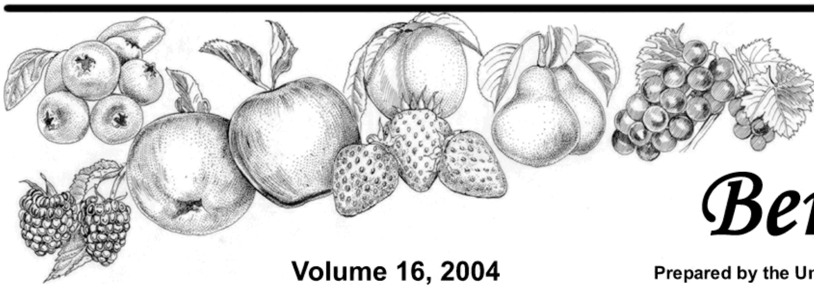

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Berry Notes

Volume 16, 2004

Prepared by the University of Massachusetts Fruit Team

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

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IN THIS ISSUE:

Message from the Editor:

Changes in small fruit fungicides and insecticides for 2004: New changes and updates to the New England Small Fruit Pesticide Recommendations will be posted the last week of April on the Fruit Team website. Go to www.umass.edu/fruitadvisor update on fungicide and insecticide recommendations for berry crops. Weed management updates will be added soon.

Research Projects for 2004: The UMass Extension Small Fruit Program has a few new research projects starting up this summer. Below are some brief descriptions of these projects and this newsletter will provide periodic updates on their progress.

Strawberry sap beetle project: UMass is participating in a 2-year study initiated by Dr. Greg English-Loeb at Cornell University to establish more detailed information about strawberry sap beetle overwintering habitats and alternative food sources in an effort to improve management options for this pest. The study will also evaluate some pheromone lures for trapping. Funding for this project comes from the USDA Northeast IPM Program.

Grape SARE project: Dr. Bill Coli and others from UMass Extension wrote a successful proposal to the USDA Sustainable Agriculture Research and Education (SARE) program to help identify and promote locally adapted sustainable practices for commercial viticulture in Southern New England. This is a 3-year project and is in collaboration with Connecticut and Rhode Island vineyards.

New Crop Demonstration Plantings at UMass Cold Springs Orchard: Small demonstration plantings of Seedless Table Grapes, Beach Plums, and Ribes cultivars are being cultivated to determine their value for diversified fruit farms. A new crop will be added in 2005 of 200 *Schisandra chinensis* (Chinese magnolia berry) vines. We'll keep you posted on their progress.

No Section 18 for Indar for MA: There is no Section 18 Emergency Exemption for the use of Indar in Blueberries in MA for 2004. Growers who feel this label is essential to their production in 2005 must contact UMass Extension or the MA Dept. of Agricultural Resources by Sept. 2004 in order for us to file the EPA petition.

Strawberry

Frost Protection in Strawberries

Marvin P. Pritts, Cornell Univ., Ithaca, NY

Strawberry growers can ensure a full crop of berries only if they exert some influence on temperature during the year. Temperature control is especially important during the winter and early spring when flowers are susceptible to frost. Of all the factors that negatively affect strawberry production, frost can be the most serious. Frost can eliminate an entire crop almost instantaneously. Strawberries often bloom before the last frost free date, and if a frost occurs during or just prior to bloom, significant losses can result. The strawberry flower opens toward the sky, and this configuration makes the flower particularly susceptible to frost damage from radiational cooling. A black (rather than yellow) flower center indicates that frost damage has occurred.

Strawberry growers occasionally delay the removal of straw mulch in spring to delay bloom and avoid frost. Research has demonstrated, however, that this practice also results in reduced yields. Also, applying straw between the rows just prior to bloom will insulate the soil from the air. This will increase the incidence of frost injury as solar radiation will not be absorbed by the soil and re-radiated at night. If additional straw is to be applied between the rows in spring, delay its application for as long as possible before fruit set.

Table 1. Water application rate (in/hr) for a given humidity and wind speed.

	Wind Speed				
Temp (F)	**0-1**	**2-4**	**5-8**	**10-14**	**18-22**
Relative humidity of 50%					
27	0.10	0.20	0.30	0.40	0.45
24	0.10	0.30	0.35	0.45	0.60
20	0.15	0.35	0.45	0.60	0.75
18	0.20	0.40	0.50	0.65	0.80
Relative humidity of 75%					
27	0.05	0.10	0.20	0.25	0.25
24	0.10	0.20	0.30	0.35	0.40
20	0.10	0.25	0.40	0.45	0.60
18	0.15	0.30	0.45	0.55	0.70
FROSTPRO model from North Carolina State University					

Overhead irrigation is frequently used for frost control because flowers must be kept wet during a freeze in order to provide protection. As long as liquid water is present on the flower, the temperature of the ice will remain at 32F because the transition from liquid to ice releases heat. Strawberry flowers are not injured until their temperature falls below 28F. This 4 degree margin allows the strawberry grower to completely cover a field with ice and yet receive no injury from frost. However, if insufficient water is applied to a field during a freeze event, more injury can occur than if no water was applied.

Several principles are responsible for the ability of ice to protect strawberry flowers from injury. First, although pure water freezes at 32F, the liquid in the strawberry plant is really a solution of sugar and salt. This depresses the freezing point to below 32˚F. Also, ice crystals need nucleators to allow them to form initially. Certain bacteria serve as nucleators. Sometimes, in strawberry flowers, the bacteria that allow ice to form are absent, allowing the freezing point to be lowered. The temperature of the applied water is usually greater than the temperature of the plants, so this serves to warm the flowers before heat is lost to the air. As long as liquid water is continually applied to the plants, the temperature under the ice will not fall below 32˚F. When one gallon of water freezes into ice, 1172 BTUs of heat are released.

Several factors affect the amount of water that is required to provide for frost protection, and the timing of application. At a minimum, apply water at 0.1 - 0.15 in/hr with a fast rotating head (1 cycle/min). Water must be applied continuously to be effective. A water source of 45 - 60 gal/min-acre is required to provide this amount of water. Choose nozzle sizes to deliver the amount of water required to provide protection under typical spring conditions in your location. Under windy conditions, heat is lost from the water at a faster rate, so more water is required to provide frost protection. For every gallon of water that evaporates, 7760 BTUs are lost. The application rate then depends on both air temperature and wind speed (see Table 1).

Under windy conditions, there is less chance of flower temperatures falling below that of the air because of the mixing of air that occurs at the boundary of the flower. Winds are beneficial if the temperature stays above the critical freezing point, but detrimental if the temperature approaches the critical point. Less evaporation (and cooling) will occur on a still, humid night. Under extremely windy conditions, it may be best not to irrigate because the heat lost to evaporation can be greater than the heat released from freezing

<u>*Stage of development:*</u> Strawberry flowers are most sensitive to frost injury immediately before and during opening. At this stage, temperatures lower than 28˚F likely will injure them. However, when strawberry flowers are in tight clusters as they are when emerging from the crown, they will tolerate temperatures as low as 22˚F. Likewise, once the fruit begins to develop,

temperatures lower than 26˚F may be tolerated for short periods. The length of time that plants are exposed to cold temperatures prior to frost also influences injury. Plants exposed to a period of cold temperatures before a frost are more tolerant than those exposed to warm weather. A freeze event following a period of warm weather is most detrimental.

Flower temperature: The temperature of all flowers in a field is not the same. Flowers under leaves may not be as cold as others, and those near the soil generally will be warmer than those higher on the plant. On a clear night, the temperature of a strawberry flower can be lower than the surrounding air. Radiational cooling allows heat to be lost from leaves and flowers faster than it accumulates through conduction from the surrounding air.

Soil also retains heat during the day and releases heat at night. It is possible that on a calm, cloudy night, the air temperature can be below freezing yet the flowers can be warm. Wet, dark soil has better heat retaining properties than dry, light-colored soil.

Table 2. Starting temperature for frost protection based on dewpoint

Dewpoint	Suggested starting air temperature
30 °F	32 °F
29 °F	33 °F
27 °F	34 °F
25 °F	35 °F
24 °F	37 °F
22 °F	38 °F
20 °F	39 °F
17 °F	40 °F

Using row covers: Row covers modify the influence of wind, evaporative cooling, radiational cooling, and convection. Because wind velocity is less under a row cover, less heat will be removed from the soil and less evaporative cooling will occur. Also, relative humidity will be higher under a row cover, reducing heat loss from evaporation. In addition, convective and radiational heat loss is reduced because of the physical barrier provided by the cover. Plant temperature under a cover may eventually equal that of the air, but this equilibration takes longer than with uncovered plants. In other words, row covers do not provide you with additional degrees of protection, but they do buy time on a cold night as flower temperatures will fall less rapidly inside a cover. Often the temperatures fall so slowly under a row cover that irrigation is not needed. If irrigation is required, less water is needed to provide the same degree of frost protection under a row cover. Water can be applied directly over the row covers to protect the flowers inside.

Rules of Thumb

- Store sufficient water for 2 or 3 consecutive nights of frost protection
- Use small diameter nozzles (1/16 - 3/16 in. diameter)
- A 30 X 30 ft. staggered spacing of nozzles is preferable
- Use metal sprinklers to minimize icing
- Minimum rotation of once per minute

Turning on the water: Since cold air falls to the lowest spot in the field, a thermometer should be located here. Place it in the aisle at the level of the flowers, exposed to the sky, and away from plants. Air temperature measured at this level can be quite different from the temperature recorded on a thermometer at the back of the house. The dewpoint temperature measured in the evening is often a good indication of how low the temperature will drop on a clear night, and is related to the relative humidity. Air temperature will fall less if the humidity is high. If the air is very dry (a low dewpoint), evaporative cooling will occur when water is first applied to the plants, so irrigation must be started at a relatively warm temperature. Most local weathermen can provide the current dewpoint, or it can be obtained from World Wide Web-based weather information services.

If the air temperature falls below 34˚F on a clear, calm night, especially before 3 A.M., it would be wise to start irrigating since flower temperatures could be several degrees colder (Table 2). On the other hand, if conditions are cloudy, it may not be necessary to start irrigation until the temperature approaches 31˚F. If conditions are windy or the air is dry, and irrigation is not turned on until the temperature approaches 31˚F, then damage can occur due to a drop in temperature when the water first contacts the blossom and evaporation occurs. Therefore, the range in air temperatures which indicates the need for irrigation at flowering is normally between 31˚ and 34˚F, depending on cloud cover, wind speed and humidity, but can be as high as 40˚F. Admittedly, these numbers are conservative. Flowers can tolerate colder temperatures for short periods of time, and irrigation may not be needed if the sun is about to rise. Obviously, one does not want to irrigate too soon since pumping is expensive, and excess water in the field can cause disease problems.

Turning off the water: Once irrigation begins, it should not be shut off until the sun comes out in the morning and the ice begins to slough off the plants, or until the ice begins to melt without the applied water.

Waterless frost protection agents: Future solutions to frost protection could lie in waterless methods, such as genetically engineered bacteria that do not promote the formation of ice. However, to date, these materials have not been consistently effective, so they are not recommended as the sole basis for frost protection. (***Source****: New York Berry News, Vol. 3, No.4*)

Brambles

Raspberry Weed Management

Courtney Weber, Cornell University

A combined approach using chemical controls, cultural practices, and selective hand weeding can be used to effectively manage weeds in raspberry. Herbicides provide good overall control of most weeds. The key to successful chemical control is a vigorous, healthy stand of canes to crowd out competing weeds within rows. Between row control can be managed using a cover crop with herbicide banding to limit spreading, mulches, cultivation, or broad-spectrum herbicide application.

Chemical control is most effective in combination with the establishment of a vigorous stand of canes. In the establishment year, care must be taken to eliminate perennial weeds such a Canadian thistle and field bindweed with a broad-spectrum herbicide such as glyphosate (RoundUp) before planting because these weeds can spread from root pieces moved during cultivation. Once established in a planting, they are very difficult to control.

After planting, a preemergent herbicide such as napropamide (Devrinol) should be applied to eliminate germinating weed seeds. Be aware that tissue culture plugs and young canes can show increased sensitivity to many herbicides until they are well established and reduced rates may be needed. Shallow cultivation is also recommended in the establishment year to eliminate young weeds while allowing the new canes to develop. Deep cultivation is not recommended as it can damage the root systems and turn up new weed seed that would not be controlled by the preemergent herbicide. Turf can be seeded between rows late in the summer to crowd out weeds and can be managed successfully by banding with a grass herbicide along the rows as the planting matures. Mulches within the rows as well as in row centers can be used to keep weeds down but care should be taken to maintain soil fertility. Also, in less than optimally drained soils or when growing root rot susceptible varieties, mulches can retain excess moisture and exacerbate root rot problems. Bare ground can also be maintained between rows with shallow cultivation, mowing, and/or broad-spectrum herbicides, but erosion can be a problem. However, special care must be taken to avoid disturbing the raspberry roots with the cultivator, to avoid weed seed development through regular mowing, and to avoid spray drift onto the raspberries when maintaining alleyways.

In established plantings, much of the chemical control is done in the fall or in the spring before bud break. By late spring, chemical control is limited to sethoxydim (Poast) for grass control. Be aware that Poast has a 45 days-to-harvest period in raspberry and by late spring may not suitable for early season varieties that can fruit in June such as Prelude, Killarney, and Reveille. Spot treatments of glyphosate with a wick applicator can be used to treat problem weeds making sure to avoid contact with the raspberries. This herbicide will translocate and kill not only the cane touched but also ones connected by the roots and can be spread not only by the applicator but by treated weeds blowing into the canes while still wet. A well thought out herbicide program combined with timely mowing and selective hand weeding is an effective integrated approach to weed control in raspberry and can be used to successfully manage weed pests for maximum yields and profits. (***Source****: New York Berry News, Vol. 3, No.4*)

Purple Raspberry Cultivars for Ohio

Richard C. Funt, The Ohio State University

When black raspberries are crossed with red raspberries (mainly floricane types), a purple raspberry can be created. Purple raspberry plants have beenavailable for a long time with the latest introduction in 1982.

Royalty is a complex cross using Newburgh, a summer red and Cumberland, a high quality black raspberry. In New York, Royalty's berry size averages 3.0 grams (range 2.0 to 3.7) and is similar in size to Titan. Royalty produces vigorous canes, which requires a double cross arm four-wire trellis. Fruit begins to ripenin early July, is soft, reddish-brown in color, and is of excellent quality. Plants are immune to large raspberry aphid. Royalty is pruned similar to a summer red. It is described as similar to Titan for winter hardiness. Titan is considered to be lower in quality than Royalty. In central Ohio, Royalty ripens between July 7 and 20th. Generally, summer reds and black raspberries have completed their harvest by early July.

Brandywine (NY631 and Hilton) is a tall, upright plant similar to a black raspberry, and requires a single cross arm trellis system. It can be more vigorously than most black raspberries and is pruned like a black raspberry. In two studies, Brandywine has had higher yields than Royalty. Fruit are round, firm, large, and somewhat tart, making it excellent for jam and jellies. Brandywine is susceptible to verticillium wilt, raspberry aphid, and crown gall. It is considered to be more winter hardy than Royalty. It does not tolerate wet soils. Raised beds with organic matter are suggested. In central Ohio, Brandywine ripens at approximately the same time as Royalty. (***Source****: Ohio Fruit ICM News, Volume 8, Issue 12, April 15, 2004*)

Blueberries

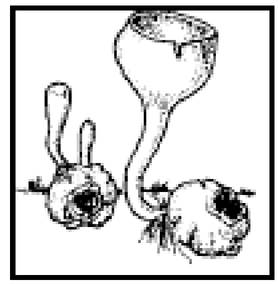
More on Mummyberry

Peter V. Oudemans, Rutgets Univ)

Mummy Berry: For mummy berry control, two phases must be considered. The primary phase occurs when spores produced from the cups infect developing shoots. Blueberry cultivars are susceptible from budbreak until shoots are ON AVERAGE two inches in length.

Infections occur approximately two weeks before symptoms appear and symptoms must correspond with the flowering period for the disease to complete its lifecycle. Control of the primary stage should be made to prevent infection. Thus, fungicide applications to control the primary phase should target budbreak. Cup development can also be monitored in the field. Spore production occurs when stipes form an deep indentation at the tip and the tip begins to expand to form the cup.

Mummy berry occurs in wet and poorly drained areas of the field. The fungus cannot overwinter in dry soils and apothecium formation cannot occur on dry soils. Scouting should therefore target the wet areas of a field. Sprays should also target wet areas with mummies and include at least a 300 foot buffer surrounding these areas. Cultivars such as Weymouth, Bluetta, Early Blue and Jersey are very susceptible whereas Bluecrop, Duke and Elliott are much less susceptible.



Mummy berry cup development. Look for developing stipes (left) and fully developed cups (right)

There are currently eight fungicides registered for mummy berry control this year (Table 1). Most have low efficacy and provide marginal control. Two of these materials (Abound and Switch) performed very well in tests in 2003. Indar (a section 18 material) is among the best and most consistent, however, the Section 18 label must be issued prior to being used. For control in areas with a susceptible variety fungicide applications should begin at budbreak and follow a ten day interval. Scouting should target leaf blighting when bloom begins. In areas with native populations of blueberry growers may see significant berry infections without leaf blighting. For these areas and fields with signs of leaf blighting fungicide applications should continue through the bloom period. All of the materials listed below have excellent Botryis control and several have excellent anthracnose control. Therefore applications made during bloom should be made in consideration of other diseases that may become active during these times.

Table 1. Fungicides currently registered for mummy berry control in New Jersey

Material	Mummy berry activity	Rate	Limitations
Abound1,2	Good	15.4 oz	Max. 3 applications
Bravo3	Poor	3.6lb or 4 pt	Max. 3 applications
Captan1,2	Poor	3lb or 4lb	Max 14 applications
Captevate1,2	unknown	3.5lb	Max. 4 applications
Elevate1	unknown	1.5 lb	Max. 4 applications
Pristine1,2	unknown	18.5 -23 oz	Max. 4 applications
Switch1	Excellent	14 oz	Max. 4 applications
Ziram1,2	Poor	4.0 lb	Max. 4 applications

1. Excellent Botrytis control
2. Excellent Anthracnose control
3. Can by phytotoxic to bloom

(***Source****: Blueberry Bulletin, Vol. XIX, No. 1, April 2, 2004*)

Herbicide Options for Michigan Blueberries

Eric Hanson, Michigan State University

Preemergent herbicides should go on blueberries in late April to early May. The herbicide choices are described in detail in Extension Bulletin E-154. [**Editors Note**: *New England Growers can find this information in the 2004 New England Small Fruit Pest Management Guide*] Preemergent herbicides are soil-applied chemicals that kill germinating weed seeds or young seedlings. Many materials applied at high rates also kill established weeds. Properly chosen and applied preemergent herbicides will provide effective weed control throughout most of the growing season. Here are several considerations in using these materials effectively.

Princep 90WG (simazine), Karmex 80DF (diuron), Sinbar 80W (terbacil), Solicam 80DF (norflurazon). These are the workhorse preemergent herbicides in established blueberries. They are moderately priced, reasonably safe on blueberries, and control many germinating annual weeds for one to three months. Princep and Karmex tend to be stronger materials on broadleaf weeds, whereas Sinbar and Solicam are stronger on grasses. Use these only on established plants that have been in the ground for two years or more. Use rates per acre are 2.2-4.4 lb Princep 90 WG, 2-4 lb Karmex 80DF, 1-2 lb Sinbar 80W, and 2.5-5 lb Solicam 80DF. These rates are for an acre of treated surface area, so if you treat half the surface by spraying a strip beneath the plants, you will use half these amounts. To prevent injury to blueberries, use the lower rates on smaller plants or on sandy soils low in organic matter. This is particularly true of Sinbar.

Other preemergent herbicides labeled for blueberries are Casoron, Devrinol, Kerb, Surflan, and Velpar. The utility of Kerb, Casoron and Velpar in blueberries is limited by either cost (Casoron, Kerb) or crop safety (Velpar). Devrinol and Surflan are primarily grass materials that are very safe on blueberries (can be used on new plants), but have no post-emergent activity and must be applied before weeds germinate.

Table 1. Approximate Costs of Blueberry Herbicides1

Product	Common Name	Rate (Product per acre)	$ per Treated Acre2
Pre-emergent Herbicides			
Casoron 4G	dichlobenil	100 to 150 lb	200 to 300
Devrinol 50 DF	napropamide	8 lb	80
Gallery 75DF	isoxaben	0.7 to 1.3 lb	?
Karmex 80 DF	diuron	2 to 4 lb	8 to 18
Kerb 50 WP	pronamide	2 to 4 lb	80 to 160
Princep 90 DF	simazine	2.2 to 4.4 lb	9 to 18
Sinbar 80 WP	terbacil	1 to 2 lb	30 to 60
Solicam 80 DF	norflurazon	2.5 to 5 lb	50 to 100
Surflan 4AS	oryzalin	2 to 4 qt	45 to 90
Velpar 2L	hexazinone	2 to 4 qt	26 to 52
PostEmergent Herbicides			
Fusilade DX 2E	fluazifop butyl	1 to 2 pt	18 to 36
Gramoxone Max 3L	paraquat	1.7 to 2.7 pt	9 to 16
Poast 1.5E	sethoxydim	1 to 2 pt	9 to 18
Rely	glufosinate	3 to 5 qt	50 to 80
Roundup Ultra 4L	glyphosate	1 to 2 qt	18 to 36

1 Costs approximated from dealer quotes, 3/04. Actual costs will vary with source.
2 Product costs for treating an acre of ground. If bandapplying under blueberry rows so half the ground surface is treated, costs would be half of those listed

Rely is a postemergent herbicide labeled on blueberries just last winter. This product may do a better job of killing some perennial weeds than Gramoxone, but appears to be safer to use in blueberries than Roundup. Rely will still kill any green blueberry stems or leaves, but it does not seem to translocate out of treated parts to injure the bush. Try Rely this year and learn what weeds it will control.

Rotate herbicides to avoid resistance

Continued use of herbicides from the same chemical families (see accompanying table) can result in weeds that are resistant to all herbicides in that family. Many weed species have developed resistance to the triazine family, which includes the blueberry herbicides Princep and Velpar. Triazine resistant weeds may also be more tolerant of herbicides from other chemical families that share the same mode of action. For example, Princep, Karmex and Sinbar all affect weeds through the same mechanism; they kill weeds by inhibiting photosynthesis.

Triazine-resistant marestail and ladysthumb (a smartweed) are present in Michigan blueberries. If you suspect that triazine-resistant weeds are present on your farm, switch to herbicides with a different mode of action. Solicam and Surflan offer different modes of action and would be good choices to rotate with the photosynthesis inhibitors to control resistant types or to avoid the development of resistant populations. (***Source**: Michigan State Fruit CAT Advisory Vol. 19, No. 2, April 13, 2004*)

Table 2. Families and modes of action of blueberry herbicides

Herbicide	**Chemical Family**	**Mode of action**
Casoron	Benzonitrile	Inhibit cell division.
Surflan	Dinitroaniline	Inhibit active growth processes.
Princep/Velpar	Triazine	Hill reaction inhibitor (photosynthesis)
Karmex	Urea	Hill reaction inhibitor (photosynthesis)
Sinbar	Uracil	Hill reaction inhibitor (photosynthesis)
Kerb	Benzamide	Inhibit cell wall synthesis
Solicam	Pyridazinone	Inhibit carotenoid synthesis
Devrinol	Acetamide	Interferes with mitosis

Grapes

What to Consider for Spring Grape Disease Management

Annemiek Schilder, Michigan State University

Disease history of the vineyard

Most vineyards do not have a history of all grape diseases. Growers should focus their disease control efforts on the diseases they know are a problem for them. Disease pressure depends on the weather conditions, the cultivar grown, the age of the vineyard, the location, and the training system. For instance, humid weather is more conducive to powdery mildew, and hedged vineyards typically have more Phomopsis than handpruned vineyards.

Cleanup of vineyard

Prune out dead canes and stubs as much as possible since they are the main sources of phomopsis spores. Remove any fruit mummies still hanging on the vine, since these may release black rot spores. Also remove large pieces of wood from the vineyard and burn them. This is especially important in Eutypa-infected vineyards, since dead wood remains a source of Eutypa inoculum for multiple years.

While it is recommended to remove pruned canes from vineyards, most growers find it more practical to chop them up. This may be okay, provided that the canes are well pulverized so that they can decompose quickly. Make two passes with a brushchopping mower if necessary.

Timing of disease control measures

Timing of disease control measures is critical to success. Protectant fungicides have to be used before an infection period occurs. Between one and five inches of shoot growth, Phomopsis cane and leaf spot is the primary disease of concern. Clusters and shoots are vulnerable as soon as they become exposed. Young tissues are most susceptible.

Spray timing trials have indicated that this stage is important for controlling cluster stem (rachis) and shoot infections. Wet weather conditions during this period of rapid shoot elongation are ideal conditions for the infection and spread of Phomopsis.

Applications should be made 10 days to two weeks apart, depending on weather conditions. If there are frequent rain events (several per week, with rainfall totals greater than one inch since the last spray) then the spray interval should be 10 days. Protectant materials will protect the shoots and leaves for two weeks if rain events occur weekly with rainfall totals less than one inch since the last fungicide application. Powdery mildew control should not be delayed in vinifera and susceptible French hybrid vineyards past the 10 to 12 inch growth stage. However, in most Concord vineyards, powdery mildew control is not imminent at this time.

Phomopsis is still the primary concern at this stage of growth. Black rot may be an issue in vineyards that had a problem the previous year. There is an abundance of succulent tissue that is highly susceptible to infection. In addition, the clusters are also exposed to infection at this stage.

Extended periods of wet weather are very favorable to most grape diseases. In general, if the leaves and shoots are wet for eight hours or longer, infection is possible if not protected by a fungicide.

What fungicides to use early in the season?

The fungicides most effective in controlling phomopsis are also effective in controlling earlyseason (foliar) black rot. The broadspectrum fungicide mancozeb (Dithane, Manzate, Penncozeb and Manex) is the most effective material for controlling these diseases early in the season.

It is recommended to save the use of SI's (e.g., Nova and Elite) and strobilurins (e.g., Abound, Sovran, Flint) until later in the season when they are needed for control of multiple diseases. Both of these groups of fungicides are prone to resistance development, so are best used at critical disease control periods (immediate prebloom until second postbloom). Do not use these materials more than three times per season regardless of the material. Rotating these two fungicide groups can help delay the development of resistance.

JMS Stylet Oil or sulfur may be used to control powdery mildew early in the season. However, powdery mildew generally is not a great concern at this time, except in susceptible cultivars and vineyards that had a problem with fruit infection the previous year. Resistance development to these materials is not a concern, but there are some compatibility restrictions with Stylet Oil and other spray materials. Read the label for details. Do not apply sulfur to sensitive varieties.

Use of dormant sprays

Delayed dormant sprays (before budbreak) have shown promising results for Phomopsis control in Michigan. We observed, on average, a 50 to 60 percent decrease in disease severity on the grape leaves as well as clusters from a single dormant spray of Topsin M, lime sulfur, sulfur, Stylet oil, or copper (Kocide) at budswell. Tank mixing Sulfur and Stylet oil did not increase control; rather the combination was worse than each product used singly.

A single dormant application with a sulfur or copper product appeared to be the most inexpensive of the treatments tested. If no green tissue is showing, these products should be safe on sulfur or coppersensitive varieties. At this time, only lime sulfur and copper products are explicitly labeled for use as dormant sprays in grapes. The labels on sulfur products are somewhat ambiguous on dormant use. We will be evaluating these and various other products again as dormant sprays in 2004, as well as reducedspray programs in combination with dormant sprays. (Source: Fruit Crop CAT, Vol. 19, No. 2, April 13, 2004)

Grape Update

Alice Wise, Cornell Cooperative Extension of Suffolk County

Winter Injury: Winter injury to grapevines is not something that we commonly deal with on Long Island. After this winter however, it is quite likely that most vineyards will see some effects from the harsh conditions. We should consider ourselves fortunate in this regard as many wine industries are bracing themselves for bad news in the spring.

Our coldest night, coincidentally the second night of the Ag Forum on January 16, was 1ºF. Fortunately, vines were deep in dormancy and at their most cold tolerant. Though we recorded 6.5" of snow the day before, it was a windy night and the snow was really blowing around. Thus, in terms of protection, we really did not have enough snow cover this winter to make a whole lot of difference. Rather than go over all the details, take some time to visit a couple of websites. Dr. Robert Pool, Cornell viticulturist, along with Dr. Martin Goffinet, Cornell's grape anatomist, have produced a series of excellent papers on winter injury. They cover it all, down to the specific trunk issues that can be injured and what various stages of trunk injury are manifested. Check out the following websites: www.nysaes.cornell.edu/hort/faculty/pool/grapepagesindex.html and grapes.msu.edu/pdf/cultural/avoidcoldinjury.pdf Michigan State has some interesting information on snow cover and straw as insulating materials.

Dr. Goffinet also gave a presentation at the Finger Lakes Grape Grower Conference in February. It is now posted on his faculty web site here at Cornell in Geneva. This would certainly be worth a visit if you are at all concerned or curious about winter injury. www.nysaes.cornell.edu/hort/faculty/goffinet/AnatomyWinterInjury.pdf.

We know that there is some level of winter injury in Long Island vineyards. Our best guess is that it will be spotty – some sites unaffected, some with slight injury and a few with problems. Injury can be manifested in various ways.

Buds, canes and trunks can all suffer from injury. Check out the websites to read the details. There are two important points: 1) certain types of winter injury, namely trunk injury, may not be evident until well into the growing season (classic symptom: young shoots suddenly collapse on a whole vine or on one trunk); and 2) if winter injury is an issue in your vineyard, take good notes on where it happened and how it was manifested.

Local observations the past few months have included the following:

Canes: Split canes, particularly near the base of the cane. At the research vineyard, we saw this on an occasional Chardonnay vine. It is hard to judge at this point how detrimental this will be. We will certainly lose production where the cracks were significant. But a portion of the canes had very subtle cracks.

Buds: There does not seem to be abnormally high numbers of dead buds based on what we have seen as well as reports from the industry. One grower found buds with splits in the primaries. As buds were sliced for evaluation, periodically a small split in the primary was noted. It fortunately was an occasional observation rather than throughout the block. Still, it seems likely that those primaries will be lost. Again, the impact can only be judged after budbreak as well as later in May when clusters appear (or don't).

Trunks: Trunk splitting, both minor and major, have been seen though it does not appear to be industry wide nor is it related to a single variety. Two reports, as well as our observations here, indicate that trunks in cross section have looked good (not that the samples taken have been large or representative). Injury to trunks appear as light to dark discoloration.

Crown gall: There are a few reports of crown gall. We noted pretty extensive trunk galling on 2 yr old Syrah vine in the research vineyard. This has happened previously with our Syrah. Syrah is known to be a slightly more winter tender vinifera. Though we don't see any crown gall other than that, I suspect we might see a little more here and there as the season progresses. Undoubtedly there will be crown gall in commercial vineyards as well.

Vine death: There have been two reports of some losses in young vines. There have been no reports of vine death in bearing vines. Again, we will have to wait until May to make final judgments.

We can learn a lot from other regions who have the unfortunate distinction of having to deal with winter injury periodically. Who knows if this past winter is an anomaly or if it is the start of a series of colder than normal winters. Nevertheless, the conservative approach would be for local growers to invest some time and effort into managing vines to minimize winter injury.

Perhaps we should be renewing older trunks more frequently. This can be difficult as sometimes as vines/trunks age, the generation of suitable shoots at the base of the vine diminishes. We see this particularly with Cabernet Sauvignon at the research vineyard. Many of us have abandoned the practice of maintaining renewal spurs at the base of the vine. Perhaps it is time to revisit this strategy. The merits of single vs. double trunks are often discussed. Double trunking does serve a purpose in that younger trunks can survive episodes that injure older trunks. Snow cover and straw mulch can provide significant benefits, particularly in young vineyards, as found in a study by Tom Zabadal at Michigan State. "Old timers" will remember Tom as the former Finger Lakes Grape Specialist. See the web address above.

Don't overfertilize winter injured vines. If shoot number and/or cluster number has been reduced, avoid overstimulation of remaining shoots. Most of us have seen bullwood (canes excessively large in diameter) before. Bullwood is less fruitful, harder to train (ex: use of a bull cane for a cane pruned vine – it is not easy to wrap around the wire) and may be more susceptible to future winter injury. The Cornell website has some very good information on dealing with winter injured vines. (***Source**: Long Island Fruit & Vegetable Update, No. 6, April 16, 2004*)

New this Spring for Grape Growers

Michigan State University has been working with the National Grape Cooperative and the Michigan Wine Industry to bring you a new resource for integrated vineyard management. Visit http://www.grapes.msu.edu/. [Ed. Note: This is a very valuable new resource for grape growers from any region.]

Soil Analysis and Interpretation

Warren C. Stiles, Emeritus of Cornell University

Before planting an orchard a thorough evaluation of the soil chemical conditions through soil testing provides the best information on which to base decisions concerning the need for and extent of modifications required. In established orchards, soil testing is critical to monitor pH and provides additional information needed for satisfactory interpretation of results of leaf analysis and developing fertilizer management programs.

Soil Sampling Procedures

How, when and where samples are collected all influence the results of soil analysis. Both topsoil and subsoil samples are needed to obtain the best analysis of conditions throughout the rooting zone. Topsoil samples (0 to 8 inch depth) reflect the effects of recent lime and fertilizer additions and are important in monitoring pH and nutrient availability in the upper portion of the rooting zone. However, topsoil samples alone are not representative of the total root zone and may not show good correlation with crop response. Subsoil (8 to 16 inch depth) samples indicate inherent problems such as low pH and lack of fertility, reflect the long-term response to lime and fertilizer additions, and supplement the information obtained from topsoil analysis.

During pre-plant soil preparation, soil samples can be taken at any time that is convenient. However, in established orchards the preferred time of sampling is in mid- to late-summer or in the fall after harvest. Samples collected in the fall usually show lower phosphorus (P) and potassium (K) as a reflection of crop removal. Those collected in the spring reflect winter "recharge" for various elements.

Thorough sampling is necessary if the results are to be meaningful. In a 10-acre orchard, a minimum of 10 to 20 sub samples are usually needed in collecting one soil sample for analysis. In established orchards these sub samples should be coordinated with leaf samples taken in the same area. Soil chemical analysis prior to planting a new orchard is essential. It provides the best information for proper soil nutrient improvement before planting. After planting, soil chemical analysis is used to supplement leaf tissue analysis in developing fertilization programs. Samples should be taken from within the tree row where most of the nutrient elements are taken up by the trees, not in the middle of the alleyways.

Soil pH, CEC and Base Saturation

Soil pH and Soil Acidity. The term "pH" is used to describe relative acidity or basicity and is a measure of hydrogen ion (H+) activity expressed in logarithmic terms. The pH scale covers a range of 0 to 14, with a value of 7 indicating neutrality. Values from 0 to 7 indicate acidity and those from 7 to 14 indicate basicity. Since this is a logarithmic scale, each 1.0 unit change indicates a 10-fold change in acidity or basicity. Soil pH can range from 4 to 9.

The term "active acidity" refers to concentrations of hydrogen ions in the soil solution and is measured using a suspension of soil in water. "Reserve acidity" (exchangeable acidity) includes hydrogen ions held on negatively charged soil particles of clay and organic matter plus other positively charged ions such as aluminum. Both "active" and "reserve" acidity are involved in determining the amount of lime that may be needed to adjust soil pH. In the Cornell soil test reports, "reserve" acidity is reported as meq of hydrogen (H+) per 100 grams of soil. Reserve acidity must be included when estimating total cation exchange capacity of the soil.

Problems associated with low pH (below 5.5) include measles associated with excessive uptake of manganese; calcium and magnesium deficiencies; restricted root growth or regeneration, particularly of new lateral roots affected by aluminum toxicity; reduced availability of phosphorus; reduced efficiency of nitrogen and potassium use; and poor response to applied nitrogen and potassium fertilizers.

High pH may be associated with soil parent materials, in some cases with excessive lime applications, or a reflection of carbonate accumulation due to poor internal soil drainage. High soil pH (>7.0) may reduce availability of manganese, copper, zinc and boron.

During pre-plant site preparation, suggested targets for pH adjustment are pH 7.0 for the topsoil and 6.5 for the subsoil. In established orchards, these targets should be 6.5 for the topsoil and 6.0 for the subsoil. Soil pH should be maintained in the range of 6.0 to 6.5 throughout the total root zone to optimize nutrient availability.

Soil pH is usually measured using a mixture of one part soil and one part water. In some cases pH may be measured using a mixture of one part soil and two parts $CaCl_2$ solution, in which case the resulting pH is about 0.6 unit lower than with water. Likewise, pH measured using 1 Normal KCl (potassium chloride) solutions is somewhat lower than that obtained using soil:water suspensions.

Cation Exchange Capacity (CEC). Soil clay particles and humus, collectively called colloids, have negative charges. They adsorb positively charged ions (cations). Cation exchange capacity (CEC) is the sum total of exchangeable cations that are adsorbed on the soil colloids and is a measure of the ability of a soil to hold cations. CEC is expressed as milliequivalents of cations per 100 grams of soil. There are two types of cations on the soil colloids: acid forming cations (H+, AI3+, Fe3+, Mn2+) and base cations (Ca2+, Mg2+, K+, and Na+). The sum of exchangeable acid forming cations is called exchange acidity or reserve acidity. It is expressed as milliequivalents of hydrogen ion per 100 grams of soil. The sum of exchangeable bases and the exchange acidity is equal to CEC. The percentage of CEC that is accounted for by exchangeable bases is base saturation. Cation exchange capacity is important in estimating the quantities of calcium and magnesium needed in managing the specific soil.

The term "equivalent" refers to the quantity of various elements that is equal to 1 equivalent of hydrogen. On a comparative basis, equivalent weights of common cations may be expressed as parts per million or as pounds per acre (Table 1). Soil test results reported in PPM are converted to pounds per acre by multiplying by 2, since a 6-inch depth of soil is assumed to weigh 2 million pounds.

The cation exchange capacity of a soil is determined by the type and amount of clay and organic matter content and is influenced by pH. Organic matter has a cation exchange capacity of approximately 200 meq/100 g, thus 1 percent organic matter in a soil provides about 2 meq/100g of cation exchange capacity. The cation exchange capacity of New York soils may range from as low a 3 meq/100g in very coarse sands to as high as 35 to 40 meq/ 100g in clayey soils (Table 2).

Cation exchange capacity can be estimated by calculating the total milliequivalents of the major basic elements (Ca++, Mg++, and K+) and adding the milliequivalents of reserve acidity (H+). If the value for reserve acidity is not known, CEC can be estimated by dividing the sum of the meq/100grams of the basic elements by the percent base saturation for the pH of the sample.

Base Saturation. Base saturation refers to the degree to which the cation exchange complex is saturated by basic elements such as calcium, magnesium and potassium. It is usually expressed in terms of percentages of the total exchange complex that is represented by these elements, individually or in total. As soil pH increases the percent base saturation also increases. At a given pH "sandy" soils have a higher percentage base saturation than the majority of soils because they have lower total cation exchange capacities and lower buffering capacities.

Calcium (Ca)

Calcium content of soil samples may be expressed as PPM, lbs/acre, meq/100g, or as percent saturation of CEC. Low levels of soil calcium are usually associated with low soil pH and low cation exchange capacity, particularly in sub soils. However, in some fine-textured soils calcium availability and uptake may be more directly related to exchangeable acidity than to pH or the total amount of calcium in the soil.

Imbalances of calcium, magnesium and potassium are frequently cited as problems in orchard soils. In most cases, inadequate amounts of one or more of these nutrient elements are of greater importance than an imbalance in tree nutrition. Such shortages are particularly important in the subsoil.

Magnesium (Mg)

Magnesium content of soil samples may be expressed in various terms, as indicated for calcium. Most tree fruits have a high requirement for magnesium and, with some exceptions, most soils in the Northeast are low in magnesium content. Raising pH by applying calcitic (high calcium) lime increases the availability of the magnesium present in the soil but does not correct the long-term problem of low magnesium supply. Applying dolomitic limestones (high in magnesium content) is the usual method for correcting low magnesium supply.

Lime Requirement for Adjusting Soil pH and Soil Ca and Mg Levels

The amount of lime needed to adjust the soil reaction to the desired pH is referred to as the lime requirement. The lime requirement is related to the initial soil pH, the amount of pH change desired, and the cation exchange capacity. Since cation exchange capacity is largely determined by the amounts of clay and organic matter in the soil, the lime requirement is influenced by soil texture and increases as the desired pH for a given soil is raised. Various alternative methods may be used for estimating the lime requirement. (See article by Cheng and Stiles in this issue). Approximate amounts of calcium and magnesium desired in topsoil at pH 6.5 and in the subsoil at pH 6.0 for soils of various soil textures are given in Table 3.

The amount and type of lime to be applied should be determined on the basis of pH adjustment desired and the amounts of calcium and magnesium in both the topsoil and the subsoil, and the amounts of these elements required to achieve their desired concentrations. On an equivalent basis, a 5:1 ratio of calcium:magnesium is presently recommended as a target for most fruit crops in New York State. This is equal to approximately 8.23 pounds of calcium per pound of magnesium. These ratios are used in estimating calcium and magnesium requirements and should not be interpreted as precise requirements. Acceptable ratios may vary within broad ranges depending on the specific soil, crop, and environmental conditions at the individual site.

Potassium (K)

Soil test results for potassium may be reported in various terms: milliequivalents per 100 grams of soil; parts per million; pounds per acre; or percent of potassium saturation of the cation exchange capacity. Results may vary considerably among different laboratories primarily because of the method of extraction employed.

TABLE 1				
Equivalent weight of various cations.				
Element	Atomic weight	Equivalent weight	Parts per million	Pounds per acre (6-inch depth)
Hydrogen	1.008	1.008	10	20
Potassium	39.10	39.1	391	782
Calcium	40.08	20.04	200.4	400.8
Magnesium	24.32	12.16	121.6	243.2
Aluminum	26.97	8.99	89.9	179.8

TABLE 2		
Approximate cation exchange capacities of various soil types		
	Approximate CEC (meq/100g)	
Texture	0-8 inch depth	8-16 inch depth
Sand, Gravel	5	3
Sandy Loam	12	8
Silt Loam, Loam	18	12
Silty Clay Loam	20	14
Clay, Silty Clay	25	18

TABLE 3		
Approximate Amounts Calcium and Magnesium Needed in Both the Topsoil and Subsoil of Various Textured Soils		
Texture	Calcium	Magnesium
Topsoil at pH 6.5 (lbs/acre 0 to 8-inch depth)		
Sand, Gravel	1,500	185
Sandy Loam	3,600	440
Silt Loam, Loam	5,500	660
Silty Clay Loam	6,100	740
Clay, Clay Loam	7,600	900
Subsoil at pH 6.0 (lbs/acre 8 to 16-inch depth)		
Sand, Gravel	800	100
Sandy Loam	2,100	260
Silt Loam, Loam	3,200	385
Silty Clay Loam	3,700	450
Clay, Clay Loam	4,800	580

The potassium that is readily available for use by plants occurs primarily as potassium ions in solution or as exchangeable ions on the cation exchange complex. The majority of potassium in most soils is present in mineral form as a constituent of clay particles. Potassium status, or the ability of a soil to release potassium in available form, therefore varies with soil texture (Table 4).

Soil texture influences potassium availability through its effect on root development. Since potassium is relatively immobile within the soil, extensive root development is required for efficient uptake.

Fine-textured soils, although they may contain larger amounts of potassium, may limit the extent of root development to the extent that the crop may not be able to efficiently access this supply. The more extensive root development by crops grown on coarser-textured soils provides more efficient uptake of the smaller amounts of potassium that they contain. Potassium availability and uptake is improved if an adequate soil moisture supply is maintained.

Potassium status of the soil must be considered in conjunction with that of pH, calcium and magnesium. Potassium availability generally decreases as pH decreases below about 6.0. Generally, liming acid soils increases availability of potassium and reduces losses of potassium by leaching. The percentage of the cation exchange capacity occupied by potassium should be considered in relation to calcium and magnesium. It is not likely that calcium or magnesium would depress potassium uptake, but the reverse may occur - particularly with magnesium.

Approximate values used in interpreting the Cornell soil test results for orchards on soils of different textures are presented in Table 5. Potassium needs approximate 5 percent of those for calcium on an equivalent basis, or about 10 percent of those for calcium on a weight basis.

Phosphorus (P)

Phosphorus needs of most perennial fruit crops are relatively low in comparison to those for nitrogen and potassium and with the needs of herbaceous plants. Soluble phosphorus is precipitated out of solution as insoluble iron, aluminum, or manganese phosphates, or oxides of aluminum, iron, or magnesium in acid soils, and as insoluble calcium phosphates in alkaline soils. Maximum availability of phosphorus occurs when soil pH is maintained between 6.0 and 7.0.

Various extractants may be used by different laboratories to test the availability of phosphorus in soil samples. This results in widely different values from different labs. In most cases, the amount of phosphorus obtained with these methods usually increases as the soil pH increases. Results of soil tests are usually reported in terms of either parts per million or pounds per acre of P (phosphorus).

In the Cornell soil tests, the amounts of phosphorus (pounds of P2O5 per acre 6-inch depth) required for pre plant incorporation is calculated as follows: [(10 - sample content) + 40], and for established plantings [(10 - sample content) + 20]. It is recommended that phosphate fertilizers be thoroughly incorporated into the soil during pre plant site preparation. Further soil surface applications after orchards have been established are not recommended unless leaf sample P values are less than 0.08 percent. Even then, low values of leaf sample P are more likely to be associated with low soil pH than with a lack of available soil phosphorus.

Boron (B)
Boron is very soluble and mobile in the soil and is relatively easily leached under humid conditions. Availability of boron decreases as soil pH is increased and liming acid soils to a pH of 6.5 to 7.0 reduces losses by leaching. Finer-textured soils have a higher buffering capacity and require higher concentrations of boron to meet crop needs than those of coarser texture. Likewise, toxicity problems from excessive applications of boron are less frequent in finer-textured soils. Boron availability is reduced when soil moisture supply is low. Leaching losses are increased by excessive rainfall or irrigation.

Various extractants have been used in analyzing soil samples for boron; the most common is hot water. Results of soil tests for boron are most often reported in terms of parts per million or pounds per acre.

Suggested rates of boron application vary with soil texture and the amount of boron already present in the soil (Table 6). Rates of boron application indicated are for apples and pears. Stone fruits, especially peaches, are more sensitive to excess boron and boron applications should be reduced by 50 percent for these crops unless leaf analysis indicates a greater need.

Zinc (Zn)
Availability of zinc in acid to neutral soils decreases sharply as soil pH is increased. For each unit (1.0) increase in pH between 5.0 and 7.0, zinc concentration in the soil solution may decrease by a factor of 30. High organic matter content of the soil may decrease availability of zinc through the formation of insoluble organic complexes. Zinc availability and uptake is inhibited by high levels of phosphorus through the formation of insoluble zinc phosphates. Several extractants have been used in determining zinc availability in soil samples, each providing different relative values. Results of these tests are usually reported in terms of parts per million or pounds per acre. For most fruit crops, standards for interpreting soil zinc values have not been well established.

Copper (Cu)
Copper availability is strongly influenced by soil pH, organic matter content of the soil, and levels of phosphates in the soil in manners similar to zinc. Like zinc, copper is not mobile in soil. Soil test methods used in estimating copper availability are similar to those used for zinc. Likewise, the standards for interpreting soil copper values for fruit crops are not well established.

TABLE 4
Available Potassium of Some NY Soils

Soil type	Texture	K (lb/acre/yr)
Adams	Loamy fine sand	20-60
Arkport	Fine sandy loam	80-100
Elmwood	Fine sandy loam	80-100
Howard	Gravely loam	100-120
Dunkirk	Silt loam	100-120
Hudson	Silt loam/silt clay	120-140

TABLE 5
Desired Soil Potassium Levels for Various Soil Textures (lbs/acre)

Soil Texture	0 to 8-inches	8 to 16-inches
Sand, Gravel	150	100
Sandy Loam	350	220
Silt Loam, Loam	525	335
Silty Clay Loam	580	370
Clay, Silty Clay	730	465

TABLE 6
Boron Soil Test Levels for Soils of Different Textures and Recommended Amounts to Apply Preplant.

	Soil Texture			
Relative Level	Loam, Silt Loam (lb. B / a)	Sandy Loam (lb. B / a)	Loamy Sand (lb. B / a)	B to apply (lb. B/ a)
Very high	> 2.4	> 1.8	> 1.2	none
High	1.6-2.4	1.2-1.8	0.7-1.2	1
Medium	0.8-1.6	0.6-1.2	0.4-0.7	2
Low	< 0.8	< 0.6	< 0.4	3

Iron (Fe)
Availability of iron decreases as soil pH increases. Excessive levels of phosphates or carbonates reduce iron availability through the formation of insoluble iron compounds. Organic matter is a source of iron and also complexes and chelates iron. Soil tests for iron have not been well correlated with response of most fruit crops.

Manganese (Mn)
Excessive amounts of manganese are of concern because of toxic effects on crops. Soil pH has a major role in regulating manganese availability and raising pH of a soil from 4.5 to 6.5 has been shown to reduce the concentration of exchangeable manganese by a factor of 20 to 50 times. Most deficiencies of manganese are associated with higher soil pH or highly leached soils. The manganese content of plants is frequently more closely related to soil pH than to the concentration of manganese in the soil.

Aluminum (Al)
Aluminum is of concern because of its adverse effect on root development and consequently on uptake of other elements. Relatively low levels, 10 to 20 parts per million or less, of aluminum in the soil solution can adversely affect some fruit crops. Using the Cornell soil test methods, 200 pounds of aluminum or of a combination of aluminum, manganese and iron indicates a potential problem situation for these crops. Liming acid soils to a pH of 6.0 to 6.5 may be necessary to adequately limit availability of aluminum. Draining soils to improve aeration helps to reduce the severity of aluminum toxicity problems.

Organic matter
Organic matter serves a multitude of functions in soils. Under usual conditions, organic matter content tends to be lower in coarse-textured soils and higher in finer-textured soils. Organic matter usually accounts for most soil nitrogen. In general, one percent organic matter in the soil will result in the release of 20 pounds of plantavailable nitrogen per year. Soils in New York State vary in nitrogen supplying ability, ranging from approximately 30 pounds to as much as 80 pounds per acre per year. Therefore, the contribution of nitrogen from organic matter must be considered in developing nitrogen management programs for fruit crops.

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Warren Stiles is an emeritus professor of pomology who led Cornell's fruit mineral nutrition research and extension program for many years. He is still widely recognized as a world authority on fruit mineral nutrition.

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Development and Testing of a Shrouded Flame Weeder for Non-Chemical Weed Control

Kevin Bittner and Ian Merwin, Cornell University

The first use of a flamer for agricultural purposes was in 1938 by Price McLemore who used a kerosene flamer for cultivation of his corn and cotton. In the early 1940s, Louisiana State University began testing the concept, and, by the middle of the decade, there were many flamers in use in Mississippi for desiccation of cotton. The flaming concept expanded from there through constant testing and experimenting with new uses and designs. Today, there are many applications on a variety of crops throughout the world that utilize this concept (Flame Engineering 2003).

Examples include weed control in strawberries and potatoes (Ivens, 1966), alfalfa, corn (Sullivan, 2001), and cotton (Seifert, S. and Snipes, 1998), seedbed sterilization, and pest control. Colorado potato beetles are easily controlled on young plants by using a flamer that kills the beetles without seriously damaging the plants (Cornell University, 2002).

Weed control is the primary use of flamers. Weeds are not completely burned by this technique. Rather, travel speed is adjusted so that surface vegetation is merely scorched, and essential enzymes are denatured, disabling the plants' metabolism. Weeds then wither and succumb over a period of several hours. If done properly, weeds will appear normal immediately after flaming, remaining green and still standing. It takes from a few minutes to a few hours until they start to wilt and die (Hickey, 2000).

Flaming conserves plant residues as organic matter and mulch for the soil. The key to effective weed control with flaming is that weeds must be shorter and more tender than the crop you are protecting. Flaming weeds at the same level of maturity as the crop plants may damage the crop. As crop plants mature, they develop a hard outer coating on the stems.

Extreme caution should be exercised when flaming around tender crops such as potatoes, strawberries, and young grapevines and fruit trees. Even young trees and bushes can be harmed since they do not yet have a protective layer, and flaming can burn the cambium, xylem and phloem in the base of the plant. Flamers have also been known to ignite and burn mulches or other flammable materials, and may best be used following rain, or when there is dew on the surface vegetation to impede combustion of weeds (Young, et al., 1990). Engle, et al. (1988) concluded that flame weeding is comparable to contact herbicides in efficacy.

Propane "flamers" may be useful to control weeds in situations where herbicides are not desirable. The model tested here was affordable with operating and material costs similar to that of a typical burn down herbicide application but without the soil or water residues. This technique could be particularly valuable in organic fruit production where herbicide use is prohibited.

One of the advantages of flaming is that the soil is not disturbed and buried weed seeds are not brought to the surface where they can break dormancy and germinate (Hickey, 2000). Tillage often results in serious weed problems reoccurring in just a few weeks. Problematic orchard weeds like pigweed (*Amaranthus* spp.) and lambsquarter (*Chenopodium album*) are especially prone to regenerate after tillage since these weed seeds can remain dormant in the soil for decades (Sullivan, 2001).

Flaming works relatively well for controlling annual weeds, but perennials such as quackgrass (*Agropyron repens*) may grow back rapidly after flaming or mechanical tillage (Williams and Peachey, 2001). Similar problems with weed regrowth can also occur with non-residual herbicides such as paraquat.

Propane flamers are potentially important pest control devices for organic farmers, providing a non-chemical method of controlling weeds and insect pests (Young, et al.,1990). Some commercial literature suggests that propane may also be more economical than the alternative herbicides (Flame Engineering, 2003) with no indirect farm worker hazard, reentry period, or necessity for pesticide applicators certification.

Types of Flamers

There are many different types of flamers currently available. They vary in size from the small handheld burner wands found in gardening catalogs, to tractor and truck mounted burners handling four rows of corn at a time. Red Dragon Company Inc. makes several of these including orchard, row crop and field or alfalfa flamers (Flame Engineering, 2003).

The orchard and vineyard flamers advertised on their website are trailer mounted and available in either single or double row models. The row crop burners range from two to eight rows. They are sold in fully assembled three point mounted machines or in kits to build your own machine.

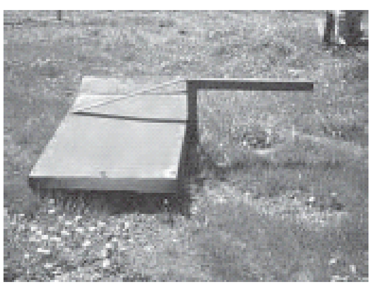

Figure 1. Shroud around burners.

Figure 2. Propane tank and carrier on forklift.

Figure 3. Flamer mounted on front of tractor.

Figure 4. Front view of unit on tractor. For scale, the tractor is 50 inches wide.

Figure 5. Operator's view of mounted flame weeder from cab of tractor

Figure 6. Flamer raised for easy transport and repairs or adjustments.

The kits include the burners, valves and regulators. Typically, the burners are set 30-60 degrees below horizontal. This directs them below the crop foliage and at the ground where short weeds are. Theoretically, the crop is only warmed slightly while weeds are scorched. The alfalfa flamers are meant to burn everything in an alfalfa field or other open fields to control pests and weeds. This allows the alfalfa to re-grow without competition from weeds. Red Dragon Co. also markets a 12-foot unit to drag behind a trailer-mounted tank, as well as handheld burners. The cost of these flamers ranges from the $50 handheld unit to $11,000 for tractor mounted units.

Flaming speeds vary greatly depending on the application. Speeds are affected by the type of flamer, application rate, and atmospheric temperatures. On cold days, the flamer must travel more slowly to achieve the necessary minimum temperatures for weed control. It is more difficult to flame after a rain, because heat goes into evaporating the water before it can affect weeds or pests. However, the risk of combustion in weed residues, and smoke generation are also reduced in wet conditions.

The position of burners is also crucial. If directed too far apart, the flame will not cover all the treatment area. If positioned or directed too close together, the flames will overlap, wasting fuel and increasing the likelihood of undesirable combustion of plant residues (Flame Engineering, 2003). Proper spacing is essential for proper economical flaming.

Once the flamer setup is operational, it should work with any sized tank that is large enough to supply it for the length of time desired. In larger applications such as row crops and alfalfa, the only limit is the size and weight of liquid fuel tanks. Most tanks have gas coming out of the valve, while some flamers use liquid feed to the torch, and have the evaporator located in the burner. This eliminates having the tank ice up when large quantities of propane are being used. It also allows smaller hoses and valves to be used. The only difference between these tanks is a standpipe to draw liquid off of the bottom, instead of gas off the top of the reservoir.

The intent of this project was to refine and test a prototype shrouded flame weeder custom designed and built specifically for orchards and vineyards by Ian Merwin. The flamer is unique in that the flame torches are enshrouded within a metal casing that concentrates the heat, reduces the amount of propane required, and protects the trees, vines and irrigation lines from heat damage. We attempted to determine the best operating speed and pressure for this machine with and without shrouding. The research was conducted at Singer Farms, operated by the Bittner family in Barker, NY, from January to September 2001.

TABLE 1

Percentage of groundcover killed using various tractor speeds and operating propane pressures.

Weed Control Treatment	Tractor Speed (mph)	Propane Pressure (psi)	Percentage of Groundcover Killed
1 qt Paraquat/Acre (Chemical Standard)			95
Shrouded Flamer	**2**	**20**	**60**
Shrouded Flamer	2	40	90
Shrouded Flamer	4	20	40
Shrouded Flamer	4	40	50
Unshrouded flamer	**2**	**20**	**30**
Unshrouded flamer	2	40	40
Unshrouded flamer	4	20	2
Unshrouded flamer	4	40	20

Flamer Setup and Modifications

The initial components were the tank, valve assembly, two burners, control solenoids, and a skid mounted steel shroud (Fig. 1). A plate was welded to a set of rear pallet forks for the tank to sit on (Fig. 2). The forks with the tank went on the back of the tractor while the burners went on the front of the tractor. The burner unit was mounted on a mounting bracket for a Muller rototiller and brush sweeper. This allowed the burners to float freely over the ground surface. A frame was then built near the balance point of the shroud to support it from two points, one on each side (Fig. 3). This was welded to a square tube that fits the Muller bracket. The bracket has its own single action hydraulics for lifting and allows the shroud to float over clumps of sod and groundhog holes (Figs. 4-6). This bracket arrangement also allowed a width adjustment for different orchard or vineyard row spacings. Alternatively, the burner unit could be mounted on the end of a weed sprayer bar that fits on the forks of a tractor with a front mounted lift mast or front-end loader.

The burners were bolted to the back of the shroud facing inward. A hinge previously welded onto the shroud allowed the burners to be adjusted for angle. Roundstock skids were then made up to assist the shroud in floating over any rough areas as well as to provide replaceable wear points. For use on larger trees, the right side of the shroud can be unbolted and the burners can be angled towards the trees, enabling control of weeds in between the trees. As long as the flamer was traveling fast enough there was no damage to established trees.

A hose was routed along the hood of the tractor connected the tank in the back with the burner unit in the front. All the electronics and valves were relocated inside the cab of a tractor, to protect them from the weather and tree branches. Protecting these components may help extend the life of the machine. If located outside the cab they should be protected.

Weed Control Trials

January through May 2001, we operated the machine in empty lots to ensure proper operation. On July 11, 2001, we tested the flamer under field conditions in a uniform 10-acre block of Montmorency tart cherries on Mahaleb rootstock, spaced 22 by 20 ft. In previous years, the block had had rotating paraquat and glyphosate herbicide applications with excellent control of established weeds. Prior to the flame weeder treatments, the ground cover was mowed to three inches in height.

Treatments included:
1) One quart paraquat/acre;
2) Shrouded flamer at 2 mph and 20 psi;
3) Shrouded flamer at 2 mph and 40 psi;
4) Shrouded flamer at 4 mph and 20 psi;
5) Shrouded flamer at 4 mph and 40 psi;
6) Unshrouded flamer at 2 mph and 20 psi;
7) Unshrouded flamer at 2 mph and 40 psi;
8) Unshrouded flamer at 4 mph and 20 psi; and
9) Unshrouded flamer at 4 mph and 40 psi.

Effectiveness was measured by assessing ground cover height before and after each application, making a visual estimation of percentage of treated ground cover affected by flaming, and by observing the types of weeds that recovered the quickest.

Results and Discussion

Paraquat was the best treatment with 95 percent of the groundcover area treated killed (Table 1). The next best treatment was the shrouded flamer at 2 mph and 40 psi resulting in 90 percent of treated foliage killed. The shrouded treatment at 4 mph and 20 psi was roughly equivalent to the unshrouded treatment at 2 mph and 40 psi with 60 percent and 40 percent respectively of the ground cover treated killed. The unshrouded flamer operated at 20 psi and 4 mph was ineffective. The effect of shrouding was significant since the shroud appeared to nearly double the effectiveness of the flamer at equivalent speeds and pressures.

Although only one replication was run on the Singer farm, the results were encouraging. The economics of this flamer are affordable and the cost of propane was comparable to that for herbicides. It takes the same number of operator-hours per acre, but the propane does not create a chemical soil or water residue. This technique would be particularly valuable in organic fruit production where herbicide use is prohibited.

On our farm, we found that it was desirable to wait a few hours after rain before flame treatments, depending on wind and sun conditions. One of the advantages of flaming relative to tillage is that flaming is possible when soils are too wet for effective cultivation. The addition of a shroud around a burner reduced the amount of fuel necessary, since it contained the heat so that the wind did not dissipate the heat energy. Inside the shroud the heat is also more uniform and constant.

Besides weed control, flaming weeds in orchard crops may also have other positive side effects in pest management resulting in economic benefit for farmers. Secondary pests such as Tarnished Plant Bug and Lygus may be killed (Seifert and Snipes, 1996). In contrast, when weeds are mowed or sprayed with herbicides, insect and mite pests typically move up into the canopy.

Flaming may have many uses in agriculture. It could provide an economically sound and environmentally friendly way of controlling certain pests and weeds on farms where crops are grown organically. But it may also be useful in conventional farming due to its environmental and economical benefits.

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