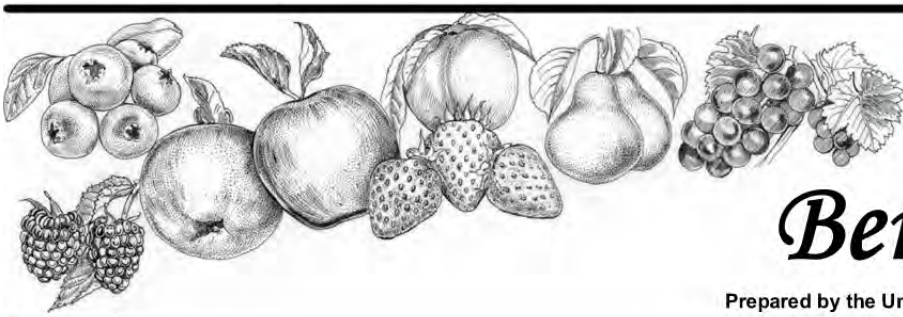

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Berry Notes

Prepared by the University of Massachusetts Fruit Team

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

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IN THIS ISSUE:

MESSAGE FROM THE EDITOR:

Strawberry flower trusses are emerging from the crown. Row-covered fields are in early bloom. Once bloom begins, row-covers must be removed in order for pollination to occur. All fields should have irrigation in place for frost protection during bloom. See more in this issue on frost protection. Bloom is the most important period for controlling gray mold. Begin scouting for clipper and tarnished plant bug as we approach bloom. New fields are being planted. **Raspberry** leaves are expanded and flower buds are visible. Fall raspberry new cane growth is about 4". Watch for raspberry fruitworm feeding on new leaves. **Blueberries** are in pink bud and should be in bloom mid-May. Sublethal frost/freeze damage may predispose tissue to fungal infections, especially mummyberry. In this case pay particular attention to your fungicide programs and make sure to use correct rates and get excellent coverage. Mummyberry is active at this time. See information on this in the last issue. Botrytis gray mold can also infect blossoms at this time. See more below. Be ready for pollination with adequate numnumbers of bee hives. The first fertilizer application should be made now and the second in about a month. Pre- emergent herbicides may still be applied, though it is getting late for this. **Grapes** buds have burst and leaves are unfolding in some varieties. Fungicide applications now for controlling early infections of Phomopsis are critical. Scout fields for flea beetle damage. Fertilizer may be applied now as well as pre- emergent herbicides. **Currants and Gooseberries** are at or past bloom and showing excellent fruit set.

ENVIRONMENTAL DATA

The following growing-degree-day (GDD) and precipitation data was collected for an approximately one-week period, April 21 through April 27, 2011. Soil temperature and phenological indicators were observed on or about April 27, 2011. Total accumulated GDDs represent the heating units above a 50° F baseline temperature collected via our instruments for the 2011 calendar year. This information is intended for use as a guide for monitoring the developmental stages of pests in your location and planning management strategies accordingly.

Region/Location	2011 Growing Degree Days		Soil Temp (˚F at 4" depth)	Precipitation (1-week gain)
	1-week gain	Total accumulation for 2011		
Cape Cod	30	61	50˚	0.75"
Southeast	31	72	67˚	0.50"
East	16	57.5	61˚	0.60"
Metro West	28	50.5	52˚	0.50"
Central	17	42	50˚	0.68"
Pioneer Valley	n/a	63	50˚	0.19"
Berkshires	29	62	61˚	1.17"
Average	25	58	56˚	0.63"

(***Source***: *UMass Extension Landscape Message #9 April 29, 2011*)

STRAWBERRY

Irrigation For Frost Protection Of Strawberries

Pam Fisher and Rebecca Shortt – Ontario Ministry of Agriculture Food and Rural Affairs

Summary

- Frost injury can cause significant damage to strawberry plants, especially open bloom, but also to unopened buds if it is cold enough.
- Strawberry fields are often colder at ground level than the weather forecast suggests.
- Irrigation for frost protection works because heat is released as water freezes.
- Irrigation rates must be adjusted to account for evaporative cooling due to winds and relative humidity. More water is required on windy nights.
- Failure to apply enough water can result in greater damage than no irrigation at all.
- When to start up the irrigation is critical. Two tools can determine the optimum time for starting frost protection: dew point, and wet bulb temperatures. Use the dew point and table 5 to determine the temperature at which to start irrigation. Alternatively measure the wet bulb temperature; irrigation should start before the wet bulb temperature reaches the critical temperature (table 1).
- Dew point is also useful in predicting the lowest expected temperature, and how quickly the temperature will drop.
- In general, the start temperature for frost protection is higher when the humidity is low; the start temperature for frost protection is lower when the humidity is high.
- Where row covers are used, irrigation can take place over the cover. Information on temperatures under the cover can be determined by using digital thermometers and thermocouples.

Introduction

There's nothing colder than a strawberry field on a frosty spring night. Strawberry plants bravely bloom in early spring, often before the last frost. The blooms are close to the ground, and the ground, covered with straw, doesn't provide much heat. That's why many strawberry growers pull a few all-nighters each spring to run the irrigation system and use a thermodynamic principle to protect their crop from frost injury.

This paper will describe types of frost, frost injury, and how irrigation can be used to protect strawberry plants from frost injury.

Symptoms of Frost Injury

Frost occurs when the temperature around the plant drops below 0°C (32°F). At this temperature, pure water forms ice crystals on surfaces which have fallen below the freezing point of water.

Plant sap is not pure water; therefore strawberries have a lower freezing point than 0°C (32°F). When the critical temperature (Table 1) is reached, crystals form and damage cell membranes allowing cell fluids to leak out.

Frost can kill flowers outright, or injure them enough to cause misshapen berries. When a flower is injured by cold, the pistils are killed first. If killed after pollination, then embryos do not develop. A seedy spot on the berry forms, with hollow seeds. Sometimes fruit cracks at the bottom. Leaves can also be injured by the frost, especially when they are growing vigorously and very tender. The edges or tips of leaves blacken, and then dry out.

Frost usually damages the biggest and earliest bloom. This represents the best and most lucrative part of the berry crop, because prices are highest at the beginning of the season. Further, the first flowers to open produce the largest fruit. If 5 percent to 7 percent of the flowers are lost, and these flowers are mostly king bloom, the total crop will be reduced by 10 to 15 percent.

Critical Temperatures for Frost Injury
Bloom and flower parts are most susceptible to freezing temperatures.

Table 1. Critical temperatures of strawberries based on stage of development (Perry and Poling, 1985)

Stage of Development	Approximate Critical Temp. °C (°F)
Tight bud	-5.5 (22°F)
"Popcorn"	-2.2 (26°F)
Open blossom	-1.1 (30°F)
Fruit	-2.2 (28°F)

These temperatures are tissue temperatures, and a degree or two lower than the critical air temperature in the plant canopy. There are many variables that affect the actual critical temperature for a given plant and the amount of injury.

- Duration of cold
- Growing conditions prior to the cold event
- Cultivars: (because of plant habit, or avoidance, rather than genetic differences)
- Stage of development
- Super cooling (in the absence of ice nucleation points, plant sap can cool below the freezing point without forming ice crystals)
- Soil type and condition (moist dark soil holds more heat than dry light soil)

Figure 1: Frost-injured strawberry bloom

Figure 2: Misshapen berries resulting from blooms which are partially damaged by frost

Figure 3: Frost injury on strawberry leaves

Understanding Heat Transfer
Cold conditions occur when heat is lost. Cold can not be added, only heat can be removed.

Heat can be transferred by:

- **Conduction**: transfer of energy within an object or system. Metal is a good conductor, water is a good conductor, but air is a poor conductor of heat. Ice is a good conductor.
- **Convection**: Transfer of heat by movement and mixing of liquid or gas. Most air is warmed by convection.
- **Radiation**: Is the transfer of energy through free space without a transporting medium. We receive energy from the sun by radiation. Objects on earth also radiate energy back to space.
- **Changes in state**: When water molecules change state, from gas to liquid to ice, heat is released. This potential energy is called latent heat. It is not measured by a thermometer, until it is released by a change in state of the water.

When water condenses, cools or freezes, the temperature around the water rises as latent heat is released. Water changing to ice on the surface of a plant will add heat to that plant. Conversely, when ice melts, or water evaporates, the temperature around the water is cooled, as heat moves to the water. Water evaporating from the surface of a plant will draw heat from that plant.

Table 2. Heat exchange due to changes in state: Positive signs indicate the water is cooling or freezing and air is warming. Negative signs indicate water is warming or evaporating and air is cooling

Change in state	Heat exchange (calories/gram)
Water freezes at 0°C (32°F)	+79.7
Water evaporates at 0°C (32°F)	-597.3
Water condenses at 0°C (32°F)	+597.3

Energy Budgets
During the day, the sun warms the soil and solid objects, i.e. crops. When these objects become warmer than the air, they pass heat to the air by conduction. This warm air is less dense, and rises, and is replaced by cooler air from above. This mixing of air is how the lower atmosphere is warmed. Normally, air near the surface of the earth is warmer than the air above it. Crops also radiate heat to outer space. Some of this energy is reflected back to the earth by clouds and $C0_2$ in the atmosphere.

At night, there is no incoming radiation from the sun. If the atmosphere is clear, there is little heat reflected back to earth. The soil and crops continue to radiate energy out to space. Temperatures drop near the earth's surface, forming a layer of air that is colder at the bottom and warmer at the top. If a wind or breeze is present, the warm air and cooler air are mixed. But on a still night, especially when the air is dry, the air temperature at ground level is coolest, and the temperature increases with height up to a certain level. Because this situation is the opposite of normal daytime conditions, the term inversion is used to describe these conditions.

Objects can radiate heat faster than the air around them. Frost can form on the roof of a building or the hood of a car when air temperatures are still a degree or two above zero. Strawberry blooms can also radiate heat quite quickly on a clear night.

Important Facts about Weather
Although the terms "frost" and "freeze" are used interchangeably, they describe two distinct types of cold events.

An advective, or windborne freeze, occurs when a cold air mass moves into the area, and brings freezing temperatures. Significant wind occurs as the cold front moves in. the thickness of the cold air layer is 500-5000 feet deep. It is difficult to protect crops from frost injury when these conditions occur.

A radiation frost, occurs when a clear sky and calm winds allow an inversion to develop and temperature near the surface of the earth drop below freezing. The thickness of the cold air inversion is 30-200 feet (with warm air above).

Microclimate monitoring
Air temperatures referred to in weather reports and forecasts are measured 5 feet above the ground. Temperatures can be much colder at ground level and even colder in the low parts of the field. Cloud cover and wind speeds are also important factors to consider when determining the risk of frost.

Use max/min thermometers to monitor the low temperatures in your fields. Compare these to the forecast lows. In cloudy breezy weather, forecast lows are likely to be similar to the observed low in a region. On clear calm nights, especially in a strawberry field, the observed low can be much lower than the forecasted low.

You can also use max/min thermometers to compare the temperatures at several locations on your farm on a given night. After several observations you will know just how much colder each field is compared to your back yard. A frost alarm can be installed in a convenient location if you know how much colder it gets in the field.

Table 3. Characteristics of a radiation frost and an advective freeze

Radiation frost	Advective freeze
Calm winds (less than 5 mph)	Winds above 5 mph
Clear skies	Clouds may exist
Cold air 30-200 feet deep	Cold air mass 500-5000 feet deep
Inversion develops: air next to the ground is cooler than air above it.	Protection success limited
Cold air drainage occurs	-
Successful frost protection likely	-

Factors affecting the risk of frost
Cold air is heavier than warm air, and it sinks and flows across a field like water. It also piles up where obstructions block its flow to a lower area. Road banks, hedge rows, berms are examples of obstructions to cold air flow. Cold air will drain from elevated areas, to lower storage areas, such as a large body of water. Strawberry fields on sloping fields, or in generally elevated areas, are less prone to frost damage. Be aware of frost pockets within the field.

Remove obstructions at the lower end of the field to improve air drainage. Windbreaks should be designed to slow the wind, not block all air movement. To allow air drainage through a windbreak about 50% air space at the bottom of the windbreak is recommended.

Soil moisture and compaction can have a significant effect on temperature. A moist compact soil will store more heat than a loose dry soil and therefore has more heat to transfer to the crop at night. Cultivation just before a frost can increase the risk of injury, because the soil is looser and drier after cultivation. Soil under a grassy cover crop will hold more heat if the grass is mowed short.

Irrigation for Frost Protection
Most growers rely on sprinkler irrigation for frost protection. When water from sprinklers turns to ice, the heat released protects the plant from injury. As long as a thin layer of water is present, on the bloom or on the ice, the blossom is protected. (This is important. It's not the layer of ice that provides the protection. It's the water constantly freezing that keeps the temperature above the critical point.)

System specifications

- Make sure the sprinkler irrigation system has the capacity to irrigate the whole field at one time.
- Use sprinkler heads designed for frost protection. These have low output nozzles, made of metal rather than plastic, and the spring is covered to prevent freeze-up. Sprinkler rotation should be rapid, at least 1 revolution per minute. The back nozzle should be plugged (Figure 4).
- Spacing of risers should not exceed 30-60% (depending on wind conditions) of the area wetted by each sprinkler. Generally an off-set pattern provides more uniform coverage than a square or rectangle, but this really depends on the nozzle and sprinkler you are using. The Center for Irrigation Technology has developed a program called SPACE, which predicts the distribution of water from the sprinklers, and calculates the efficiency of different designs. Tools like this are used by irrigation supply specialists who can help design your system.
- Traditional spacing is 60' by 60', not as many sprinklers required, but it takes longer for sprinklers to cover area. In areas where many advective freezes occur, with winds, a spacing of 30' x 30' is recommended.
- Need enough water on hand to irrigate for several nights in a row.

For example: For 1 acre, you need about 60 gallons per minute, to irrigate 0.125 inch/acre/hr. This is 3600 gallons per hour. If irrigation is required for 10 hours, you need 36000 gallons per night. Plan to irrigate for several nights in a row.

Figure 4: Sprinkler used for frost protection with back nozzle plugged

How much water to apply
The amount of water applied per hour is based on the amount of wind and the temperature (Table 4). Higher water application rates are required on windy nights, or when humidity is low because considerably more energy is removed when a gram of water evaporates than is added when a gram of water freezes (Table 2). A rate of 0.1 inch/hour is considered adequate to protect to -4.4°C (24°F) with no wind. When the water is frozen on the plant the ice should be clear, which indicates that there was enough water applied. If the ice is cloudy or milky white, the water application rate is not fast enough to protect the flower (Figure 5). In this case you can increase the water application rate by reducing the sprinkler spacing or changing to higher flow rate nozzles. At wind speeds above 16 km/hr or at temperatures below -6.7°C (20°F) sprinkler irrigation can do more harm than good because of rapid freezing.

When to start irrigation
To successfully use irrigation for frost protection, growers need information about the dew point. Dew point is especially important in determining the irrigation start-up point.

The dew point
The dew point is the temperature at which moisture condenses from the air to form dew. The dew point is related to relative humidity: when the air is humid the dew point occurs at a higher temperature than when the air is dry. Once dew begins to form, the air temperature begins to drop more slowly. When temperatures reach freezing, the dew turns to frost.

Dew points are available from agricultural weather forecasts, e.g.

- Environment Canada - provides current dew points and other current weather conditions, for certain locations
- Farmzone.com - provides forecasted dew points

Figure 5: Strawberry bloom coated in clear ice

What is the significance of dew point?
Growers can use dew points to estimate how quickly the temperature might drop in any given night. Once dew begins to form, the air temperature drops more slowly because heat is released. Frequently, the nighttime temperature drops to the dew point, but not much below it. Sometimes the dew point is referred to as the basement temperature.

If the air is dry, then the dew point will be low. If the dew point is below 0°C (32°F), frost forms instead of dew. Black frosts occur when temperatures are below freezing but above the dew point. Don't wait for frost to form before starting the irrigation system (especially when the humidity is low).

Wet bulb temperature
Sometimes the term wet bulb temperature is used to determine when to start up irrigation systems. The wet bulb temperature represents the temperatures a wet surface will cool to as the water evaporates. A wet bulb thermometer is covered with clean muslin soaked in distilled water. Air is passed over the bulb; the water evaporates, reducing the temperature around the thermometer.

If wet bulb temperatures are available, these can be used directly to determine when irrigation should begin, and when the system can be shut off. Start irrigation just before the wet bulb temperature reaches the critical temperature (Table 1).

Table 4. Inches of Water/Acre/Hour to Apply for Protection at Specific Air Temperatures and Wind Speeds (Martsoff and Gerber, Penn State University)

Wind speed at crop height (km/hr)	-2.8°C (27°F) air temperature at canopy	-4.4°C (24°F) air temperature at canopy	-6.7°C (20°F) air temperature at canopy	-7.8°C (18°F) air temperature at canopy
0-2	0.10	0.10	0.16	0.20
3-6	0.10	0.16	0.30	0.40
7 – 14	0.10	0.30	0.60	0.70
15 – 19	0.10	0.40	0.80	1.00
20 – 35	0.20	0.80	-	-

Table 5: Suggested starting temperatures for irrigation, based on dew point. The lower the dew point, the sooner you should start to irrigate.

Dew Point	Suggested starting air temperature
-1.1°C (30.2 ̊F)	0°C (32.0 ̊F)
-1.7°C (28.9 ̊F)	0.5°C (32.9 ̊F)
-2.8°C (26.9 ̊F)	1.1°C (34.0 ̊F)
-3.8°C (25.2 ̊F)	1.6°C (34.9 ̊F)
-4.4°C (24.1 ̊F)	2.7°C (36.9 ̊F)
-5.5°C (22.1 ̊F)	3.3°C (37.9 ̊F)
-6.7°C (19.9 ̊F)	3.8° C (38.8 ̊F)
-8.3°C (17.1 ̊F)	4.4°C (39.9 ̊F)

When to stop irrigation
Irrigation can be stopped when ice on the plants begins to melt, usually after sunrise. Monitor carefully to make sure that the ice continues to melt and the temperature remains above freezing. Changes in wind speed could change temperatures near the plant surface. Irrigation should be started up again if water begins to freeze.

Ice does not have to be completely melted. The plant temperature will warm up as the sun rays hit the field. When the ice can be sloughed off the plant, you know that plant temperatures are above freezing and the water next to the pant has started to melt. At this point, you can turn off the irrigation water, usually around 7:30 or 8 am.

The best way to know when to turn off the irrigation is to monitor plant tissue temperatures beneath the ice. Digital thermometers, attached to thermocouples inserted into the plant tissue can indicate when plant temperatures begin to warm up above the critical temperature.

Negative side effects

One negative side effect of irrigation for frost protection is increased potential for disease outbreaks. Angular leaf spot is a bacterial disease that is spread by splashing rain or irrigation, and seems to get established in frosty conditions. Anthracnose, which can cause fruit rot, generally likes warm humid weather. However, even during cool periods, it will spread by water splashing on the plants and, after establishing itself, it will thrive when warm weather arrives (Figure 6).

Root rots, such as red stele, thrive in saturated soil conditions. Outbreaks of red stele and other root rots have occurred after long periods if irrigation for frost protection. The sites most suited for frost protection by irrigation are well drained sites with sand or sandy loam soils.

Figure 6a: Angular leaf spot

Figure 6b: Anthracnose fruit rot

Figures 6a, 6b: Splashing water can spread diseases like angular leaf spot and anthracnose fruit rot

Figure 7a: Standing water and water-saturated soil in a strawberry field

Figure 7b: Water-saturated soils favor root diseases such as red stele.

Disease and fungus can be limited by reducing the water applied. Water volumes can be reduced by:

- Low application rates / nozzles
- Stopping when ice begins to melt, not when all the ice is melted.
- Monitor the weather to irrigate only when needed.
- Using row covers. This can delay the start up time for irrigation by several hours.

Row Covers

Row covers reduce evaporative cooling and the rate of cooling under the cover. According to vendor's information, the heavier weight covers (1.5-2 oz/yd_2) can protect 4-6 degrees, but this varies both with the weight and between manufacturers. They do buy time on a frosty night.

When frost protecting with irrigation and row covers, you need to know plant temperature under the cover. Start when temperatures under the cover drop to 0.6 - 1.1°C. Irrigate right over the cover. Stop when plant temperatures start to climb. Digital thermometers attached to thermocouples, inserted in the flower buds before the frost event, are necessary for successful protection with covers.

Research suggests that 2 layers of 1 oz cover provide more protection than 1 layer of 2 oz material. Research on the use of low impact sprinklers, i.e. mini-wobblers, is in progress. These sprinklers, widely used in the ornamental industry, wet a smaller diameter, use lower pressures, and are less prone to freezing. By using irrigation and row covers it may be possible to frost protect in adverse conditions.

Related Links

- Environment Canada
- Farmzone.com
- Frost/Freeze Protection for Horticultural Crops,North Carolina State University Horticulture Information, Leaflet 705
- Rainbird Agricultural Irrigation - Technical resources, specifications
- Center for Irrigation Technology Technical resources, SPACE program
- Biometeorology Program, Atmospheric Science, University of California - web site with tables, theory, course on biometeorology
- Berry agent, North Carolina State University

(***Source***: *OMAFRA Factsheets at: www.omafra.gov.on.ca/english/crops/facts/frosprot_straw.htm*)

BLUEBERRY

Blossom and Twig Blight in Blueberries

Annemiek Schilder, Michigan State University

Cold, rainy conditions with freezes during bloom are conducive to the development of blossom and twig blight in blueberries. Frost can cause microscopic wounds on plant tissues that allow invasion by fungi and bacteria. Extended duration of wetness of plant surfaces enhances fungal and bacterial growth and infection. In Michigan, at least five different pathogens can cause blossom blight: *Phomopsis vaccinii* (Phomopsis twig blight), *Botrytis cinerea* (Botrytis blossom blight), *Colletotrichum acutatum* (anthracnose blossom/twig blight), *Monilinia vaccinii-corymbosi* (mummy berry flower strikes), and *Pseudomonas syringae* (bacterial twig blight). In addition, blueberry scorch virus and blueberry shock virus can cause blossom blight that can resemble Phomopsis twig blight. Just by looking at a blighted blossom or twigs it is difficult to identify the causal agent unless fungal growth is present, so it is a good idea to inspect the blighted tissues with a hand lens or magnifying glass.

Botrytis blossom blight, caused by *Botrytis cinerea*, is characterized by fluffy, gray to tan spores that are present all over the surface of killed blossoms. In the case of mummy berry flower strikes, a dense layer of gray powdery spores will be restricted to the flower stem or cluster stem. In general, flower strikes are much less common than shoot strikes, so it is unlikely to see flower strikes without shoot strikes. Anthracnose blossom and twig blight does not have very diagnostic features to distinguish it from Phomopsis twig blight. Pseudomonas blight is characterized by dark brown to black necrosis on the twigs. Incubation in the laboratory is necessary to identify the causal agents. Samples can be sent for diagnosis to the MSU diagnostic lab (http://www.pestid.msu.edu/; phone 517-355-4536. (**Editor's note:** To submit samples in MA for disease diagnosis, contact Plant Disease Diagnostic Clinic at http://www.extension.umass.edu/agriculture/index.php/services/plant-problem-diagnostics).

To scout for blossom blight, walk several rows in a blueberry field and scan the bushes for symptoms. When you find any, inspect the flower clusters for twig lesions and fungal sporulation. Also be alert to the presence of insects, webbing, and insect frass, e.g., caused by cranberry fruit worm infestation. To get a better handle on disease severity and changes over time, flag five random bushes and record the number of blighted blossoms per bush every week for the next three to four weeks.

At this time, it would be good to apply a protectant fungicide that provides broad-spectrum control of blossom and twig blight pathogens. A spray of Pristine works well against most causes of blossom blight. Other options are Indar + (Captan or Ziram or CaptEvate) if you have high mummy berry and Phomopis pressure. CaptEvate and Switch have good activity against Botrytis and anthracnose, and moderate activity against mummy berry and Phomopsis. None of the common fungicides control Pseudomonas bacterial blight, since only copper products are able to control bacterial diseases. No antibiotics are labeled for use in blueberries. Serenade (*Bacillus subtilis*) and Regalia (giant knotweed extract) may also have efficacy against bacterial blight, but have not been evaluated for that purpose in Michigan.

*(**Source**: MSU Fruit Crop Advisory Team Alert, May 10, 2010).*

Time to Fertilize Blueberries

Eric Hanson, Michigan State Univ.

How to get the right rate and timing with fertilizer applications: Most Michigan blueberry fields need annual applications of nitro- gen (N). Too little N reduces growth and yields, but too much can have similar effects, as well as wasting money and possibly impacting water quality. To be effective, use the right fertilizer at the right rate and time.

Fertilizers: Use fertilizers supplying ammonium-N, such as ammonium sulfate or urea. Ammonium sulfate is more acidifying than urea, and is the best choice if you want to reduce pH slightly. If pH is sufficiently low (below 5.0), urea may be best since it has less effect on pH. The cost per pound of N is considerably higher for ammonium sulfate than urea. Fertilizer blends work fine if most of the N is ammonium, but calculate the price you are paying per pound of N (not per bag of fertilizer).

Table 1. Nitrogen Recommendations for Blueberries (lb/acre).

Age (years)	N	Urea	Ammonium sulfate
2	15	35	75
4	30	70	150
6	45	100	215
8	65	150	300

Rates: General rates in pounds per acre are given in Table 1. These may be low for plants on very sand soil with low organic matter, since these soils supply relatively little N from organic matter breakdown. High organic soils and mucks may require lower rates than those in Table 1 because these soils naturally supply high amounts of available N. The best way to judge whether you are using proper rates for your fields is to submit leaf samples for nutrient analysis in the middle of the summer. This will not help this year, but will give you guidance for next season.

Timing: Blueberries absorb little N until after budbreak. Active uptake begins during bloom or petal fall, and rapid uptake and strong demand continues from this time until harvest. Apply N between bud break and bloom. This will allow N to move down into the root system by petal fall. If the soil sandy, a split application is usually beneficial; apply half between bud break and bloom and half in early to mid June. This will help maintain available N until harvest. On heavier soils or muck soils where N does not leach as readily, a single application may be just as effective. N should not be applied to the soil after June because this may promote late flushes of growth that may not harden off adequately in the fall.

Monitoring: Collect leaf samples in the middle of the summer and have these analyzed for nutrient content. Leaf N levels will tell you whether rates for your specific fields need to be adjusted up or down. Leaf N below 1.7% indicates rates should be increased and levels higher than 2.3% mean you are applying too much. Sample at least 50 leaves from different bushes in late July to early August. Select healthy leaves from the middle of this year's shoots. If the leaves are dusty, rinse them briefly in tap water, spread them on a table top until they are dry to the touch, package them in paper bags, and send thee bags to a reputable laboratory. Leaf analysis is well worth the time and money. (***Source**: Ohio Fruit ICM News, April 14, 2011, Volume 15, Issue 4*)

GRAPE

Early-Season Disease Management

Anne DeMarsay, formerly of Univ. of Maryland Extension

Growers should apply a series of protectant fungicide sprays to new shoots to protect them from several diseases, beginning shortly after bud break. Maryland growers may refer to Extension Fact Sheet 848, *Guidelines for Developing an Effective Fungicide Spray Program for Wine Grapes in Maryland* for specific management recommendations.

1⁄2- to 1-inch Shoots

· **Phomopsis cane and leaf spot** is usually the earliest disease threat. Spores can germinate as soon as temperatures are above freezing, so include protection in your first shoot spray. Cool, rainy weather favors spore production and shoot and leaf infection.

· **Powdery mildew (PM)**. In Maryland, the ascospores that cause primary infections on shoots and rachises may be present as soon as bud break, so include a PM fungicide in your first shoot spray. Temperatures above 59° F, high humidity, and overcast skies favor infection. Protecting new growth from primary infections on shoots and rachises is the key to preventing later fruit infections.

· **Black rot (BR)**. You may want to include BR protection in the first spray in warmer parts of the state, particularly in wet weather and in vineyards that had high levels of disease last year. Leaf infections may occur at temperatures as low as 50° F if leaves remain wet for 24 hours or longer. The warmer the temperature, the shorter the leaf wetness period needed for infection.

3- to 5-inch Shoots

· Continue protection for **Phomopsis** and **PM**. Begin protection for **BR** if you didn't do so at the first shoot spray. Preventing leaf lesions reduces BR inoculum for fruit infections.

· Make your second shoot spray 7–10 days after the first spray. Use a 7-day interval if you are applying sulfur for PM, if 2 or more inches of rain have fallen since the first spray, or if shoots are growing rapidly. Fungicides must be re-applied as new growth occurs, as they do not move systemically to protect it.

· If rain is predicted between 7 and 10 days after the first spray, make the second spray *before* the rain. To be effective, protectant fungicides must be on the shoots and leaves before spores arrive.

6- to 10-inch Shoots

· Continue protection for **Phomopsis**, **PM**, and **BR**. Make your third spray 7–10 days after the second spray. See the note on intervals under the previous spray.

Pre-Bloom

· If you are using a fungicide that is at high or medium risk of resistance development, remember to rotate to a fungicide with a different mode of action after each spray. Limit total applications of these fungicides to no more than 2 per season. See Table 2 of Fact Sheet 848 for more information on fungicide classes and resistance risks.

· Protection against **downy mildew (DM)** may be warranted in warm, wet years once 5 or 6 leaves have emerged on the shoot, though generally no earlier than mid-May. If you are using mancozeb or captan for Phomopsis and BR, they will protect shoots against DM as well.

12- to 17-inch Shoots

· **If you have been spraying at 10-day intervals** and your vines are approaching bloom, make sure you include **DM** protection in this spray. Add a fungicide for **Botrytis blight** for Botrytis-prone varieties or if the weather is consistently wet.

· **If you have been spraying at 7-day intervals**, make one more shoot spray for **Phomopsis**, **PM**, and **BR**. Make sure to include **DM** protection in this spray.

· If you have been using paraffinic oil (JMS Stylet-Oil or Pure-Spray) for PM, switch to another fungicide after the last shoot spray. Later in the season, oil can slow growth and retard fruit ripening.

· Remember to increase spray volume as the canopy fills out to ensure thorough coverage. (***Source**: Maryland Timely Viticulture, April 2010*)

Prebloom Foliar Nutrient Sprays:

Alice Wise, Cornell University Extension

Given the cost of fertilizers and fuel, it is important to think through the benefits of all foliar nutrients. Visual verification as well as petiole and soil analysis can be helpful in diagnosis of deficiencies, even at this time of year.

Nitrogen – Long term nitrogen (N) needs of vines, particularly in sandy soils, can be addressed in whole or in part by improving soil organic matter. Otherwise, N fertilization is best addressed via ground application whether using a dry product or dripping in liquid N. The benefits of foliar N are de- bated but experience dictates that periodic foliar applications can be of benefit in maintaining a green, photosynthesizing canopy. Some growers feel foliar N helps sluggish early spring growth; others feel the primary benefit is later in the season both in terms of maintaining canopy and helping to avoid sluggish and/or stinky fermentations. There are many different products from which to choose. Price may dictate what a vine- yard can afford to use. Note that some phosphorous acid products contain nitrogen. If an organic product is preferred, liquid fish products are the primary choice. Experience with the efficacy of these products has been mixed.

Magnesium – Many growers include Epsom salts (magnesium sulfate) in a few of their prebloom sprays. Though replicated research trial results are lacking, there is universal agreement among growers that this foliar nutrient is essential in maintaining a green, healthy canopy.

Zinc - Considered essential for proper cluster development, berry set and normal shoot growth. Deficiency is seen early summer. New leaves are smaller, distorted and may be chlorotic with darker green veins. Straggly clusters and shot berries may also occur. Soil application of Zn is less effective because Zn can be tightly bound in soil (though past soil test recommendations for our vineyard were soil applications of zinc sulfate). Zinc sulfate, zinc oxide and chelated Zn are used as foliar sprays; follow label for rates and timing. Rely on your soil and petiole analyses to gauge the need for this nutrient. For all the micronutrients, there are proprietary liquid formulations that are OMRI approved. Some have both macro and micronutrients. Many are kelp based.

Boron – Another micronutrient that is required in very small quantities for proper fruit set. Distorted basal 1-2 leaves at this time of year might indicate B deficiency. A good lab can verify this in a few days. Later deficiency symptoms are stunted zigzag growth and death of shoot tips, poor set with shot berries that are often flattened or oblong. Soil treatment is effective since boron (B) moves with the soil water, however this is best applied in the fall or with the spring herbicide. Com- mon boron products include Solubor and Borosol. For foliar sprays, no more than 0.2 lb./a actual B in 1 or 2 prebloom sprays is the standard recommendation. The low rate reflects the high risk of phytotoxicity with boron. Improper calculation of foliar rates (the minute quantities required leaves less room for error), sprays applied too close together and overzealous soil applications have all resulted in toxicity symptoms. Boron interferes with the dissolving of water-soluble packets used for certain pesticides. When tank mixing, dissolve the packet thoroughly in the spray tank and then add B to the spray mix.

Manganese - Deficiency is seen mid-late summer starting as interveinal chlorosis on basal leaves. A herringbone pattern is characteristic. At soil pH's >6.0, e.g. properly limed soils, Mn availability in the soil is relatively low. Where a deficiency is confirmed by petiole analysis, foliar applications of manganese sulfate (2-3 lbs./100 gal.) are recommended as a corrective measure. Other manganese products used at label rates may also be effective. Foliar manganese oxide materials are considered to be less effective.

Calcium – Calcium deficiency is best addressed through the soil via liming and use of gypsum (calcium sulfate). However, some feel foliar app's are useful. These are very common in apples but the case for calcium sprays in grapes is a little murkier. If choosing to try this, 1) observe label cautions as phytotoxicity can be an issue; and 2) try to leave an untreated area to gauge efficacy. If getting calcium into leaves is the goal, then earlier sprays might be useful. To improve fruit integrity, make the application when fruit is present as the mobility of Ca in the phloem is very limited. (***Source****: Long Island Fruit and Vegetable Update, No. 8, May 5, 2011*)

GENERAL INFORMATION

Saving Your Fertilizer Dollar, Revisited

by Steve Reiners, Cornell University

Editor's note: This is a revision of an article by Steve in 2008 when fertilizer prices in the US began to rise significantly; he has recently revised it to reflect possible impacts on the 2011 production season.

The cost of fertilizers has reached record levels this spring. Compared to a year ago, price per ton of urea is up $76, DAP $209, MAP $207, Potash $83, UAN $90, and Anhydrous $261. There are several factors that are causing the rise. High grain prices are resulting in increased plantings in 2011, which puts more demand on fertilizer. Mideast political instability has impacted the importation of urea, as Egypt has become a major exporter. Finally, China has imposed high fertilizer export tariffs. Growers can visit this website, http://www.ams.usda.gov/mnreports/gx_gr210.txt, maintained by the USDA-Illinois Dept. of Ag, to monitor prices. By monitoring price trends growers may find a window when prices are lowest.

With costs skyrocketing, berry growers are rightfully asking how they can maintain yields and save on their fertilizer bill. Here are some suggestions.

1) Soil test. Not only does this reveal the soil's nutrient status, it will let you know if your pH is optimum. For most berry crops, the ideal soil is a well-drained, sandy loam with a pH of 6.2 - 6.8 and a moderate to high organic matter content (>3%). For blueberries, the ideal pH is between 4.2 and 4.8 and the ideal soil is a loamy sand with high organic matter (>4%). Planting in soils with a pH out of the preferred range will result in poor nutrient uptake by the target crop. Be sure to modify the pH with lime or sulfur to ensure that the appropriate range is obtained. Agro One is now handling soil testing previously done by Cornell. For more information visit their website at http://www.dairyone.com/AgroOne/default.htm.

2) Take nitrogen credits. Cover crops, manures, previous crops and even the soil organic matter (SOM) provide nitrogen. Figure about 20 pounds of N for every one percent SOM. A legume cover crop incorporated prior to planting will likely give 40 pounds of N minimum, with two to three times that amount in a well-established, legume sod. Even that field of cereal rye that was planted last fall has N in it, scavenged from last year's applications. Figure on 10-20 pounds of N once the rye begins to break down.

3) Don't apply N preplant. For nitrogen management growers must continue to rely upon scheduled fertilizer applications as large fluctuations in N that occur from week to week make estimating its availability with soil test and even leaf analysis of limited value. See tables 1 and 2 below for timing and amount of N necessary for berry crop production.

4) Don't let N blow in the wind. Broadcast applications of urea or ammonium based fertilizers have an increased chance of being lost through volatilization than do incorporating or knifing these same products into the soil. Any tillage or applicator that puts the nitrogen in the soil rather than on the soil improves efficiency of the nutrient. Applying N through drip irrigation systems or covering fertilizer with mulch is an easy way for berry growers to reduce volatilization.

5) Use foliar testing to promote best nutrient efficiency. Foliar tissue testing is the most reliable way to measure a plant's nutrient load. Using a combination of soil testing, tissue analysis, scheduled fertilizer applications and observation of crop response is currently a grower's best approach for managing nutrients in berry fields.

- **Strawberries:** Collect 30 leaflets after renovation in July or August.
- **Raspberries:** Collect 30 newly expanded leaflets from primocanes in early August.
- **Blueberries:** Collect 30 newly expanded leaves from well-exposed branches in late July.
- **Currants and Gooseberries:** Collect 30 newly expanded leaves from well-exposed branches in late July
- **Cranberries:** Collect upright tips only (no more than top 2" of growth), mixing flowering and vegetative uprights for about 1 cup material between mid-August and mid-September.
- **Juneberries**: Collect 30 newly expanded leaves from well-exposed branches in early August.

Contact Agro-One for detailed instructions, submission forms, and fees for leaf analysis.

6) Reduce tillage. The quickest way to burn off organic matter is with conventional tillage. This puts lots of oxygen into the soil and microbe populations explode, at the expense of SOM. The perennial nature of berries and their relatively shallow roots makes cultivation a poor choice for weed control in berry crops; if you are using cultivation as a means of controlling weeds, you might want to reconsider.

7) Don't over apply P. If your soil level is high and you are planting when soils are still cool, use no more than 20 pounds of actual P/A as a starter. This will help the plants get established until soil P becomes available as the soil warms in the spring. If planting in warm soils after June 10 on high P soils, no additional P may be needed. For transplants on plastic mulch, a high P soluble fertilizer in the transplant solution may be enough on high P soils.

8) Fertilized Mulched Acre. When using mulch, think "Fertilized Mulched Acre" or FMA. Let's say you are planting on 5 foot centers, with the plastic mulch covering 3 feet and bare ground between the rows covering 2 feet. To figure the FMA, take the area of soil covered by mulch (3') and divide by the row center distance (5'), which gives 0.6 or 60%. If the soil test calls for 100 pounds of actual N per acre, you can cut this amount to only 60 pounds if you apply the N only to the area covered by the mulch. In this situation, you are only applying fertilizer where it will be used by your crop, not by weeds or ground cover growing between rows.

9) Soak up residual N this fall. Planting a rye (or rye/vetch) cover crop after removing a planting can hold on to nitrogen that would otherwise be lost. Tilling in the cover crop next spring will return that captured N to the soil surface.

Table 1. Nitrogen guidelines for berry crops. *(Source: 2011 Cornell Pest Management Guidelines for Berry Crops)*

Crop	Age of planting	Amount/*timings* (actual N)	N source	Comments
Strawberries				
	0	30 lb./A, *early June* 30 lb./A, *early Sept*	calcium nitrate ammonium nitrate or calcium nitrate	Be sure plants are growing well prior to application.
	1+	70 lb./A, *at renovation* 30 lb./A, *early Sept*	ammonium nitrate, urea, calcium nitrate	Adjust fall amount based on leaf analysis.
Raspberries and Blackberries (summer-bearing)				
	0	25-35 lb./A, *4 weeks after planting*	calcium nitrate	Avoid touching plants with fertilizers after planting.
	1	35-55 lb./A, *in May or split between May and June*	urea or ammonium nitrate	Use higher amount on sandier soils or if irrigation is used.
	2+	40-80 lb./A, *in May or split between May and June*	urea or ammonium nitrate	Use higher amount on sandier soils or if irrigation is used.
Raspberries (fall-bearing)				
	0	25 lb./A, *4 weeks after planting*	calcium nitrate	Avoid touching plants with fertilizers after planting.
	1	50-80 lb./A, *split between May and June*	urea or ammonium nitrate	Use higher amount on sandier soils or if irrigation is used.

Table 1. Nitrogen guidelines for berry crops. *(Source: 2011 Cornell Pest Management Guidelines for Berry Crops)*

Crop	Age of planting	Amount/*timings* (actual N)	N source	Comments
	2+	70-100 lb./A, *split between May and June*	urea or ammonium nitrate	Use higher amount on sandier soils or if irrigation is used. Adjust with leaf analysis.
Blueberries				
	0	Do not fertilize newly planted blueberries		Soil should be adjusted to pH 4.5 prior to planting.
	1	15 lb./A, *split between May and June*	ammonium sulfate or urea	Use ammonium sulfate where soil pH is >5.0.
	2	20 lb./A , *split between May and June*		
	3	25 lb./A, *split between May and June*		
	4	35 lb./A, *split between May and June*		
	5	45 lb./A *split between May and June*		
	6	55 lb./A *split between May and June*		
	7+	65 lb./A *split between May and June*		
Currants and Gooseberries				
	0	25 lb./A, *4 weeks after planting*	calcium nitrate	
	1	50-80 lb./A, *split between May, June, August*	calcium nitrate	
	2+	70-100 lb./A, *split between May and early August*	calcium nitrate	
Elderberries				
	0	Do not fertilize newly planted elderberries.		
	1+	Apply 1/8 pound of ammonium nitrate for each year of the plant's age, up to one pound per plant. or Apply 0.5 lbs. 10-10-10 for each year of the plant's age, or up to 4 lbs. 10-10-10.	Ammonium nitrate or 10-10-10	In spring, spread fertilizer with a spreader in bands one foot wide along both sides of the rows.
Cranberries				
All varieties	0	50 lb./A	Alternate N-only products with N-P-K products with a 1:1:1 ratio	Use frequent applications (every 2-3 weeks) of 5-10 lb./A until late summer to promote good runner growth.
Small –fruited varieties (i.e. 'Early Black', 'Howes')	1+	20-30 lb./A*, split between roughneck (20-25%), bloom (30-35%), and fruit set (30-35%) growth stages	Ammonium nitrate	Wait to make first split application until soil temperatures are between 50 to 70^{o}F**
Large-fruited varieties (i.e. 'Stevens')	1+	30-60 lb./A*, split between roughneck (20-25%), bloom (30-35%), and fruit set (30-35%) growth stages	Ammonium nitrate	Wait to make first split application until soil temperatures are between 50 to 70^{o}F**
Juneberries				
	0	25 lb./A, *4 weeks after planting*	calcium nitrate	Avoid touching plants with fertilizers after planting.

Table 1. Nitrogen guidelines for berry crops. *(Source: 2011 Cornell Pest Management Guidelines for Berry Crops)*

Crop	Age of planting	Amount/*timings* (actual N)	N source	Comments
	1	50-80 lb./A, *split between May and June*	urea or ammonium nitrate	Use higher amount on sandier soils or if irrigation is used.
	2+	70-100 lb./A, *split between May and June*	urea or ammonium nitrate	Use higher amount on sandier soils or if irrigation is used. Adjust with leaf analysis.

*****Rates > 40lb/A actual N should be used with caution to prevent vine overgrowth and reduced fruit set. Rates may need to be adjusted based on soil type and temperature, soil and tissue analysis results, and observations of plant growth and appearance.
******If soil temperatures exceed 70°F and air temperatures exceed 70°F, reduce, delay, or omit N applications.

For more information on cranberry fertilization or other aspects of cranberry production consult: "Cranberry Production A Guide for Massachusetts", available from the UMASS Cranberry Station, College of Natural Resources and the Environment, East Wareham, MA.

Table 2. Nitrogen sources and calculation of actual N.. *(Source: 2011 Cornell Pest Management Guidelines for Berry Crops)*

Fertilizer	% actual N in fertilizer
Ammonium nitrate	34.0
Ammonium sulfate	20.5
Calcium nitrate	15.0
Diammonium phosphate	17.0
Potassium nitrate	13.0
Urea	46.0

To calculate the actual amount of fertilizer to apply, divide the desired amount of actual N by the percent N in the fertilizer and then multiply the result by 100. Apply the total amount of fertilizer in a 3-foot band in the row (1 foot band over the row for strawberries).
Example: Calcium nitrate, actual N 30 lbs./A on strawberries
Calculation:

$$\frac{\text{30 lbs./A actual N}}{\text{15 percent N in calcium nitrate}} \times 100 = \text{200 lbs./A calcium nitrate}$$

(***Source***: *New York Berry News, Volume 10, Number 3, March/April 2011*)

Guthion and Endosulfan Updates

Rick Foster, Department of Entomology Purdue University

As the phase-out for Guthion continues, growers should be aware of the restrictions on use of this product for 2011. Apple and pear growers are limited to 3 lb. of product per acre this year while blueberry and cherry growers are limited to 1.5 lb of product per acre. These same limitations will be in effect for 2012. Remember that you can- not use Guthion on any fruit crops after September 30, 2012.

Endosulfan (Thionex, Thiodan) is also being phased out. It cannot be used after July 31, 2012 on nectarines, peaches or sweet cherries. July 31, 2013 is the last day it can be used on pears. It cannot be used after July 31, 2015 on apples or blueberries and July 31, 2016 is the last day it can be used on strawberries. Endosulfan cannot be used on any crop after July 31, 2016. (***Source***: *Facts for Fancy Fruit, March, 2011 Volume 11 • Issue 1*)

UPCOMING MEETINGS:

May 14, 2010 - *Insecticide Application and Pesticide Safety* at Nuestras Raices Farm, 24 Jones Ferry Rd, Holyoke MA, 10:00-12:00 Ruth Hazzard, UMass Extension Vegetable Production Educator Participants will learn how to identify damaging pests, and the basics and safety of choosing an insecticide for application. For more information or to register, contact Amy at 413-535-1789

May 12, 2011 - *Getting Ready to Sell at a Farmers Market*, Rockingham County Nursing Home Auditorium, Brentwood 6:00-8:00 pm. To register on-line go to this link: http://cecf1.unh.edu/formbuilder/forms/form352_FrmMktRg.htm or contact Nada Haddad at 603-679-5616 or nada.haddad@unh.edu.

May 17, 2011 - *Getting Ready to Sell at a Farmers Market* Derry Municipal Center , Derry 10:00 – Noon. To register on-line go to this link: http://cecf1.unh.edu/formbuilder/forms/form352_FrmMktRg.htm or contact Nada Haddad at 603-679-5616 or nada.haddad@unh.edu.

May 17, 2011 - *UMass Fruit Team Twilight Meetings*. Location TBD. Tree fruit twilight meetings start promptly at 5:30 PM. 1 (one) pesticide recertification credit will be offered. There will be a $25 meeting admission charged at the door. For more information, check the Fruit Team website or call Jon Clements: 413-478-7219 or email at clements@umext.umass.edu.

May 18, 2011 – *UMass/UNH Fruit Team Twilight Meetings*. Lavoie's Farm - 172 Nartoff Road, Hollis NH 03049. Tree fruit twilight meetings start promptly at 5:30 PM. 1 (one) pesticide recertification credit will be offered. There will be a $25 meeting admission charged at the door. For more information contact George Hamilton at george.hamilton@unh.edu.

May 19, 2011 - *UMass Fruit Team Twilight Meetings*. Location TBD. Tree fruit twilight meetings start promptly at 5:30 PM. 1 (one) pesticide recertification credit will be offered. There will be a $25 meeting admission charged at the door. For more information, check the Fruit Team website or call Jon Clements: 413-478-7219 or email at clements@umext.umass.edu.

May 20, 2011 - *UMass Good Agricultural Practices Training*, **8:30-5:00** Berkshire Room, University of Massachusetts Collaborative Services Facility, 333 South Street, Shrewsbury, MA 01545-4169.
Preregistration required. Space is limited. The cost is $50.00 for the first registration. Cost for additional employees is $10.00 each which includes the presentation, pesticide credit, refreshments, but not the GAP manual. Send the check payable to "UMass" to Doreen York, Agriculture & Landscape Program, 210 Bowditch Hall, 201 Natural Resources Rd., University of Massachusetts, Amherst, MA 01003. If you have questions, please contact Doreen at 413-545-2254 or email at dyork@umext.umass.edu. Note that we cannot accept cash payments. No walk-in registrations will be accepted.

June 8, 2011 – *Canopy Management in Hybrids for Quality Wines,* Grape Twilight Meeting co-sponsored with the Massachusetts Farm Winery and Growers Association, UMass Cold Spring Orchard 391 Sabin Street, Belchertown, MA 01007. Featuring Justine Vanden Heuvel and Anna Katherine Mansfield from Cornell University. For more information or to register contact Sonia Schloemann via email at sgs@umext.umass.edu.

June 9, 2011 *Getting Ready to Sell at a Farmers Market* Auburn Safety Complex, Auburn 6:00 - 8:00 pm. To register on-line go to this link: http://cecf1.unh.edu/formbuilder/forms/form352_FrmMktRg.htm or contact Nada Haddad at 603-679-5616 or nada.haddad@unh.edu.

June 16, 2011 - *High Tunnel Workshop and Vegetable & Berry Twilight Meeting*. Ledgewood Farm, Moultonborough NH. 3-7PM. Hosted by Ed Person of Ledgewood Farm. For more information, contact Russ Norton at 603-447-3834 or russell.norton@unh.edu.

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.

June 22, 2011 - *On-Farm Workshop: Strawberry Production*, Killdeer Farm, Norwich VT. For more info contact Vern Grubinger at vernon.grubinger@uvm.edu.

July 12, 2011 - *On-Farm Workshop: Raspberries and Blue Berry Production*: Rochester VT. For more info contact Vern Grubinger at vernon.grubinger@uvm.edu

August 1, 2011 - *On-Farm Workshop: Pest Management/IPM*, Littlewood Farm, Plainfield VT. For more info contact Vern Grubinger at vernon.grubinger@uvm.edu