Vine Crops

Wednesday morning 9:00 am

Where: Ballroom D
Recertification credits: 1 (1B, PRIV CORE)
CCA Credits: PM(2.0)
Moderator: Phil Tocco, Agriculture & Natural Resources Educator, Jackson Co. MSU Extension

9:00 a.m. Weed Control in the Age of Neighbors

- Mark Van Gessel, Plant Science Dept., Univ. of Delaware

9:30 a.m. Aphid Vectored Viruses in Cucurbits

- Emily Mueller, Entomology Dept., Univ. of Wisconsin-Madison

10:00 a.m. Practices That Encourage Native Bees in Vine Crops

- T`ai Roulston, Entomology Dept., Univ. of Virginia

10:30 a.m. Phytophthora and Downy Mildew Update

- Mary Hausbeck, Plant Pathology Dept., MSU

Weed Control for Vine Crops on the Delmarva Peninsula

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Weed control in vine crops can be challenging. Most vine crops are planted with wide row spacings and at considerable distances in the row so the crops are not very competitive with weeds. Many cucurbits are relatively long season crops requiring the need for weed-free fields for a considerable amount of time. Furthermore, there are relatively few herbicides registered for use with cucurbits.

Most squash (winter and summer) and pumpkins are direct-seeded, bare-ground production on the Delmarva Peninsula. However, in the past few years there has been an increase in no-till, rye cover crop pumpkin production. Almost all of the commercial watermelons and cantaloupes are now grown with plasticulture.

The rye cover crop for pumpkin production provides a number of soil and environmental benefits. The cover crop is effective in suppressing many weeds, and reduces the density and vigor of weed seedlings. However, there are enough weeds not control with the rye that weed control must be supplement with herbicides and/or hand weeding. The rye cover crop eliminates the potential for cultivation.

Plasticulture requires the forming of beds and laying black polyethylene plastic (about 30 inches wide) over the rows. A herbicide is often used under the plastic to eliminate weeds from emerging in the transplant holes and competing with the crop. Most growers are using a hooded-sprayer to spray the soil between the rows of plastic. This is often delayed until after the crop has been transplanted but before the vines begin to extend off the plastic. A residual herbicide is tankmixed with paraquat (Gramoxone Inteon) to control existing vegetation since most soil-applied herbicides provide no postemergence weed control. Rows of plastic are often alternated with a narrow strip of grain rye (or a ten foot strip of rye is planted every six to eight rows of plastic). The rye helps to reduce wind damage to the seedlings and allows for soils to warm sooner.

Rye planted as a cover crop or as a wind break is usually sprayed with a non-selective herbicide (Gramoxone Inteon or glyphosate) after the rye has headed out. As a result, this allows the rye to produce viable seed that can become a weed in the following crop.

Stale-seedbed is not commonly used by farmers in the region. The concept is to prepare a seedbed with primary tillage and allow weeds seeds to germinate and emerge. While the weed seedlings are small, they are destroyed with a shallow cultivation (which prevents bring new weed seeds to the soil surface) or with a non-selective herbicide. Due to the potential for crusting from multiple tillage operations and the prolong emergence of most weed species, this approach has limited utility in the Delmarva Peninsula.

Labeled Herbicides for Cucurbits:

Herbicide	Cucumber	Summer squash	Winter squash	Pumpkin (ornamental)	Watermelon	Cantaloupes
Soil-applied						
Alanap	**XXX**				**XXX**	**XXX**
Command	**XXX**	**XXX**	**XXX**		**XXX**	**XXX**
Curbit	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**
Prefar	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**[c]	**XXX**[c]
Sandea	**XXX**	**XX**[b]	**X**[a]	**X**[a]	**XXX**[c]	**XXX**[c]
Sinbar					**XXX**[c]	
Strategy	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**
Postemergence						
Aim	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**
Alanap	**XXX**				**XXX**	**XXX**
Poast	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**
Sandea	**XXX**		**XXX**	**XXX**		**XXX**
Select / Max	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**

[a]Labeled but not recommended in the Mid-Atlantic region.
[b]Only labeled for soil between the crop rows (plasticulture)
[c]Labeled for soil application under plastic layer or with bare-ground production.

Soil-applied herbicides:

Alanap (naptalam) may be applied pre-plant incorporated or preemergence. Alanap will control a limited number of grass and broadleaf weeds. Weed control is reduced on sandy soils with less than 1% organic matter. Alanap provides good to fair control of pigweed and common purslane. Alanap is used in combination with other herbicides.

Command (clomazone) is labeled for preemergence application only. Used predominately for annual grass, velvetleaf, jimsonweed, purslane, and common lambsquarters control. Not labeled for jack-o-lantern type pumpkins, however Strategy is labeled for this crop. Strategy is a pre-packaged mixture of clomazone and ethalfluralin.

Curbit (ethalfluralin) is labeled for preemergence application only. Curbit controls a number of annual grasses but only a few broadleaf weeds (pigweed and carpetweed). Curbit is often applied in combination with another herbicide (Command and/or Sandea). Curbit provides better weed control than Prefar, yet it has a slightly higher risk of crop injury.

Prefar (bensulide) can be applied pre-plant incorporated or preemergence. Prefar will control some annual grasses (barnyardgrass, large crabgrass, fall panicum, giant foxtail, and johnsongrass seedlings) but only suppression of certain broadleaves, such as common lambsquarters, common purslane, and pigweed species. Risk of crop injury is less with Prefar than with Curbit.

Sandea (halosulfuron) can be applied as a preemergence application. Sandea, applied preemergence, provides fair to good control of common ragweed, common lambsquarters, pigweed, cocklebur, jimsonweed, smartweed, galinsoga, and yellow nutsedge. Yellow nutsedge control is better when applied as a postemergence herbicide. Sandea does not control grass species. Sandea can be used as a soil-applied herbicide for cucumbers, watermelon, and cantaloupes. It is labeled for winter squash and pumpkins as a soil-applied treatment, but university research in the mid-Atlantic region shows the risk of crop injury is too high.

Sinbar (terbacil) is labeled for watermelons only. Apply preemergence to control many annual broadleaf weeds. Sinbar will not control pigweed species. Sinbar may be used for direct seeded or transplanted watermelons. Apply to seeded watermelons after planting, but before emergence. Apply to transplanted watermelons before transplanting.

Postemergence herbicides:

Aim (carfentrazone) can be applied as a directed (shielded) spray to suppress or control broadleaf weeds including morningglory species, pigweed species, common lambsquarters, and nightshade species when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Aim applied postemergence will not control annual or perennial grasses. The shielded (hooded) sprayer must be designed to prevent spray or drift from contacting the stems, leaves, flowers, or fruit of the crop, or severe injury may occur. No carry over restrictions with Aim.

Alanap (naptalam) will control a limited number of broadleaf weeds. Alanap provides good to fair control of pigweed and common purslane. Avoid use early in the season due to increase risk of crop injury. No carry over restrictions with Alanap.

Sandea (halosulfuron) provides good to excellent control common ragweed, pigweed, cocklebur, smartweed, galinsoga, and yellow nutsedge. Yellow nutsedge control is better when applied as a postemergence herbicides. Common lambsquarters and jimsonweed control is much better when Sandea is applied preemergence. Sandea does not control grass species. Sandea has good crop safety with cucumbers and cantaloupes. It is labeled for pumpkins and winter squash, but yellowing and stunting can be quite evident on these crops. Carry over can be an issue with Sandea.

Poast (sethoxydim) is used exclusively for grass control. Poast will control annual grasses and certain perennial grasses. Grass control will be best when the plants are treated while actively growing.

Select or Select Max (clethodim) are used exclusively for grass control. Will control annual grasses and certain perennial grasses, although not as effective on goosegrass as Poast. Select requires crop oil concentrate, while Select Max is labeled for use with non-ionic surfactant. Grass control will be best when the plants are treated while actively growing.

Recently, the manufacturer of Alanap, Chemtura, has voluntarily cancelled the EPA registration for Alanap herbicide on cucurbits. There is no time limitation regarding when a distributor may sell Alanap or when a grower may use the product. There is a 2.5-year supply of Alanap in inventory and this product will move to distribution channels within the next few months. The product should hold up well in storage for 3 or more years if properly stored.

Caution and common sense needs to be used when applying any pesticide, including herbicides, in close proximity to residential and non-crop land. Drift problems usually are first noticed when plants contacted by the herbicide begin to display injury symptoms. While drift can occur with any herbicide, a relatively small number of products are capable of damaging plants at the low concentrations typically associated with drift. The plant growth regulator herbicides (2,4-D, dicamba, etc.) are responsible for the majority of off-target injury reports. The abundance of problems with this class of chemistry is due to their ability to cause easily noticeable symptoms at fractions of the labeled rate. Glyphosate (Roundup), herbicides that cause whitening (Command or Callisto), and paraquat (Gramoxone Max) can induce noticeable symptoms at low rates. It is important to realize that managing drift is important with all herbicides, not just those that may injure plants on adjacent properties. Risk of drift can be reduced by not spraying in windy conditions and lowering the height of the spray boom; increasing spray droplet size by reducing pressure, increasing the size of the nozzles, and/or using nozzles that produce larger droplets.

Volatility is the movement of spray vapors after the herbicide has reached its intended target. When a herbicide volatilizes it can move great distances. Plant growth regulator herbicides and other herbicides are prone to volatilization. Factors affecting volatilization from soil are mode of application, air temperature, soil moisture, wind velocity, and soil type. Conditions of pre-plant application, hot air temperatures, very moist soils, windy conditions, and low organic matter content soils exhibit the highest degree of volatility.

Aphid-vectored Viruses in Cucurbits

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Aphids are common organisms in the agricultural landscape, especially after the establishment of the soybean aphid (*Aphis glycines* Matsumura) in the North Central Region of the United States. While they can cause direct damage in crop quality by sap removal, aphids have a greater impact on vegetable production as transmission agents of plant viruses. Since the discovery of the soybean aphid, recent virus epidemics have been reported in a variety of crops such as: cucurbits, snap bean, soybean, and sweet peppers.

In cucurbits, the major aphid-transmitted viruses include: Cucumber mosaic virus (CMV), Watermelon mosaic virus-2 (WMV-2), Papaya ringspot virus, Squash mosaic virus, and Zucchini Yellow Mosaic Virus. A wide host range, i.e. they can infect many plant species, and high virus strain variability are important epidemiological factors of CMV and WMV-2 that contribute to their common occurrence in landscape. The prevalence of these viruses in overwintering plant species, especially forage legumes and weedy hosts along crop borders and roadside ditches, provides a greater potential source of virus inoculum for aphids to acquire and transmit to cucurbit fields.

Aphid-vectored viruses of cucurbits can be characterized as nonpersistent. That is, aphids can acquire and subsequently transmit the virus in feeding periods as brief as a few seconds. Thus, a competent vector is not limited to aphid species that can colonize and reproduce on cucurbits. Often, efficient aphid vectors are transitory species, such as the soybean aphid in a cucurbit crop. The soybean aphid visits and conducts a quick test probe of plant sap from a cucurbit crop before taking flight in a continued search of a soybean plant. This behavior is sufficient to spread viruses to cucurbit crops.

Aphid management is an effective means of control for an aphid-virus complex. Winged aphids are attracted to yellow-green colors, yet deterred by ultraviolet radiation. The use of reflective mulches, therefore, can distract winged aphids and delay aphid colonization, which in turn would delay virus infection. Trap cropping, weed control, rouging, mineral oil sprays, and planting resistant varieties are all common cultural practices for controlling aphid populations. Aphid predators are an effective biological control strategy, preventing aphid populations from building up and dispensing, while chemical sprays are generally ineffective. Foliar applied insecticides, such as Dimethoate or Warrior®, provide no significant reduction in winged aphid populations. The active ingredient in insecticides must be ingested by the aphid vector to take effect, at which time these aphid-vectored, nonpersistent viruses are simultaneously transmitted to the host plant.

Native Bees in Vine Crops

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European Honey Bees, *Apis mellifera*, were brought to the New World with European colonists for the production of honey and wax. With increasingly intensive agricultural practices, farmers began using honey bees for crop pollination because honey bees would visit many different crops and could be introduced in great numbers during flowering and removed during pesticide applications. Now, the honey bee is considered by most farmers and extension personnel as essential to successful crop production of most insect-pollinated crops.

In 2006, a new disease, Colony Collapse Disorder, spread rapidly through the United States killing 50-90% of the colonies of some commercial beekeepers. This has led to widespread concern that insufficient honey bees will be available for commercial pollination in the near future, potentially resulting in decline and possible failure of row crop agriculture in America. But honey bees are just one of about 3500 species of bees in the U.S., all of which visit flowers, potentially visit and pollinate crop plants, and are not susceptible to Colony Collapse Disorder or most other diseases that harm honey bees. The contribution of wild bees to agricultural pollination has frequently been observed, but has seldom been quantified. It is apparent, however, that wild bees can sometimes provide full pollination of particular crops, including vine crops such as cucurbits.

Recent work in California has shown that native bees provide only about a quarter of the needed pollination service on conventional farms isolated from native habitat, but that organic farms near native habitat can receive full pollination service from native bees alone (Kremen et al. 2002). Work in Pennsylvania and New Jersey, on the other hand, has shown that watermelon is already getting full pollination by native bees on most farms, making the addition of honey bees superfluous for this crop (Winfree et al. 2007). Similarly, wild pollinators generally provide full pumpkin pollination in Virginia and Maryland (Julier and Roulston, submitted). Furthermore, in this region, the addition of honey bee colonies doesn't necessarily increase the density of honey bees on squash and pumpkin plants, most likely reflecting the honey bees' preference for other forage (Shuler et al. 2005).

Why do eastern farmers seem to get so much more pollination from wild bees than Californian farmers? This is an active area of study, and there is much to learn still, but one important factor is likely to be the greater availability of undisturbed nest sites near farms in the East than in California, where, at least in the most intensively farmed agricultural areas, there is little undisturbed soil.

Maintaining populations of native bees in an intensively managed agricultural landscape requires providing food (pollen and nectar) throughout the foraging season and safe nesting areas year round. Most native bee species nest in the ground, frequently within tilling depth. This includes bumble bees, which frequently occupy abandoned mouse nests, and numerous species of solitary bees that excavate narrow tunnels in hard ground. Other species build nests in tree cavities or the hollow stems of herbaceous vegetation, neither of which tends to be common within agricultural areas. If safe nesting sites aren't available within agricultural areas, they will need to be available within bee commuting distance of crops if these bees are to be maintained in the landscape at sufficient density to contribute to crop pollination.

While some crops provide substantial floral resources for bees, they often flower for only a short period of time. Bee species that have only one generation a year will require resources for the 4-6 weeks that they are generally active; species that have multiple generations require resources throughout the summer. Thus, an important consideration in maintaining native pollinators is making sure they have foraging opportunities beyond the window of time that any single crop is flowering. This can come from wild plants, staggered plantings, or multi-cropped agricultural areas that provide a steady flower supply over a long period of time.

Finally, bees are susceptible to most pesticides that target insect pests so care should be used in applications that might target plants during flowering, especially during the time of day that bees are active.

Colony Collapse Disorder is very bad news for honey production, hobby beekeeping, and agricultural pollination when only honey bees can reach sufficient density to pollinate the crop. There is good news, however: when conditions in the agricultural landscape can support wild pollinators year round, farmers can receive full pollination of some target crops without honey bees at all.

Literature Cited.

Julier, H.E. and T.H. Roulston. Submitted, Journal of Applied Ecology. Beyond Apis: conditions for full pollination of cultivated pumpkins by wild bees.

Kremen, C., Williams, N. M. and R. W. Thorp. 2002. Crop pollination from native bees at risk from agricultural intensification. PNAS 99:16812-16816.

Shuler, R. E., Roulston, T.H. and G. E. Farris. 2005. Farming practices influence wild pollinator populations on squash and pumpkins. Journal of Economic Entomology 98:790-795.

Winfree, R., Williams, N.M, Dushoff, J. and C. Kremen. 2007. Wild bees provide insurance against ongoing honey bee losses. Ecology Letters 10: 1105-1113

Phytophthora and Downy Mildew Update

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Downy mildew on vine crops

Downy mildew causes symptoms on the leaves of vine crops (such as cucumber, squash, and melon) similar to a mosaic or angular leaf spot. The tell-tale symptom of downy mildew is the purplish/gray fuzz on the underside of the leaf that gives a somewhat "dirty" or "velvet" appearance. This fuzz is made up of thousands of spores and may be most evident in the morning. Downy mildew is well-known for causing catastrophic losses in a brief period of time. When the conditions are favorable, unprotected foliage can become completely infected and appear to be frosted within 10 days of initial infection. Downy mildew is not known to produce over-wintering spores and will not persist in soil and field debris in Michigan from year to year. Downy mildew was first reported in Michigan in August 2005 and appeared again in June 2006 and 2007. As of September 11, 2007, 24 Michigan counties had confirmed reports of downy mildew. Downy mildew primarily caused disease on cucumber, however, there were also reports on cantaloupe, gourd and zucchini.

Currently, there are few cultivars with adequate resistance to downy mildew and chemical control is the most effective tool. Products should be used in alternation with each other and applied at short intervals. Results from our downy mildew research indicated that the most effective spray programs, when applied before disease, were: Gavel 75WG (2 lb), Previcur Flex 6SC (1.2 pt), Ranman 3.6SC (2.8 fl oz), and Tanos 50WG (8 oz), each tank mixed with either Dithane DF Rainshield (3 lb) or Bravo Weather Stik 6SC (1.5 pt). After disease is identified in the field, the most effective products were: Previcur Flex 6SC (1.2 pt), Ranman 3.6SC (2.8 fl oz), and Tanos 50WG (8 oz), each tank mixed with either Dithane DF Rainshield (3 lb) or Bravo Weather Stik 6SC (1.5 pt). A new fungicide called Presidio will be available soon and has performed very well in our downy mildew trials.

In addition to fungicides, it is recommended that any infected vines remaining after harvest be killed with a contact herbicide or plowed under immediately so that they do not serve as a source of downy mildew for nearby crops.

Table 1. Recommended products for managing downy mildew on vine crops.

APPLIED BEFORE DISEASE (7-day intervals)	**APPLIED AFTER DISEASE (5-day intervals)**
• Gavel 75WG (5 day PHI) • Previcur Flex 6SC (2 day PHI) • Ranman 3.6SC (0 day PHI) • Tanos 50WG (3 day PHI)	• Previcur Flex 6SC (2 day PHI) • Ranman 3.6SC (0 day PHI) • Tanos 50WG (3 day PHI)
Alternate products and mix each with either: • Dithane (mancozeb) 3 lb or • Bravo (chlorothalonil) 1.5 pt	Alternate products and mix each with either: • Dithane (mancozeb) 3 lb or • Bravo (chlorothalonil) 2 pt

Please note: Gavel 75WG and Dithane are not registered on some vine crops.

Phytophthora capsici on vine crops

Michigan growers producing vine crops have reported significant losses due to Phytophthora blight in recent years. The pathogen responsible is *Phytophthora capsici*. Recognizing disease due to *P. capsici* is not always easy as the disease often occurs in the low areas of a field where water accumulates. Many growers assume that when plant stunting occurs in these sites, it is due to the 'water logging' of the roots, but infection by *P. capsici* may be to blame. Under conditions of standing water, *P. capsici* produces swimming spores (zoospores) which can move about in water and cause infection of nearby plants. Squash and pumpkin plants often have obvious symptoms of plants wilting or collapsing prior to dying. Such plants often have brown to black discolored roots and crowns. The disease is easily seen on infected fruit, initially as dark, water-soaked lesions which then develop a distinctive white 'powdered sugar' layer of spores on the surface of the fruit. Fruit infection is especially troublesome because the infection may occur days before the symptoms become visible. As a result, healthy-appearing fruit may be harvested and then shipped. Fruit then break down during transit or on grocers' shelves resulting in disposal cost.

To control *P. capsici* several control measures need to be implemented. Good drainage is important in managing this disease. However, even plants growing on well-drained fields on raised beds may have severe disease if rainfall is heavy. Crop rotation may reduce the number of *P. capsici* spores remaining in a field. A minimum of 3 years crop rotation to hosts other than those listed in Table 1 is recommended to avoid build-up of *P. capsici*. Growers should avoid relying on a single fungicide for disease control in order to delay development of fungicide resistance with *P. capsici*. There are many fields in Michigan where the *P. capsici* has become resistant to the commonly used fungicide, Ridomil Gold (mefenoxam). Fungicide programs including the following may provide disease management: Acrobat 50WP (6.4 oz), Gavel 75DF 1.5-2.0 lb, Tanos 50WG (8-10 oz). Fields heavily infested with *P. capsici* may require the use of pre-plant fumigation for disease control. Fumigants that are most effective include: Telone C35, Vapam HL, and Sectagon 42. Trial results from a new fungicide, Presidio (fluopicolide), appears promising and may complement a spray program that includes other Phytophthora fungicides.

Control of *Phytophthora* is complicated by its broad host range, long-term persistence in agricultural soils, presence in irrigation water sources, and ability to develop resistance to fungicides. An integrated production system that combines cultural methods and tolerant cultivars, effective fungicides and use of uncontaminated irrigation sources.

Table 1. Common vegetable hosts affected by *Phytophthora capsici*.

cucumber	summer squash	zucchini	hot pepper	snap beans
gourd	watermelon	eggplant	tomato	yellow wax beans
pumpkin	winter squash	bell pepper	lima beans	

Table 2. Products tested in Phytophthora trials.

Product	Active ingredient	Labeled
Captan 80WDG	captan	no
Forum 4.16SC..	dimethomorph	yes
Gavel 75DF..	zoxamide/mancozeb	yes
Presidio 4FL...	fluopicolide	registration pending
Previcur Flex 6EC..................................	propamocarb	yes
ProPhyt 4.2EC	phosphorous acid salts	yes
Ranman 3.6SC	cyazofamid	yes
Reason 4.13SC.......................................	fenamidone	yes
Revus 2.08SC	mandipropamid	no
Ridomil Gold MZ 76.5WP	mefenoxam/mancozeb	yes
Tanos 50WG...	famoxadone/cymoxanil	yes

Evaluation of fungicides for control of crown, root, and fruit rot of yellow squash in fumigated beds

The trial was conducted on a commercial farm in Cass County, MI with a history of *Phytophthora capsici*. Beds were fumigated with Telone C-35 at 35 GPA on 31 May, and covered in black plastic mulch with drip irrigation. Yellow squash seeds, commercially treated with Thiram, were planted 2 ft apart in 20-ft-long rows on beds 2-ft-wide on 22 Jun. The plots were arranged in a randomized complete block design. In Aug, the Southwest Michigan Research and Extension Center at Benton Harbor, located 15 miles away from the commercial field, received a total of 11.62 in. of rainfall. All treatments were applied with a CO_2 backpack sprayer and a 3-nozzle swivel boom with 50 mesh screens and 8003XR nozzles, calibrated to deliver 50 GPA. The outer two swivel nozzles were aligned at 45^o angles towards the squash crown, and the middle stationary nozzle was positioned directly over top of the plant crown. The applications were initiated when the plants had developed one true leaf and continued until harvest concluded. Eleven chemical treatments were applied every 5-7 days. In the event of rainfall > ½ in. in a 1 hour period, additional treatments were applied outside of the regular spray schedule to prevent increased infection from the rain splash. Treatments were applied on 6, 13, 20, 27 Jul, 3, 8, 15, 21, 24, 31 Aug and 7 Sep. Fruits were harvested from the entire row and evaluated for *P. capsici* infection on 8, 14, 17, 21, 24, 31 Aug, 7 and 14 Sep. The healthy fruits were stored for 4-5 days in ambient conditions and evaluated again for disease.

Heavy rainfall occurred in the first two weeks of Sep with a total of 6 in. documented. In the untreated plots, 87.5% of the plants were wilted and/or dead. Although applications of Mandipropamid 2.08SC, Captan 80WDG, Gavel 75DF, Previcur Flex 6EC, Ridomil Gold MZ 76.5WP, Tanos 50WG, and Presidio 4FL produced significantly healthier plants than the untreated control (14 Sep), plant wilting and death was still relatively high (up to 55.4%) among these treatments. Plots treated with Captan 80WDG and Gavel 75DF had <13% plants wilted and dead (14 Sep) and were significantly better than several of the other treatments. The percentage of fruit infected at harvest was low across all treatments. However, postharvest disease exceeded 10% for all treatments. Ridomil Gold MZ produced significantly higher yields than the untreated check. ProPhyt treatments reduced yield significantly from the untreated control because phytotoxicity caused stunting and yellowing of the foliage earlier in the growing season.

Treatment and rate/A, applied at 5-7 day intervals	Plants/20 ft of row* 9/14		Infected yield (lb/20 ft of row)	
	Dead (%)	Wilted and dead (%)	At harvest (%)	Post-harvest (%)
Untreated	80.0 e**	87.5 e	2.4	18.0
Gavel 75DF 2 lb	7.5 a	10.0 a	1.5	18.3
Captan 80WDG 6 lb	4.8 a	12.6 a	0.8	17.9
Ridomil Gold MZ 76.5WP 2 lb	20.5 ab	27.5 ab	0.8	18.7
Presidio 4FL 0.18 pt	29.6 a-c	32.1 a-c	0.7	12.2
Revus 2.08SC 0.5 pt	23.4 ab	33.0 a-c	1.6	14.0
Tanos 50WG 0.5 lb	41.1 b-d	53.0 b-d	1.7	11.8
Previcur Flex 6EC 1.2 pt	42.9 b-d	55.4 b-d	2.1	23.2
Reason 4.13SC 0.34 pt	54.6 c-e	59.3 c-e	1.9	10.4
Ranman 3.6SC 0.18 pt	48.9 b-d	63.4 de	2.7	21.1
Forum 4.16SC 0.4 pt	59.3 de	68.6 de	2.7	16.4
ProPhyt 4.2EC 4 pt	63.5 de	75.3 de	0.6	12.8

*Total numbers of emerged plants were statistically similar between all plots.

**Column means with a letter in common or with no letter are not significantly different (Fisher LSD Method; P=0.05).

Evaluation of fungicides for control of crown, root, and fruit rot of yellow squash in nonfumigated beds

The experiment was conducted in a commercial vegetable grower's field in Cass County, MI that had hosted a crop exhibiting symptoms of severe *Phytophthora capsici* infection the previous year. Summer squash seeds, commercially treated with Thiram, were planted 2 ft apart on 3-ft-wide raised beds covered with black plastic mulch with drip irrigation on 22 Jun. The plots were 20 ft long and replicated four times in a complete block randomization. Treatments were applied using a compressed CO_2 backpack sprayer and a 3-nozzle boom with 50 mesh screens and 8003XR nozzles, calibrated at 50 GPA. The outer two nozzles were aligned at 45^o angles towards the squash crown, and the middle nozzle was directed straight over top. Treatments were initiated when the crop had developed one true leaf and continued until harvest concluded. Eleven chemical treatments were applied every 5-7 days. In the event of rainfall > ½ in. in a 1 hour period, additional treatments were applied outside of the regular spray schedule to prevent increased infection from the rain splash. Applications were made on 6, 13, 20, 27 Jul, 3, 8, 15, 21 and 24 Aug. Plants with symptoms of *P. capsici* including irreversible wilting, crown rot, and plant death were counted weekly and sampled to confirm infection until Sep. Fruits were harvested from the entire row, weighed and sorted for *P. capsici* infection on 8, 14, 17, 21 and 24 Aug. Healthy fruits were stored for 4-5 days at ambient conditions and evaluated for infection postharvest.

In Aug, there were several periods of heavy rainfall and conditions were favorable for disease development. All plants in untreated plots died. Applications of Mandipropamid 2.08SC, Captan 80WDG, Gavel 75DF, Ranman 3.6SC, Ridomil Gold MZ 76.5WP and Presidio FL produced significantly healthier plants than the untreated control; Mandipropamid, Captan and Gavel limited wilted and dead plants to <25%. All of the products provided adequate fruit protection at harvest; however, only Presidio and Captan provided >90% control after storage. Presidio had the highest yield with the cleanest fruit (*data not shown*), despite the higher incidence of plant death. ProPhyt treatments caused severe stunting of the plants and yellowing of the foliage earlier in the season, resulting in a significantly lower yield.

Treatment and rate/A, applied at 7 day intervals	Plants/20 ft of row (%)* 30 Aug		Infected yield, lb/20 ft of row (%)	
	Dead (%)	Healthy (%)	At harvest (%)	Post-harvest (%)
Untreated....................................	100.0 c**	0.0 e	6.9 c	27.0
Captan 80WDG 6 lb...................	12.5 a	80.0 a	0.2 a	9.9
Revus 2.08SC 0.5 pt..................	21.7 ab	65.8 ab	1.3 ab	16.3
Gavel 75DF 2 lb.........................	23.1 ab	61.1 ab	1.3 ab	20.2
Ranman 3.6SC 0.18 pt...............	40.6 b	46.9 bc	0.6 a	10.7
Presidio 4FL 0.18 pt...................	38.9 ab	45.8 bc	2.7 ab	8.3
Ridomil Gold MZ 76.5WP 2 lb .	33.3 ab	33.3 cd	1.3 ab	12.0
ProPhyt 4.2EC 4 pt	75.0 c	15.0 de	0.9 ab	20.0
Forum 4.16SC 0.4 pt.................	86.3 c	11.3 de	1.9 ab	14.0
Previcur Flex 6EC 1.2 pt............	73.9 c	7.5 e	3.4 b	35.7
Reason 4.13SC 0.34 pt...............	80.0 c	7.5 e	2.8 ab	17.5
Tanos 50WG 0.5 lb....................	89.7 c	0.0 e	2.3 ab	19.1

*Total numbers of emerged plants were statistically similar between all plots.
**Column means with a letter in common or with no letter are not significantly different (Fisher LSD Method; P=0.05).

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