Small Fruit News

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NC State University
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Special Reports:

Why virus-tested plants? Because it makes sense…

By Ioannis E. Tzanetakis

Dept. of Plant Pathology, Division of Agriculture, University of Arkansas

It is often quoted that the cheapest and most important factor for a successful berry farm is high quality propagation material. This is because one of the major caveats of clonally propagated crops is virus infections. It is common that a cultivar takes ten years between the original crossing and its release to the public. Breeding selections are grown in the field, in many cases without any protection from virus vectors and this translates, in the majority of cases, to plants infected with one or more viruses. Berries are tolerant to infection of one or two viruses; in other words plants do not have visual symptoms during the propagation process although yield and fruit quality may be affected. The problem multiplies in the field when plants are infected with additional viruses. Symptoms appear and there is obvious and measurable impact in yield and field longevity. There are numerous examples of virus complex diseases in the last few years: blackberry yellow vein, strawberry decline, raspberry crumbly fruit with losses that account to the tens of millions of dollars.

The United States Department of Agriculture understanding the importance of clonally propagated crops in the agricultural economy and the problems that can emerge with problematic propagation material initiated the National Clean Plant Network (NCPN). The role of NCPN is to bring close university and federal laboratories that work on clonally propagated crops and form a consortium that share knowledge and expertise. The mission statement is: '*The NCPN provides high quality asexually propagated plant material free of targeted plant pathogens and pests that cause economic loss to protect the environment and ensure the global competitiveness of specialty crop producers in the United States'.*

At this point NCPN is comprised of 16 Centers working of Berries, Grapes, Tree Fruits, Citrus and Hops with several other commodities ready to enter the network in the coming years. The NCPN-Berries includes four centers: North Carolina State University (NCSU), University of Arkansas, University of California-Davis and USDA-ARS in Corvallis, Oregon. The latter serves as the lead Center because of the long history and expertise associated with the location.

A short introduction of the Berry Centers and their role in NCPN:

• Berry Crops Testing and Therapy Program for Berry Crops, North Carolina State University, Raleigh, NC

The NCPN – B Center in the Micropropagation and Repository Unit (MPRU) at NC State University produces, maintains and supplies specific pathogen-tested plant material of berry crops (strawberry, blackberry, raspberry and blueberry) to scientists and industry. The program uses thermal therapy to eliminate viruses from plants and assesses plants for known viruses using laboratory tests and biological indexing.

• Berry Crops Testing and Development of Diagnostics, Department of Plant Pathology,

Division of Agriculture, University of Arkansas, Fayetteville, AR

The primary emphasis of the program at the University of Arkansas is the development of new diagnostic assays to provide laboratory-based tests for all the virus and virus-like agents that infect strawberry, raspberry, blackberry and blueberry. This program is coordinated with the other centers to implement the new tests into virus elimination and diagnostic programs. This center also works on the development of next generation diagnostics that will allow the detection of all pathogens affecting the crops using a single assay.

• Foundation Plant Services (FPS), University of California, Davis, CA

Foundation Plant Services (FPS) carries out virus elimination, tests, maintains and distributes virus-tested strawberry propagation stock from the University of California strawberry breeding program. FPS research programs develop new techniques for disease detection and elimination to improve the quality of propagation materials.

• Research Unit, USDA-ARS, Corvallis, OR
The NCPN – B is headquartered at the USDA-ARS in Corvallis, where the clean plant center was initiated in1967 in collaboration with Oregon State University and fully managed by USDA-ARS as part of the small fruit virology program since 1997. The program works closely with breeders and nurseries to develop strawberry, blackberry, raspberry and blueberry plants free of known viruses. The program uses thermal and chemotherapy to eliminate viruses from plants and indexes plants using bioassays and laboratory based assays. The program in Corvallis is also involved in developing and implementing new diagnostic assays for viruses of these crops to improve the quality of the plants produced.

The plants that will be release by the Berry Centers will be of the best quality possible as they will be tested for all known viruses; minimizing the possibility of latent infections. In addition, and as part of the work done in Arkansas and Oregon, new techniques are being developed that have the capacity to detect both known and unknown viruses. This can potentially lead – for the first time ever – to **virus-free** plants.

We are also working with State regulators for the harmonization of certification protocols between states with the goal to develop a national certification scheme that would allow free movement of propagation material across the country. Blueberry is well underway whereas the first meeting for rubus (blackberry, raspberry and their hybrids) was done at the end of May. The work of the NCPN-Berry Centers in combination with the National Certification efforts will allow growers across the country to use the best quality propagation material possible.

Pruning Grapevines

David W. Lockwood
Univ. of TN/Univ. of GA

With the holiday season coming up, you may find yourself with a little more spare time than normal and, if the weather is nice, getting a head-start on pruning might seem like a good idea. This brings up the question, “How early can grapevines be pruned?”

Like most things in biology, variation is the name of the game. Therefore, the actual answer will depend on a number of factors. Generally speaking, it would be a good idea to wait as late in the dormant period as possible to start pruning, yet still be able to get it all done. There are considerations and modifications to the above statement.

Considerations:
By waiting until after the first of the year to begin pruning, there should be no question as to whether the vines are fully dormant. Pruning vines before they are fully dormant could interfere with the ability of the vine to go dormant thus increasing the potential for cold injury.

The earlier that vines are pruned in winter, the greater the number of buds that should be left as a hedge against cold injury. The down side to this is that if no bud loss occurs, repruning and/or cluster thinning will be necessary to prevent overcropping.

Varieties that are highly fruitful on secondary buds can be pruned earlier and/or closer to the desired bud count than other varieties. French-American hybrids tend to be more fruitful on secondary buds than American or *V. vinifera* varieties.

Pruning wounds remain susceptible to Eutypa infection much longer early in the season than later. Prune late in the dormant season to promote rapid healing of cuts, especially for varieties that are more susceptible to Eutypa.

Modifications:
Delayed pruning may be of value in lessening frost damage. Bud break begins first on the terminals of canes. Waiting until new growth reaches about 3 to 4 inches in length before pruning will set back bud break in the desired areas on canes by several days which may be enough to escape damage by a late frost. A drawback to delayed pruning is the damage that can be done to new growth and buds as prunings are removed from vines.

Double pruning is a modification of delayed pruning. With it, canes that will not be needed for fruiting are removed while the vine is dormant. Replacement canes and canes that will be cut back for fruiting spurs are pruned after growth has begun, as described above.

Pruning involves making cuts on vines to:

- eliminate dead, broken, or diseased wood
- eliminate older, non-productive or marginally productive wood
- encourage development of new wood where the best future crops will be formed
- open the canopy to sunlight, air and spray penetration
- facilitate the ease of management of the vines (pruning, thinning, harvest)
- keep vines within desired size limits

Grapevine pruning terminology:
Bud → Shoot → Cane→ Cordon (Arm)

Balanced pruning – adjusting bud number on a vine to allow production of good crops of high quality fruit on a sustainable basis

Bleeding – sap exudate from a woody plant after pruning, usually occurring neat the end of the dormant season. Bleeding will not harm the vine.

Bud – The bud on a grapevine is actually a compound bud containing the primary, secondary and tertiary buds. The primary bud opens first in spring and is, therefore, the most apt to be damaged by a late frost. It is the most fruitful bud on the grapevine. If the primary bud is injured or killed, the secondary bud will break and grow. Depending on the type of grape, secondary buds may or may not be fruitful. French-American hybrid varieties tend to be more fruitful on secondary buds than American or *vinifera* varieties. If the secondary bud is damaged or killed, the tertiary bud will break and grow. Tertiary buds are not fruitful. Buds are located at the intersection of a leaf petiole and the shoot.

Cane – a mature shoot after leaf fall. Beginning about veraison, a tender, succulent shoot will become woody; color will change from greenish-yellow to bronze.

Cane pruning – system of cutting the vine back to one or more canes that will produce new shoots. The aboveground portion of a cane-pruned vine will have a trunk, one or more canes on which shoots will develop from buds on canes and renewal spurs to be used as sites for new canes for future fruiting sites. Cane pruning is used on grape varieties where the most fruitful buds are located midway on canes.

Cordon (arm) – Semi-permanent horizontal structure on a vine that originates at the head of the trunk and produces shoots and canes.

Shoot – A succulent stem arising from a bud having petioles, leaves, tendrils and fruits.

Spur – short, stubby cane having a few (2 to 4) buds located on the cordon that produces new shoots

Spur pruning – Canes arising on cordons are pruned back to a few buds (2 to 4). Spurs arising from the upper portion of cordons are selected over those on the lower portion of cordons. Spur pruning is used where the most fruitful buds on a cane are found near the base of the cane.

Suckers – shoots arising at the base of the trunk (should be removed unless being used as a replacement trunk)

Steps in pruning a mature vine
Before pruning, assess the degree of bud kill. Cross-sectional cuts should be made across numerous buds to see if damage has occurred to the primary bud. The number of buds to be retained at pruning may need to be increased to compensate for different levels of bud mortality.

1. Remove suckers at the base of the vine and canes arising off the trunk below the trellis wires UNLESS these canes are to be used for trunk or cordon replacement. When selecting a cane for trunk replacement on a grafted grapevine, be sure to select one arising from the scion above the graft union as opposed to the rootstock below the graft union.

2. Separate the vine from its neighbor so that pruning cuts will be easier to identify.

3. Remove dead, broken or diseased canes.

STEPS 1 – 3 APPLY TO ALL TYPES OF PRUNING SYSTEMS

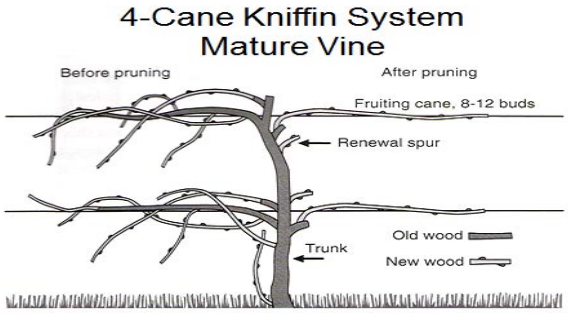
Cane pruning
4. Identify and remove canes that bore the previous year's crop. These are easily found as the bark on them tends to be more grayish in color and somewhat shaggy. In addition, newer canes, having smooth, reddish-bronze bark and easily identifiable buds will arise from the old, fruiting canes.

5. Select a healthy cane on each side of the trunk where fruiting is desired to be trained to the trellis wire for cropping in the coming year. Ideally, these canes should arise a few inches (2 – 4) below the trellis wire. Avoid selecting "bull"canes as they are too vigorous and the distance between buds is too great to allow leaving enough buds on the cane while keeping the vine within its allotted space.

6. Select another cane arising on each side of the trunk and a few inches below the crop-bearing trellis wire and prune it back to 1 or 2 buds. This is the renewal spur and shoots arising from it may be candidates for fruiting cane selection the following year.

7. Remove all other canes from the vine.

8. Cut each cane back to its desired bud number. This number will depend on type of grape, variety and vine vigor. Cane pruning is used for varieties where the most fruitful buds will be about the 5th to the 10th buds from the base. Do not allow canes to overlap those of a neighboring vine.



Spur pruning
4. Remove old fruiting wood from the previous season.

5. Select new canes to be cut back to form spurs. A spur pruned to 2 buds the previous year will have 2 fruiting canes. If the size and quality of the canes are equal, select the cane closest to the cordon to retain and prune it back to 2 to 4 buds. The number of buds to be retained on a spur will depend on the fruitfulness of lower buds. Canes having a diameter about the same as a pencil make the best fruiting spurs.

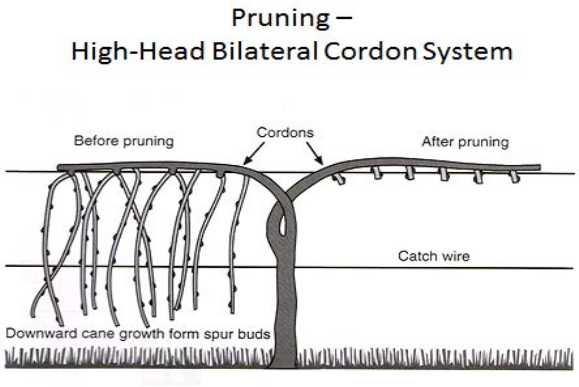
6. Select canes to be pruned back to form renewal spurs and prune it back to 1 bud. The shoot growing from this bud will develop into a cane that may be selected for pruning to a fruiting spur the next year.

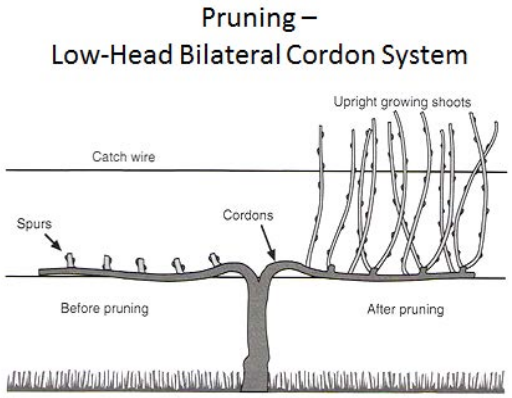
7. Remove old spurs having no 1-year-old wood.

8. Space spurs about 3 to 4 inches apart on the cordon.

9. Spurs should be oriented up or down on cordons depending on the training system being used.

10. The total number of spurs to be retained will depend on vine vigor, variety and the number of buds being left on each fruiting spur.





Pink Lemonade, Razz, and More! Wonderful Blueberries From ARS to You

Pink Lemonade blueberries have a sweet, mild, flowery flavor and a pretty pink color. Photo by Mark Ehlenfeldt

Anyone who grows backyard blueberries knows that some of the berries may turn pink before they finally ripen to a familiar dusty blue.

When a Pink Lemonade blueberry is ripe and ready to eat, however, it is, in fact, pink.

Though not a first, this intriguing coloration is "still somewhat unusual" for a ripe, harvest-ready blueberry, according to Agricultural Research Service plant geneticist Mark K. Ehlenfeldt.

Ehlenfeldt has his laboratory, greenhouse, and test plots at the Philip E. Marucci Center for Blueberry and Cranberry Research and Extension in Chatsworth, New Jersey, about 60 miles south of Newark in the state's pine barrens.

Here's more about Pink Lemonade and a glimpse of several other interesting blueberries developed through the Chatsworth research.

Pink Lemonade: Pretty and Tasty

Pink Lemonade "may be the prettiest blueberry around," says Ehlenfeldt. This plant bears moderate yields of firm, glossy, medium-sized berries, with a mild flavor that Ehlenfeldt describes as "sweet and flowery." It ripens from mid-late to late season. In New Jersey, that's usually mid to late July.

"Pink Lemonade is also a nice plant for landscaping," Ehlenfeldt says. "It has shiny green leaves in spring and summer and dusky, reddish-brown twigs in winter."

Razz blueberries offer a taste of raspberry. Photo by Mark Ehlenfeldt

Ehlenfeldt says Pink Lemonade is suited for U.S. Department of Agriculture Plant Hardiness Zone 6—where the weather, on average, never gets colder than 0°F—and for milder regions.

Pink Lemonade resulted from the crossing of two parent plants—an experimental blueberry developed by Nicholi Vorsa, a Rutgers University scientist stationed at the Chatsworth center, and a commercial blueberry, Delite, which was developed by USDA and the University of Georgia. Ehlenfeldt crossed these two plants in 1991 and, in 1996, chose one of the offspring—designated as "Selection Number ARS 96-138"—

for further testing.

While Ehlenfeldt was scrutinizing the plant's performance in New Jersey test plots, colleague Chad E. Finn, a plant geneticist in the ARS Horticultural Crops Research Unit in Corvallis, Oregon, was evaluating it on the West Coast, in response to interest by the plant nursery industry in that region.

Based on that interest and the good scores that ARS 96-138 achieved in these evaluations, the scientists formally released the variety in 2005, assigning the selection number as its identifier. In 2007, to help build market identity for the plant, the researchers named it "Pink Lemonade." In that same year, the novel blueberry garnered a "best new shrub" honor at the prestigious Far West Horticultural Show. You can find "Pink Lemonade" for sale in garden catalogs and on the web.

The superior flavor of Sweetheart blueberries isn't lost during storage. Photo by Mark Ehlenfeldt

Razz: Its Flavor Will Surprise—and Please

Razz is a blueberry with a taste that's rather surprising. Its name is a hint: Razz tastes quite a bit like a raspberry.

"The remarkable raspberry overtones make Razz unlike any other commercial blueberry that we know of," says Ehlenfeldt.

Razz is a "rediscovered" blueberry. It was bred in 1934 by USDA's first blueberry breeder, Frederick V. Coville. It was selected for further study by USDA scientist George M. Darrow and Rutgers plant breeder J.H. Clarke in 1941.

After that, it "just hung around for a long time," says Ehlenfeldt. "It was considered unsuitable for large-scale commercial production because it was too soft for shipping or storing. And, although people appreciated its flavor, the berry was simply too different for the times.

"Eventually, several nurseries expressed an interest in growing and marketing it to backyard gardeners. We decided to test it here in New Jersey and released it in 2011."

Razz produces good yields of medium to large berries that ripen in midseason. "In New Jersey, that is the end of June through the first week or two of July," Ehlenfeldt says.

"Razz should do well in most places where northern highbush blueberries can be grown. Growers, pick-your-own farms, and backyard gardeners might want to give this specialty berry a try."

Some blueberry fans say Cara's Choice is the best they have ever tasted. Photo by Mark Ehlenfeldt

Sweetheart: A Berry To Begin—and End—the Growing Season

Sweetheart may be the perfect plant for those who just can't wait for the first blueberries of the growing season—and, of course, hate to see the season end.

That's because Sweetheart meets both needs. It produces firm, delectable, medium to medium-large berries early in the season, about mid-June through the end of the month. Then, if the autumn is mild, Sweetheart may reflower and refruit, Ehlenfeldt says. "The autumn yield is not really large enough to be called a 'second crop,'" he explains, "but it's a nice treat at a time when most blueberry plants have long since stopped fruiting." Late-season refruiting is "a somewhat unusual trait," he notes.

Sweetheart berries have "a superior flavor that lasts, even in storage," he says. That's unlike

some blueberries, which "begin to lose some flavor soon after they've been picked."

Well suited for commercial growers, Sweetheart is "great for home gardens, too," says Ehlenfeldt who, in 1996, made the cross that resulted in today's Sweetheart plants. In 1999, he chose it—from among other candidate seedlings—for further study, continued testing it at Chatsworth through 2009, then formally released it as a named variety in 2010.

Sweetheart can be grown in USDA Plant Hardiness Zone 5—where temperatures usually won't get colder than –10°F, on average—and in milder zones. What's more, some preliminary studies "suggest that Sweetheart may also be hardy in regions colder than Zone 5," says Ehlenfeldt.

Cara's Choice: Outstanding Flavor

Cara's Choice is "regarded by some blueberry aficionados as having the best flavor of any blueberry," says Ehlenfeldt. "This is a very sweet, medium-sized blueberry, with a pleasant aroma."

Even though its yields are only moderate—about 35 percent less than industry standards such as Bluecrop, for example—this berry nonetheless offers growers the significant advantage of keeping its quality while still on the bush. "That's a plus," notes Ehlenfeldt, "because it allows growers to distribute their harvests over a longer period of time." Meanwhile, the berries' sweetness tends to increase.

"The berries can stay on the plant for several weeks after ripening, without losing flavor or firmness," he reports.

Best for Zone 6 and milder zones, this berry is ready for harvest in midseason.

Blueberry researcher Arlen D. Draper, formerly with USDA in Beltsville, Maryland, and now retired, made the cross that yielded today's Cara's Choice in the late 1970s and, in 1981, singled it out for further study. Since then, evaluations at the Atlantic Blueberry Company and at Variety Farms—both in Hammonton, New Jersey—by Draper; Ehlenfeldt; now-retired ARS scientists Gene J. Galletta and Allan W. Stretch; and Rutgers's Vorsa led to the plant's release in 2000.

Ehlenfeldt expects to have yet another superb blueberry ready to introduce in the near future.—By **Marcia Wood,** Agricultural Research Service Information Staff.

This research is part of Plant Genetic Resources, Genomics, and Genetic Improvement (#301) and Plant Diseases (#303), two ARS national programs described at www.nps.ars.usda.gov. To reach the scientists featured in this article, contact Marcia Wood, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; (301) 504-1662.

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Failing Fungicides For Gray Mold Control And What to Do About It

Guido Schnabel, Clemson University and
Frank Louws, North Carolina State University

Gray mold (**Figure 1**) is the most important disease of many small fruits, including strawberry and grapes. It is caused by the fungus *Botrytis cinerea*, which during wet weather and relatively cool temperatures, attacks the flowers and the fruit. To protect the crop from rotting, fungicides must be used during bloom and during preharvest fruit development. In recent years, the efficacy of fungicides has declined dramatically in experimental fields in North Carolina and Florida, which signaled for the first time the emergence of a problem. Follow up studies showed that years of exposure to modern fungicides selected for resistance to many fungicides in North Carolina and South Carolina fields rendering many applications ineffective.

Figure 1. *Gray mold of strawberry*

During the 2011/2012 growing season Clemson initiated an evaluation program and received and analyzed **gray mold** samples from about 80 commercial strawberry farms in 8 states (including Arizona, Florida, Georgia, South Carolina, North Carolina, Kansas, Maryland, and Virginia) and investigated the sensitivity of the causal agent to all 7 chemical classes (FRAC codes 1, 7, 11, 12, 17, 3, and 9) registered for the suppression or control of gray mold (**Figure 2**). Sensitivity assays were performed on fungicide-amended media containing specific discriminatory doses of fungicides that allowed the distinction of sensitive from resistant isolates. Discriminatory doses were largely described previously (3), but we made some adjustments due to assay-specific differences. Briefly, spores from 10 fruit per location were collected with cotton swabs (one swab per fruit), shipped to the Clemson lab, transferred with a toothpick to the center of amended medium in 24-well plates and incubated for 4 days. Growth was assessed visually and growth data were entered in a webapplication specifically developed for this purpose (2). The web application calculates a resistance factor that determines whether a sample is sensitive, or has low resistance, medium resistance, or high resistance to a certain fungicide.

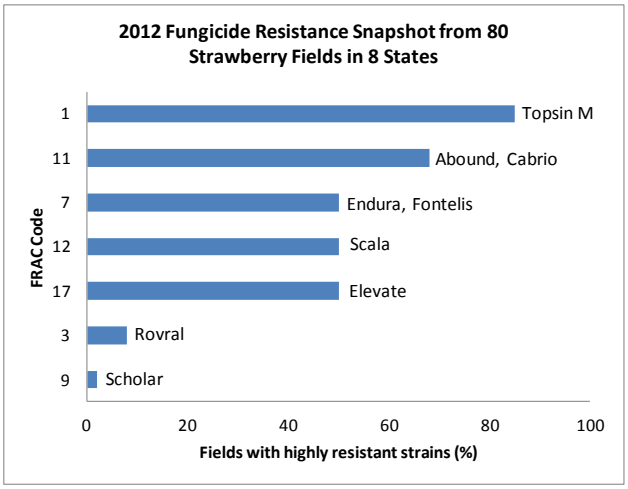


Figure 2. *Average occurrence of resistance in samples from fields of 8 states. A sample was considered 'highly resistant' if at least 20% of the strains were resistant to a fungicide.*

The monitoring indicated that the gray mold fungus from strawberry in many states had developed resistance to different classes of fungicides. The majority of all samples indicated resistance to Topsin M, Abound, and Cabrio fungicides. The latter two products are not exactly gray mold products, but according to the labels they have 'suppressive action'. To our surprise, about half of all samples revealed resistance to Elevate, Scala, and Endura. All of those products are commonly used for gray mold control. The newly registered Fontelis is listed in the figure together with Endura because these two products are more or less cross resistant. On the flipside, resistance to Rovral and fludioxonil (Scholar formulated product) was either rare or non-existent. Fludioxonil is a component of Switch.

The monitoring results indicated that resistance to various fungicides is present in the gray mold fungus, which might be surprising to many growers because pre- and postharvest gray mold has not been a tremendous issue in recent years. There

may be several reasons for this apparent discrepancy:

-inoculum (=infectious forms of the pathogen) levels in plasticulture systems are generally low. The crop starts with new, mostly disease-free plants on fumigated soil with very little plant debris from the previous season. It likely takes a couple of infection periods for the fungus to gain in numbers for an epidemic.

-we have had relatively dry springs in recent years making it hard for the fungus to establish

-we have far fewer infection periods than previously thought. Two years of monitoring infection periods in SC has demonstrated that there were only 3 (during dry springs) to 6 (during wetter springs) infection periods per season. That is it. That means a lot of our sprays are applied in the 'off season'.
But it only takes a wet spring and the application of ineffective fungicides for gray mold to thrive. Therefore we must implement resistance management practices. Below are some suggestions on how producers can extend the productive life of a chemical class in their operation and save money by spraying smart.

-reduce inoculum levels. If there is little fungus, there is little problem. Conservative application of nitrogen fertilizer makes plants less susceptible to pathogens in general and allows water to evaporate quicker due to less luscious canopies. Also, increasing plant spacing could be considered for improved air circulation. However, growers should optimize plant spacing for yield and optimum plant spacing depends on soil type among other factors.

-moderate used of fungicides. The fewer sprays applied the less selection pressure there is for fungicide resistance. In other words, it is much better to spray only when needed than calendar-based. Applications should be done PRIOR (if possible) or soon after (using fungicides with kick-back action) to anticipated rain events of more than one inch or so of rainfall. Research has shown that the focus of fungicide applications should focus on protecting the strawberry flowers.

-reduce the use of materials that are prone to resistance development. If growers want to spray prior to bloom, products like thiram and captan should be used exclusively. These products also provide effective control during bloom unless unusually high rainfall is experienced. Rovral is an effective botryticide and can be used once per season before bloom. In our experience, Rovral is the product of choice if growers encounter Botrytis crown rot due to early wet and warm spring conditions when plants are large. Products like Elevate, Pristine, Switch, should be used only during bloom and only when weather conditions such as extended rain favor disease development.

-perform sanitation measures. The majority of the Botrytis inoculum, that goes to the flowers, is believed to come from dead and dying leaves present in the beds after winter. Removing these leaves before bloom can help reduce the amount of Botrytis in the system. In our experience, sanitation increases yield slightly or has no effect. Many growers perform sanitation as part of their practice to remove weeds from holes, to lift plants from under the plastic and remove dead and dying leaves. If multiple tasks are

accomplished in one pass, then the practice may prove economical. However, sanitation does not pay for itself if gray mold management is the only purpose and if effective fungicide programs (if resistance is not a major problem) are implemented.

-take advantage of the Clemson resistance monitoring service. At first sign of gray mold during bloom or harvest contact your county agent or specialist and ask for a sample to be sent for testing. Testing will identify resistance if it is present and thus will provide valuable information to improve your spray program and avoid control failure. A detailed protocol for sample collection and shipment can be obtained from Dr. Schnabel at schnabe@clemson.edu.

Pruning Blueberries for Hand and Machine Harvest

Bill Cline, Extension Specialist, NCSU

Cultivated blueberries are upright, deciduous, woody perennials, forming multi-stemmed bushes with maximum unpruned heights varying from 6-8 feet (highbush, southern highbush) to 10-15 feet (rabbiteye). All cultivated species require annual pruning to manage bush height and shape. Pruning also prevents over-cropping, increases berry size, and removes dead, diseased or insect-infested wood. With the advent of machine harvest for the fresh market, annual pruning has become even more essential, not less so. A combination of careful cultivar selection and deliberate shaping is necessary to provide the narrow crown and flexible young canes needed for successful machine harvesting of fresh-pack fruit.

Pruning is second only to hand harvest in terms of annual labor expense. So how is pruning accomplished quickly and economically, and what is the easiest way to explain pruning goals to a crew of workers entering the field for the first time? Whether pruning for mechanical harvest or for hand harvesting, the following teachable steps, in order, can be used at each bush to rapidly eliminate undesirable growth, selecting for flexible, upright, and productive canes.

Tools and Techniques

Most blueberry pruning is done during the dormant (winter) season after the leaves have fallen. Mature canes can be up to two inches in diameter, so long-handled loppers capable of cutting large stems are essential. Smaller one-handed pruners are used for finish work and for shaping young bushes. Make flush cuts to avoid leaving stubs. Pruning cuts are not treated, though some authorities recommend timing standard fungicide sprays to occur immediately after pruning, especially when late spring and summer cuts are made on actively-growing bushes.

Steps in Winter Pruning (November – March)

Step One: Define the crown. Pruning starts at the ground, not at the top of the bush. Visualize a circle 12 to 18 inches in diameter around the crown of the bush, and remove ALL shoots of any age that have emerged from the ground outside the circle. This narrows the base of the bush to facilitate machine harvest, but is also a good general step for hand-harvested fields as well.

Step Two: Remove low-angled canes and crossovers. Low-angled canes that are too close to the ground are undesirable because the fruit is more likely to contact the ground, or to be contaminated by rain-splashed soil. Remove these low-lying branches, and also any canes that angle through the bush (crossovers). What remains is a narrower bush consisting of the most upright canes.

Step Three: Open the center. If needed, remove one to three large canes from the center of the bush to reduce crowding, improve air circulation and phase out older canes. Old canes to target for removal are larger and grayer in color, and are more likely to be covered with a fuzzy growth of foliose lichens. The goal should be to move through the field rapidly by making large cuts close to the ground.

Step Four: Thinning and heading back. As a blueberry cane ages, it branches repeatedly, resulting in smaller and smaller diameter lateral twigs in successive years. If left unpruned, this

results in excessive numbers of unproductive, matchstick-sized shoots, each with a few tiny berries. To avoid reaching this stage, thin canes by making cuts to selectively remove clumps of twiggy, brushy-looking, matchstick-sized laterals. At this time also cut (head back) any long whips or canes that are too tall.

About Flower buds

Yield reduction via flower bud removal always occurs when winter pruning is done properly. This is often a sore subject with growers who are trying to maximize yields. Flower buds are readily visible during winter pruning, and it is tempting to leave too many. This is a mistake! Expect to remove at least a third of the flower buds during pruning. Why? Because overloading the bush in one year will cause reduced yields in following years, and will eventually require even more severe pruning to bring the bush back into production.

Conclusion

These basic hand-pruning steps can be used with any blueberry bush. Every cultivar has a slightly different growth habit, and only experience will tell you how to manage each. Some cultivars produce too many new shoots from the ground and require a lot of thinning, while others are less prone to sprouting. Your goal should be to have a multi-trunked bush with strong canes of all different ages emerging from the ground, so that as each older cane is removed, a younger cane is already there to replace it.

About Summer Pruning

Summer pruning is not required, but is sometimes used in the southern US by commercial growers, both to manage bush height and to get a head start on removing weak canes. Summer pruning is done immediately after harvest, either selectively by hand, or mechanically through the use of mowers.

Mechanized Summer Pruning

Many growers in the southeastern US have partially mechanized the pruning process by mowing (hedging) the bushes at 36 to 48 inches above the ground in summer, immediately after harvest. This "summer pruning" is only possible in areas where there is an early harvest window (May-June in NC) followed by a long post-harvest growing season. If done early in the summer, the bushes have time to re-grow and produce flower buds for the following year. Summer hedging greatly reduces the amount of winter pruning required because it eliminates much of the time-consuming "detail" pruning that would normally be required to thin flowering shoots and prevent over-cropping.

Summer pruning was initially done using sickle-bar mowers, but is now mostly done with flail mowers. Flails are faster and are preferred since they both remove and shred the prunings simultaneously. Boom-mounted, single-head flails require multiple passes down each row to mow sides and top, while newer over-the-row machines with multiple cutting heads can make all mowing cuts in a single pass.

Mechanization in Winter Pruning

Though winter pruning is still done by hand annually or biannually, the process is often partially mechanized through the use of pneumatic pruners. Once cut, the prunings are piled in the row alleys and chopped in place using modified bush-hog or flail mowers.

Progress Report on a 7 Year Muscadine Pruning Severity Trial with Carlos

E. Barclay Poling, Professor Emeritus
Rocco Schiavone, Research Technician, NCSU
Stephanie M. Romelczyk, VCES Agent

The muscadine wine industry in North Carolina is primarily based on the bronze-fruited cultivar 'Carlos' (Figure 1) due to its characteristically high vigor, large yields, and ease of mechanical harvest (Figure 2).

Figure1: *Carlos muscadine grape*

Figure 2: *Mechanical harvesting*

Carlos is ideal for once-over mechanical harvesting because of its concentrated ripening. In addition, this cultivar can be pruned in the dormant season with a mechanical hedger or tractor–mounted sickle bar (Figure 3), and with this practice growers can achieve substantial savings in labor compared to hand pruning. Carlos is a very vigorous muscadine (Figure 4), and hand pruning this cultivar can require from 45-60 minutes per vine. From our experience, the annual cane prunings for a healthy 10 year old Carlos vine in a single-wire trellis (vine spacing of 20' in-the-row) can easily approach 15-16 lbs/vine.

Figure 3: *Tractor-mounted sickle bar*

Figure 4: *Un-pruned muscadine vine*

The expense for annual pruning of a mature Carlos muscadine vineyard is significantly less than hand pruning, which could cost as much as $1620 per acre assuming 45 minutes per vine, 217 vines per acre and a labor rate of $10/hr. Various authorities have commented that, "growers have switched to mechanical pruning due to labor shortages and low prices currently being paid for winegrapes, to substantially reduce production costs (Basiouny and Himelrick, 2001)." Carlos et al. (2008) estimated that the cost for annual dormant pruning of a mature muscadine vineyard is $635.16/A with mechanical equipment represents only 17% of the total annual operating costs for a muscadine vineyard in North Carolina ($3754 is the total operating expense per acre/yr). Mike Mainland, Professor Emeritus, NCSU, has reported that there was "not a detectable decline in yield from hedged vines compared to hand-pruned vines over nine seasons (2001)."

Research objectives for study initiated in Eastern NC in 2006 (planted in April 2002):

- Compare yields and berry quality for mechanical pruned vs. hand pruned Carlos vines at 3 severity levels
- To establish a pruning recommendation for growers based on experimental results and economic analysis.

Materials and Methods:

- In 2006 Four-year old 'Carlos' vines were selected, rough hedged on all vines then came back and hand pruned to:
- Treatment 1 no hand pruning only mechanical hedging (12" x 12" box) (Figure 5)
- Treatment 2=200 buds/vine (20 ft. cordon) – 10 buds/ft (Figure 6)
- Treatment 3=300 buds/vine – 15 buds/ft (Figure 7)
- Treatment 4=400 buds/vine – 20 buds/ft. (Figure 8)
- Mechanical hedging may have 1500 ~ 2000 buds/vine (Figure 9)
- A once over harvest was preformed in mid September and yield data was collected in a 6' catch frame (yield data was extrapolated to a 20' vine)
- Annual cane prunings were collected and weighed for each vine in the dormant season (prunings from both of the 10' cordons were weighed together) Ravaz indices were calculated by dividing yield by pruning weight on a per vine basis

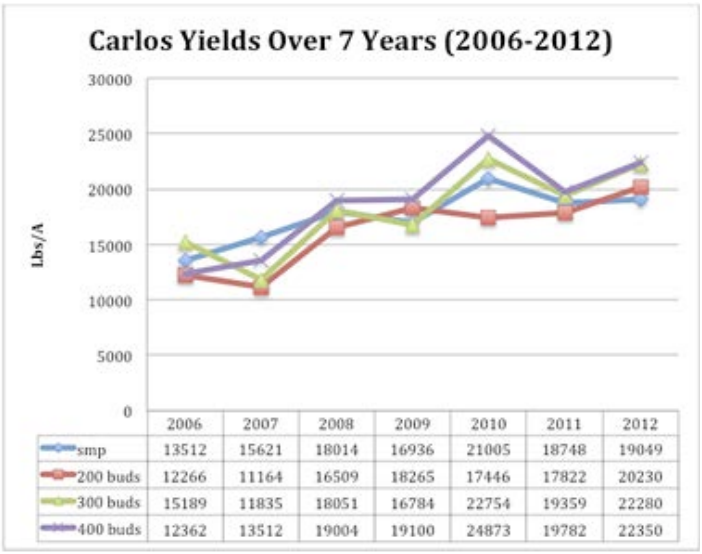
Figure 5: *Simulated mechanical pruning*

Figure 6: *Hand pruning to 400 buds/vine*

Figure 7: *Hand pruning to 300 buds/vine*

Figure 8: *Hand pruning to 200 buds/vine*

Data and Results:
In the 2007 season there was a severe freeze (April Freeze) that caused a significant reduction in yields for all of the hand pruned vines compared to the mechanically pruned vines. Overall yields were highest for this Carlos vineyard in the 2010 season (5th harvest season). And, in 2010, we had a statistically significant yield difference between vines pruned to 200 buds (17,446 lbs/A) compared to the other 3 pruning treatments, including simulated mechanical pruning (Figure 9). In other seasons, pruning treatment did have a statistically important effect on Carols yields.



	2006	2007	2008	2009	2010	2011	2012
smp	13512	15621	18014	16936	21005	18748	19049
200 buds	12266	11164	16509	18265	17446	17822	20230
300 buds	15189	11835	18051	16784	22754	19359	22280
400 buds	12362	13512	19004	19100	24873	19782	22350

Figure 9*. Carlos yields over 7 seasons (2006 – 2012)*

Although yields for the simulated mechanical pruning treatment have remained high throughout the course of this 7 year trial, and have remained above 9 tons per acre in the 2011 and 2012, there has been a noticeable decline in smp yields relative to the 300 and 400 bud treatments which produced in excess of 11 tons in 2012. Along with this slight decline in productivity of the mechanically pruned vines in recent seasons, we have observed that the average cane pruning weights of the 300 and 400 bud vines seem to have stabilized in the range of 14-15 lbs/vine while the smp vines have shown a marked increase in cane pruning weights over the last 3 seasons (Figure 10).

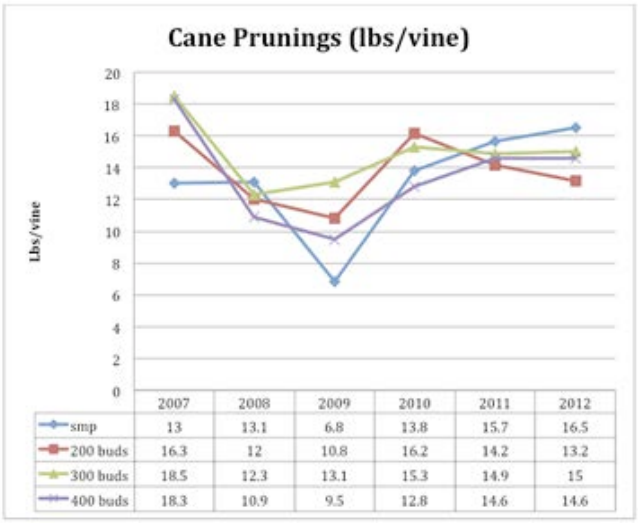


Figure 10. *Average cane prunings (lbs/vine) by pruning treatment for each winter season (2007-2012)*

In direct contrast to the smp vines which are increasing in vigor since 2010 (Figure 10), the 200 bud vines are declining in average pruning weights (and productivity) since 2010. Nonetheless, all of the pruning treatments in this study were within the 5 to 10 Ravaz index range in 2012. Ravaz indices of 5 to 10 are typical in balanced bunch grapevines (Smart and Robinson, 1991), but there is clearly more research needed to establish a desirable range of Ravaz indices for Carlos muscadine grape. The low pruning weight of the mechanically pruned vines in 2009 of only 6.8 lbs/vine (Fig. 10), resulted in an exceptionally high Ravaz index for this treatment in that year. This high Ravaz for the smp treatment was a one-time phenomenon -- perhaps related to the more rapid recovery of smp vines following the April Freeze of 2007? In the 2010 season, the Ravaz value for mechanically pruned vines was 7.0 (Fig. 11).

A Ravaz index below 5 is indicative of an unbalanced vine with excessive vegetative growth, and the only pruning treatment approaching such a problem at present are the mechanically pruned vines. Unfortunately, the resolution to this problem in the mechanically pruned vines is becoming more problematic as repeated years of mechanical pruning (7 straight years in Jan 2012), have now created a very dense tangle of older wood around the cordon's of smp vines (not shown). In Figure 12 you can see that most of the one-year fruitful canes (lighter color) is well beyond the smp's 12" x 12" pruning box. The best way to increase the fruitfulness of vines that are too vegetative is to retain more buds at dormant pruning, but this is not possible to do with older mechanically pruned where there remains only a "thin layer" of fruitful, one year wood. where there remains only a "thin layer" of fruitful, one year wood.

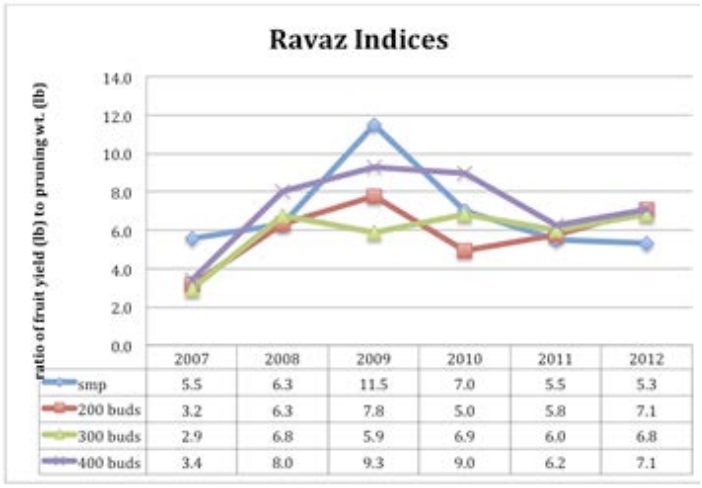


Figure 11: *Ravaz indices (vine yd/pruning wt)*

Discussion and Preliminary Recommendations:

For the last two years there has been a notable trend in the '200 bud' Carlos vines towards a reduction in vine size and productivity. The obvious resolution to this problem is to *retain more buds on these vines in the winter of 2013.* But, what would be the correct number of buds to retain? Perhaps, the question about how many buds to retain on a mature Carlos vines could be addressed by examining the productivity of the '300 bud' and '400' bud Carlos vines in this study which had yields in excess of 11 tons in 2012 by comparison to the '200 bud' vines which produced approximately 10 tons (the mechanically pruned vines had 9 ½ tons). However, it may be a mistake to leave as many as 100 more buds on '200 bud' vines (total 300) at this time when you consider the lower pruning weights in 2012 of the '200 bud' vines (13.2 lbs/vine) by comparison to the '300 bud' and '400' vines which had 15.0 and 14.6 lbs/vine pruning weights, respectively. In other research work with 'Supreme' muscadine (Poling 2012), we are actively investigating a *balanced pruning* approach which can be very helpful to vineyardists in determining the appropriate number of buds to retain.

Balanced pruning approach. Balanced pruning strives to balance the vine size with its capacity to carry out vegetative and reproductive growth. This method is based on the concept that a vine's capacity for vegetative growth and fruit production is a function of the vine's size, and the size of the

a vine is determined by the extent of growth of roots, shoots, and perennial wood (Poling, 2007). Because the growth of roots and other perennial wood cannot be conveniently measured, vine size is best estimated by weighing the one-year old wood (canes) removed at pruning. In American bunch grapes (e.g. Concord, Niagara), French hybrids (e.g. Seyval, Vidal Blanc) and *Vitis vinifera* (e.g. Chardonnay, Merlot), for example, dormant pruning is used to regulate crop size and maintain good fruit quality in the current season, and to avoid longer-term damage to the health of the vine that occurs from over-cropping. The long-term effect of over-cropping in bunch grapes is reduction in vine vigor (rate of shoot growth) and vine size, which is best determined by weighing the one-year-old wood at the time of dormant pruning.

In Table 1 you can actually see the formulas used by growers for balanced pruning of selected bunch grape varieties. For a balanced pruned Niagara vine with 6 lbs. of cane prunings, for example, you would need to leave 40 buds for the first pound of prunings. The, for every pound thereafter, an additional 10 buds are retained. Thus, a total of 90 buds would be retained on a 6 lb Niagara vine {(1st lb = 40 buds) + (5 lbs. x 10)}.

Table 1: Suggested pruning formulas for balanced pruning of selected bunch grapes

Variety	Pruning Formula*
Cabernet Sauvignon	20 + 20
Cabernet franc	20 + 20
Chardonnay	20 + 20
Seyval	5 + 10
Niagara	40 + 10

* The first number is the pruning formula indicates the number of buds to retain for the first pound of cane prunings, the second number indicates the number of buds to retain for each additional pound of cane prunings after the first.

In Supreme grape, we are investigating a '100 + 15' balanced pruning treatment that resulted in an average of about 150 buds per vine (100 + 15) in a 4-year old vineyard test location in King's Mountain (SRSFC Progress Report). The '100 + 15' formula appears to have promise for avoiding the adverse effects of over-cropping or under-cropping Supreme muscadine vines. Instead of trying to prune each vine in a vineyard to a fixed number of buds (e.g. 300), it may be worthwhile to investigate in future research several balanced pruning formulas for Carlos, which is a more vigorous vine than Supreme (see Table 2).

Table 2: Proposed pruning formulas for balanced pruning of Carlos muscadine grapes

	Carlos muscadines cane prunings/vine										
Formula	5	6	7	8	9	10	11	12	13	14	15
120 + 20	200	220	240	260	280	300	320	340	360	380	400
110 + 20	190	210	230	250	270	290	310	330	350	370	390
100 + 20	180	200	220	240	260	280	300	320	340	360	380

Can hand pruning be economical? At the outset of this study we made an assumption that hand pruning is not economical for muscadine vineyards where grapes are destined for processing markets. However, what we may have failed to consider is that by using a mechanical hedger or tractor–mounted sickle bar (Figure 3), for the initial vineyard "rough pruning," it is possible to substantially reduce the number of total labor hours/A needed to selectively prune Carlos vines. The vineyardist can also use pneumatic pruning shears to significantly reduce labor for removal older spurs, and to effectively remove the very dense tangle of wood that forms around the cordon after repeated years of mechanical pruning. At the same vineyard site where we have been conducting our Carlos trial for the last 7 years, the vineyard operator has trained his workers over the last two winters to use regular hand pruners and pneumatic shears to selectively prune Carlos cordons to appear as you see in Figure 12. At this commercial vineyard site we have calculated that only 16 minutes are required per vine for selective pruning that follows "rough pruning." In a vineyard with 217 vines per acre, this represents approximately 56 additional hours of labor/A, or $560/A ($10/hr) of expense in addition to the approximate $635/A that is normally expended for mechanical pruning ($380 for equipment/A and $255 for labor/A). If the vineyardist is able to increase yields by only 1 ½ tons per acre, then this additional labor cost for annual selective pruning ($560/A) would be more than covered (assuming a Carlos processing price of $500/ton).

Figure 12: *This shows a Carlos vine that was mechanically pruned from 2006-2009, and then in 2010 it was converted (8th yr) to a two-step pruning program which involves an initial "rough pruning" in late December/early January with a tractor–mounted sickle bar, and then workers spend an average of 56 additional hours/acre from mid-January through the end of February doing selective hand pruning of the vines (photo taken 12/6/12, E. B. Poling).*

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Blackberry and Raspberry Seasonal Checklist
Winter 2012-13

Gina Fernandez, Small Fruit Specialist
North Carolina State University

This checklist was originally developed for blackberry growers in North Carolina. Many of the items apply to raspberry production as well. You may have to adjust your work activities either earlier or later depending on your location. For more detailed information, check the Southern Region Integrated Bramble Management Guide and the Southeast Regional Bramble Production Guide at: http://www.smallfruits.org/SmallFruitsRegGuide/index.htm.
Check the items off as they get done. This list is very general, but should help get you to think about what types of activities occur at various times of the year. If you would like other items to be added to this list, send them to me and I will add them next time.

WINTER

Plant growth and development

- √ Plant is not visibly growing during the winter months although many blackberries will retain their leaves through the winter
- √ Some differentiation is occurring in the flower buds
- √ Low chilling cultivars can break bud in January after adequate winter chilling. You can monitor chilling hours accumulated in eight states in the eastern US by accessing this site: http://www.nc-climate.ncsu.edu/cronos/blackberry/index.php

Pruning and trellising

- √ Pruning should occur in late winter. However, in some areas winter ice storms can do tremendous damage to plants and trellis systems. If you produce blackberries in one of these areas, pruning can take place early winter to help avoid severe damage.
- √ **Make trellis repairs after plants have defoliated but before pruning and training.**

Erect types

- √ Prune out the spent floricanes
- √ Tie canes to wires in a fan shape
- √ Cut lateral branches back to 8-12"

- √ Thin canes to 6-8 canes/ hill (4 ft spacing)

Trailing types

- √ prune out spent floricanes
- √ tie or weave canes to wire so that they do not overlap
- √ prune side laterals to 12-18”
- √ thin canes to 6-8 hill (6-8ft spacing)

Primocane fruiting raspberries and blackberries

- √ Prune (mow) primocane fruiting types to ground level

Weed control

- √ Many summer weed problems can be best managed in the fall and winter using preemergent herbicides. Determine what weeds have been or could be a problem in your area. Check with local extension agent for cultural or chemical means to control these weeds.

Insect and disease scouting

Check the Southern Regional Bramble integrated Management Guide for recommendations. www.smallfruits.org

- √ To learn more about the spotted wing drosoplila and how it may impact your fruit in 2013, check out Hannah Burrack blog, she has lots of links in addition to her blog posts
- √ Scout fields for insect and disease damage and remove those canes
- √ Remove wild blackberries and raspberries by the roots if they are within 600 ft of your planting during the winter or treat with glyphosphate in the autumn
- √ Apply liquid lime sulphur or Bordeaux for disease control before new buds are 1/8”

Planting

- √ Take soil tests to determine fertility needs for spring plantings.
- √ There are some new raspberry and blackberry cultivars available in 2013. If you have not tried them or it is not know how they will do in your region, it is best to order a small quantity to see how well they will perform in your area
- √ For larger growers, prepare list of cultivars for 2014 plantings and order now. Smaller quantities of plants can be order in early 2013 for spring 2013 planting
- √ A commercial small fruit nursery list at http://www.fruit.cornell.edu/berry/nurseries/

Water management

- √ Make repairs to irrigation system (check pumps, lines, etc)
- √ Plants generally do not need supplemental water in winter

Marketing and miscellaneous

- √ Order containers for next season
- √ Make contacts for selling fruit next season
- √ Attend grower meetings:
  - The 2013 North American Raspberry & Blackberry Conference Meeting
- √ January 27-30, 2013 in Portland OR. http://www.raspberryblackberry.com/local.cfm?doc=webdocs%2FNorthAmericanBerryConference2013.htm
  - 2013 SE Regional Fruit and Vegetable Conference
- √ Jan 10-13, Savannah GA http://www.seregionalconference.com/
  - The North Carolina Commercial Blackberry and Raspberry Growers Association
- √ Feb 19, 2013. Shelby NC. For more information contact Daniel_Shires@ncsu.edu or Josh Beam <josh.beam@dole.com>

NOTE: NC Cooperative Extension will be taking over the Blackberry and Raspberry Information Portal in early 2013. The site will have essentially the same material, but a new look. Links will be provided from the old site to the new site.

Strawberry Seasonal Checklist

E. Barclay Poling
Professor Emeritus & Small Fruit Specialist
North Carolina State University

This checklist was originally developed for growers in North Carolina. You will have to adjust your work activities either earlier or later depending on your location. For more detailed information, check the Southern Region Integrated Strawberry Management Guide and the Southeast Regional Strawberry Plasticulture Production Guide at: http://www.smallfruits.org/SmallFruitsRegGuide/index.htm

December– January
Growers Checklist

- ✓ Due to abnormally dry Oct-Nov and warm early Dec. weather, you may wish to drip irrigate your strawberry beds (if dry) before winterizing the system.
- ✓ Keep deer out of the strawberry patch.
- ✓ Order row covers now! Don't wait until the day before you need them.
- ✓ If annual ryegrass was seeded, check to see if it is getting tall. It is getting too tall when it reaches 10 inches. A spray with Poast to stunt the annual ryegrass but not to kill it may be a good strategy. Lower rates of Poast can be very effective. Contact your agent for more information.
- ✓ If you have fresh dug or plug plants that have not grown off well, get them sent to the Plant Disease & Insect Clinic (PDIC, see www.cals.ncsu.edu/plantpath/ extension/clinic/) at NCSU for a proper diagnosis. A correct diagnosis is critical to differentiating anthracnose crown rot from crown rot caused by Phytophthora cactorum.
- ✓ Scout for weeds.
- ✓ If considering Stinger herbicide for vetch control, first check the Dow AgroSciences website to see if the required supplemental label exists for your state; it is important to download the label specific to your state. See www.cdms.net/LabelsMsds/LMDefault.aspx ?manuf=11&t=1,2,3,4q
- ✓ Scout for mites (especially before applying row covers).
- ✓ Purchase your digital thermometer before you need it! Calibrate all thermometers to read a true 32ºF in an ice bath.
- ✓ Monitor weather forecasts closely – consider a subscription to a custom weather report/service.
- ✓ Check all equipment, including sprayer (replace hoses, etc.).
- ✓ Subscribe to electronic notification of advisories for strawberry plasticulture growers. (The actual advisories are being posted at http://ncsu.edu/enterprises/strawberries.) To subscribe: send a message to mj2@lists.csu.edu with the following text in the message body: subscribe berry-mg

  You should then receive an email to confirm your email address. Once you respond to this message, you will subscribed to the notifications.

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