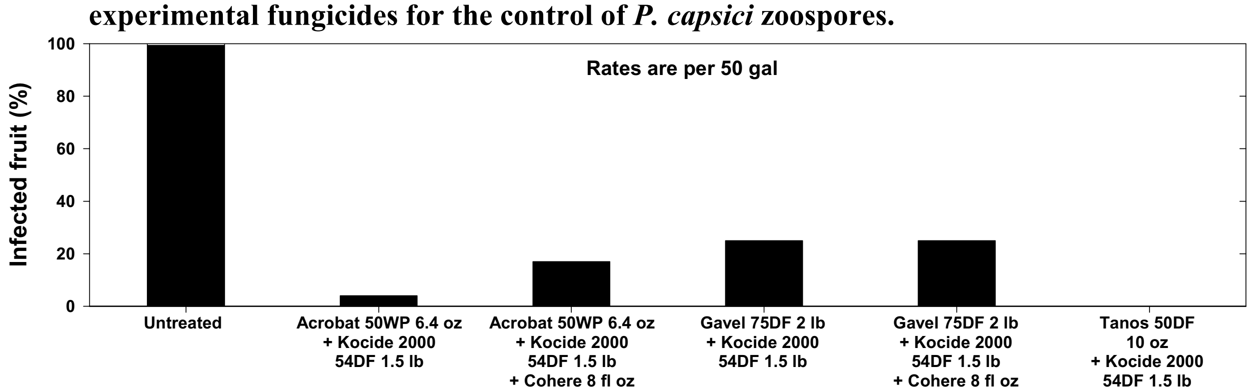
Michigan has over 40,000 acres of vegetables that are vulnerable to root, crown, and fruit rot caused by the soilborne fungus, *Phytophthora capsici*. *Phytophthora capsici* has two mating types that allow the production of long term survival spores (oospores) and development of genetic adaptations that foster fungicide resistance. The oospores can survive in soil up to ten years without the presence of a susceptible crop, and both mating types needed for oospore production have been found in every sampled field in Michigan. *Phytophthora* is favored by rain and warm temperatures that occur during the Michigan growing season and has recently been found in irrigations ponds and other surface water sources. The most effective control measure that growers have available is to avoid planting in infested soil and limit the spread of the disease to clean fields. Crop rotation is difficult as infested acreage and urban pressure is increasing across the major growing areas of the state. Properly constructed raised beds can be helpful as they keep vulnerable plants from saturated soil conditions. Topical applications of preventive fungicides can be effective if proper coverage and timing of applications can be achieved. A combined approach of all available control techniques is more effective than using just one control measure.

Fungicide Trials

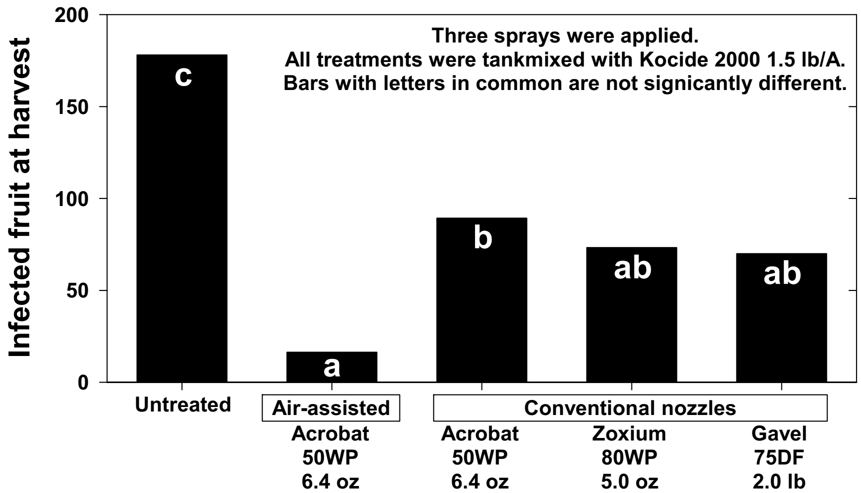
Research conducted at Michigan State University has identified fungicides that can be used to limit fruit infection of pickling cucumbers. The standard systemic fungicide mefenoxam (Ridomil, Ultra Flourish) is very effective in protecting the fruit from infection. The repeated use of this fungicide and the genetic adaptation capability of *Phytophthora capsici* has allowed the development of resistant populations of the pathogen in a significant portion of Michigan pickle fields. In these cases, using Ridomil or Ultra Flourish does not offer any control and alternative fungicides should be used. Recent registrations of Acrobat (dimethomorph) and Gavel (zoxamide/mancozeb) give growers alternatives to Ridomil/Ultra Flourish and are helpful as rotational products for growers interested in using Ridomil/Ultra Flourish (**Figure 1**).

Figure 1. Evaluation of MSU fruit screen trials testing the effectiveness of registered and experimental fungicides for the control of *P. capsici* zoospores.



During the summers of 2002 and 2003 large scale spray plots were established in commercial pickle fields. The objective of the studies was to determine if results observed in the fruit screen trials could be replicated in commercial fields. Plots were 900 feet long with 9 rows per plot, 30 inches between rows and 3 inches between plants. Irrigation, fertilization, and insect control were according to standard grower practices. Fungicide treatments were applied with a conventional boom sprayer or an air assisted sprayer. The conventional sprayer had 8003 nozzles spaced 20 inches apart, operating at 60 psi and delivering 30 gal/A. The air-assisted sprayer had four nozzles spaced 60 inches apart and delivering 10 gal/A. Sprays targeted the fruit, and were applied when fruit were 1", 3", and 5". During harvest, the number of infected fruit that came across the transfer belt of the harvester were recorded for a pass of 3 rows by 900 feet (6,750 ft^2). Three large samples of fruit were taken from each treatment strip and stored several days under different sets of environmental conditions. After storage the fruit was evaluated for fruit rot. Results of these trials are described below.

Figure 2. Large scale field study evaluating the effectiveness of foliar fungicides for the control of *P. capsici*.



In one trial, rainfall amounts between the first fungicide application and harvest were just over 3 inches. The field had significant areas of infected fruit at the time of harvest. All the treatments applied with the conventional boom had significantly less *Phytophthora* at the time of harvest compared to the untreated. Acrobat (6.4 oz/A) + Kocide 2000 (1.5 lb/A) applied with the air assisted boom had the least amount of infection during harvest (**Figure 2**) and again at 4 days after harvest. Pickles treated with Zoxium (active ingredient in Gavel) (5.0 oz/A) + Kocide 2000 (1.5 lb/A) had significantly less *Phytophthora* than the untreated portion of the field after 4 days of storage. *Pythium* infection was significant throughout all treatments after 4 days of storage.

The study conducted during the summer of 2003 received only a trace of rainfall between the first treatment application and harvest, resulting in minimal *Phytophthora* infection. The field had only a few isolated areas of infected fruit at the time of harvest. Even with low disease pressure, the untreated plot had significantly higher levels of infected fruit at harvest (**Table 1**) compared to applications of Gavel 75DF/Kocide 2000 (applied when fruit were 1" and 3" long) in a program with Acrobat/Kocide (applied when fruit were 5" long), regardless of what type of nozzle was used. Applications of Acrobat/Kocide/Dithane DF applied with the air-assisted nozzle also had significantly fewer infected fruit at time of harvest. Fruit held at ambient conditions developed a low level of infection, with fruit from the untreated plots having significantly higher levels of infection than the treatment program of Gavel 75DF/Kocide 2000 (applied when fruit were 1" and 3" long) and Acrobat/Kocide (applied when fruit were 5" long), regardless of nozzle type. Applications of Acrobat/Kocide/Dithane DF and Tanos/Kocide (applied when fruit were 1" and 3" long) in a program with Acrobat/Kocide (applied when fruit were 5" long) applied with the air-assisted nozzles also had significantly fewer infected fruit after storage in ambient conditions. No significant differences were observed among fruit stored in the cold room.

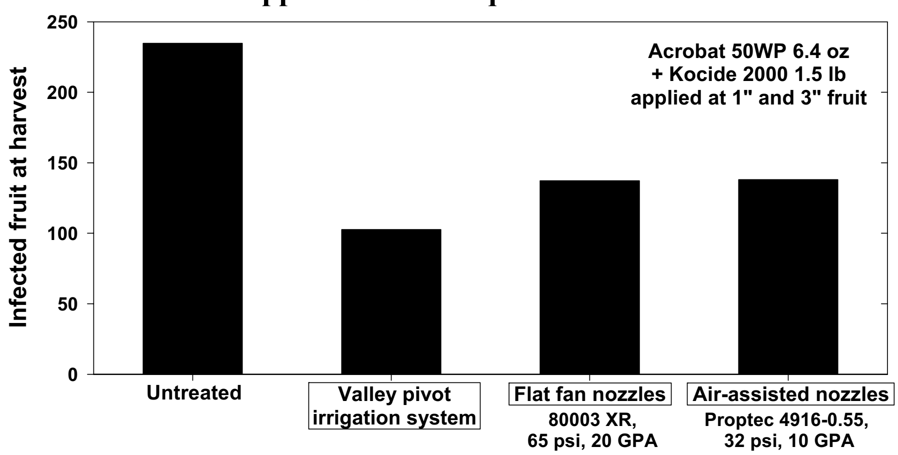
Table 1. Large scale field evaluations of new fungicides for the control of Phytophthora on pickles, 2003.

Treatment (Fruit size at application)	Nozzle	Infected fruit at harvest	Infected fruit after ambient storage[z]
Untreated	Conventional	5.0 b[y]	7.7 c
Gavel 75DF 2.0 lb + Kocide 2000 1.5 lb (1", 3", 5" fruit)	Conventional	1.0 ab	6.7 bc
Gavel 75DF 2.0 lb + Kocide 2000 1.5 lb (1", 3" fruit) Acrobat 50WP 6.4 oz + Kocide 2000 1.5 lb (5" fruit)	Conventional	0.3 a	0.0 a
Tanos 50 WP 10.0 oz + Kocide 2000 1.5 lb (1", 3" fruit) Acrobat 50WP 6.4 oz + Kocide 2000 1.5 lb (5" fruit)	Conventional	1.3 ab	2.3 abc
Acrobat 50WP 6.4 oz + Dithane DF 75DF 2.0 lb + Kocide 2000 1.5 lb (1", 3", 5" fruit)	Air-assisted	0.0 a	1.0 ab
Tanos 50 WP 10.0 oz + Kocide 2000 1.5 lb (1", 3" fruit) Acrobat 50WP 6.4 oz + Kocide 2000 1.5 lb (5" fruit)	Air-assisted	1.3 ab	1.0 ab
Gavel 75DF 2.0 lb + Kocide 2000 1.5 lb (1", 3" fruit) Acrobat 50WP 6.4 oz + Kocide 2000 1.5 lb (5" fruit)	Air-assisted	0.0 a	0.3 a
Acrobat 50WP 6.4 oz + Kocide 2000 1.5 lb (1", 3", 5" fruit)	Air-assisted	1.7 ab	3.7 abc

[z]Number of infected fruit in storage out of 100 gathered at time of harvest.
[y]Column values with letters in common are not statistically different (Fisher LSD, P=0.05).

A trial comparing application techniques received over 5" of rain between the first treatment application and harvest. The third and final fungicide application could not be made due to saturated field conditions. The field had significant levels of infected fruit at the time of harvest, and areas of standing water. Although all treatments reduced the amount of infected pickles compared to the untreated plants (**Figure 3)**, disease control was compromised as a result of not being able to make the third fungicide application.

Figure 3. Control of Phytophthora blight of pickle using different application techniques.



Irrigation Water

Phytophthora capsici contamination of ponds, creeks and rivers used for irrigation is of concern to Michigan growers. *Phytophthora capsici* zoospores can move with water in a field and run-off water from infested fields can carry the pathogen from a site of a disease epidemic to an uninfested irrigation water source. Prior to this research, the presence of *P. capsici* in Michigan irrigation water sources had not been reported. Pears and cucumbers were used as baits for *P. capsici* in water sources including a river, creek, naturally-fed pond and well-fed ponds. Baits were placed into a trap constructed from a milk crate with

Styrofoam pool noodles attached and a securable lid. A small data logger recording water temperature each hour was also placed inside the trap. Five locations were monitored twice weekly for *P. capsici* in 2002 (**Table 2**). *Phytophthora capsici* was detected in all but one of the irrigation sources. *Phytophthora capsici* was frequently detected in a river, creek, and a naturally-fed pond. All of these water sources were located near crops infected with *P. capsici*. On May 22, 2003, we resumed baiting of irrigation sources at all but two of the same locations as in 2002, with the addition of three new river locations. Data from the 2003 growing season are pending but *P. capsici* was isolated from 5 of these 8 locations from 25 July to October.

Table 2. Incidence of *P. capsici* in water sources in 2003.

Water source	Nearby infected fields	History of nearby infected fields	Incidence of *P. capsici*
River	Yes	Yes	Frequent
Creek	Yes	Yes	Frequent
Naturally-fed pond	Yes	No	Frequent
Well-fed pond #1	No	Yes	None
Well-fed pond #2	No	Yes	One

Snap Beans

The soil-borne pathogen *Phytophthora capsici* has recently been isolated from several commercial snap bean fields in northern Michigan, adding this crop to the long list of susceptible crops (**Table 3**) grown in the state. A first incidence of *P. capsici* on snap beans in Michigan was discovered on 29 July 2003 from a field in Oceana County, MI. Following this initial finding, *P. capsici* was isolated from snap bean plant tissue from a second field in the same county on two dates during the month of August. Isolations have been made from all plant parts and *P. capsici* has been identified from crown, stem, and leaf tissue. Both fields were planted to squash in 2002 and had experienced disease from *P. capsici* during that growing year. On 4 April 2003, a report of *P. capsici* on commercial lima beans in Delaware was published. Although it has been anecdotally noted among specialists and growers that a bean rotation exacerbates *P. capsici* in the ensuing cucurbit host crop, recent findings from Delaware and now Michigan may support this notion. Further investigation of host range and pathogen survival are underway. In the meantime, rotations among crops susceptible to *P. capsici* (**Table 3**) and any type of bean crop is not recommended.

Table 3. Crops commonly affected by *Phytophthora capsici*.

cucumber	summer squash	bell pepper	snap bean
gourd	winter squash	hot pepper	lima bean
muskmelon/cantaloupe	watermelon	eggplant	
pumpkin	zucchini	tomato	