

Crop Profile for Grapes in North Carolina

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General Production Information

- North Carolina ranks 10th nationally in production of grapes, and 12th in wine production
- In 2004, 1100 acres of grapes were harvested in North Carolina.
- In 2004, 3,500 tons of grapes were produced in North Carolina, valued at \$3.4 million. Wine was valued at \$34 million

Production Regions

Grapes are grown throughout the state. Bunch grapes (*Vitis vinifera*, *V. labrusca* and French-American hybrids) are produced in the Piedmont and Mountains but do not survive in the Coastal Plain due to Pierce's disease. Muscadine cultivars (*V. rotundifolia*) are resistant to Pierce's disease and are grown in the Piedmont and Coastal Plain. Muscadines are susceptible to winter injury and for this reason are not grown commercially in the western Piedmont and Mountains.

Cultural Practices

Well-drained soils in full sun with a pH of 5.5 to 7.0 are required. Trellising is erected before planting and must be maintained for the life of the vineyard. Vines are trained on wires and pruned annually in winter to maintain production and vigor. Grapes are shallow-rooted, and cultivation is avoided once roots begin spreading out. Sod middles are maintained, and herbicides are used to control weeds directly under the canopy. Depending on species, bunch grapes may need to be grown on rootstocks. Some muscadine cultivars are female-flowered and require a perfect-flowered pollinator nearby in order to produce fruit. Bunch grapes are cluster-harvested by hand, while most muscadine grapes are picked singly and may be hand or machine harvested. Planting density is higher for bunch grapes (605 plants per acre) than for muscadines (218 plants per acre). Formerly rare, drip irrigation is now commonly installed in newly established vineyards.

Worker Activities

Winter pruning -- Grape vines (both bunch and muscadine) are pruned during the dormant season. Most muscadines are mechanically pre-pruned to reduce the amount of hand labor required, followed by detailed hand pruning to balance and thin fruiting wood for the coming season. Some muscadine vineyards receive only mechanical pruning, with no follow-up hand pruning. Prunings may be hauled from the field or chopped in place using a flail mower.

Summer training (mature vines) -- Primarily for bunch grapes only. During the growing season, hand labor is used in bunch grapes to remove basal suckers, thin and position shoots on the trellis, and to remove leaves or thin clusters as needed. Mature muscadines require little summer training, and basal suckers can be removed with herbicides. Some grape growers mechanically prune excessive shoot growth. This is typically done only once during summer.

Summer training (new vines) – Newly planted vines must be hand-trained to the trellis on which they will grow. This requires 1 to 4 man-hours per acre per week in the first two growing seasons. *It probably requires much more for bunch grapes*

Weed management -- Preemergent herbicide applications are applied in early spring, primarily with tractor mounted spray equipment. Postemergence herbicide applications are made in early summer and occasionally after harvest, primarily with tractor mounted sprayers -- although backpack sprayers are occasionally used. Row middles are mowed throughout the growing season. Grow tubes are used around each vine in the first season to promote growth and shield the vine from herbicides.

Pest control -- Insecticides and fungicides are applied from early spring up to harvest primarily with air-blast orchard sprayers. Ten to 12 fungicide applications are typically applied to bunch grapes and 2 to 4 insecticide/acaricide applications are made yearly. Muscadine grapes require fewer fungicide applications, usually six to eight.

Harvesting -- Bunch grapes are mainly used for wine. Most are hand harvested but some are harvested mechanically. Most muscadine vineyards in North Carolina are planted with the cultivar Carlos (greater than 90%) for wine use, and are machine harvested. The remaining muscadine acreage consists of large-fruited fresh market cultivars that are hand-harvested for fresh sales.

Fertility -- Granular fertilizers are applied 2 to 4 times per year using tractor-mounted equipment. Some growers fertilize through the drip irrigation system. Soil samples and leaf samples (for tissue analysis) may be collected periodically.

Insect and Mite Pests

Economically significant insect pests include grape root borers (*Vitacea polistiformis*), Japanese beetles (*Popillia japonica*), green June beetles (*Cotinis nitida*), flea beetles (*Altica chalybea*), grape berry moths (*Paralobesia viteana*), several leafhoppers, aphids (*Aphis illinoisensis*), spider mites, and scale insects. The grape root borer is the larva of a clear-wing moth that bores into roots and can cause reduced vigor and plant death. Both muscadine and bunch grapes may be affected. Japanese beetles and June beetles swarm vineyards in midsummer and feed on foliage and fruit. These beetles are most numerous in the Piedmont. Grape berry moths, flea beetles, aphids, and spider mites damage new foliage and flower clusters and can attack maturing leaves and fruit. Leafhoppers are important as vectors of Pierce's disease bacteria. Stinging insects (wasps, yellow jackets, bumblebees) are attracted to ripe fruit and may pose a hazard for pickers.

The grape root borer is the most serious insect pest of grapes in North Carolina. After vines are eight years old, they often succumb to a combination of borer feeding and hot, dry summers/harsh winter temperatures.

Chemical Control

Superior Oil

Superior oil is used as a dormant spray to control scale insects. Not commonly used on muscadine

grapes.

Carbaryl (Sevin)

Carbaryl is used as a short-residual, preharvest spray to control Japanese beetles and nuisance insects (yellow jackets, wasps). It is also used throughout the growing season to control grape berry moths, flea beetles, and leafhoppers. It is not effective on aphids. Most commonly used insecticide on muscadine grape, primarily for Japanese beetles.

Methomyl (Lannate)

Lannate is used for grape berry moths, flea beetles, aphids, and leafhoppers. Not commonly used on muscadine grapes.

Phosmet (Imidan)

Imidan is used for grape berry moths, flea beetles, aphids, and leafhoppers. It is also used at a high rate for Japanese beetles and green June beetles. Most widely used insecticide on bunch grapes. Not commonly used on muscadine grapes.

Malathion

Malathion is used for grape berry moths, flea beetles, aphids, and leafhoppers. Not commonly used on muscadine grapes, except for aphids on an as-needed basis.

Chlorpyrifos (Lorsban)

Lorsban is used to control grape root borers. It is applied as a dilute spray to the soil at the base of the vine approximately 35 days before harvest. Applied as needed to both bunch and muscadine grapes.

Dicofol (Kelthane)

Kelthane is used for spider mite control. Not commonly used on muscadine grapes in North Carolina.

Fenpropathrin (Danitol)

Danitol may be used for berry moth, leafhoppers, flea beetles and aphids. Not commonly used on muscadine grapes in North Carolina.

Pyrellin

Pyrellin may be used for berry moth, leafhoppers, flea beetles and aphids. Not commonly used on muscadine grapes in North Carolina.

Pyridiben (Pyramite)

Pyridiben may be used for mite control. Not commonly used on muscadine grapes in North Carolina.

Insecticide and Miticide Use Estimates

Muscadine Grapes – Most muscadine growers use three insecticides on an as-needed basis: Sevin for

Japanese beetles, malathion for aphids and Lorsban for grape root borer.

Bunch Grapes – Estimates are not available for insecticide use on bunch grapes.

Current Insecticide Recommendations for Grapes

Current North Carolina Cooperative Extension Service recommendations for insecticide use on grapes (including information on formulations, application rates, and precautions/limitations) are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 7-6: Winegrape Spray Program <http://ipm.ncsu.edu/agchem/chptr7/706.pdf>

Table 7-7A: Muscadine Grape Spray Program <http://ipm.ncsu.edu/agchem/chptr7/707.pdf>

Non-Chemical Control

Plastic or soil placed around the base of vines gives some control of grape root borers by providing a physical barrier to adult emergence. Grape root borers can be managed by a soil mound 2 to 4 inches deep out to 39 inches from the base of the plant in early August. Plastic mulches are also effective when well placed and removed the following spring. Biological controls exist, and studies with the augmentation of *Beauveria* fungus are under investigation. Monitoring and mating disruption using sex pheromones and a trapping system offer some control for the future. Also, the use of foams to prevent adult emergence from the soil may be useful.

Clean cultivation and removal of crop debris from the ground beneath vines can reduce overwintering by some insects.

Diseases

Grape disease control is accomplished through the use of resistant cultivars or species, through pruning and field sanitation, and by the use of fungicides. Bunch grapes are more susceptible to fungal diseases and require a much more rigorous spray schedule than muscadine grapes. The principle early season diseases are downy mildew (*Plasmopara viticola*), powdery mildew (*Uncinula necator*), Phomopsis cane and leaf spot (*Phomopsis viticola*) and black rot (*Guignardia bidwellii*). Muscadine grapes are immune to downy mildew. Bitter rot (*Greeneria uvicola*, syn. *Melanconium fuligineum*), ripe rot

(*Glomerella cingulata*; *Colletotrichum gloeosporioides* and *C. acutatum*.), and Macrophoma rot (*Botryosphaeria dothidea*) commonly cause fruit rots on muscadine and bunch grapes. Botrytis fruit rot (*Botrytis cinerea*) and sour rot (a disease complex) are also important bunch rot diseases of vinifera and French-American hybrid grapes. Anthracnose (*Elsinoe ampelina*) affects stems, fruit, and leaves, primarily of American bunch grapes. . Angular leaf spot (*Mycosphaerella angulata*) is common on muscadine grapes. Pierce's disease (*Xylella fastidiosa*) is the primary disease limiting production of bunch grape species (*V. labrusca*, *V. vinifera*) in the eastern half of North Carolina. This bacterial pathogen is endemic in wild muscadine grapes; most muscadine cultivars are resistant to it. There are no chemical controls available Crown gall (*Agrobacterium tumefaciens*) is a disease caused by a bacterium that has frequently been associated with gall formation on grape vines. Symptoms of crown gall are far less severe on muscadine grapes than on bunch grapes.

Chemical Control

Liquid lime sulfur

Liquid lime sulfur is used as a dormant spray for anthracnose on American bunch grapes. Not commonly used on muscadines.

Captan

Captan is used to control fruit rots and to help control leaf diseases. Captan is one of the most commonly used fungicides on both bunch and muscadine grapes in North Carolina.

Wettable Sulfur

Sulfur is used for powdery mildew control, especially on vinifera and French-American hybrid grapes. Some bunch grapes are very sensitive to sulfur and the warm temperatures in the summer in North Carolina preclude its use during some periods.

Myclobutanil (Nova)

Nova is used to control bunch grape anthracnose, powdery mildew, and black rot. Nova is commonly used on both bunch and muscadine grapes in North Carolina.

Bayleton

Bayleton is used for powdery mildew and black rot control on bunch grapes. Generally not used on muscadine grapes in North Carolina.

Azoxystrobin (Abound)

Abound is labeled for broad-spectrum control of grape diseases. Abound was the first strobilurin fungicide labeled for grapes and is still the most widely used of that class. It is reportedly more active than Flint or Sovran for downy mildew control on bunch grape. It provides good control of most late season bunch rot diseases.

Carbamate (Ferbam)

Ferbam may be used to control black rot, anthracnose, and dead arm. Generally not widely used.

Mancozeb (Penncozeb, Dithane, Manzate)

Mancozeb is used for black rot, bunch rot, phomopsis, and downy mildew. This product has a 66-day preharvest interval (PHI). The PHI severely limits the utility of this fungicide, and only a few muscadine growers are still using it as part of their spray program. It is however widely used early in the season on bunch grapes.

Maneb

Maneb is used for black rot, bunch rot, phomopsis, and downy mildew. This product has a 66-day PHI. The PHI severely limits the utility of this fungicide, and only a few muscadine growers are still using it as part of their spray program. It is not as widely used as mancozeb.

Boscalid (Endura)

Endura may be used for Botrytis rot on bunch grapes. Also effective for powdery mildew, this is a relatively new product and not yet widely used. Not used on muscadines.

Boscalid + Propiconazole (Pristine)

Pristine is a relatively new fungicide with good activity; it is not widely used in muscadine grapes at this time, and may cause injury to certain bunch grape cultivars. In addition to powdery mildew it provides good late season control of bunch rot diseases (i.e. bitter rot, ripe rot, and Botrytis).

Cyprodinil (Vangard)

Vangard is used for Botrytis rot on bunch grapes in rotation with other Botrytis fungicides to avoid resistance. Not used on muscadines.

Fenheximid (Elevate)

Elevate is used for Botrytis rot on bunch grapes in rotation with other Botrytis fungicides to avoid resistance. Not used on muscadines.

Fenarimol (Rubigan)

Rubigan is effective against powdery mildew and black rot. Not used on muscadines.

Kresoxim-methyl (Sovran)

Sovran is not commonly used on muscadine grapes but provides good late season control of most bunch rot diseases on vinifera and French-American hybrid grapes.

Pyrimethanil (Scala)

Another AP fungicide similar to Vangard. Has good activity on Botrytis. First registered on grapes in 2005.

Tebuconazole (Elite)

Elite maybe useful for control of powdery mildew, phomopsis and black rot on bunch grapes. The product is generally not used on muscadine grapes.

Thiophanate-methyl (Topsin M)

Topsin-M is not commonly used on grapes in North Carolina.

Trifloxystrobin (Flint)

Flint is quite effective but is not commonly used on muscadine grape. This product provides good late season control of most bunch rot diseases on vinifera and French-American hybrid grapes.

Triflumizole (Procure)

Procure maybe useful for control of powdery mildew, phomopsis and black rot on bunch grapes. The product is generally not used on muscadine grapes.

Liquid lime-sulfur

Lime-sulfur is not commonly used on muscadines but may be used on American bunch grapes to reduce overwintering inoculum of *Elsinoe ampelina*, cause of Anthracnose..

Cuprofix Disperss

Not recommended on muscadines, but is the most common formulation of sulfur used on bunch grapes.

Phosphorous acid-based products (Prophyt, Phostrol)

Eradicants active against downy mildew of bunch grape; not used on muscadine grape.

Fungicide Use Estimates

Muscadine Grape -- Three fungicides are commonly used on muscadine grape: Captan 50W and 4L, Nova 40W and Abound 2.08F. All other products are used rarely or not at all, although use of Pristine 38WG is expected to increase based on experimental efficacy and crop safety. Muscadines are not susceptible to Botyrtis rot, bunch grape anthracnose or downy mildew, so many products widely used on bunch grapes have no useful efficacy on this grape species.

Bunch Grape -- The most commonly used fungicides on bunch grape include mancozeb (various trade names), captan 50W and 4L, Nova 40W, Elite 45DF, Abound 2.08F, Vangard WG, Elevate 50WG, sulfur, and Prophyt. Pristine 38WG, first registered on grapes in 2004 is beginning to be used by many growers.

Current Fungicide Recommendations for Grapes

Current North Carolina Cooperative Extension Service recommendations for fungicide use on grapes (including information on formulations, application rates, and precautions/limitations) are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 7-6: Winegrape Spray Program <http://ipm.ncsu.edu/agchem/chptr7/706.pdf>

Tables 7-7A and 7-7B: Muscadine Grape Spray Program and Effectiveness of Various Fungicides for Muscadine Grape Disease Control <http://ipm.ncsu.edu/agchem/chptr7/707.pdf>

See also the Southeastern Regional Bunch Grape Integrated Management Guide: <http://www.smallfruits.org/SmallFruitsRegGuide/Guides/BunchGrapeSprayGuide.pdf>

Non-Chemical Control

Resistance to some diseases is available. Mowing or otherwise reducing undergrowth near vines will improve air movement through the vineyard. Timely harvesting along with removal of leftover fruit at the end of the season should also help reduce fruit rots. For bunch grapes, shredding/removal of infected leaves will reduce downy mildew inoculum in the field. Shoot training, leaf removal and cluster thinning can be used to enhance drying and improve spray penetration. Avoiding excessive late-season fertilizing can reduce both disease and the likelihood of winter injury to cordons and trunks of vines.

Weeds

Weeds between rows are managed through the use of sod middles that are kept mowed. Within rows, herbicides are used. Perennial weeds such as goldenrod, red sorrel, broomsedge, Johnsongrass, and Bermudagrass are common. Without regular weed control efforts, woody vines and trees can quickly become established in the vineyard. Once overgrown by woody perennials, vineyards are very difficult to return to production and are often abandoned. Herbicide usage must be directed to the base of the plant to avoid injury. While the contact of a herbicide with older trunks may not injure the plant, care must be taken to avoid or remove new shoots emerging at ground level.

Chemical Control

Preemergence (used before emergence of weed seedlings from the soil):

Oxyfluorfen (Goal, Galigan, OxiFlo)

Goal is used on mature (established at least three years) dormant vines for annual broadleaf weed control.

Dichlobenil (Casoron)

Casoron is used on annual and many perennial weeds. It must be applied during cool weather. Casoron is not used extensively in North Carolina.

Simazine (Princep)

Princep is used on mature vines for preemergence control of annual broadleaf weeds and grasses. It is commonly used in North Carolina vineyards.

Diuron (Karmex)

Karmex is used on mature vines for preemergence control of annual broadleaf weeds and grasses. Karmex should be applied before germination of annual weeds. It should only be used as an option in vineyards having soil with at least 2% organic matter.

Napropamide (Devrinol)

Napropamide provides preemergence control of annual grasses and small-seeded broadleaf weeds. Rain or irrigation is needed soon after application for optimum activity. If not moved into the soil with rainfall or irrigation, napropamide is subject to breakdown by sunlight. Napropamide is an option for newly planted and established vineyards.

Oryzalin (Surflan)

Surflan provides preemergence control of annual grasses and small-seeded broadleaf weeds. Oryzalin is an option in newly planted and established vineyards.

Pendimethalin (Prowl)

For dormant, newly planted, and 1-year-old vines, Prowl provides preemergence control of annual grasses and small-seeded broadleaf weeds. It cannot be used in vineyards that will bear within 1 year of application.

Pronamide (Kerb)

Kerb is used on 2-year-old or older vines as a directed spray for control of annual grasses and small-seeded broadleaf weeds.

Norflurazon (Solicam)

Solicam is used for control of annual grasses and small-seeded broadleaf weeds. It also provides preemergence control of certain perennial broadleaf weeds.

Postemergence (sprayed on weeds after they have emerged from the soil):**Paraquat (Gramoxone MAX)**

Gramoxone is used as a directed spray for contact-kill of all weeds.

Glyphosate (Roundup)

Roundup Ultra is used as a directed spray for systemic-kill of all weeds.

Glufosinate (Rely)

Rely is used as a directed spray to kill most annual and some perennial weeds. It can be used for grape sucker control.

Sulfonate (Touchdown)

Touchdown is used as a directed spray for systemic-kill of all weeds.

Clethodim (Select)

Select provides postemergence control of emerged grasses. Sequential applications are used for perennial grasses.

Fluazifop (Fusilade DX)

Fusilade provides postemergence grass control and be used in vineyards that will not bear fruit within 1 year. Sequential applications are used for perennial grasses.

Sethoxydim (Poast)

Poast provides postemergence control of grasses. Sequential applications are used for perennial grasses.

Herbicide Use Estimates

Muscadine Grapes – The most commonly used post-emergence herbicides on muscadines are Roundup, Gramoxone, and Rely. With the advent of grow-tube use on young vines (allowing close spraying with postemergence products), many growers do not use preemergence herbicides.

Bunch Grapes – Estimates are not available for herbicide use on bunch grapes.

Current Herbicide Recommendations for Grapes

Current North Carolina Cooperative Extension Service recommendations for herbicide use on grapes (including information on formulations, application rates, and precautions/limitations) are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 8-11A: Chemical Weed Control in Fruit Crops – Small Fruits <http://ipm.ncsu.edu/agchem/chptr8/814.pdf>

Non-Chemical Control

Organic production is being attempted in at least one new vineyard being established in North Carolina.

Weeds are the primary stumbling block to date. Weed barrier fabrics and mulches have been used with some success, but hand-labor expense for hoeing and pulling weeds has been excessive. Plastic growth tubes 3 inches in diameter and 24 to 36 inches long have been used experimentally to protect vines and accelerate growth.

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On-Line Resources

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2. Insect Note – Grape Root Borer
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The image of grapes is provided by the Department of Communication Services at North Carolina State University.