UMass Amherst EXTENSION

Berry Notes

Prepared by the University of Massachusetts Fruit Team

December 2009 Vol. 21, No. 12

www.umass.edu/fruitadvisor/berrynotes/index.html

Massachusetts Berry Notes Underwriters:

Berry Notes is edited by Sonia Schloemann with articles written by other contributors with attribution; sources are cited. Publication is funded in part by the UMass Extension Agriculture & Landscape Program, subscription fees and corporate underwriting. Questions can be directed to Sonia Schloemann at 413-545-4347, sgs@umext.umass.edu. Please cite this source if reprinting information that originates here.

IN THIS ISSUE:

Editors Note:

NEV&FConference a Success: Thanks to all who participated in the recent New England Vegetable & Fruit Conference. Record attendance was achieved (1,500+), many excellent presentations were given, and more networking and farmer-to-farmer opportunities than ever. Let's all look forward to an outstanding year in 2010!

Time to renew: Once again we've come to subscription renewal time for Massachusetts Berry Notes. Subscription costs remain at $10 per year thanks to the generous underwriting by Nourse Farms. Your subscription fee helps support the production of the newsletter as well as other educational activities. Stay in touch with what is happening and renew your subscription today!

Go to www.umass.edu/fruitadvisor/fruitsubscriptions.htm.

Cornell Berry Webinar Series

January 6, 2010 - 12:45 PM EST
Bramble Production

Growing Brambles in High Tunnels
Dr. Marvin Pritts, Cornell University

Rotating Cross Arm Trellis for Brambles
Dr. Fumiomi Takeda, USDA ARS Kearneysville

Register by contacting Laura McDermott at lgm4@cornell.edu.
Or go to www.fruit.cornell.edu/Berries/webinarindex.htm

Strawberry Nutrition: The ABCs of NP&K

David Handley, UMaine Extension

The strawberry plant is an herbaceous perennial. In New England, the plants typically exhibit leaf growth early in the spring, followed by flower bud emergence. The plants bloom and then fruit during the late spring early summer. Following a brief "rest" period after fruiting, the plants typically enter a phase of vegetative growth in the summer, including leaves and runners. As the daylength gets shorter and the temperature gets cooler during the late summer and fall, the plants start to produce fewer runners and more branch crowns, and develop fruit buds. The plants concentrate nutrients and carbohydrates in the crowns during the fall as the leaves senesce and the plants go dormant for the winter. As the growth of the strawberry plant changes during a season, so too do its nutrient demands. A strawberry grower should be aware of the changing needs of the plants and develop a fertilizer program that can meet those needs at the optimum time and in the optimum amounts. This will both promote excellent plant growth and utilize fertilizers as effectively and efficiently as possible.

A nutrient program begins with the soil. Careful attention to soil type, preparation and stewardship will encourage good plant growth and reduce stress. Regular testing of the soil to monitor its nutrient status and overall health is critical to maintaining good plant performance in the long term. Soils consist of several components, including minerals, organic matter, water and air. The type and amount of different minerals varies from one soil type to another. The solubility of these minerals and their availability to plants will also vary according to concentration, pH, temperature and other factors. Soil types that consist of mostly fine particles, such as silts and clays, hold more minerals than soils with larger particles, such as sand.

Organic matter is one of the most important components of any agricultural soil. Organic matter is basically decayed vegetable matter, including plant residues and manures, which are broken down by various soil organisms, primarily microbes. Organic matter is an important source of plant nutrients, including two of the three major nutrients: nitrogen (N), phosphorus (P) as well as minor nutrients, such as sulfur, and several micronutrients. Organic matter particles in the soil typically have a negative charge on their surface, which allows them to hold positively charged ions such as calcium, magnesium and iron. These ions can then be exchanged when they contact plant roots. Organic matter also plays an important role in binding the soil into friable clumps or colloids that make the soil more friable and allow air and water to move easily through. A good agriculture soil should contain a minimum of 2% organic matter. Levels of 6% or higher will provide optimal conditions for nutrient holding and exchange.

Water is another critical component of the soil. Water moves nutrients into and though the soil, and into the plants. Water also helps move minerals within the plant, and plays an important role in chemical reactions both in the soil and within the plant cells. Soils with finer particles (especially clay) can hold more water than soils with larger particles, but may drain poorly, and are difficult to get water into once they become dry.

A productive soil must also have plenty of air space. Plant roots need oxygen to survive and carry out their function of nutrient absorption. Air also provides a source of carbon and other ions the plant needs to build more complex compounds. Soils with large particle sizes tend to have greater pore space and thus more air. However, such soils also tend to have less water holding capacity and therefore are more susceptible to drought.

The three nutrients needed in the highest amounts by plants include **nitrogen** (N), **phosphorus** (P), and **potassium** (K). Typical granular fertilizer blends contain all three of these nutrients in various ratios and concentrations listed in the order of N, P and K. For example, a 10-10-10 fertilizer contains 10% nitrogen, 10% phosphorus and 10% potassium, respectively. Nitrogen is the most commonly applied nutrient because it is needed in relatively high amounts by plants, but most soils do not hold it in large available reserves. It is very soluble, so that any that is not soon taken up by the plants may quickly leach out of the soil.

The nitrogen available to plants in the soil occurs in two forms: the nitrate form (NO_3^-) and the ammonium form (NH_4^+). Nitrate is the preferred form for uptake by the plant. It is readily available for use and simple for the plant to metabolize. However, from a fertilizer perspective, it is more expensive than the ammonium form and more prone to leaching. Typical nitrogen fertilizers used on strawberries include urea (46% N), ammonium nitrate (34% N) and calcium nitrate (15% N). Organic growers often supply nitrogen by "front loading" or incorporating slowly available sources such as compost or green manures, which tend to have relatively low concentrations (2-3%). Other sources of nitrogen, both higher in concentration and more readily available to the plants, may also be used by organic growers, such as fish emulsion, dried blood or various dried plants meals (3-12% N), but these tend to be very expensive. The use of animal manures that have not been composted is not recommended. Although these may contain higher concentrations of nitrogen at a relatively low price, the risk of microbial contamination by organisms such as salmonella and E. coli is too great for fresh produce. No fresh manure should be applied to the soil within 120 days of harvest.

Nitrogen is an essential component in the synthesis of amino acids and proteins in the plant. As a fertilizer, it stimulates vegetative growth, such as leaves, petioles and shoots. Heavy applications are not recommended in the springtime because excess vegetative growth at this time will result in dense leaf canopy that will cover developing fruit, keeping it in a dark, cool wet microclimate, and encouraging the development fruit rot such as gray mold. In a matted row system, the majority of nitrogen fertilizer should be applied during the summer months, following harvest when new leaf and shoot (runner) growth is needed to re-establish good planting vigor for next year's crop.

During the planting year (assuming the general fertility and condition of the soil is good), a strawberry planting should receive 20 to 40 pounds of actual nitrogen per acre incorporated into the soil prior to planting. Another 30 pounds should be applied in late June to early July, and a final 20 pounds can be applied in late August to early September. Each of these applications corresponds to periods of growth in the plants. Calcium nitrate (CaNo3, 15% N) is the recommended source of nitrogen in new plantings because it is readily available, not volatile, and also provides calcium. For established beds, only 10-20 pounds of actual nitrogen, if any, should be applied in the spring. As part of the renovation process following harvest, 50 to 70 pounds of nitrogen per acre should be applied to the planting, followed by 20 to 30 pounds in late August to early September. If nitrogen is being applied through an irrigation system, typical in plasticulture systems, pre-plant nutrients should be incorporated into the soil as recommended. In the planting year, three to four pounds of actual nitrogen per acre should be applied through the irrigation system per week from mid-May through early September. In the fruiting years, apply approximately 10 pounds of nitrogen per acre per week from mid July through late August.

Phosphorus is important in order for the plants to store energy, and plays a role in fruit development. It is often present in adequate amounts for good strawberry growth, but much of it is not readily available to the plants because it gets tied up in both the mineral and organic fractions of the soil. As a result, it does not tend to move through the soil or leach very easily. As a fertilizer, it becomes available to the plants slowly, and should be worked into the soil prior to planting to improve its uptake. Strawberries don't have a very high phosphorus demand, and deficiencies are relatively rare in New England. Availability is reduced if the soil pH is too low, or other nutrients, such as calcium are out of balance. Soil tests should read 20 to 30 ppm for optimal phosphorus uptake.

Although potassium, the third major nutrient, is needed in relatively high amounts by strawberries, deficiencies are fairly rare in New England. Soils often have sufficient potassium reserves, with 120 to 180 ppm being optimum the optimum range. Potassium is an important component of strawberry fruit and helps the plants regulate water movement and enzymatic reactions. Like phosphorus, it is slowly available and should be worked into the soil prior to planting to improve its uptake. Potassium may compete with magnesium for uptake by the roots and must therefore be kept in an appropriate ratio (4:1, K: Mg) in the soil to prevent one of these nutrients from overriding the other and creating a deficiency. Most soil tests calculate a "Base Saturation" to measure the balance of potassium, calcium and magnesium.

Calcium (Ca) is the first of what are known as the "minor" nutrients needed by the plant. Levels of calcium are usually adequate in the soil if the pH is in the appropriate range (6.0-6.2). Soils with a low pH may become calcium deficient. Ground limestone applied to the soil prior to planting is the most common source of calcium, with soil test levels of 1000 to 1500 ppm being optimal. Calcium is essential for building cell walls and membranes in the plant. It is not very mobile in the soil, or in the plant tissue. It should be worked into the soil to improve uptake. Cool soil temperatures and dry, droughty

conditions will greatly limit the plants ability to take up calcium and may therefore induce a calcium deficiency even though adequate amounts are present in the soil. Calcium deficiencies are not uncommon in New England, especially in the spring. However, they can usually be attributed to cold soils, dry soils or low pH.

Magnesium (Mg) content of soils in New England varies greatly. Soil test levels of 120-180 ppm should provide optimal growth for strawberries. Availability of magnesium is reduced under low soil pH. Deficiencies in strawberry plants are not uncommon, but can be easily remedied. The most common source of magnesium is dolomitic or "high-mag" lime, which contains a significant percentage of magnesium, in addition to calcium. Epsom salts, also known as magnesium sulfate (MgSO4) is another way to add magnesium to the soil, and may also be applied to plants as a foliar spray. Potassium can compete with magnesium for root uptake, and should therefore be kept in an appropriate balance (4:1, K: Mg) to prevent one from causing a deficiency of the other.

In addition to the major and minor nutrients needed by the plants, some elements, while still required for good growth, are needed in only very small amounts. These are known as micronutrients. The most important micro-nutrients in terms of strawberries grown in New England include boron (B) and zinc (Zn). Others include iron, manganese, copper and molybdenum. Boron is essential for good root growth and pollination of the flowers. It is easily leached from the soil and is often deficient in New England. Although boron is often recommended as a nutrient supplement for strawberries, excessive levels can be toxic to the plants, so care must be taken to make sure that the plant has enough, but never too much. No more than one pound of actual boron per acre should be applied to a field in any year. Boron is often added to fertilizer blends of the major nutrients or applied in a foliar spray, such as Solubor (20% B).

Zinc, although needed in very small amounts by strawberry plants, is often deficient in New England soils, yet is very important in biochemical processes and fruit development. Zinc in the soil is more available to plants under low pH conditions. Heavy applications of lime and/or phosphorus can reduce the availability of zinc to the plants. The optimal level of zinc in leaf tissue is 35 ppm. It is typically applied as part of a fertilizer blend to the soil, or applied as a foliar spray, to help achieve uniform distribution of a small amount of material over a relatively large area.

Soil pH has a strong influence on nutrient availability, and should be regularly monitored and corrected as needed through applications of ground limestone or some other liming agent. A low pH or acid soil will have reduced availability of nitrogen, phosphorus, potassium, magnesium and molybdenum, while a high pH or alkaline soil will have reduced availability of zinc, boron, iron, manganese, and copper. To maintain nutrients at their optimum availability and balance in the soil, the pH should be maintained at 6.0 to 6.2, i.e., slightly acidic (7.0 being neutral). Limestone takes some time to go into solution and react with the soil to change the pH, so applications needed to significantly correct a very acid soil should be made well in advance of planting, and may be split over two to three years. The soil should be tested to monitor the pH every two to three years to assure that only small corrections will be needed at any one time. In general, soils in New England will tend to acidify over time, due to acid rain and fertilizer applications. For most soils, a "maintenance" application of two tons of ground limestone per acre per year, will keep the soil at a relatively stable pH.

For more information on strawberry nutrition, consult the Strawberry Production Guide, available from NRAES at nraes.org (607) 254-7654 or your state university Cooperative Extension. (***Source**: 2007 New England Vegetable & Fruit Conf. Proceedings – illustrations added)*

Strawberry Soil Stewardship

Marvin Pritts, Cornell University

Soil stewardship involves the maintenance of nutrient availability, soil physical properties and biological health, in addition to preventing run-off and erosion. In perennial strawberries, erosion is rarely a concern as fields are mulched continuously and prepared for planting only once every few years. However, much attention has been paid to the maintenance of nutrient availability. Soil tests and foliar analyses are routinely used to determine chemical amendments to be added. Soil scientists have also recognized the importance of soil physical properties, most notably the negative effect of compaction on plant health. More recently, scientists have begun to study how active biological processes in the soil (i.e. microbial activity) affect plant health. However, most of this work has focused on field and vegetable crops – very little information is available for fruit crops. We have been investigating how soil compaction and soil biology affect perennial strawberry root health.

Soil physical properties: Compaction

The effect of soil compaction on strawberry root health is unknown. In the absence of standing water, is compaction alone damaging to roots? How much compaction can strawberries tolerate? A field study, pot study and a farm

survey were used to better understand the relationship between soil compaction and perennial strawberry root health. In 2004, a virgin field received four preplant compaction treatments (heavy compaction, light compaction, no compaction, and subsoiling), with compaction imposed by a commercial-grade Stone Rhino road compacter. After planting, treatments were further subdivided and received three additional compaction treatments over the three-year life of the planting (management without any driven equipment, use of light equipment, and use of heavy tractor-powered equipment). Soil penetrometer readings taken over the three years reflected the various levels of imposed compaction. Stolon production and yield were recorded each year and effects of compaction on these variables were determined. Interestingly, soil compaction prior to planting had only a modest impact on yield. Relatively severe compaction between rows had a minimal effect on yield and fruit size.

Soils from three fields with a history of black root rot (eastern, central and western NY) were brought to Ithaca and subdivided into two lots. One lot was fumigated. Each of the soils was placed into 3 gallon pots and 5 levels of compaction were imposed using vermiculite to lessen compaction and mallets to increase compaction to a predetermined bulk density. One 'Jewel' was planted into each pot and grown for one year. Per plant yields were determined and root health was assessed after washing soil from the roots. Essentially, plants in fumigated soils had healthier roots, but compaction had only a slight effect on root health.

Soil penetrometer readings were taken from different-aged plantings (1 through 7 years old) at a pick-your-own strawberry farm that did not use tractor-powered equipment, to determine the cumulative effect of foot traffic on compaction. At this farm, soil compaction was similar regardless of planting age. Strawberries seem to be tolerant of moderate soil compaction in the absence of standing water. Also, the large amount of straw that is incorporated into strawberry rows each year, and the infrequent cultivation afforded by straw mulch, has generally prevented strawberry fields from developing severe compaction problems.

Soil biological processes: Replant problems

In July 2001, a study was established in a field with a 30-year history of perennial strawberry production to examine effects on replant disorder of 12 different species of preplant cover crops, soil fumigation (methyl bromide plus chloropicrin) and fallow management. In May 2002, strawberries ('Jewel') were planted into pots containing soils with the incorporated cover crops, grown for one year, then fruited. Strawberry yields in 2003 were highest in pots containing indiangrass (*Sorghastrum avenaceum*) and brown mustard (*Brassica juncea*) incorporated soils, resulting in 32% and 28%, respectively, higher yield than plants in pots containing untreated, bare fallow soil. Yield was lowest in fumigated soil or soil incorporated with sunnhemp (*Crotolaria juncea*), having 19% and 10% less yield than the fallow treatment, respectively.

In August 1999, a complementary study was established in a field with a 7-year history of continuous perennial strawberry production to examine the effects of single species and multiple species rotations on replant disorder, bacterial populations, and fungal pathogens over two fruiting years. Cover crop treatments included various monocultures and sequences of perennial alfalfa (*Medicago sativa*), brown mustard, kale (*B. oleracea* 'Winterbor'), sweet corn (*Zea mays* 'Saccharata'), rye (*Secale cereale*), hairy vetch (*Vicia villosa*), marigold (*Tagetes patula* 'Nemagone'), oats (*Avena sativa* 'Newdak'), and sudangrass (*Sorghum bicolor* x*S. sudanese*). These rotations were compared to the effects of fumigation using methyl bromide with chloropicrin (99:1), continuous strawberry, and bare fallow.

Symptoms of replant disorder developed in the continuous strawberry plots within a few months of planting. Plants in the fumigation treatment produced greater fruit yield than all other treatments in 2003, 139% more than plants from the continuous strawberry treatment. Strawberry plants grown in the kale/sweet corn/rye treatment had consistently high yield, and both the hairy vetch/marigold/rye and the oats/sudangrass/rye treatments led to marked improvement over the continuous strawberry treatment. Plants from the brown mustard treatment also were more vigorous and productive than plants from the continuous strawberry treatment during 2002, despite having relatively low foliar biomass and a relatively high level of fungal infection on strawberry plant roots. In the field, symptoms of replant disorder were best overcome by fumigation with methyl bromide or multiple species rotations, particularly that of kale followed by sweet corn and rye. Although *Rhizoctonia* levels were associated with poor root health, general fungal and bacterial root infection rates were not consistently associated with the presence of visible symptoms of replant disorder, nor with strawberry plant growth and productivity.

For the past 3 years, these results have been integrated into a study comparing cover crop rotations, compost amendments, and root dips with methyl bromide fumigation. The study was replicated at two farms each in Michigan and Maryland. Results suggest that managing the soil with cover crops and composts can maintain soil health and suppress harmful pathogens without reliance on fumigants.

Soil stewardship

Scientists are beginning to study the various components of soil health and learn which are critical for plant growth and yield. Managing these components, in many cases, does not require large amount of input. Preserving soil

quality with low external inputs is a key to a successful and sustainable agriculture. (***Source**: 2007 New England Vegetable & Fruit Conf. Proceedings)*

RASPBERRY

Biennial Raspberry Production

Kevin Schooley, Ontario Ministry of Agriculture, Food & Rural Affairs

Introduction

Biennial raspberry production has many benefits. These benefits include labour savings through the elimination of hand pruning and yields that compensate for the acreage that is not in production. The bottom line is more money in the grower's pocket and fewer headaches.

Research conducted in the late 80's at HES Simcoe under the direction of Adam Dale indicated that biennial raspberry production was a viable technique suitable for Ontario growing conditions. In these studies the yields of the biennial treatments were equal to or greater than the annual system over a five year period. Until now there has not been a suitable technique to remove young primocanes so this system has not been widely promoted. With the registration of Ignite (glufosinate ammonium) in 1996, this method of production is now possible in Ontario.

What is Biennial Raspberry Production?

Biennial raspberry production differs from annual production in that a portion of your planting is only allowed to fruit every second year. Some growers refer to this as alternate year mowing. Biennial production takes alternate row mowing one step further. The biennial system employs the same technique of mowing dormant canes after they finish fruiting. Additional management in the biennial system includes the maintenance of narrow rows during the vegetative year of growth and the use of primocane suppression during the fruiting year. A trellis or support mechanism for the cane is a necessity, not an option.

Why Does It Work?

For many years researchers and growers have know that for optimum yield raspberries must be managed with a cane density of approximately 15 canes per metre of row. The reasoning behind this practice is based on the fact that raspberry plants can only intercept so much light. Additional canes act as competition for the limited amount of light available. The use of primocane suppression eliminates much of the competition by reducing the number and height of the primocanes. With more light available you can now double the amount of fruiting canes which ultimately increases the yield dramatically.

Managing Biennial Production

The system will vary depending on whether you are starting with a new planting or adapting an old. If an existing planting is being converted, you must decide which rows or blocks of raspberries you would like to primocane suppress and fruit this growing season. Some growers mow every other row, while some alternate blocks. Mowing alternate rows can discourage pickers from wandering and picking off adjacent rows.

Transition Period

If you choose to start with a new planting, it is suggested that you plant half the acreage the first year with the other half planted the following year. This separates your planting into two blocks that can be managed accordingly. If you are moving into a biennial management system from an existing planting do not mow half of your planting in the first year. There is an option to fruit all of your canes while still moving toward the biennial system. The yield potential during this transition year is large and should be taken advantage of. Marketing this large crop has been a challenge for some growers.

Year 1

- primocane suppress half your acreage (as described in Fruiting Year)
- manage the remaining acreage as an annual system
- pick from your entire planting
- mow the acreage that was primocane suppressed in the fall once the plants are dormant or early the following spring before new growth occurs
- prune the acreage that was treated as an annual system leaving approximately 20-25 canes per metre of row

Year 2

- half your acreage will now be in the vegetative year and should be managed accordingly
- the other half will be fruiting and should be primocane suppressed and managed as described below

Fruiting Year

- establish trellis system (removable or permanent)*
- suppress primocanes once they are 10-15 cm in height (4-6") using Ignite (primocane growth can be very rapid if warm weather occurs)
- continue to suppress primocanes (10-15cm) until fruiting canes are in bloom or early fruit set
- red raspberries tend to have several (3) flushes of primocanes while blacks and purples normally have 1 flush of primocanes

- manage the crop re: fertility, insect and disease control Weed control should be satisfactory with the application of Ignite for cane suppression

* The establishment of a trellis system is a necessity, not an option. With the lack of tall primocanes there will be no support available for the fruiting canes. A removable trellis system can make mowing easier after fruiting is complete.

Vegetative Year
- after harvest mow the raspberries down in late fall once the plants are dormant or early spring (before new growth occurs). Early spring is preferred to ensure dormancy
- maintain narrow rows 20-30 cm wide (8-12") mowing is usually used to narrow rows maintain a minimum of 25-30 primocanes per metre of row for optimum yield
- manage the crop re: fertility, insect, disease and weed control
- establish a trellis system (removable or permanent)* in the fall

Primocane Suppression
Ignite was registered for primocane suppression on raspberries in 1996. When applying Ignite you must get excellent coverage. A flat fan nozzle is recommended and it would be wise to shroud your boom to prevent drift. Ignite will kill most vegetation that it contacts. Ignite is generally a contact herbicide but does appear to have limited systemic activity. *Remember, timing is critical - be sure to apply the correct rate and water volume as specified on the label*. Application on clear sunny days improves the efficacy of Ignite.

Advantages to Biennial Raspberry Production
- reduced pruning costs, little or no hand pruning
- less labour to manage
- less competition between fruiting canes and primocanes means increased yields
- fruit is more accessible to pickers, primocanes do not hide the fruit
- PYO customers may pick more fruit
- decreased disease pressure
- increased net return

Disadvantages
- different management techniques timing is critical for primocane suppression
- must have a trellis system
- transition period - management

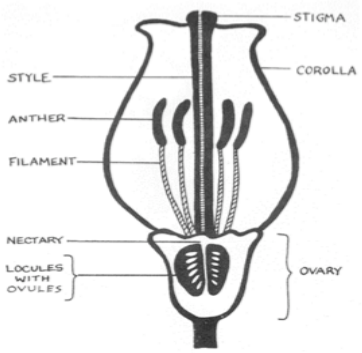
There are advantages and disadvantages to the biennial system. The biennial system once adopted should be easier to manage and should provide greater net income to you the raspberry grower. (***Source**: Ontario Berry Factsheet Series*)

BLUEBERRY

Pollination Issues in Blueberry Production

Sonia Schloemann, UMass Extension

Growers can prune, fertilize, irrigate, control pests and otherwise care well for their blueberry plantations, but without proper pollination their efforts would be in vain. Highbush blueberries are capable of setting fruit on 100 percent of the flowers produced by the bushes, although 80 percent set is considered a full crop. Once set, some fruit may succumb to injury from insects, birds, diseases or environmental conditions. But, the high initial set of fruit is key to the profitability of the crop. Understanding the anatomy of blueberry flowers and the behavior of some of the pollinating agents will help the grower make good decisions that promote optimal conditions for pollination. This presentation will cover the information growers will need in order to make good pollination decisions.



The Blueberry Flower - Blueberry flowers are 'perfect' and 'complete'. That is, they have calyx, corolla, stamen and one or more pistils (complete). And they have actively functioning organs of both sexes (perfect). The male parts are the anthers and filaments, which comprise the stamen and the female parts are the stigma, style and ovary, which comprise the pistil. This means that blueberry flowers are theoretically capable of being self-fertile. However, the structure of the flowers is such that the pollen will not make contact with the stigma without active pollination by insects. Thus, pollinating insects are a must for attaining the high level of fruit-set growers expect. This is accomplished by insects

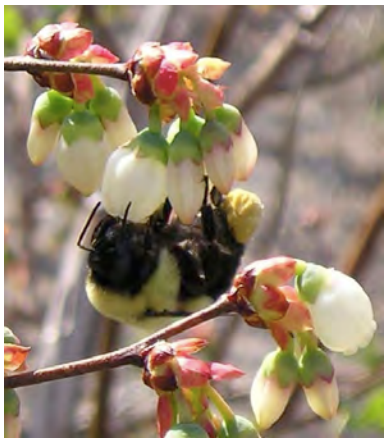
visiting blueberry flowers foraging for nectar and pollen. Pollen adheres to their bodies and is carried with them as they move from flower to flower. Then when bees probe for nectar inside another flower, they brush against the stigma and unwittingly leave behind some of the pollen they are carrying.

Pollinators - There are many species of pollinating insects, both wild and domesticated. In the wild the wide variety of pollinators includes bumble bees (*Bombus* spp.), mason bees (*Osmia* spp.), leafcutting bees (*Megachile* spp.), and feral, or wild, honey bees (*Apis mellifera*). Another species of wild bees can be found foraging in blueberry plantings, but does little to promote pollination is carpenter bees (*Xylocopa* spp.). Commercially, there are two types of pollinator available, domesticated honey bees (*A. mellifera*) and domesticated bumble bees (*Bombus impatiens*). Other pollinators (e.g., mason and leafcutter bees) are also commercially available, but are less common.

Domesticated honey bees have, by far, been the most important pollinators of highbush blueberries for decades. However, with the decline in availability of commercial hives following the epidemic of colony collapse disorder, parasitic mite infestations and disease problems, growers are turning to conservation of wild pollinators and alternative domesticated pollinators.

Pollination Needs - Whether or not a grower will need to import domesticated pollinators into a blueberry planting as well as the number of colonies needed, will depend on several factors:

- the number of surviving wild pollinators in the area of the planting in a given year
- the number of other plants that compete for the attention of the pollinating insects during the bloom period
- flower-set in a given year
- attractiveness of individual cultivars to the pollinators.
- the weather conditions during the bloom period



It has long been observed that bees work different cultivars preferentially. That is, they like some cultivars more than others. Some suggest that this is because some cultivars produce more nectar or pollen. Others have observed differences in the size or shape of the corollas in different cultivars making it easier or harder for pollinators to reach the nectaries of the flowers. Yet others have observed the tendency in some cultivars (e.g., 'Stanley' and 'Bluecrop') to have the corollas separate slightly from the ovaries allowing bees to gain access to the nectar from the base of the corolla, bypassing the pollen altogether.

Blueberry flowers are open and receptive to pollen for 5-8 days. However, research shows that if a blueberry flower is not pollinated within 2-3 days after opening, it is unlikely to set fruit. So, another benefit of high numbers of pollinators is that the most attractive flowers are pollinated first and drop off, thus forcing the pollinators to work the less attractive flowers and increasing the overall level of pollination.

Cross Pollination - Blueberry flowers, while 'perfect' and 'complete' as described above, frequently have pollen that is self-sterile. Many cultivars are parthenocarpic, or capable of forming fruit without pollination, However, parthenocarpic fruit is distinctly smaller and ripens later with less flavor. The use of giberellic acid can increase fruit size of parthenocarpic fruit, but is reported by growers to be unreliable. It is, therefore, very important for the formation of fully sized, ripe, flavorful fruit, that cultivars be cross–pollinated with pollen from other cultivars. For this reason blueberries should not be planted in large uniform block of one cultivar, but broken up into smaller sections with a mix of 2 or more cultivars.

How Many Pollinators Are Enough? - How can a grower tell if pollinators (domestic or wild) are doing an adequate job? One method is to assess the "buzz" level in the field. During sunny warm periods of the day during bloom (>60˚F), there should be an audible "buzz" in the field. Another rule of thumb is that 4 - 8 bees should be foraging on each blueberry plant at any one time during the warmest part of the day during bloom. When wild pollinators are not abundant, domesticated honeybees can be introduced.

Once pollinated, the corolla separates from the ovary of the blossom and is easily knocked off the plant. One indication of good pollination is a carpet of white corollas lying beneath the blueberry bush. If in doubt, a grower may gently shake a few branches and observe whether or not the corollas fall to the ground. Brown corollas on the plant or on the ground usually indicate frost damage.

Protecting Your Pollinators - Pollinating insects have a host of natural enemies. Hives are an irresistible attraction for some mammals, especially bear. Electric fencing is often required to protect honey bee hives from predation by mammals who go after both brood and honey. Nesting shelters for solitary bees may need protection from mammals. There are also some parasitic insects and colonies should be closely monitored for infestations.

More importantly though, is conserving pollinators, both wild and domestic, by taking great care with the use of pesticides in and around the blueberry planting, especially during bloom. Always protect the water supply from contact with pesticides. If contaminated, replace the water with water from a clean source. Insecticides should never be used during the bloom period unless absolutely necessary to avoid major losses. If needed, insecticide sprays should always be made at night when pollinators are not active and materials should be chosen that have the lowest bee toxicity. Charts with this information are usually found in spray guides and recommendations. Always have hives moved out of the planting before resuming the use of insecticides.

GRAPE

Long Island Horticultural Research & Education Center Vineyard Performance of Less Common Varieties

Alice Wise, Cornell University

Our observations from the 2009 season follow. Vineyard data will be distributed shortly via the list serv. In 2009, performance of varieties varied widely. General comments on the research vineyard:

1. **Birds** – We lost a lot of fruit this year to birds. Though bird pressure varies from year to year, we haven't seen losses like this in 5 or 6 years. The exploration of ear- lier ripening varieties has exacerbated the problem as verai- son starts in late July, often when conditions are hot and dry. Reds in particular were targeted right at color change. Once established, it was impossible to dislodge flocks. Nets reduced but did not eliminate losses.

2. **Birds and other wildlife are forcing early harvest** – This is a difficult call but we have chosen to harvest fruit rather than lose all data. As a result, some selections such as Segalin and Semebat, have never been allowed to fully mature.

3. **Nutrition and water management** – With so many varieties, inevitably management is not optimal for every variety. There were some vigor issues in 09.

4. Canopies displayed the brightest, most intense fall colors (not all of it was leaf roll) ever seen, it was spectacular.

After each variety, harvest date, Brix, TA and pH are listed.

• **Zweigelt**: Sept. 18, 19.0, 7.95, 2.83. Zweigelt is part of our exploration of earlier ripening cool climate reds. These 2 yr old vines each hosted a few clusters that were devastated by birds literally as they started veraison. The berries had a lot of color; otherwise, all we can say is that fruit was very attractive to wildlife.

• **Marquette**: Sept. 18, 25.5, 10.65, 3.20. This is a hybrid with some vinifera parentage. Two year old vines were more than filling the trellis thus vigor management will be important. Clusters went through veraison early so were under constant bird pressure. By harvest, there was some dehydration of fruit. This variety is known for holding onto its acids. Only two sprays were applied for early downy.

• **Norton**: Oct. 30, 22.9, 15.75, 3.21 (yes, that TA is accurate). Another disappointing year with this variety. A low crop in 09 due to both light set and few clusters. VSP is not the best system for a procumbent growth habit. Vines continue to suffer from what appears to be Mg deficiency, we can't seem to get enough on. Fruit is very late ripening, pectiny and highly colored. Sprayed only twice for early downy.

• **Dornfelder**: Sept. 24, 18.1, 6.9, 3.05. Clusters were slightly looser than normal but yields were decent. Dornfelder has been consistent even in difficult years. It has big, juicy berries with medium tannins and lots of color. The biggest issues are wildlife and high vigor.

• **Lemberger**: Nov. 4, 20.6, 10.5, 2.87. In terms of canopy quality and crop, this was one of the more stellar performers in 09. The challenge with Lemberger is patience, as fruit holds onto green flavors until just before harvest.

• **Muscat Ottonel**: Sept. 24, 19.5, 6.5, 3.05. This variety has beautiful aromas and pleasant muscat flavors. However, cluster number and set are variable thus crop was abysmally low in 09. The smallish vines, currently 6 ft apart, should be more closely spaced. Early ripening variety that merits more acreage than currently exists (<10 total).

• **Albariño** - Sept. 18, 20.6, 13.4, 2.83. The few clusters left on 2 yr old vines were attacked by birds. Initial impressions – clusters were small to medium, loose and cylindrical with bright, lean citrus flavors.

• **Sangiovese**: Oct. 25, 20.5, 10.95, 2.85. Large clustered and late ripening but does not suffer from uneven ripening like a few other large clustered selections (Dolcetto, Petite Sirah). Good set in 09 but again, wildlife forced harvest. For those willing to put some effort into canopy management and cluster thinning as well as wine- making technique, Sangiovese fruit has been decent quality even

in difficult years. Slightly susceptible to Botrytis in wet years.

• **Aligoté**: Oct. 7, 19.8, 9.0, 2.97. A remarkably consistent performer in terms of cluster number, cluster thinning is always necessary. Clusters are well-filled, tight and rot prone. Aligoté has lively, fresh lemon flavors, an interesting variety. The rot susceptibility is not insurmountable (we sort fruit at harvest even in dry years) but many will not want to deal with the extra work – well executed and timely shoot thinning/leaf pulling/cluster thinning.

• **Tocai Friulano**: Oct. 7, 19.5, 11.4, 2.93. Tocai again was a disappointment as the vines had an abundance of sterile shoots and the few clusters that existed were loose. Though crop was below normal in 09, normal or rather a successful crop is still only 1-2 t/a. The unique flavors, not quite muscat, maybe a little more nutty in character, are interesting but getting a consistent yield has proven difficult. The vines have been ultra-sensitive to water, very quick to shift into drought stress or excess vigor. Finding a site that mitigates that tendency may be the key.

• **Barbera**: Nov. 4, 21.7, 14.95, 2.84 and 22.5, 13.9, 2.80. High acids, often with high Brix, are normal for Barbera. Fruit has rot susceptibility similar to Malbec. Flavors are dark fruit, rich and intense and can be very good even in cool seasons like 09. The challenge with Barbera is canopy management as shoots are spindly and leggy and require careful thinning and positioning. We use lots of catch wire clips to keep shoots upright.

• **Segalin**: Sept. 24, 21.0, 9.9, 2.87 on Sept. 24. One of the INRA vinifera hybrids that is a favorite of birds. The fruit needs to hang into October. The canopies were a beautiful clear orange color in the fall.

• **Semebat**: Sept. 24, 20.8, 19.1 (yes, 19.1), 2.67. The other INRA hybrid. Yes, this fruit was not even close to ripe but again, that did not matter to all the wildlife. Semebat is larger clustered than Segalin and looks to be even later ripening. One of the reasons we planted these two varieties was that they were reported to be high quality, early ripening reds. In five years, we still don't really have a handle on potential quality. (***Source**: Long Island Fruit & Vegetable Update, No. 31, December 2009*)

GENERAL INFORMATION

Funding Available to Help Farmers Extend the Growing Season While Protecting Natural Resources

AMHERST, Mass. (December 21, 2009) – The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) has announced a new pilot project under the 'Know Your Farmer, Know Your Food' initiative for farmers to establish high tunnels - also known as hoop houses - to increase the availability of locally grown produce in a conservation-friendly way.

A seasonal high tunnel is a greenhouse-like structure, at least six feet in height, which modifies the climate inside to create more favorable growing conditions for vegetable and other specialty crops grown in the natural soil beneath it. This pilot will test the potential conservation benefits of growing crops under these structures. Participating farms can receive funding for one high tunnel. High tunnels in the study can cover as much as five percent of one acre or approximately a 30 by 72 foot structure.

Local farmers who would like to sign-up for the high tunnel pilot should call or visit the NRCS office at a local USDA service center by **January 15th**. USDA service center locations are listed on-line at http://offices.usda.gov or in the phone book under Federal Government, U.S. Department of Agriculture. General program information is available on the NRCS Massachusetts website at www.ma.nrcs.usda.gov.

"Massachusetts is one of 38 states participating in a three-year study that will verify if high tunnels are effective in

reducing pesticide use, keeping vital nutrients in the soil, extending the growing season, increasing yields, and providing other benefits to growers," said Christine Clarke, State Conservationist for NRCS in Massachusetts.

Made of ribs of plastic or metal pipe covered with a layer of plastic sheeting, high tunnels are easy to build, maintain and move. High tunnels are used year-round in parts of the country, providing steady incomes to farmers - a significant advantage to owners of small farms, limited-resource farmers and organic producers.

NRCS will provide financial assistance for the project through the Environmental Quality Incentives Program

(EQIP), the EQIP Organic Initiative and the Agricultural Management Assistance program.

Participating states and territories are Alabama, Alaska, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Pacific Islands, Illinois, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Washington, West Virginia, Wisconsin, and Wyoming.

The Natural Resources Conservation Service is an agency of the U.S. Department of Agriculture that helps people conserve, maintain, and improve our natural resources and environment. NRCS has seven Massachusetts field offices – in Greenfield, Hadley, Holden, Hyannis, Pittsfield, Westford, and West Wareham – that work with local conservation districts and other partners to serve farmers and andowners throughout the commonwealth. (***Source**: NRCS Massachusetts - Conservation Connection e-blast12/21/09*)

NEMATODES – A Mini Series

Cathy Heidenreich, Cornell University

I recently had the opportunity to attend an excellent all day workshop on plant parasitic nematodes, sponsored by Northeast SARE. This program was developed and led by plant pathologist/nematologists from across the NE region including Drs. George Abawi from Cornell, Beth Gugino from The Penn State University, Jim LaMondia from the Connecticut Agricultural Experiment Station, and Deborah Neher from the University of Vermont. The workshop included a3 ring binder for participants with nematode resources, a series of presentations that discussed nematode biology and ecology, symptoms and diagnosis in vegetable, fruit, and perennial crops, strategies for nematode management, techniques for nematode sampling and simple on farm methods for evaluating nematode levels in soil.

One of the key features of the workshop for me was the hands on opportunities. We saw nematodes of various types and life stages under the microscope and observed their damage and symptoms on infected plant materials. Another highlight of the workshop was the opportunity to interact with some of the world's leading nematologists and other participants and discuss nematode issues in the Northeast. Yet another highlight was to have the opportunity to observe a demonstration of how to set up the simple on farm nematode bioassays, and evaluate sample test plants provided. They even gave each participant a do-it-yourself nematode sampling/bioassay kit complete with pail, trowel, sample bags, test plant seeds, pots, and labels!

This workshop was so informative and inspiring that I wanted to share some of the knowledge I gained with berry growers across the state. Thus a nematode mini series is born…

PART I: NEMATOLOGY 101

If you were like me before I attended the workshop, you may have had a vague idea that nematodes are some sort of microscopic soil worms (yuck!) which may or may not be important to small fruit operations (aren't they more of a problem in vegetable crops really?!). What follows is a brief introduction to the fascinating world of nematodes, gleaned from the workshop, a brief look at how nematodes may impact small fruit production, and with the gracious permission of the organizers, resources reprinted from the workshop I think you will find both interesting and useful as you delve into the wide, wide world of nematology!

What is a nematode, anyway?

The word "nematode" comes from the Greek words '*nematos',* meaning thread, and '*eidos',* meaning form. A nematode's body is long and narrow, resembling a tiny thread in many cases, thus it's name. Nematodes belong to the phylum *Nematoda* or roundworms. This group includes unsegmented worms having cylindrical elongated bodies without appendages. Nematodes have well developed digestive, reproductive, excretory, and sensory systems, but lack circulatory and respiratory systems. Their head structures range from the very simple to the complex, depending on their food source. They are aquatic, living freely in soil or water, or as parasites of plants or animals.

Nematodes are the most numerous multicellular animals on earth and have successfully adapted to nearly every

ecological niche. They are found in locations as diverse as the polar regions to the tropics, the highest to the lowest of elevations, and Antarctica to the oceanic trenches. They are capable of tolerating harsh habitats – pHs ranging from 1.6 to 11.0, temperatures between sub-zero and 60C +. They are also capable of living in oxygen-deprived environments, tolerating O_2 ranges between 5% and 100 %. This adaptability allows them to avoid interspecific competition and many environmental selection pressures.

Nematodes play an important role in decomposition of organic matter and recycling of nutrients (soil food web). Predatory (free-living) species of soil nematodes may feed on other nematodes, protozoa, bacteria, fungi etc. Some nematode species are also biological control agents, esp. for insects. Their relatively simple "tube within a tube" anatomy and physiology makes some nematodes, such as *Caenorhabditus elegans*, useful model systems for biological research studies on aging, neurology, and ectotoxicology. *C. elegans* has had its entire genome sequenced, the developmental fate of every cell determined, and every neuron mapped.

Nematodes may cause diseases of animals and humans including heartworm, Trichinosis, hookworm, pinworm, etc. The largest nematode ever observed is *Placentonema gigantisma*, discovered in the placenta of a sperm whale, measuring 8 meters in length. The smallest is 0.3 mm in length. Nematodes are also important plant pathogens. Plant parasitic nematodes (PPN) are small in size, usually less than 1 mm in length.

Plant parasitic nematodes

PPN, like other nematodes, have well developed chemosensory systems and respond to CO2 & root exudates in soil as a means of locating and identifying potential feeding hosts. PPN use a stylet (or spear), protruded through their oral opening to penetrate plant cells like a hypodermic needle and remove cell contents. Their movement in soil is limited, usually restricted to a few cm per day. PPN lifecycles range from 3 weeks (Root-Knot Nematode) to 2 yrs + (Dagger Nematode).They may be generalists or specialists with hosts ranging number from 1 into the 100's. Most PPN are root parasites but some species have adapted to parasitize other plant tissues, including leaves, stems, buds, flowers and bulbs. PPN damage is most frequently associated with coarser textured soils – sands. Larger pore spaces in these soils allow for better ease of PPN movement.

PPN are divided into two feeding types, ecto-parasites and endo-parasites. Ecto-parasites feed outside the root, using their stylets to puncture cells on the root surface and draw out cells contents. Ecto-parasites are further divided based on their feeding habits. Migratory ecto-parasites move through soil, feeding from plant to plant (i.e. Dagger Nematode). Sedentary ecto-parasites remain on same plant (i.e. Spiral Nematode).

The second PPN feeding type is endo-parasites. They also are further divided based on feeding habit. Migratory endoparasites penetrate the root and migrate from cell to cell leaving a trail of damaged tissue behind (i.e. Lesion Nematode). Sedentary endo-parasites penetrate roots and establish permanent feeding sites inside root tissue (i.e. Root-Knot Nematode).

How do PPN affect plants?

All crop plants are susceptible to at least one nematode species. Effects on plants include direct feeding, malformation of host tissues (morphological & physiological), and predisposition of host plants to physical stress. Other negative impacts on plants include providing entry for secondary pathogens (disease complexes), breakdown of resistance to other pathogens, vectoring of plant pathogens (viruses & bacteria) and suppression of beneficial organisms.

General field symptoms of PPN infestation on plants may include reduced growth, yellowing of foliage (nutrient deficiency-like), excessive wilting in hot or dry weather, reduced yields, and poor quality produce. Accompanying root symptoms vary depending on nematode species involved but may include galls, stubby roots, excessive root branching, necrotic lesions, general discoloration, and rots.

PART II: NEMATODES AND SMALL FRUIT: THE REST OF THE STORY…

Next in the mini series is a brief review of PPN and the role they potentially may play in small fruit production. Sections are organized by small fruit crop and include short crop specific descriptions of nematode symptoms, hints on nematode sampling, and notes on management strategies. A more broad-spectrum section on nematode management in small fruit plantings rounds off the article.

STRAWBERRIES

Several species of PPN attack strawberries. The majority of these feed on strawberry roots, weakening plants. Others may feed on strawberry leaves and stems. Another, sometimes more serious injury occurs when nematodes transmit virus diseases to strawberries. Nematode-infested strawberry fields show uneven growth. Stunted and/or weak plants occur next to apparently healthy vigorous plants.

Symptoms of Nematode Damage on Strawberries. Symptoms of nematode injury on strawberries may include malformation of flowers, leaves, stems, and roots. Strawberry plants may be dwarfed; flowers, leaves and roots may be poorly developed. Not all nematode diseases of strawberry have obvious symptoms that allow them to be easily identified. Root knot nematode has conspicuous root galling symptoms on the roots. Root-lesion, dagger, sting and foliar nematodes are more difficult to diagnose, having symptoms very similar to those caused by nutrient deficiencies, moisture stress or other abiotic disorders. In addition, dieback and/or nutrient deficiency symptoms on leaves may occur as a result of nematode damage to roots.

Spring Dwarf Nematode (SDN), *Aphelenchoides fragariae*. Symptoms of SDN include stunting and deformation of leaves, buds, and flowers. Puckering and distortion of newly formed leaves is often evident in spring, hence the disease name spring dwarf. These ecto-parasitic nematodes congregate in the crown, living on leaves and buds, as well as in soil. They are transported from one point to another through rain splash or moisture films from dew or high humidity. Infestations may spread from mother plants to runners unless foliage dries between wetting events. SDN is most often transmitted through infested planting stock; use only certified nematode-free plants for new plantings. Heat therapy is effective in control of SDN in planting materials. Roguing out infested plants as soon as symptoms are observed in the spring may help reduce spread in the field.

Northern Root-Knot Nematode (NRKN), *Meloidogyne hapla***.** **N**RKN is the most common soil nematode in the northeast region. Galls caused by this sedentary endo-parasite are relatively small in size. Adventitious roots commonly grow from these galls giving roots a 'hairy' appearance. NRKN disrupts normal formation and function of roots and allow easier entry into the roots for many fungi and bacteria which can cause disease or decay of the roots. Management strategies for NRKN include fumigation, crop rotation (corn and/or small grains), planting of nematode free planting stock, and use of resistant cultivars. Good weed management practices in strawberry plantings is important because many weeds serve as hosts for NRKN.

Root Lesion Nematode, (RLN) *Pratylenchus penetrans*. RLN is probably the most common and most important nematode causing damage to strawberries. This migratory endo-parasitic nematode, considered the most important plant pathogenic nematode in much of the US and Canada, has a wide host range attacking more than 400 other host plants apart from strawberry. Such a wide host range makes RLN difficult to manage with crop rotation. Fields with histories of lesion nematode problems should be kept clean fallow before planting; many weeds also serve as RLN hosts. Utilizing sorghum or sudax as a rotational crop may help to reduce population densities of RLN. In addition to direct feeding damage, RLN is associated with development of strawberry black root rot complex. See the article that follows by Jim LaMondia for more information on nematodes and their role in this important strawberry disease complex. The best way to manage lesion nematodes is to prevent their introduction into a field. Control with nematicides is not always successful.

Dagger Nematode (DN), *Xiphinema americanum*. DN, as a migratory ecto-parasite, feeds primarily at the root tips of roots, stopping root extension. Galls sometimes are formed at root tips. These injuries often result in stunted plant growth and reduced runner production. DN is more sensitive to soil moisture and soil types in terms of survival; soils high in organic matter do not support large populations of DN. They also do not survive well in extremely wet or extremely dry soils. DN transmits nepoviruses such as Tomato Ringspot Virus (ToRSV) and Tobacco Ringspot Virus (TRV). Symptoms of ToRSV on strawberry include dwarfing along with chlorotic patterns, rings, lines, streaks, or blotches on leaves.

Needle Nematode (NN), *Longidorus elongates*. NN, another ecto-parasitic nematode, causes symptoms similar to *X. americanum* on strawberries. It also may be a vector of nepoviruses. This nematode is important in northern Europe and Canada, causing direct damage and decline of strawberry plantings. Crop rotation with non-host crops is recommended to reduce population densities of NN. One

year without a host plant may be sufficient to adequately reduce NN numbers as they are often present in fairly low numbers, and produce few eggs.

BLUEBERRIES

Nematodes, while often found associated with blueberries at relatively high population numbers, rarely if ever cause damage to blueberries by direct feeding. They pose a more serious threat to blueberries as vectors of virus diseases.

Dagger Nematode (DN), *Xiphinema americanum* As vectors of *Tobacco Ringspot Virus* (TRSV) and *Tomato Ringspot Virus* (ToRSV), DN can be damaging at very low population levels. Virus symptoms on leaves may include yellowing of veins, mosaic, and malformation of the plant. Yields may be reduced when nematode populations reach high levels. TRSV causes necrotic ringspot disease of blueberries. The virus causes a slow, steady decline in productivity. Affected leaves are misshapen and crinkled and have very small necrotic spots (0.1 inches in diameter), which may fall out. Some cultivars may have very short internodes, but no dead spots on leaves. Small twigs are often necrotic. December through March is the best time to sample for DN in established blueberry fields. If planting new fields, take samples during this period to increase the probability of detecting any DN present.

Root Lesion Nematode (RLN), *Pratylenchus penetrans* RLN causes a nonspecific decline with poor growth and yellowish foliage in blueberries. Diagnosis generally is possible only by comparing nematode densities in root and soil samples of sick and healthy plants. Always include both soil and roots in samples sent for nematode analysis. July and August are good times to sample for these nematodes in blueberries and in fields that will be planted to blueberries.

RASPBERRIES AND BLACKBERRIES

Viruses transmitted by DN is the most limiting factor to growing brambles in many areas of the U.S. Nematode direct feeding also causes raspberry and blackberry plants to decline over time. Canes get shorter and weaker; primocane growth becomes sparse. Plants are poorly rooted and can be easily pulled from the soil.

Northern Root-Knot Nematode (NRKN), *Meloidogyne hapla***. N**RKN poses an occasional problem on blackberries, especially in sandy soils.

Root Lesion Nematode (RLN), *Pratylenchus penetrans*. RLN is the most common nematode pest on raspberries and blackberries. During the growing season, RLN live and feed inside plant roots. When the plants and roots die in the autumn, they move out of the root into the soil. RLN feeding causes death of root tissues which weakens roots and can lead to a general decline. Root symptoms may be difficult to distinguish initially when populations are relatively low or during early stages of infestation. Look for small, elongated discolorations or lesions on new roots. Symptoms become more obvious as populations increase. Look for witches-boom type symptoms (proliferation of fine roots resulting from death of feeder roots). In the final stages of infestation, all feeder roots die, leaving only large diameter roots. Above ground symptoms start with a slight stunting, which may not be distinguishable unless compared side by side with healthy canes. Reduction in cane number, diameter and general lack of plant figure follow. A slow decline results over a 3-4 year period with die out occurring 2-3 years after decline symptoms begin. The rate of decline may increase in the presence of other stresses such as drought, diseases, insect, and infertility.

Dagger Nematode (DN), *Xiphinema spp.*. Three species of dagger nematodes affect brambles. *X. diversicaudatum*, causes gall formation and stops root elongation. *X. bakeri* also causes significant direct feeding damage to raspberries. Symptoms of *X. bakeri* include swelling and 'fishhook curling' of the root tips. *X. americanum* causes little direct feeding damage to raspberries however it serves as the vector of ToRSV in brambles. This virus causes a general stunting of the bush, yellowing of leaves, and production of small, crumbly fruit, reduction in yield, and/or overall plant health in raspberries. Transmission of ToRSV is slow and generally confined to adjacent plants. However, the disease may spread more rapidly if soil containing nematodes is moved within a field. To help reduce spread in infested fields, establish a perennial grass in the alleyways between rows and eliminate all cultivation that might move soil to other areas of the field.

Needle Nematode (NN), *Longidorus elongatus*. NN appears to cause little direct feeding damage to raspberries, but substantial plant damage may be caused by the Raspberry ringspot (RRV) and Tomato black ring spot (TBRV) neopoviruses it vectors.

NEMATODE MANAGEMENT STRATEGIES FOR SMALL FRUIT PLANTINGS

Start with a nematode-free planting site whenever possible. Nematode sampling prior to planting is the first and most important component of nematode management in small fruit production. See the factsheets that follow this article for more in-depth information on nematode sampling and testing. Whenever possible, avoid replanting on sites with a previous history of nematode problems.

Keep nematodes from being introduced into clean plantings. Pest exclusion is the most important strategy to prevent nematode problems. Purchase and plant only certified nematode-free planting materials. Distance new plantings from older plantings with a history of infestation. Avoid movement of soil and equipment between infested and nematodefree plantings.

If nematodes are present. Steps should be taken to reduce populations prior to planting if test results indicate

nematodes are present at economically damaging levels. Options may include fumigation, crop rotation, and/or use of cover crops as biofumigants. Following population reduction, nematode-free resistant or tolerant small fruit varieties should be planted whenever possible.

☐ *Fumigants* - Growing a shallow-rooted grass crop for 1 to 2 years will bring nematodes to upper soil levels where fumigation more easily controls them. Fumigants currently labeled for use in small fruit crops in NY include 1,3 dichloropropene (various Telone products), and sodium methyl dithiocarbamate (Vapam). Some of these products may be growers applied; others require custom application. Soil should be moist and friable before fumigation application, soil temperatures should be between 50 and 90 oF. All plant material should be decomposed prior to fumigation. Always read the label before making any pesticide applications; follow label instructions carefully.

☐ *Crop rotation*. One to two year crop rotations with non-host crops may be used as a management tactic to reduce nematode population buildup.

 Cover crops as biofumigants. This tactic involves timely incorporation of a green manure cover crop with the ability to release toxic products that are lethal to the nematodes upon decomposition. Crucifer crops, such as mustards, rapeseed, oilseed, radish, etc. have been used with some success as nematode biofumigants. Other nematode biofumigant cover crops include sudangrass and sorghum-sudangrass hybrids, forage pearl millet, marigolds, and flax. Planting and incorporation of these cover crops appears to suppress nematodes nearly as well as chemical fumigation.

Reduce nematode spread within plantings. Monitor, monitor, monitor! Watch for signs and symptoms of nematode infestation. Rogue out infested plants as soon as they are detected. Spot treat areas to reduce nematode population spread where possible.

Keep plants healthy. – Healthy plants have resources needed to potentially offset nematode damage; stressed plants become more susceptible to nematode damage. Minimize crop stress by maintaining adequate soil moisture and nutrition. In respect to fertility 'adequate' does not necessarily mean 'maximum'. Succulent plant tissue tends to act as a nematode magnet.

Concluding Remarks

Watch for part 2 of this nematode mini-series in the January issue which is a very well-written and informative article on strawberry black root rot, by Jim LaMondia. Part 3 will be featured in the February issue and is comprised of 3 resources provided through the workshop that include a factsheet on soil sampling for PPN assessment by George Abawi and Beth Gugino, and informational brochures on setting up and evaluating results of simple on farm bioassays for Root-Knot and Lesion Nematodes, also by George Abawi. I hope you find this miniseries as interesting and helpful as I did. Happy Nematode Hunting!

Other Selected Nematode Resources:

1. Neher, D.A., Powers, T.O. 2004. Nematodes. In: Hillel, D., Rosenwig, C., Powelson, D., Scow, K., and Sparks, D. (editors) Encyclopedia of Soils in the Environment, Vol. 3, pp 1-5, Academic Press, NY.

2. Abawi, G.S., and Gugino, B.K. 2007. The Root-Lesion Nematode on Major Vegetable Crops Grown in NY.

3. Widmer, T.L., Ludwig, J.L, and Abawi, G.S. 1999. The Northern Root-Knot Nematode on Carrot, Lettuce, and Onion in New York. New York's Food and Life Sciences Bulletin Number 156. Cornell University, Geneva, NY.

Selected Nematode Web Resources:

1. Cornell University: http://plantclinic.cornell.edu/FActSheets/nematodes/nematodes.htm.

2. University of California Davis, Dept of Nematology: http://nematology.ucdavis.edu.

3. University of Florida: http://www.entnemdept.ufl.edu/publicat.html.

4. University of Nebraska, Lincoln: http://nematode.unl.edu/. (Source: New York Berry News, Vol. 8, No. 12, Dec. 2009)

UPCOMING MEETINGS:

January 6, 2010. *NE IPM Berry Webcast Series #9*: **Bramble Production: High tunnels, RCA trellis.** More information: Laura McDermott, lgm4@cornell.edu, 518-746-2562, http://www.fruit.cornell.edu/Berries/webinarindex.htm.

January 20, 2010. *NE IPM Berry Webcast Series #10*: **Bramble Weed Management: cultural weed management, using herbicides effectively**. More information: Laura McDermott, lgm4@cornell.edu, 518-746-2562, http://www.fruit.cornell.edu/Berries/webinarindex.htm.

January 25-27, 2010. *Empire State Fruit and Vegetable EXPO/NYS Farmer's Direct Marketing Association Annual Conference*. OnCenter, Syracuse, NY. Mark your calendars – berry session Wednesday January 27th.

February 3, 2010. *NE IPM Berry Webcast Series #11*: **Bramble Disease Management: root and crown diseases, viruses**. More information: Laura McDermott, lgm4@cornell.edu, 518-746-2562, or go to: http://www.fruit.cornell.edu/Berries/webinarindex.htm.

February 2-4, 2010. *Mid-Atlantic Fruit and Vegetable Convention*, Hershey Lodge, Hershey, PA. For more information visit http://www.mafvc.org/html/.

February 17, 2010. *NE IPM Berry Webcast Series #12*: **Bramble Insect Management: crown/cane borers, TBA**. More information: Laura McDermott, lgm4@cornell.edu, 518-746-2562, http://www.fruit.cornell.edu/Berries/webinarindex.htm.

Feb 5-12, 2010. *North American Farmers Direct Market Association 25th Anniversary Convention***,** Lancaster PA. More information to follow.

February 24-26, 2010. *North American Raspberry & Blackberry Conference,* Monterey, California, preceded by preconference tour. More information: http://www.raspberryblackberry.com/.

June 22-26, 2011. *10th International Rubus and Ribes Symposium, Zlatibor, Serbia***.** For more information contact: Prof. Dr. Mihailo Nikolic, Faculty of Agriculture, University of Belgr, Belgrade, Serbia. Phone: (381)63 801 99 23. Or contact Brankica Tanovic, Pesticide & Environment Research Inst., Belgrade, Serbia. Phone: (381) 11-31-61-773.
