Great Lakes Fruit, Vegetable & Farm Market EXPO

Michigan Greenhouse Growers EXPO

December 9 - 11, 2014

DeVos Place Convention Center, Grand Rapids, MI

Carrot

Wednesday afternoon 2:00 pm

Where: Grand Gallery (main level) Room C

MI Recertification credits: 2 (1B, COMM CORE, PRIV CORE)
OH Recertification credits: 0.5 (presentations as marked)
CCA Credits: NM(0.5) PM(1.5)

Moderator: Corey Noyes, Horticulture Dept., MSU

2:00 pm Update on Disease Control in Carrots (OH: 2B, 0.5 hr)

- Mary Hausbeck, Plant, Soil and Microbial Sciences Dept., MSU

2:30 pm Testing for Aster Leafhopper Infectivity in Michigan Carrot and Celery Crops

- Zsofia Szendrei, Entomology Dept., MSU

3:00 pm Slow-Release Nitrogen for Carrots: Effects of Rate and Timing on Quality and Yield.

- Corey Noyes, Horticulture Dept., MSU
- Daniel Brainard, Horticulture Dept., MSU

3:30 pm Managing Plant-Parasitic Nematodes with Cover Crops in MI

- Fred Warner, Plant, Soil and Microbial Sciences Dept. MSU

4:00 pm Session Ends

Update on Disease Control in Carrots

Dr. Mary K. Hausbeck, 517-355-4534
Michigan State University, Department of Plant, Soil & Microbial Sciences

***Cercospora* and *Alternaria* leaf and petiole blights.** Because high humidity and frequent rainfall or irrigation is common during the Michigan growing season, yield-threatening foliar blights are a recurring problem, reducing photosynthetic area and weakening leaves and petioles, and requiring a management program to prevent crop loss. Michigan growers harvest carrots mechanically and weakened petioles and foliage (Fig. 1C) can disrupt harvest due to carrot tops breaking off during lifting. In situations where foliar disease is severe and not controlled, the tops may be compromised to the extent that the crop cannot be harvested.

Cercospora blight (Fig. 1B) is caused by the fungus, *Cercospora carotae*, and is an important foliar disease of carrots. The fungus can attack young foliage, either on the leaves or petioles. *Cercospora* leaf spot occurs as small circular brown spots that rapidly enlarge, accompanied by yellow/red discoloration on younger leaves and can girdle petioles, resulting in defoliation. *Alternaria* blight (Fig. 1A) is caused by the fungus, *Alternaria dauci*, and is usually detected later in the season on older foliage. Symptoms of *Alternaria* leaf spot include dark brown/black spots with yellow margins appearing on older leaves. Petioles may also become blighted. Severe disease results in weak petioles or defoliation. Warm temperatures and long periods of leaf wetness promote disease development. Spores of these fungi are wind-blown to nearby plants or even adjacent fields.

Alternaria and *Cercospora* foliar blights may occur together and are managed similarly. Methods to reduce disease pressure include planting disease-free seed, following a 2-year crop rotation, minimizing overhead irrigation during warm weather, and applying fungicides. Methods to effectively schedule fungicide applications according to field scouting and the TOM-CAST disease forecasting system have been developed and adopted by many growers.

***Fig. 1. A**, Alternaria leaf spot. **B**, Cercospora leaf spot. **C**, Petiole lesions.*

Table 1. List of products tested in field trials.

Product	Active ingredient	FRAC	Labeled
Bravo WeatherStik SC	chlorothanonil	M5	yes
Fontelis SC	penthiopyrad	7	yes
Inspire EC	difenoconazole	3	no
Luna Sensation SC	fluopyram/trifloxystrobin	7/11	no
Luna Transquility	fluopyram/pyrimethanil	7/9	no
Omega SC	fluazinam	29	no
Presidio SC	fluopicolide	43	yes
Priaxor SC	fluxapyroxad/pyraclostrobin	7/11	no
Quadris SC	azoxystrobin	11	yes
Reason SC	fenamidone	11	yes
Ridomil Gold SL	mefenoxam	4	yes
Rovral SC	iprodione	2	yes
Serenade Optimum WP	*Bacillus subtilis*	--	yes
Serenade Soil FL	*Bacillus subtilis*	--	yes
Tilt EC	propiconazole	3	yes

Foliar blight field trial. A field trial compared fungicide programs applied according to the Tom-Cast disease forecaster versus calendar-based applications of fungicides (Table 1). Five treatments were scheduled according to Tom-Cast on 31 July; 13, 22 and 29 August; and 8 September. Six calendar-scheduled treatments were applied every 14 days on 31 July; 13 and 25 August; 8 and 23 September; and 7 October. Plants were evaluated for disease on 21 October. Roots were harvested from the center 10 feet of treatment row and yields weighed on 23 October.

The percentage of plants with infected petioles (%) was relatively high in the untreated control and nearly 50% of the plants were infected (Fig. 2). All treatments significantly limited disease compared with the untreated control. The applications of Rovral were not as effective as the other fungicides included in the study. Applying fungicides according to the Tom-Cast disease forecaster was especially effective, limiting plants with infected petioles to ≤3.9%, and disease to ≤0.8, when rated on a scale of 0 to 12. Bravo WeatherStik applied according to Tom-Cast resulted in the greatest yield, significantly higher than Rovral and Luna Tranquility applied at 14-day intervals. Adding Fontelis to a fungicide rotation in conjunction with the Tom-Cast disease forecaster was effective and could ease reliance on Bravo and Quadris which have been standards for carrot growers.

Root Dieback (Pythium Brown Rot and Forking). Damaged, diseased or otherwise unmarketable carrots are known as culls. Approximately 30% of the carrots delivered to packing plants are rejected as not suitable (cull) for fresh market packs. Forking and stubbing of carrot roots (Fig. 3) is a complex problem likely resulting from a combination of mechanical damage, disease, and/or nematodes.

Root dieback caused by *Pythium* spp. can occur wherever carrots are grown. Root dieback of carrots produces excessively branched or stubbed roots. The fungus kills young taproots after seed germination, reducing root length and/or stimulating forking. Forking and stubbing symptoms can also be caused by soil compaction, nematodes, and/or excessive water. The severity of the disease may be depend on the density of *Pythium* spores in fields, in addition to other factors such as wet soil conditions and large amounts of crop residue. *Pythium* spp. produce sporangia and overwintering spores (oospores). Spores and mycelia are responsible for the spread of the fungus in the field, which is facilitated by wet soil conditions. Disease control can be achieved by avoiding excessive watering, by providing good field drainage and by planting carrots in deep, friable, and well-drained soils. Post-emergent fungicides containing the active ingredient mefenoxam (i.e., Ridomil Gold EC) can be applied to control damping-off. Rotations with small grains may reduce soil populations of some *Pythium* spp.

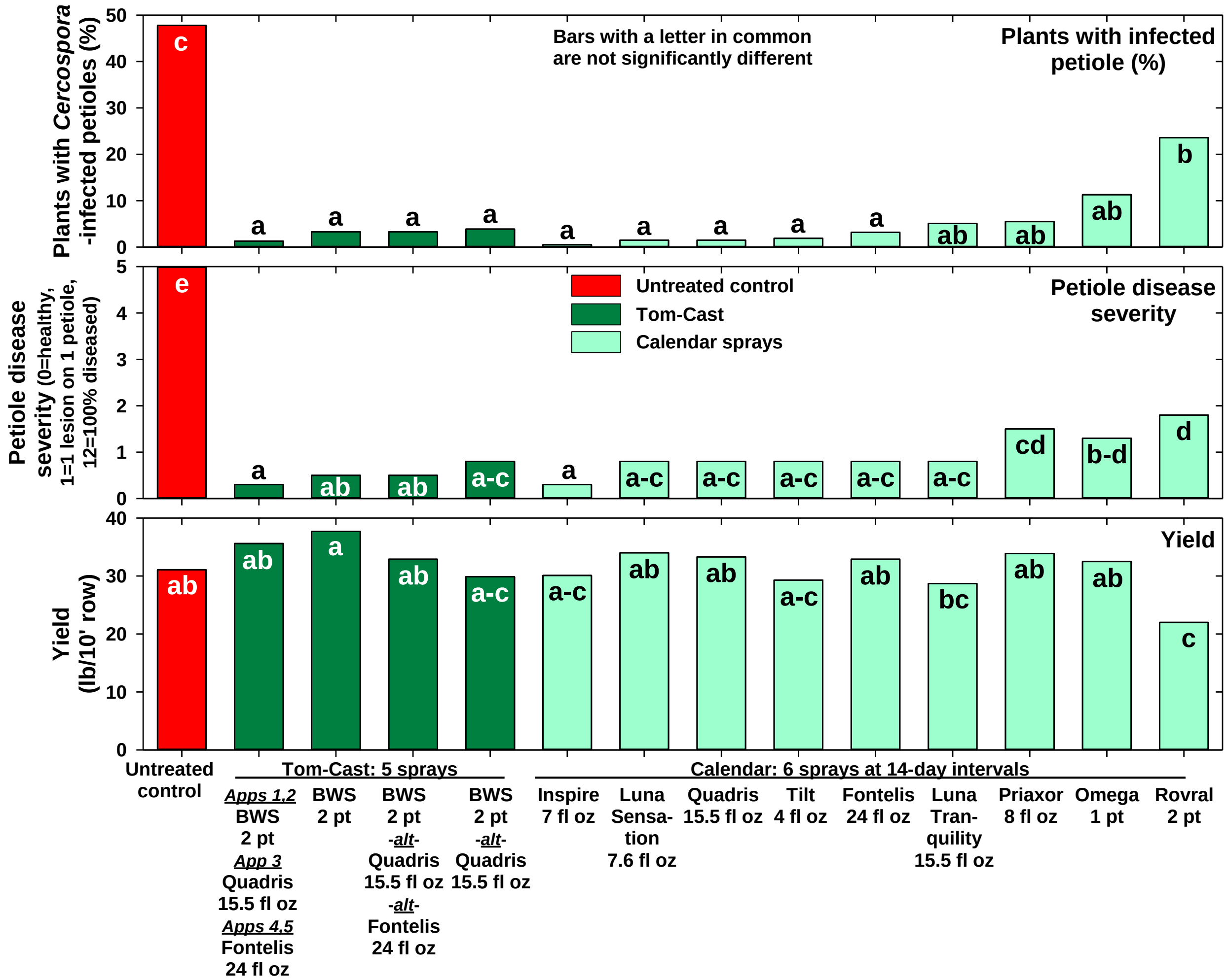

Fig. 2. *Evaluation of fungicides applied according to the Tom-Cast disease forecaster or in a calendar-based program. BWS=Bravo WeatherStik. Petiole disease severity rated on a modified Horsfall-Barratt scale of 0 to 12, where 0=0% plant area diseased, 1=1 lesion on 1 petiole/plant, 2=>1 lesion to 3% of plant area diseased, 3=>3 to 6% plant area diseased, 4=>6 to 12%, 5=>12 to 25%, 6=>25 to 50%, 7=>50 to 75%, 8=>75 to 87%, 9=>87 to 94%, 10=>94 to 97%, 11=>97 to <100%, 12=100% plant area diseased.*

Root forking/stubbing field trial. A field trial evaluated fungicide programs for control of *Pythium* forking and stubbing of carrots. The first application was applied as a band over the seedbed on 8 May. Foliar treatments were applied on 31 July; 8, 15, 22 and 29 August; 4 and 18 September. Roots were harvested from the center 10 feet of the treatment row and total yields and forked/stubbed yields were weighed on 18 September.

There were no significant differences among treatments for total yield (Fig. 4). Forking/stubbing reached 34.1% in the untreated control. Programs that included Ridomil Gold or Presidio applied both at planting and as a 7-day foliar spray significantly limited forking/stubbing compared to the untreated control, as did Serenade Soil at planting/Serenade Optimum as a 7-day foliar spray.

Fig. 3. *Root forking and stubbing.*

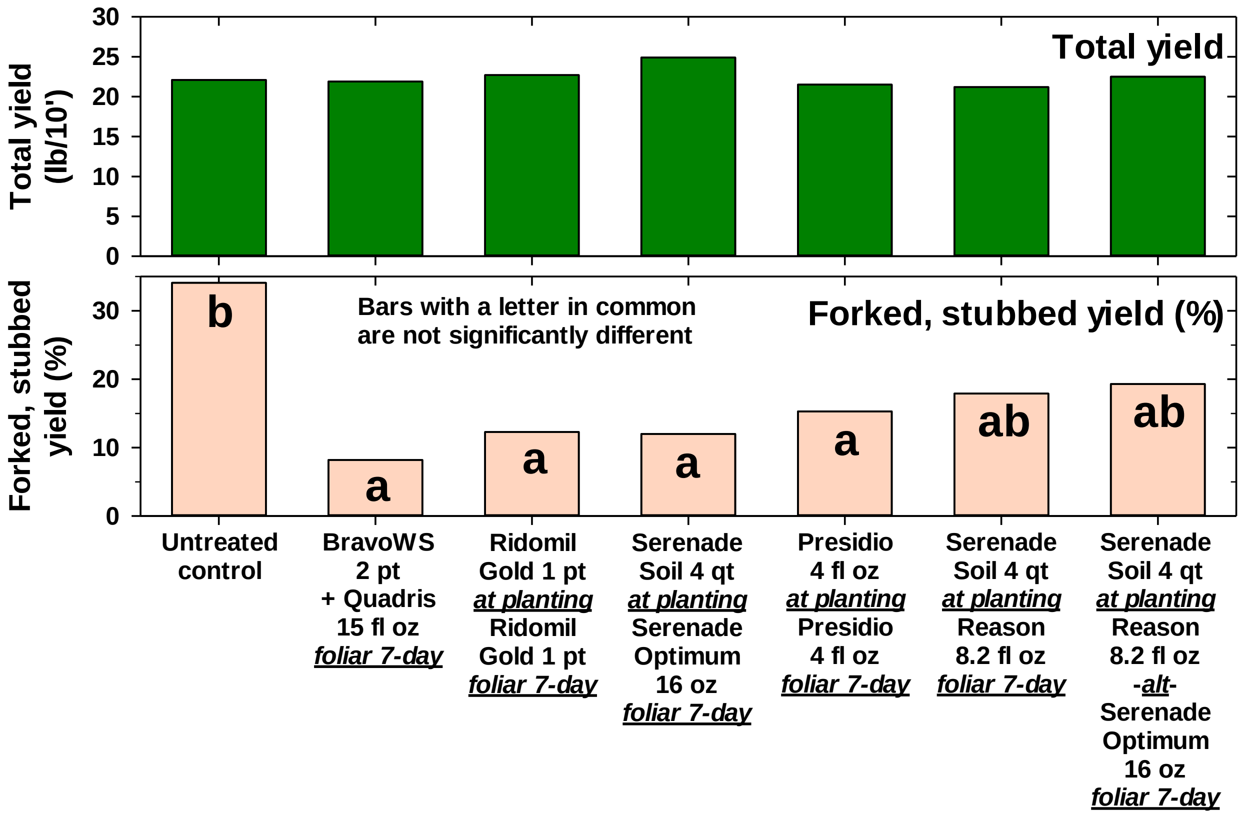

Fig. 4. *Evaluation of fungicides applied in a band at planting and as 7-day foliar sprays for control of Pythium forking and stubbing of carrots.*

Acknowledgements. This research was supported by funding from the Michigan Carrot Committee, and by a State Block Grant administered by the Michigan Carrot Committee.

Managing Plant-Parasitic Nematodes with Cover Crops in Michigan

Fred Warner, Diagnostic Services
578 Wilson Rd., 117 CIPS
Michigan State University
East Lansing, MI 48824-6469
517-432-1333 -- fwnemalb@msu.edu

INTRODUCTION

Plant-parasitic nematodes are microscopic roundworms that feed on plants. The longest plant-parasitic nematode in Michigan is the corn needle nematode that measures almost 6 mm in length (*ca.* ¼ inch). Every described plant species has at least one nematode parasite. Most plants are fed upon by multiple species of nematodes. Feeding by plant-parasitic nematodes typically results in the production of symptoms. Most of these symptoms are not characteristic therefore, plant-parasitic nematode problems often go undiagnosed. This can be costly as feeding by nematodes on many host crops can result in significant yield losses of 50% or more.

Since this presentation is in the carrot session, the plant-parasitic nematode of emphasis is the northern root-knot nematode (NRKN). Root-knot nematodes are serious pathogens of carrot because they affect quality and quantity. Infected carrots are often stubby or forked, reducing marketability. Galls, which are small swellings on feeder roots caused by northern root-knot nematodes, are characteristic symptoms caused by these parasites. There are other important nematode parasites of carrot such as: carrot cysts; lesion and pin nematodes. Controlling these nematodes may require different strategies and tactics than those recommended for managing NRKN.

NORTHERN ROOT-KNOT NEMATODES

Northern root-knot nematodes are important pathogens of fruit, landscape/nursery and vegetable crops in Michigan. They also parasitize many row crops but losses on these plants due to NRKN are usually minor. Many vegetables are extremely susceptible as just the detection of NRKN in a soil sample is a concern for carrot growers where qualitative losses can exceed 50% in infested fields. Nurseries often suffer significant losses as reports of 75-100% culled daylily roots have occurred due to NRKN infestations. On a world-wide basis, root-knot nematodes including NRKN, cause greater economic losses than any other types of plant-parasitic nematodes.

Grasses are non-hosts for the NRKN. Many grasses (Poaceae) are utilized as cover crops and they are the best choices if a major objective is to manage NRKN. They work as pest starvers. All dicotyledonous plants should be considered hosts unless they have been screened against these nematodes and reported as non-hosts. African and French marigolds are also effective pest starvers even though they are dicots. As mentioned previously, if management of NRKN is imperative, most dicots should be avoided. It should be noted that dicotyledonous plants differ greatly in their susceptibilities/tolerances to NRKN and in the numbers of these nematodes they will support. The latter becomes clear after examining the data provided in the table below.

Plant species that are most often employed as pest gassers are good to excellent hosts for the NRKN. They really should be avoided. Edible radish can be used as a pest trapper for NRKN but very careful monitoring of the nematodes within root tissue is imperative if this tactic is to be used effectively. Radish can go from seed to harvest prior to NRKN going from egg to egg. However, if the radishes are left in the ground too long, NRKN females will produce eggs and the trapping is inadequate. The roots must be removed from the soil prior to any egg production for this type of trapping to be efficient. The trapping works only if the radishes are harvested prior to egg production because the nematodes are "trapped" within the roots and are then physically removed from fields. While some cultivars of oilseed radishes are very effective pest trappers for sugarbeet cyst nematodes, they do not function in this manner against NRKN.

The question is often asked, “How long should I grow a cover or rotational crop to control nematodes?” This could be expanded to include the length of time required to drive nematode numbers below damaging levels. The answer to this question generates two new questions. 1) How quickly do the nematode species present decline under a non-host or poor host? 2) How susceptible is the main crop(s) to the nematode species? Root-knot nematodes do not possess extended survival stages like cyst nematodes so typically a year or two of a non-host should be adequate to reduce their population densities below damaging levels. The initial population density plays a role in this decision. The more nematodes present, the more time out required. The susceptibility of the main crop is critical to address. Carrots are very susceptible to NKRN, so ideally they are below detectable levels prior to growing this crop without the use of a nematicide(s). Soybeans, for instance, will tolerate some feeding by NRKN so it is not necessary to drive their numbers so low. Of course, to assess NRKN (as well as all plant-parasitic nematodes) population densities, it is necessary to collect soil and root samples and have the samples processed in a Nematode Diagnostic Lab such as the one at MSU. As a rule of thumb, the more susceptible the main crop is to a particular species of plant-parasitic nematode, the longer the time recommended in a non-host crop including cover crops and the more important it is to sample for nematodes in an attempt to avoid significant yield losses.

Mean numbers of northern root-knot nematode second-stage juveniles and eggs recovered per gram of root tissue from a greenhouse study after 9 weeks. Average dry root weights also included.

		northern root-knot nematodes/g root tissue					
		second-stage juveniles		eggs		dry root weights (g)	
species	variety/type/line	X	SE	X	SE	X	SE
alfalfa	Foregrazer	867.50	361.47	68.75	31.92	0.80	0.054
alfalfa	L447 HD	361.25	128.86	156.25	74.02	0.65	0.060
alfalfa	L449 APH2	530.00	125.22	10.00	5.00	1.13	0.013
white clover	Kopu II	3241.25	609.98	146.25	44.74	0.25	0.106
red clover	mammoth red	6225.00	931.48	761.25	215.26	0.15	0.035
red clover	medium red	4866.25	1929.92	90.00	69.28	0.25	0.035
white clover	Dutch white	630.00	259.32	67.50	32.10	0.17	0.019
yellow sweetclover	yellow blossom sweet	1767.50	655.40	445.00	219.18	0.73	0.043
mustard	Caliente 199 blend	8220.00	1199.01	1290.00	332.70	1.20	0.058
brown mustard	Kodiac	13500.00	2091.80	3510.00	684.95	0.60	0.035
yellow mustard	Pacific Gold	18240.00	1858.67	2680.00	249.53	0.53	0.031
oilseed radish	FumaRad	7905.00	1723.11	2870.00	774.83	0.88	0.083
oilseed radish	Cannavaro	13040.00	1074.31	2520.00	354.96	0.40	0.054
oilseed radish	Carwoodi	1475.00	401.84	585.00	206.29	2.48	0.152
oilseed radish	Defender (certified)	86.25	19.08	5.00	1.77	3.88	0.500
oilseed radish	Ground Hog	405.00	61.93	50.00	11.73	1.35	0.116
oilseed radish	Pile Driver	491.25	42.41	102.50	16.63	1.25	0.242
oilseed radish	Respect	710.00	200.69	40.00	11.55	4.43	0.189
oilseed radish	Tajuna	906.25	221.48	113.75	34.78	3.78	0.239
oilseed radish	Toro	630.00	111.84	35.00	10.31	3.13	0.333
rapeseed	Dwarf Essex	26.25	12.31	0.00	0.00	5.83	0.373
Italian ryegrass	Feast II	0.00	0.00	0.00	0.00	9.78	0.715
soybean	Pioneer 92Y91	435.00	80.43	0.00	0.00	0.98	0.109
soybean	Peking	611.25	161.35	35.00	10.31	1.85	0.151
soybean	PI 88788	33090.00	5165.05	4570.00	1606.08	0.53	0.055

BENEFICIAL NEMATODES

It is estimated that a shovel full of garden soil may contain up to 1,000,000 or more nematodes. Usually, almost all of these nematodes are beneficial as they feed on bacteria, fungi or other microorganisms. Practically all soil inhabiting nematodes are microscopic but, regardless of their sizes, nematodes play huge roles in soil ecosystems.

The rhizosphere of roots is typically dominated by bacteria or fungi (also protozoans). In annual cropping systems, bacteria are dominant in the rhizosphere and colonize the surfaces of roots. In perennial systems, especially those where trees are dominant, fungi can dominate although bacteria are common in these habitats also. Therefore, the types of beneficial nematodes found in these habitats will differ.

Plants grow better in the presence of beneficial nematodes particularly species that feed on bacteria. Bacteria often have higher concentrations of nitrogen within their cells than needed by nematodes, so nematodes need to excrete this extra nitrogen. Bacterial-feeding nematodes excrete the excess nitrogen from their bodies often as ammonia. Since nematodes feed on bacteria colonizing the surfaces of roots, ammonia is released right in these areas making it readily available to plants. This constitutes a more effective way to feed plants instead of dumping nutrients into the soil at one or two times during a growing season. It's similar to the way mineralization occurs after growing a legume and why these plants provide nitrogen credits; nutrients are pulsed into the soil over an extended period of time. Feeding plants steadily is more optimal than giving them large amounts of nutrients infrequently. This is probably true for most living organisms.

Most beneficial nematodes are found in the "O" horizon of the soil where the majority of the microorganisms are found. As a general rule of thumb, the abundance of microorganisms decreases as soil depth increases. Cover crops are often used to increase numbers of beneficial organisms because the evidence is quite conclusive that as soil organic matter increases, biological abundance and diversity follows suit. Think of growing cover crops as providing food for your friends.

CONCLUSION

It is very important to recognize that not all plant-parasitic nematodes are the same. There is no one magical cover crop that will control all types of these important plant pathogens. Before choosing a cover crop, if nematode control is an important objective, it is critical the types of nematodes present in any given location are properly identified. Proper cultivar selection is also important. If managing plant-parasitic nematodes is not an objective, most cover crops will provide food for your friends unless you're trying to take them out using pest gassers. Respiratory poisons really don't discriminate.