UMass Extension
Vegetable Notes
For Vegetable Farmers in Massachusetts since 1975

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In this issue:

Crop conditions

Subsoiling in many grain and potato fields is done, and some mixed vegetable fields have the look of cake batter after being plowed last week between the snow and rain. Fruit growers did not appreciate the late cold and snow, as low temperatures damaged blueberry and apple buds that had begun to emerge. Asparagus growers fared better—many Pioneer Valley growers were concerned that spears would come on too early after the mild winter, but the recent cold may have held them off and set the season back on track. The first spring plantings are going in the ground, including peas, potatoes and some early transplants like lettuce and beets. Greenhouses are starting to bust at the seams with starts for the field and for direct marketing to gardeners. High tunnels are being cleaned up and fertilized after a productive winter, getting ready for tomato, pepper, and cucumber crops. In warmer parts of the state, alliums are slated to go out in the field soon as well; which brings us to the first pest alert of the season: first emergence of seedcorn maggot has occurred in many parts of the state and cabbage root maggot is expected to emerge soon as well. Yellow rocket (*Barbarea vulgaria*) is in bloom in Southeastern MA which is a signal to start looking out for adult maggot flies.

Yellow rocket flowering means maggot fly adults may be active!

Pest alerts

Multiple: Seed corn maggot has the earliest emergence of the maggot flies at 200 GDD (base 40°F) and peak flight (50% emergence) is 360 GDD. Emergence has likely begun in many parts of the state. Larvae feed on seeds and young seedlings of many large-seeded crops (corn, beans, beets, peas, spinach, onions, cole crops, etc.). Like other maggot flies, adults prefer to lay eggs in cool, wet soil high in organic matter. Eggs hatch within 2-4 days at soil temperatures of 50°F. Row covers can help, but only if flies are emerging from overwintering sites outside of the field. Eric Sideman of Maine Organic Farming Association noted: "If you need to replant, wait at least 5 days if maggots that you find are a quarter inch long; if they are smaller than that, wait at least 10 days to make sure they have pupated and will not damage the new seeds."

Brassicas: Cabbage root maggot is next to emerge, at 288 GDD (base 40°F). Adult flies are active in some locations around the state (Table 1) and can be monitored using yellow sticky cards. Look for medium sized, gray, hump-backed flies with stiff hairs on their backs. No scouting has been done yet this year, so there are no reports from the field.

Alliums: Onion Maggot first emergence is slightly later than cabbage maggot at 390 GDD (base 40°F) and are not currently active but will likely begin to emerge in the next two weeks if warm weather continues.

UMass Plant Diagnostic Lab ready to serve you in a new location

A reminder for the fast approaching 2016 season... the UMass Plant Diagnostic Lab **has moved back to the UMass Amherst campus**. Although the setting has changed, we will continue to provide our green industry clients with accurate

and timely disease diagnostics.

The new location is in the basement of French Hall, Room 3. To deliver samples, drive up Thatcher Road from North Pleasant Street; French Hall is on the left just after the Franklin Dining Hall. Turn into the rear parking lot (lot 62) - there is a designated short-term parking space next to the back door for Diagnostic Lab clients. Metered parking is also available.

Nematode samples may be submitted at the French Hall lab or taken directly to Dr. Rob Wick in Stockbridge Hall, Room 209.

For complete information on our services, fees, and instructions for collecting samples and submitting samples by mail, go to the Diagnostic Lab web site at ag.umass.edu/diagnostics. You can also call the lab at 413-545-3209.

We look forward to working with you this season!

NORTHERN ROOT KNOT NEMATODES IN VEGETABLE CROPS

Carrots can be rendered unmarketable due to knot formation. R.L. Wick

Introduction: Nematodes are microscopic roundworms that occupy a vast array of ecological niches and have many different lifestyles. Of the more than 25,000 species of nematodes on earth, only a handful are known to feed on plants in the northeastern US. The plant pathogenic nematode species of greatest concern to vegetable growers in the region is the Northern Root Knot Nematode (NRKN), *Meloidogyne hapla*. NRKN feed on plant roots and are capable of causing damage to almost all vegetable crops. Unlike the Southern Root Knot Nematode (*M. incognita*) and a few other species found primarily in the southern US, NRKN is capable of surviving the freezing temperatures of New England winters.

Life Cycle: NRKN can be introduced by infested transplants, but the nematodes also overwinter as eggs in the soil. The eggs hatch when soil temperatures reach approximately 65°F (18°C), but embryo development may begin at temperatures <50°F (10°C). The juveniles molt four times, once inside the egg and three times after hatching; the last molt results in an adult. Juveniles are no more than 0.5 mm long and enter into the root where they establish a feeding site next to the vascular system. The nematode remains sedentary, feeding in one site while undergoing successive molts until the adult stage. The adult is almost always a female and sac-like in shape. Their feeding induces formation of the characteristic root galls. A single female can lay a thousand eggs which are extruded to the surface of the root in a gelatinous matrix. At optimum temperatures (80°F), the life cycle is completed in 3-4 weeks, so the population of NRKN in the soil can increase significantly in a short time.

Knots formed on roots of a pepper plant. R.L. Wick.

Symptoms and Signs: Symptoms may include stunting, wilting in the hottest part of the day, yellowing, loss of vigor, and uneven growth. Root crops such as carrots typically become forked (Fig 1). Symptoms are typically unevenly distributed in the field as individual nematodes do not move far; symptoms may begin as small patches, but these may enlarge as the nematode population increases.

NRKN feeding induces formation of characteristic root galls, which interfere with proper root function. Feeding activity also robs plants of nutrients and causes wounds through which other pathogens may enter. Plants seldom die from nematode infestation alone, but nematodes can have a serious impact on plant health and crop yield. NRKN damage is also known to increase the severity of disease caused by some plant pathogenic fungi, particularly species of *Verticillium* and *Fusarium*.

If nematode damage is suspected, examine plant roots for galls (Fig 2). The number of root galls is dependent upon the nematode population density and the species and cultivar of the host. NRKN galls about 1/8th inch in diameter but may be larger. Don't mistake the nodules on legumes for root-knot galls- the roots of these plants develop these nodules as they form beneficial associations with soil bacteria. Club root of brassicas also resembles root-knot nematode galls but club

root galls are larger.

Control: The best way to manage NRKN in vegetable fields involves developing an integrated pest management (IPM) plan that may include crop rotation, cultural controls, and pesticide applications.

Crop rotation: Almost all vegetable crops are highly susceptible to NRKN, with a few exceptions. Asparagus and small grains are relatively resistant to NRKN. Corn is also not considered to be a host in the Northeast, although it has been reported as a host in the Pacific Northwest. Brassicas are generally less susceptible to NRKN than other vegetable families. Two studies have shown that a three year rotation with onions and barley can significantly reduce NRKN damage on carrots in organic soils. Consider growing early crops such as lettuce, peas, spinach, or radishes, as they grow mainly in the cooler weather of spring before NRKN activity reaches its peak.

Resistance: Cultivars of several vegetables (most notably tomatoes) are marketed as nematode resistant; however, this designation refers to nematode species other than *M. hapla*. Currently, there are no NRKN resistant cultivars available for common vegetable crops.

Cultural control: Destroy infested plants at harvest, do not compost them. Control weeds as some common species (including dandelion, purslane, and plantain) are also hosts for NRKN. Increase soil organic matter: in addition to improving soil structure and boosting plant nutrition, this increases microbial competition and populations of natural enemies in the soil. Plants growing in fertile soils are able to withstand nematode infestation better than those grown in poor soils. Do not move infested soil to an uninfested area- clean tools, tractors, and boots before moving from one area to another.

Conventional control products: Telone and Vapam are available for pre-plant soil fumigation. Vydate is labeled for use on solanaceous crops in Massachusetts. Choices are limited as many conventional nematicides have been removed from the market due to their toxicity. Fluensulfone, a new nematicide chemistry, has recently been released under the name Nimitz. Nimitz is not a fumigant, and is labeled for cucurbits and solanaceous crops.

Organic control products: Several OMRI approved products, such as DiTera, MeloCon, and NemaKill, are available for nematode control; however, evidence of effectiveness is often lacking.

Biofumigation: Certain brassica species can be used as biofumigants to suppress NRKN. Research has shown that biofumigation can be effective; however, it also impairs the activity of *Steinernema feltiae* and other species of beneficial nematodes that are used to control certain insect pests. For more information, see this factsheet from Cornell University.

Threshold Levels: NRKN populations and the levels of damage they cause may be influenced by temperature, rainfall, soil type, plant nutrition, crop/ cultivar susceptibility, and pesticide applications. Accurate threshold levels are difficult to establish because of these variables.

Field Assay: Researchers at Cornell University have developed a simple field assay growers may use to estimate the severity of NRKN infestation in a field. For more information, see this factsheet from Cornell University. Keep in mind that this assay will only detect root knot nematodes- other species of plant pathogenic nematodes may also be present.

Accurate diagnosis is crucial to the development of an effective control program. Soil samples can be examined for root knot juveniles and other species of nematodes. If root galls are present, the roots and soil may be submitted for analysis. For information on submitting samples to the UMass Extension Diagnostic Laboratory for nematode analysis, please see http://ag.umass.edu/plant-problem-diagnostics/vegetable-floriculture-diagnostics

-by Angela Madeiras, UMass Plant Disease Diagnostician and Rob Wick, UMass Plant Pathologist

PEST CONTROL PREPAREDNESS

The season is heating up (and cooling down…and heating up again!). Where tender spring crops are emerging, pests will be right behind. You've been seeding your new resistant varieties, shaking out the row cover, rotating into new fields, and polishing up your sprayer—have you made sure you've got what you need on the shelf? Now is a good time to assess your supply of pesticides and adjuvants, and make sure you're ready to go when the pests arrive.

The shelf life of pesticides and adjuvants varies and is dependent upon the conditions under which products have been stored, but on average is two years. These products can degrade over time, as can their containers, especially under extreme temperatures. Ideally, you would purchase only enough pesticides to get you through a single season, as the safest way to dispose of these chemicals is to use them up, applying them to their intended targets according to the label's instructions. If you find that you are routinely storing pesticides over multiple growing seasons, talk to your dealer about special-ordering smaller-sized containers, or work with other growers in your community to share a larger container if the product is general-use. Always keep products in their original containers with their pesticide labels attached, and place them in secondary containment when transporting between locations.

Good pesticide storage means keepingsolids stored above liquids, using secondary containment like a plastic bin for liquids and a plastic bag for solids, making sure things are clearly marked and have the label attached. Photo from UC-ANR

If pesticides were stored through the winter, they should have been stored between 40° and 100° F in a relatively dry place. They should be kept in a lockable room or cabinet that is clearly marked for pesticide storage, on plastic or metal shelves – wood is not ideal as it will absorb spills. Always refer to the label for specific storage instructions.

Liquid formulations should be stored inside of metal or plastic bins in case their original containers break or corrode. Liquids should never be stored above powders as they may leak and cross-contaminate these products. Allowing liquid pesticides to freeze can result in separation or inactivation of the ingredients. This guide to *Cold Weather Storage and Handling of Liquid Pesticides* from Montana State University provides a chart of many common pesticides and their tolerances for freezing/thawing, as well as how to handle frozen products to maximize their efficacy.

Powders, dusts, and granules must be kept dry. Excess humidity will cause wettable powders to harden and prevent them from properly going into suspension. If a dry product may be damaged by moisture, a quick way to check if it will go into suspension is by adding a small sample to water in a mason jar at the same rate that you would apply it in the field, capping it tightly, and shaking it. You will be able to see if it is able to dissolve. If it won't dissolve in the jar, it won't dissolve in a tank mix either, and you would end up spraying weak or inconsistent concentrations on your crops.

Check stored pesticides for these signs that they may no longer be effective:

Formulation	Signs of breakdown
Oil sprays	Sludge forms, solution separates
Emulsifiable concentrates	Addition of water does not produce a milky solution
Wettable powders	Lumping, powder will not mix with water
Dusts and granules	Excessive lumping
Aerosols	Generally effective until nozzle clogs or propellent is dissipated

(*Table from Cornell Pesticide Safety Education Program fact sheet, "Shelf Life of Pesticides"*)

Keep a record of what you have and in what quantities, and when you purchase new materials, write the purchase date on the container. Be sure that the label and all of the use instructions are in good condition and are legible. Labels may also have been updated to reflect current research, such as the product's environmental or pollinator precautions or number of applications per season or use rate. New, current labels can be obtained from your pesticide dealer, or can be found on-line at manufacturer's websites or the Crop Data Management Systems searchable database at http://www.cdms.net/

LabelsMsds/LMDefault.aspx.

If a pesticide is expired or degraded, or if it is no longer registered, it is considered hazardous waste and must be disposed of through the proper channels. Make arrangements to dispose of unwanted or unusable pesticides. Currently Massachusetts does not have an active statewide pesticide disposal program. Contact your city or town office or regional waste management group for information on hazardous waste collection events and local facilities. The Massachusetts Statewide Contract for Hazardous Waste Disposal lists these vendors: Clean Harbors, New England Disposal Technologies, Stericylcle Environmental, Triumverate Environmental.

For more information on pesticide storage and waste guidelines from MDAR, see:

Pesticide Storage Mixing and Loading Guidelines for Applicators

Hazardous Waste Requirements for Commercial Pesticide Users

Maintaining good records of your pesticide inventory and usage will tell you how much of a product you used and how much you need to purchase each year, and will also help you figure out what worked and what didn't. Beyond that, records of your usage are required by the EPA Worker Protection Standard (WPS).

More on WPS…This regulation was recently revised to improve protections for workers and provide better guidance for employers. Farms will have to comply with the majority of the revisions to the WPS on January 2, 2017, but must remain in compliance with the existing law until that date. The law requires that workers and handlers are trained by either a certified pesticide applicator or someone who has completed an EPA Train-the-Trainer program (currently workers must be trained every 5 years; the new law mandates annual training). Other current WPS requirements are to maintain a central posting area accessible to all workers where pesticide labels with safety data and information on when and where pesticides have been applied on the farm within the last 30 days can be found. Employers must also provide personal protective equipment, decontamination supplies, and emergency assistance in the case of exposure. See EVENTS this issue for upcoming UMass Extension WPS training opportunities.

-Lisa McKeag, Umass Extension Vegetable Program

WIREWORMS IN VEGETABLE CROPS

Wireworm larvae take 2-5 years to mature in soil. M. Spellman

Corn wireworm is reported to be the most common wireworm species in the Northeast, but others may also be present including the tobacco wireworm, (*Conodoerus verspertinus*). Wireworm causes damage to vegetable crops including cabbage, corn, lettuce, pepper, potato and sweet potato, as well as field crops including field corn, sorghum, soybean, tobacco, and wheat. Wireworms are attracted to CO_2 released by germinating seeds, and can be a pest in large-seeded crops such as beans, peas and corn. Wireworms are the underground larval stage of click beetles, which are elongated, brown beetles that snap their bodies to make a clicking sound. Larvae are slender, yellow-brown, hard-shelled, and shiny, with three pairs of legs.

Adult click beetles emerge in May-June. D. Ferro.

Life Cycle: Adults emerge from the soil in May and June, hiding during the day and flying at night. Each female can lay 200-400 eggs on the soil surface down to a depth of 6 inches, preferring grassy or weedy fields. Larvae hatch within 3-7 weeks and then spend **2-5 years** in the soil before becoming an adult. They feed on other insects, roots, seeds, tubers, and other plant tissue. Wireworms prefer wet soils and moderate temperatures (at least 70°F); they migrate upwards in soil to reach warmer, moist soils, and down to avoid excessive cold, heat, drought, or saturated soils.

Damage: Due to their long and variable lifecycles, infested fields will likely contain wireworms at all stages of their life, and the larvae begin feeding at 1-2 years old. Wireworm problems occur most often in fields that were forested, in hay, pasture or sod, had grassy weeds, were in grain production, or were planted with high residue grass cover crops (eg. sorghum sudan or winter rye) within the past 3 years. Larvae feed on roots of many crops, where they can cause damage to growing seed-

lings or kill plants outright. Crops with starchy underground structures like potatoes can be rendered unmarketable due to tunneling caused by wireworms.

Avoidance and Control: Unfortunately, practices that enhance organic matter in the soil may actually worsen wireworm problems. The most important method of wireworm control is to avoid planting potatoes or other susceptible crops into infested fields. So, avoid fields with a long history of grasses. Rotating with buckwheat or brown mustard may help to reduce wireworm populations. In the spring, baits using corn, wheat or rolled oats placed 6 to 8 inches deep can be used to determine if wireworms are present, but this sampling method is labor intensive, and potatoes are often planted early spring, before such samples could be completed. Cultivation in July-August can be effective in killing pupae, but not larvae or adults. There are varieties of potato (Cherry red, Yukon Gold, Maris Piper, Whitu, Alamo, Anco) and sweet potato (Ruddy and Charlseton Scarlet) that have some resistance to wireworm damage. In one university trial, Beauregard and Covington sweet potato cultivars were found to be highly susceptible. This resistance may be due to high glycoalkaloid and low sugar content near the skin. A review of many insecticide trials over two decades indicated that organophosphate insecticides applied as a pre-plant broadcast or in-furrow treatment gave better control than carbamates, and that fipronil (phenyl pyrazol) and bifrenthrin (pyrethroid) were as effective as the organophosphates, but with less environmental impact and potential human safety concerns. For organic growers, the product PFR-97, containing the active ingredient *Isaria fumosorosea* Apopka Strain 97, a fungal bio-control which penetrates the wireworm larvae cuticle, may be used.

Resources:

Evaluation of Advanced Sweet potato Genotypes for Resistance to Soil Insect Pests, 2013. D. Michael Jackson and Howard F. Harrison USDA–ARS, U. S. Vegetable Laboratory, Charleston, SC. http://amt.oxfordjournals.org/content/amt/40/1/M1.full.pdf

Wireworm Biology and NonChemical Management in Potato in the Pacific Northwest. N. Andrews, M. Ambrosino, G. Fisher, and S.I. Rondon; Oregon State University, PNW 607 December 2008. https://catalog.extension.oregonstate.edu/sites/catalog.extension.oregonstate.edu/files/project/pdf/pnw607.pdf

Wireworm Pest management in Potatoes. Thomas P. Kuhar, Hélène B. Doughty, John Speese III, and Sara Reiter; Department of Entomology, Virginia Tech, Eastern Shore AREC, 2009. Pub#: 2812-1026. http://pubs.ext.vt.edu/2812/2812-1026/2812-1026.html

-Updated by Katie Campbell-Nelson, 2016

Events

EPA Worker Protection Standard Train-the-Trainer Courses for Organic and Non-Certified Pesticide Users

When: Wednesday, April 27th, 20161 from 8am to 11am
Where: Country Club of Pittsfield, 639 South Street, Pittsfield, MA 01201

When: Thursday, May 12th, 2016 from 8am to 11am
Where: Hadley Farms Meeting House, 41 Russell Rd, Route 9, Hadley, MA 01035

All farmworkers must be trained under the EPA Worker Protection Standard (WPS) if your farm uses any pesticides, including those approved for organic production and other general use pesticides. The agricultural worker employer is responsible for complying with all components of WPS including the training of farmworkers. This training can only be provided by an individual who has a pesticide certification license or has attended an approved EPA WPS Train-the-Trainer workshop.

The train-the-trainer workshops are 3 hours long and will be held in Pittsfield, Hadley, Marlborough and East Wareham. The registration fee is $28.00 per person. Participants will received the EPA WPS How to Comply Manual, WPS Pesticide Record Keeping book, EPA WPS Safety Poster, EPA WPS Trainer's Manual, Certificate of Attendance, and the ability to train farmworkers in WPS.

For information on registering for these workshops please refer to our website at www.umass.edu/pested

Please contact Natalia Clifton, UMass Extension , 413-545-1044 or email nclifton@umass.edu

Sponsored in part by the UMass Extension Risk Management/Crop Insurance Education Program.

Conservation Biological Control Short Course Sponsored by the Xerces Society, NE-SARE and USDA-NRCS

Where: Bristol County Agricultural High School, Dighton, MA
When: Thursday May 5th, 9am to 4:30pm

In response to growing interest in promoting beneficial insects for their pest control services on farms, the Xerces Society has authored the book Farming With Native Beneficial Insects and developed the Conservation Biological Control Short Course to educate farmers, agriculture employees, natural resource specialists, land managers, and conservation organization staff. Skills and objectives include:

The importance of beneficial insects - predators and parasitoids that attack insect pests.

Overview of conservation biological control and integrated pest management (IPM).

How to identify beneficial insects and distinguish them from other insects.

How to recognize the habitat needs of beneficial insects and identify habitat deficiencies.

The design and implementation of habitat improvements, including site preparation, insectary strip plantings, hedgerows, beetle banks, and more.

The current best management practices that minimize land-use impacts on beneficial insects and mitigate exposure to insecticides.

How to access USDA conservation programs for financial and technical support.

Participants will receive the Xerces Society's Conservation Biological Control Toolkit which includes habitat installation guidelines and other relevant publications, and the Xerces' book, Farming with Native Beneficial Insects.

Certified Crop Advisor (6 CEUs) and Pesticide Applicator Continuing Education (PACE) (5 CEUs) Available.

Contact: Jillian Vento, The Xerces Society at 503-232-6639 or pollinators@xerces.org

THANK YOU TO OUR SPONSORS

Vegetable Notes. Katie Campbell-Nelson, Lisa McKeag, Susan Scheufele, co-editors.