VI—INSECT AND DISEASE CONTROL OF FRUITS

Apple Spray Program

J. F. Walgenbach and S. M. Villani, Entomology and Plant Pathology

See *Integrated Orchard Management Guide for Commercial Apples in the Southeast* (AG-572) for more detailed information on apple disease and insect control. For a copy, contact Jim Walgenbach, 455 Research Drive, Mills River, NC 28759; jim_walgenbach@ncsu.edu. The guide is also available online at apples.ces.ncsu.edu.

Many pesticides have brand name and generic formulations. In general, information is provided for the most commonly used formulations of active ingredients available in multiple formulations. Carefully check the label of the product you plan to use in the event that it differs from those listed. The label is the law!

Table 6-1. Apple Spray Program

Number and Time of Application	Amount of Fungicide and Insecticide Per Acre
Green-Tip Spray[1] When buds show 0.25-inch new growth	**Fungicide: NOTE: Captan will cause injury if applied with or too close to oil applications.** **Apple Scab:** Apply dodine (Syllit FL) 1.5 pt + mancozeb (Manzate Max) 2.4 qt *OR* dodine (Syllit FL) 1.5 pt + Captan 80 WDG 2.5 lb *OR* cyprodinil (Vangard 75WG) 5 oz *OR* cyprodinil (Vangard 75WG) 3 to 5 oz + mancozeb (Koverall) 3 lb *OR* cyprodinil (Vangard 75WG) 3 to 5 oz + metiram (Polyram 80DF) 3 lb *OR* pyrimethanil (Scala SC) 7 to 10 oz *OR* pyrimethanil (Scala SC) 5 oz + mancozeb (Koverall) 3 lb *OR* pyrimethanil (Scala SC) 5 oz + metiram (Polyram 80DF) 3 lb *OR* fluopyram/pyrimethanil (Luna Tranquility) 11.2 to 16 fl oz + mancozeb (Manzate Max) 2.4 qt *OR* penthiopyrad (Fontelis SC) 16 to 20 fl oz *OR* penthiopyrad (Fontelis SC) 16 to 20 fl oz + mancozeb (Manzate Max) 2.4 qt *OR* fluxapyroxad (Sercadis) 4.5 fl oz *OR* fluxapyroxad (Sercadis) 4.5 fl oz + mancozeb (Manzate Max) 2.4 qt *OR* captan (Captan 80 WDG) 5 lb *OR* metiram (Polyram 80DF) 3 to 6 lb *OR* mancozeb (Manzate Max) 2.4 to 4.8 qt. **Fire Blight:** Apply copper hydroxide/copper oxychloride (Badge SC) 3.5 to 7 pt (rate for silver to green tip only) *OR* copper hydroxide/copper oxychloride (Badge X2, OMRI listed) 3.5 to 7 lb (rate for silver to green tip only) *OR* copper hydroxide (Kocide 3000-O) 3.5 to 7 lb (discontinue rate at ½" green tip) *OR* basic copper sulfate (Cuprofix Ultra 40 Disperss) 5 to 7.5 lb (apply rate between silver and green tip). Other formulated copper products are available but are too numerous to list in this publication. **Frogeye Leaf Spot:** Apply captan (Captan 80WDG) 5 lb *OR* thiophanate methyl (Topsin 4.5FL) 15 to 20 fl oz *OR* captan (Captan 80WDG) 2.5 lb + thiophanate methyl (Topsin 4.5 FL) 15 to 20 fl oz. **Phytophthora Rots:** Apply phosphorous acid (ProPhyt) 2 to 4 pt/100 gal. Ridomil Gold SL may be applied as a soil drench or spray prior to bud break in the spring (silver tip) or in the fall after harvest. **Insecticide:** Apply 2 to 3 gallons oil per 100 gallons water. This is an important spray for European red mite eggs and San Jose scale. For improved control of San Jose scale add pyriproxyfen (Esteem35WP) 4 to 5 oz OR buprofezin (Centaur 70 WDG) 34.5 oz. See petal fall to first cover spray as an alternative timing for scale control. If using mating disruption for codling moth and oriental fruit moth, dispensers (200 Isomate CM-OFM TT dispensers per acre or 1 CheckMate CM-OFM Puffer per acre) should be in place before bloom.
Half-Inch Green Spray One week after GREEN-TIP SPRAY	**Fungicide:** Use same materials as GREEN-TIP SPRAY. See label warnings about high application rates of copper. **Insecticide:** If an insecticide was not applied at green tip, use one of the products listed above; otherwise, no insecticide is needed.
Tight Cluster Spray One week after HALF-INCH GREEN SPRAY	**Fungicide:** **Apple Scab:** Apply trifloxystrobin (Flint Extra) 2.5 to 2.9 fl oz *OR* kresoxim-methyl (Sovran 50 WG) 3.2 to 6.4 oz *OR* fenbuconazole (Indar 2F) 6 to 10 fl oz *OR* fluopyram/pyrimethanil (Luna Tranquility) 11.2 to 16 fl oz *OR* fluopyram/trifloxystrobin (Luna Sensation) 4 to 5.8 fl oz *OR* fluxapyroxad/pyraclostrobin (Merivon) 4 to 5.5 fl oz *OR* penthiopyrad (Fontelis) 16 to 20 fl oz *OR* inpyrfluxam (Excalia) 3 to 4 fl oz *OR* cyprodinil/difenoconazole (Inspire Super) 12 fl oz *OR* benzovindiflupyr (Aprovia) 5.5 to 7 fl oz *OR* fluxapyroxad (Sercadis) 4.5 fl oz *OR* captan (Captan 80WDG) 5 lb *OR* mancozeb (Manzate Max) 2.4 to 4.8 qt *OR* metiram (Polyram 80 DF) 3 to 6 lb. *OR* mefentrifluconazole (Cevya) 4 to 5 fl oz *OR* pydiflumetofen (Miravis) 3.4 fl oz. For resistance management of single-site/"systemic" fungicides, it is suggested that a ½ rate of a multi-site protectant fungicide such as captan or mancozeb be added to the tank mixture. **Frogeye Leaf Spot:** Apply captan (Captan 80WDG) 5 lb *OR* thiophanate methyl (Topsin 4.5FL) 15 to 20 fl oz *OR* captan (Captan 80WDG) 2.5 lb + thiophanate methyl (Topsin 4.5 FL) 15 to 20 fl oz *OR* mefentrifluconazole (Cevya) 4 to 5 fl oz *OR* boscalid + pyraclostrobin (Pristine WG) 14.5 to 18.5 fl oz *OR* fluxapyroxad/pyraclostrobin (Merivon) 4 to 5.5 fl oz *OR* kresoxim-methyl (Sovran 50 WG) 4.0 to 6.4 oz. **Powdery Mildew:** Apply myclobutanil (Rally 40 WSP) 5 to 10 oz *OR* fenbuconazole (Indar 2F) 6 to 10 fl oz *OR* triflumizole (Procure 480SC) 8 to 16 fl oz *OR* flutriafol (Topguard) 8 to 12 fl oz *OR* mefentrifluconazole (Cevya) 5 fl oz *OR* pydiflumetofen (Miravis) 3.4 fl oz *OR* fluopyram/pyrimethanil (Luna Tranquility) 11.2 to 16 fl oz *OR* fluopyram/trifloxystrobin Luna Sensation (4 to 5.8 fl oz) *OR* fluxapyroxad/pyraclostrobin (Merivon) 4 to 5.5 fl oz *OR* penthiopyrad (Fontelis) 16 to 20 fl oz *OR* trifloxystrobin (Flint WG) 2 to 2.5 oz *OR* kresoxim-methyl (Sovran 50 WG) 4 to 6.4 oz *OR* benzovindiflupyr (Aprovia) 5.5 to 7 fl oz *OR* flutianil (Gatten) 6 to 8 fl oz *OR* paraffinic oil (JMS Stylet Oil) 1 to 2 gal/100 gal *OR* sulfur (Microthiol Disperss) 10 to 20 lb. Note: do not apply paraffinic oil in tank mixture with captan or within a few days prior to or following a captan application. **Cedar Apple/Quince Rust:** Apply a DMI (FRAC GROUP 3) used for powdery mildew *OR* mancozeb (Manzate Max) 2.4 qt. **Insecticide:** For rosy apple aphid, apply 5 ounces acetamiprid (Assail 30 SG) *OR* 10 to 14 oz flupyradifurone (Sivanto Prime). For rosy apple aphid and plant bugs, apply 2.75 oz sulfoxaflor (Closer SC), 5.4 ounces thiamethoxam (Actara 25 WP) *OR* 16 ounces fenpropathrin (Danitol 2.4 EC).
Pink Spray When blossom buds are pink, stems extended	**Apple Scab, Powdery Mildew, Rusts, Frogeye Leaf Spot:** Use same fungicide as TIGHT CLUSTER SPRAY. Make sure to rotate between different FRAC Groups. **Marssonina Leaf Blotch:** mefentrifluconazole (Cevya) 5 floz **Fire Blight Control:** For early shoot blight control, initiate applications of prohexadione calcium (Kudos 27.5 WG) 2 to 6 oz and repeat at 7- to 21-day intervals *OR* prohexadione calcium (Apogee) 6 to 12 oz/**100 gal**. Repeat at 14- to 21-day intervals. **Prohexadione calcium is a plant growth regulator that will reduce/retard vegetative growth**. **Insecticide:** If an insecticide effective against rosy apple aphid and/or tarnished plant bug was not applied at TIGHT CLUSTER, apply one of the above materials.
Bloom Spray	**Fungicide:** Use same fungicide as TIGHT CLUSTER or PINK SPRAY. **Fire Blight Control:** Apply streptomycin (Firewall, Agrimycin, Harbour) 24 oz *OR* kasugamycin (Kasumin 2L) 64 fl oz/100 gal *OR* oxytetracycline (Fireline) 12 oz/100 gal *OR* acibenzolar-S-methyl (Actigard 50WG) 1 to 2 oz + streptomycin (Firewall) 24 oz *OR* acibenzolar-S-methyl (Actigard 50WG) 1 to 2 oz + oxytetracycline (Fireline) 12 oz *OR Bacillus mycoides* (LifeGard) 4.5 oz/100 gal + streptomycin (Firewall) 24 oz *OR* copper octanoate (Cueva) 2 qt *OR Bacillus amyloliquefaciens* (Double Nickel LC) 1 to 2 qt + copper octanoate (Cueva) 2 qt *OR* copper sulfate pentahydrate (MasterCop) 0.5 to 1.5 qt *OR* copper hydroxide/copper oxychloride (Badge SC) 0.5 to 1.5 pt *OR* copper hydroxide/copper oxychloride (Badge X2, OMRI listed). Other formulated copper products are available but are too numerous to list in this publication. Be aware that phytotoxicity to fruit and leaves may occur if copper is used during this timing. **Insecticide:** DO NOT USE an insecticide at BLOOM SPRAY. The exception is 8 oz methoxyfenozide (Intrepid 2F) in late bloom where green fruitworm is a problem.

Table 6-1. Apple Spray Program

Number and Time of Application	Amount of Fungicide and Insecticide Per Acre
Petal-Fall Spray When most petals have fallen	**Fungicide:** **Apple Scab, Powdery Mildew, Rusts:** Use same fungicide as TIGHT CLUSTER SPRAY. Make sure to rotate between different FRAC Groups. **Black and White Rot (Bot Rots):** Apply captan (Captan 80WDG) 5 lb *OR* trifloxystrobin (Flint Extra) 2.5 to 2.9 fl oz *OR* kresoxim-methyl (Sovran 50 WG) 4 to 6.4 oz *OR* thiophanate-methyl (Topsin 4.5 FL) 15 to 20 fl oz *OR* fluazinam (Omega 500F) 13.8 fl oz. **Glomerella Leaf Spot and Bitter Rot:** Apply captan (Captan 80WDG) 5 lb *OR* phosphorous acid (ProPhyt) 4 pt + captan (Captan 80WDG) 3.75 lb *OR* fluxapyroxad/pyraclostrobin (Merivon) *OR* boscalid/pyraclostrobin (Pristine) 14.5 to 18 oz *OR* boscalid/pyraclostrobin (Pristine) 14.5 to 18 oz *OR* trifloxystrobin (Flint Extra) 2.9 fl oz *OR* trifloxystrobin + fluopyram (Luna Sensation) 5.8 fl oz *OR* fluazinam (Omega 500F) 13.8 fl oz *OR* benzovindiflupyr (Aprovia) 7 fl oz. For resistance management of single-site/"systemic" fungicides, it is suggested that a ½ rate of a multi-site protectant fungicide be added to the tank mixture. **Insecticide:** For plum curculio and Oriental fruit moth, apply 5 ounces indoxacarb (Avaunt 35WD) *OR* 3 pounds phosmet (Imidan 70 WP) *OR* 4.5 ounces thiamethoxam (Actara 25 WP) *OR* 8 ounces acetamiprid (Assail) OR 11 ounces cyclaniliprole (Verdepryn) OR 6 ounces thiamethoxam + chlorantraniliprole (Voliam Flexi). For preventive control of European red mite, use 3 ounces abamectin (Agri-Mek 0.7SC) *PLUS* 0.25% horticultural spray oil (not a superior-type oil). If rosy apple aphid control is needed, use Actara, or add 2.8 ounces imidacloprid (Admire 4.6SC).
First Cover Spray 8 to 10 days after PETAL-FALL SPRAY	**Fungicide:** **Powdery Mildew, Glomerella Leaf Spot, Black Rot, White Rot, Bitter Rot:** Refer to fungicides for PETAL FALL Application. **Flyspeck/Sooty Blotch:** Apply captan (Captan 80WDG) 2.5 to 5 lb *OR* trifloxystrobin (Flint 50WG) 1.5 to 2.5 oz *OR* kresoxim-methyl (Sovran 50 WG) 4 to 6.4 oz *OR* thiophanate methyl (Topsin 4.5FL) 15 to 20 fl oz *OR* ziram (Ziram 76DF) 3 to 6 lb *OR* cyprodinil/difenoconazole (Inspire Super) 12 fl oz *OR* fenbuconazole (Indar 2F) 6 to 8 fl oz *OR* benzovindiflupyr (Aprovia) 5.5 to 7 fl oz *OR* fluopyram/trifloxystrobin (Luna Sensation) 4 to 5.8 fl oz *OR* fluxapyroxad/pyraclostrobin (Merivon) 4 to 5.5 fl oz *OR* boscalid/pyraclostrobin (Pristine) 14.5 to 18.5 fl oz *OR* copper octanoate (Cueva) 2 qt *OR* copper octanoate (Cueva) 2 qt + *Bacillus amyloliquefaciens* (Double Nickel LC) 1 to 2 qt **Fire Blight (shoot blight/rat-tail bloom):** Apply prohexadione calcium (Apogee) 6 to 12 oz/**100 gal** *OR* Bacillus mycoides (Lifegard) 4.5 oz/100 gal *OR* copper octanoate (Cueva) 2 qt *OR* copper octanoate (Cueva) 2 qt + *Bacillus amyloliquefaciens* (Double Nickel LC) 1 to 2 qt *OR* copper hydroxide/copper oxychloride (Badge X2, OMRI listed) 0.5 to 1.5 lb *OR* copper hydroxide/copper oxychloride (Badge SC) 0.5 to 1.5 pt. Other formulated copper products are available but are too numerous to list in this publication. Be aware that phytotoxicity to fruit and leaves may occur if copper is used during this timing. **Insecticide:** For codling moth, apply 3 ounces chlorantraniliprole (Altacor 35 WDG) *OR* 8 ounces cyclaniliprole (Verdepryn) *OR* 5 ounces spinetoram (Delegate 25 WDG). If preventative control of European red mite is desired but was not applied at petal fall, apply 4 ounces clofentezine (Apollo SC) *OR* 4 ounces hexythiazox (Savey 50 DF), 3 ounces etoxazole (Zeal 72 WD), *OR* 18 fl oz spirodiclofen (Envidor 2SC). Where control of San Jose scale is needed, apply 4 oz pyriproxyfen (Esteem 35 WP) *OR* 2.1 lb buprofezin (Centaur 70WDG) *OR* 6 to 9 fl ounces spirotetramat (Movento 2SC). Movento will also provide season-long protection against woolly apple aphid.
Second Cover Spray 10 to 14 days after FIRST COVER SPRAY	**Fungicide:** Refer to relative effectiveness table for appropriate fungicides and to FIRST COVER SPRAYS (above) for summer disease control. Substitute ziram (Ziram 76DF) for mancozeb products as mancozeb has a 77-day PHI. **Insecticide:** Same as FIRST COVER SPRAY for control of codling moth.
Third Cover Spray 10 to 14 days after SECOND COVER SPRAY	**Fungicide:** Refer to relative effectiveness table for appropriate fungicides and to FIRST COVER SPRAYS (above) for summer disease control. **Insecticide:** Same as first cover for codling moth if needed. For tufted apple bud moth, apply an insecticide recommended for codling moth above *OR* 12 ounces methoxyfenozide (Intrepid 2 F). On plantings susceptible to dogwood borer, apply 8 oz acetamiprid (Assail 30SG) to trunk at base of tree using a handgun application anytime between June 1 and mid-July. If aphid and/or potato leafhopper control is needed, apply 2.8 fl ounces imidacloprid (Admire Pro 4.6SC), *OR* 2 ounces thiamethoxam (Actara 25WD), *OR* 10 to 14 oz flupyradifurone (Sivanto Prime), *OR* 2 fl ounces sulfoxaflor (Closer 2SC), *OR* 2.5 to 4 ounces acetamiprid (Assail 30WD) *OR* 1.5 ounces afidopyropen (Versys).
Summer Cover Sprays 7- to 14-day intervals or as pest density and weather conditions dictate	**Fungicide:** Refer to relative effectiveness table for appropriate fungicides and to FIRST COVER SPRAYS (above) for summer disease control. **Insecticide:** Refer to relative effectiveness tables and AG-572 for appropriate insecticides and miticides for summer insect control. For second generation codling moth sprays (mid to late July), do not use insecticides in the same MOA group that was used for first generation control (first and second cover sprays). Important sprays include codling moth in mid to late July, apple maggot in late July or early August. For apple maggot, apply 2.8 ounces imidacloprid (Admire Pro) or 3 pounds phosmet (Imidan). In orchards not using mating disruption up to this point or where pyrethroids are not applied for stink bug (see below), apply 1.2 ounces/acre of Check OFM-F (sprayable pheromone for mating disruption) in mid to late July and again one month later for late-season oriental fruit moth control. For control of brown marmorated stink bug, sprays should be based on insect population densities and timing of infestation of first generation adults in mid-July in the piedmont and early to mid-August in the mountains; apply 5 oz thiamethoxam (Actara 25 WDG), *OR* 6 oz clothianidin (Belay) *OR* 18 oz fenpropathrin (Danitol 2.4EC) *OR* 5.12 oz bifenthrin (Brigade 2EC or Fanfare 2EC), *OR* 2.8 oz lambda-cyhalothrin (Karate 2.04EC) *OR* other pyrethroids listed in the efficacy table. 2 to 3 sprays may be needed depending on stink bug pressure and cultivar of apple. Weekly applications may be needed on Granny Smith in orchards with high BMB populations.

[1] Do not follow oil with captan or sulfur for 14 days.

Further Information

Southern Appalachian Apples Extension Portal: apples.ces.ncsu.edu
A Grower's Guide to Apple Insects and Diseases in the Southeast. (ipm.ces.ncsu.edu/ipm-apples).

Relative Effectiveness of Various Fungicides for Apple Disease Control

S. M. Villani, Entomology and Plant Pathology

Many pesticides have brand name and generic formulations. In general, information is provided for the most commonly used formulations of active ingredients available in multiple formulations. Carefully check the label of the product you plan to use in the event that it differs from those listed. The label is the law!

(E = excellent; G=Good; F = Fair; P = Poor; NC = No control; ND = No data)

Table 6-2. Relative Effectiveness of Various Fungicides for Apple Disease Control

Fungicide and Amount Per Acre	FRAC Code	Days Between Last Spray and Harvest	Relative Control Rating						
			Apple Scab	Rusts	Brooks Spot	Black Rot/ White Rot	Glomerella/Bitter Rot	Sooty Blotch and Flyspeck	Powdery Mildew
benzovindiflupyr (Aprovia) 5.5 to 7 fl oz	7	30	E	F	ND	G-E	P-F	G-E	F-G
captan (Captan 80WDG) 5 lb	M4	0	G	P	G	G	E	F	P
cyprodinil (Vangard 75 WG) 5 oz	9	0	F	NC	NC	NC	NC	NC	NC
difenoconazole + cyprodinil (Inspire Super) 12 fl oz	3 + 9	14	E	E	F	G-E	P	G-E	F
dodine (Syllit 3.4 FL) 1.5 to 3.0 pt + mancozeb (Koverall) 3 lb OR + captan (Captan 80WDG) 2.5 lb	M7 M3 M4	See label 77 (see label)	E E	P-F P	n/a n/a	n/a n/a	n/a n/a	n/a n/a	NC n/a
fenbuconazole (Indar 2F) 6 to 10 fl oz	3	14	E	E	F	F-G	P	G	G
fluazinam (Omega 500F) 13.8 fl oz	29	28	F	F	ND	F-G	F-G	F	P-F
fluopyram + trifloxystrobin (Luna Sensation) 4.0 to 5.8 fl oz	7 + 11	14	E	F	G-E	G	G-E	G-E	E
fluopyram + pyrimethanil (Luna Tranquility) 11.2 to 16 fl oz	7 + 9	72	E	F	ND	ND	ND	ND	G
flutianil (Gatten) 6 to 8 floz	U13	14	ND	ND	ND	ND	ND	ND	G
flutriafol (Topguard) 13 fl oz	3	14	G	E	P-F	F	P	F-G	E
fluxapyroxad (Sercadis) 4.5 fl oz	7	0	E	F	ND	ND	P	F	F-G
fluxapyroxad + pyraclostrobin (Merivon) 4.4 to 5.5 fl oz	7 + 11	0	E	F	G-E	G-E	E	G-E	E
Inpyrfluxam (Excalia) 4 to 5 fl oz	7	Petal Fall	E	P	ND	ND	P	ND	G
kresoxim-methyl (Sovran 50 WG) 4 to 6.4 oz [1]	11	30	E	P-F	G-E	G	F-G	G	G
mancozeb (Manzate Max) 2.4 to 4.8 qt	M3	see label	G	F-G	F-G	F	E	P-F	P
mefentrifluconazole (Cevya) 4 to 5 fl oz	3	0	G	G-E	ND	G	P	E	F-G
metiram (Polyram 80 DF) 3 to 6 lb	M3	see label	G	F-G	F	P-F	F	P-F	P
myclobutanil (Rally 40WSP) 5 to 10 oz [1]	3	14	G	E	P-F	P-F	P	P	E
penthiopyrad (Fontelis 1.67 SC) 14 to 20 fl oz	7	28	G	F	F	F-G	F-G	G	G
phosphorous acid (ProPhyt) 3 to 4 pt + captan (Captan 80WDG) 3.75 lb	33 M4	0	G-E	F-G	G	G	E	F-G	P
phosphorous acid (ProPhyt) 4 pt + captan (Captan 80WDG) 2.5 lb + fluxapyroxad + pyraclostrobin (Merivon) 5.5 fl oz	33 M4 7 + 11	0	E	F	G-E	G-E	E	E	E
pydiflumetofen (Miravis)	7	30	E	F	ND	G-E	P	G-E	G
pyraclostrobin + boscalid (Pristine 38 WG) 14.4 to 18.4 oz	11 + 7	0	G-E	F	G-E	G-E	G-E	G-E	G
pyrimethanil (Scala 5 SC) 7 to 10 fl oz	9	72	F-G	NC	NC	NC	NC	NC	NC
sulfur (Microthiol Disperss) 10 to 20 lb	M2	see label	P-F	P-F	NC	NC	NC	P	G-E
thiophanate methyl (Topsin 4.5FL) 15 to 20 fl oz	1	1	— [3]	NC	G	G-E	P-F	G-E	P-F
trifloxystrobin (Flint Extra) 1.5 to 3 fl oz	11	14	G	P-F	G-E	G	E	G	G-E
triflumizole (Procure 480SC) 8 to 16 fl oz [1]	3	14	F-G	E	G	P-F	P	P	G-E
ziram (Ziram 76 DF) 3 to 6 lb [2]	M3	14	F	G	G	F	G	G-E	P

[1] Use higher rate when the likelihood of disease is high.

[2] Combine Ziram with Topsin-M 70W at 8 to 12 ounces per acre to improve white rot, black rot, sooty blotch, and flyspeck control.

[3] Thiophanate methyl is not recommended for apple scab control in North Carolina because of resistance within populations of the fungus causing apple scab.

Relative Effectiveness of Various Insecticides for Apple Insect and Mite Control

J. F. Walgenbach, Entomology and Plant Pathology

(E – excellent; G – good; F – fair; P – poor; NC – no control or insufficient data)

Table 6-3A. Relative Effectiveness of Various Insecticides for Apple Insect and Mite Control

Insecticide, Brand Name, and Amount per Acre	IRAC MOA Group	Days Between Last Spray and Harvest	Insects and Mites (Table continues on next page)								
			San Jose Scale*	European Red Mite*	Rosy Apple Aphid	Green Apple/ Spirea Aphids	White Apple Leafhopper	Coddling Moth	Tufted Apple Bud Moth	Redbanded Leafroller	Oriental fruit moth
carbaryl (Sevin XLR) 4 pt	1A	1	P	NC	NC	NC	E	F	P	G	G
oxamyl (Vydate 2L) 2 qt	1A	14	F	P	G	G	E	P	P	P	P
methomyl (Lannate LV) 1 qt	1A	14	NC	NC	P	G	E	P	G	G	G
chlorpyrifos (Lorsban 50W) 3 lb[1]	1B	>100	E	NC	G	NC	NC	NC	NC	NC	NC
diazinon (Diazinon 50WP) 4 lb	1B	21	G	P	F	F	F	F	P	F	F
phosmet (Imidan 70W) 3 lb	1B	7	P	NC	NC	NC	NC	G	P	G	G
bifenthrin (Brigade 2EC, Fanfare 2EC) 5.1 oz	3A	14	NC	G	E	G	E	G			
cyfluthrin (Tombstone 2EC) 2.4 oz	3A	7	NC	NC	G	G	E	G	E	E	E
esfenvalerate (Asana XL) 8 oz	3A	21	NC	NC	G	G	E	F	E	E	E
fenpropathrin (Danitol 2.4 EC) 16 oz	3A	14	NC	G	E	G	E	F	E	E	E
gamma-cyhalothrin (Proaxis 0.5EC) 3 oz	3A	14	NC	NC	E	G	E	G	E	E	E
lambda-cyhalothrin (Warrior II) 2 oz	3A	21	NC	NC	E	G	E	G	E	E	E
permethrin (Ambush 2E) 8 oz	3A	>100	NC	NC	G	G	E	F	E	E	G
zeta-cypermethrin (Mustang Maxx 0.8EC)	3A	14	NC	NC	E	G	E	G	E	E	E
acetamiprid (Assail 30 SG) 5.0 oz	4A	7	G	NC	E	E	E	G	P	P	G
clothianidin (Belay 2.13 SC) 6 oz	4A	7	NC	NC	E	E	E	NC	NC	NC	NC
imidacloprid (AdmirePro4) 2.8 oz	4A	7	NC	NC	E	E	E	NC	NC	NC	NC
thiamethoxam (Actara 25 WP) 4.5 oz	4A	35	NC	NC	E	E	E	P	NC	NC	NC
sulfoxaflor (Closer 2 SC)	4C	7	F	NC	E	E	E	NC	NC	NC	NC
flupyradifurone (Sivanto Prime) 10.5 oz	4D	14	NC	NC	E	E	E	NC	NC	NC	NC
spinetoram (Delegate 25WDG) 5 oz	5	7	NC	NC	NC	NC	NC	E	E	E	E
abamectin (Agri-Mek 0.7SC) 3.0 oz	6	28	NC	E	NC	NC	G	NC	NC	NC	NC
pyriproxyfen (Esteem 35 WP) 5 oz	7C	35	E	NC	P	P	NC	F	P	G	G
afidopyropen (Versys 0.83 DC)	9D	7	NC	NC	E	E	NC	NC	NC	NC	NC
clofentezine (Apollo SC) 4 oz	10A	45	NC	E	NC	NC	NC	NC	NC	NC	NC
hexythiazox (Savey 50DF) 4 oz[1]	10A	28	NC	E	NC	NC	NC	NC	NC	NC	NC
etoxazole (Zeal 72 WDG) 3 oz	10B	28	NC	G	NC	NC	NC	NC	NC	NC	NC
B. thuringiensis (various brands) 1 lb	11A	0	NC	NC	NC	NC	NC	P	G	G	P
novaluron (Rimon 0.83 EC) 20 oz	15	14	NC	NC	NC	NC	NC	G	E	E	E
buprofezin (Centaur 70WDG) 34.5 oz	16	14	E	NC	NC	NC	G	NC	NC	NC	NC
methoxyfenozide (Intrepid 2 F) 16 oz	18	14	NC	NC	NC	NC	NC	G	E	E	G
acequinocyl (Kanemite 15 SC) 31 oz	20B	14	NC	NC	NC	NC	NC	NC	NC	NC	NC
bifenazate (Acramite 50WS) 1 lb	20D	7	NC	E	NC	NC	NC	NC	NC	NC	NC
fenpyroximate (Portal 0.4EC) 2 p	21A	14	NC	E	NC	NC	G	NC	NC	NC	NC
pyridaben (Nexter 75 WP) 4.4 oz	21A	25	NC	G	NC	P	G	NC	NC	NC	NC
indoxacarb (Avaunt 30WDG) 5 oz	22A	28	NC	NC	NC	NC	E	P	G	G	G
spirotetramat (Movento 2CS) 7.5 oz	23	7	G	NC	E	E	G	NC	NC	NC	NC
cyflumetofen (Nealta 1.67SC) 13.7 oz	25	7	NC	E	NC	NC	NC	NC	NC	NC	NC
chlorantraniliprole (Altacor 35WDG) 3 oz	28	14	NC	NC	NC	NC	NC	E	E	E	E
cyantraniliprole (Exirel 0.83SE) 12 oz	28	3	NC	NC	NC	F	NC	E	E	E	E
cyclaniliprole (Verdepryn 100SL) 8.2 oz	28	7	NC	NC	NC	NC	NC	E	E	E	E
codling moth virus (CYD-X) 3 g		0	NC	NC	NC	NC	NC	G	NC	NC	F
oil, superior-type 3 gal/100 gal		NC	E	E	P	NC	NC	P	P	P	P

* Denotes pest populations that have developed resistance to certain pesticides in some areas, and in which case products may not perform as rated.

[1] Use prebloom only.

Table 6-3B. Relative Effectiveness of Various Insecticides for Apple Insect and Mite Control (continued)

Insecticide, Brand Name, and Amount per Acre	IRAC MOA Group	Days Between Last Spray and Harvest	Insects and Mites								
			Spotted Tentiform Leafminer	Tarnished Plant Bug	Stink Bugs	Apple Maggot	Plum Curculio	Japanese Beetle	Woolly Apple Aphid	Safety of Beneficials[2]	
										Coccinellids (lady beetles)	*Predatory mites*
carbaryl (Sevin XLR) 4 pt	1A	1	P	G	P	G	G	E	NC	P	P
oxamyl (Vydate 2E) 2 qt	1A	14	G	G	P	NC	P	P	NC	G	G
methomyl (Lannate LV) 1 at	1A	14	G	E	G	NC	P	P	NC	P	P
diazinon (Diazinon 50WP) 4 lb	1B	21	P	G	NC	G	G	G	E	P	G
phosmet (Imidan 70W) 3 lb	1B	7	P	G	P	E	G	E	NC	P	G
bifenthrin (Brigade 2EC, Fanfare 2EC) 5.1 oz	3a	14	G	E	E	E	G	G	NC	P	P
cyfluthrin (Tombstone 2EC) 2.4 oz	3A	7	G	E	E	E	G	G	NC	P	P
esfenvalerate (Asana XL) 8 oz	3A	21	G	G	F	G	F	G	NC	P	P
fenpropathrin (Danitol 2.4 EC) 16 oz	3A	14	G	E	E	G	G	G	NC	P	P
gamma-cyhalothrin (Proaxis 0.5EC) 3 oz	3A	14	G	E	E	E	G	G	NC	P	P
lambda-cyhalothrin (Warrior II) 2 oz	3A	21	G	E	E	E	G	G	NC	P	P
permethrin (Ambush 2EC) 8 oz	3A	>100	G	G	G	F	F	G	NC	P	P
zeta-cypermethrin (Mustang Maxx 0.8EC)	3A	14	G	E	E	E	G	G	NC	P	P
acetamiprid (Assail 30 SG) 5 oz	4A	7	G	F	F	G	F	E	P	P	G
clothianidin (Belay 2.13SC) 6 oz	4A	7	G	G	E	G	G	G	P	P	F
imidacloprid (Admire Pro) 2.8 oz	4A	7	G	F	F	G	F	G	P	P	G
thiamethoxam (Actara 25 WP) 4.5 oz	4A	35	G	E	E	F	E	G	P	P	F
sulfoxaflor (Closer 2 SC)	4C	7	G	E	F	NC	F	NC	P	F	G
flupyradifurone (Sivanto 200SL) 10.5 oz	4D	14	G	F	P	NC	NC	NC	NC	F	G
spinetoram (Delegate 25WDG) 5 oz	5	7	E	NC	NC	P	NC	NC	NC	F	G
abamectin (Agri-Mek 0.7SC) 3.0 oz	6	28	E	NC	NC	NC	NC	NC	NC	F	G
pyriproxyfen (Esteem 35 WP) 5 oz	7C	35	G	NC	NC	NC	NC	NC	NC	G	G
afidopyropen (Versys 0.83 DC)	9D	7	NC	NC	NC	NC	NC	NC	F	E	E
clofentezine (Apollo SC) 4 oz	10A	45	NC	NC	NC	NC	NC	NC	NC	E	G
hexythiazox (Savey 50DF) 4 oz[1]	10A	28	NC	NC	NC	NC	NC	NC	NC	E	G
etoxazole (Zeal 72 WDG) 3 oz	10B	28	NC	NC	NC	NC	NC	NC	NC	E	G
B. thuringiensis (various brands) 1 lb	11A	0	NC	NC	NC	NC	NC	NC	NC	E	E
hexakis (Vendex 50W) 4 lb	12B	14	NC	NC	NC	NC	NC	NC	NC	E	G
novaluron (Rimon 0.83 EC) 20 oz	15	14	NC	NC	NC	NC	NC	NC	NC	P	P
buprofezin (Centaur 70WDG) 34.5 oz	16	14	NC	F	NC	NC	NC	NC	NC	G	E
methoxyfenozide (Intrepid 2 F) 16 oz	18	14	E	NC	NC	NC	NC	NC	NC	E	E
acequinocyl (Kanemite 15 SC) 31 oz	20B	14	NC	NC	NC	NC	NC	NC	NC	E	G
bifenazate (Acramite 50WS) 1 lb	20D	7	NC	NC	NC	NC	NC	NC	NC	E	G
fenpyroximate (Portal 0.4 EC) 2 pt	21A	14	NC	NC	NC	NC	NC	NC	NC	E	G
pyridaben (Nexter 75 WP) 4.4 oz	21A	25	NC	NC	NC	NC	NC	NC	NC	E	G
indoxacarb (Avaunt 30WDG) 5 oz	22A	28	F	NC	NC	P	E	G	NC	F	E
spirotetramat (Movento 2CS) 7.5 oz	23	7	P	NC	NC	NC	NC	NC	NC	E	E
cyflumetofen (Nealta 1.67SC) 13.7 oz	25	7	NC	NC	NC	NC	NC	NC	NC	E	G
chlorantraniliprole (Altacor 35WDG) 3 oz	28	14	E	NC	NC	P	P	NC	NC	E	E
cyantraniliprole (Exirel 0.83SE) 12 oz	28	3	E	NC	NC	F	F	NC	NC	E	E
cyclaniliprole (Verdepryn 100SL) 8.2 oz	28	7	E	NC	NC	NC	G	NC	NC	E	E
codling moth virus (CYD-X) 3 g		0	NC	NC	NC	NC	NC	NC	NC	E	E
oil, superior-type 3 gal/100 gal		NC	NC	NC	NC	NC	NC	NC	NC	E	G

[1] Use prebloom only.

[2] Ratings for beneficial arthropods are based on toxicity to the organism; for instance, E implies excellent safety (low toxicity) to the beneficial and will result in conservation of natural enemies, while P implies high toxicity and elimination of natural enemies.

Blueberry Management Program

M. H. Favre and W. O. Cline, Entomology and Plant Pathology

The Insecticide Resistance Action Committee (IRAC) groups insecticides and the Fungicide Resistance Action Committee (FRAC) groups fungicides into mode of action (MOA) categories. These categories are listed following the pesticide and formulation names. To reduce the risk of resistance development, avoid successive applications of products with the same MOA. Organically acceptable insecticides (**OMRI** listed) are indicated in Precautions and Remarks.

Insecticides should only be applied if the pest of concern is present in economically damaging levels. If insect injury does not result in greater loss than the cost of treatment, treatment is not justified. Therefore, some degree of insect presence should be tolerated, and insecticides should **not** be applied on a scheduled basis as may be appropriate for fungicides. Note that insecticides listed are acceptable for use on fruit to be marketed in the United States. If fruit is to be exported, check with purchasers to ensure that the materials you intend to use are acceptable for use on fruit in their target markets.

Fungicides are mainly protectants and are usually applied prior to the appearance of disease symptoms, based on past history of the particular disease threat on a given cultivar, location and plant growth stage. Not all diseases are present on every farm. To avoid applying fungicides unnecessarily, learn to identify diseases by their symptoms, and keep records of those that occur on your farm.

Many pesticides have brand name and generic formulations. In general, information is provided for the most commonly used formulations of active ingredients available in multiple formulations. Carefully check the label of the product you plan to use in the event that it differs from those listed. The label is the law!

Table 6-4. Blueberry Management Program

Season and Pest	Product Name, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI) (hours)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Dormant					
Scale insects	Oil superior-type, IRAC Unknown	1 to 3% vol/vol	4	0	Oil may be applied dormant or delayed dormant. Apply as needed for scale infestations. Reduce to 1% rate just before bloom. Do not apply oil when temperatures are expected to be higher than 65ºF or lower than 30ºF within 24 hours. Do not use within 14 days of lime-sulfur or captan. Use 200 to 400 gallons water per acre. Some oils are **OMRI** listed; check labels.
Gall midge	**Blueberry gall midge** adults are tiny flies, and larvae are tiny white, carrot-shaped maggots that feed inside flower buds and leaf buds. Blueberry gall midge can be extremely injurious, especially to rabbiteye cultivars. Flies lay eggs in flower buds on warm winter days when bud scales initially begin to separate. **Gall midge sprays should be timed to protect the earliest flower buds which can realistically be expected to survive anticipated spring cold events.** Gall midge sprays also typically provide suppression of pre-bloom thrips population.				
	diazinon (IRAC 1) (Diazinon AG500)	1 pt per 100 gal water	5 days	7	Only one foliar application is allowed per year.
	spinosad (IRAC 5) (Entrust SC)	4 to 6 fl oz	4	1	Entrust is **OMRI** listed. Do not apply more than 29 fl oz Entrust SC (0.45 lb active ingredient) per acre per year, including all application methods (foliar, soil, and seed treatments).
	(Entrust)	1.25 to 2 oz	4	3	Do not apply more than 9 oz Entrust (0.45 lb active ingredient) per acre per year.
	spinetoram (IRAC 5) (Delegate WG)	3 to 6 oz	4	3	Do not apply more than 19.5 oz of Delegate WG (0.305 lb ai spinetoram) per acre per year.
Delayed Dormant					
Exobasidium leaf and fruit spot	calcium polysulfide (FRAC M2) (Lime-Sulfur solution)	5 to 6 gal per acre in 100 to 150 gal of total spray volume	48	—	Apply at delayed dormant 1 to 2 weeks before leaf and/or flower buds begin to break. Exobasidium is not specifically on some labels. However, when applied for Phomopsis, suppression of Exobasidium has been observed. **DANGER – calcium polysulfide products are caustic and can cause injury.** Calcium polysulfide products are also corrosive to metals and may permanently discolor or stain non-metal sprayer parts. Do not mix lime-sulfur solutions with acids or phosphate fertilizer products because deadly and potentially extremely flammable hydrogen sulfide gas may be emitted. Not labeled for home garden use.
	calcium polysulfide (FRAC M2) (Sulforix)	1 gal per acre in sufficient water for coverage	48	—-	Do not apply lime-sulfur or Sulforix within 14 days of an oil spray. Do not apply when air temperatures are above 85ºF. As a precaution, do not apply within 14 days of a Dormex spray. Not labeled for home garden use.
Pre-Bloom Sprays - Green-tip on vegetative and flower buds					
Twig blight Mummy berry	fenbuconazole (FRAC 3) (Indar 75 WP) (Indar 2F)	2 oz 6 fl oz	12 12	30 30	
	Prothioconazole (FRAC 3) Proline 480 SC	5.7 fl oz	12	7	Apply up to two (2) applications per year
	metconazole (FRAC 3) (Quash 50 WDG)	2.5 oz	12	7	May be applied by ground (min. 20 gpa) or air (min 10 gpa). Do not apply more than twice in a row, or more than 7.5 ounces per season, or more than 3 times per season.
	propiconazole (FRAC 3) (Tilt 3,6E, Bumper 41.8EC, Propimax EC)	6 fl oz	12	30	
	azoxystrobin + propiconazole (FRAC 3+11) (Quilt Xcel, Aframe Plus)	14 to 21 fl oz	12	30	Do not apply more than 82 fluid ounces per acre per season. May be applied by ground or air (minimum of 15 gpa).
	pyraclostrobin + boscalid (FRAC 11+7) (Pristine 38 W)	18.5 to 23 oz	12	0	Do not make more than 2 sequential applications with any combination of strobilurin fungicides (Abound or Pristine) before alternation with a fungicide that has a different mode of action (captan, Ziram, Switch). Do not make more than 4 applications of strobilurin fungicides per season. Do not tank mix Pristine with any other product except Pristine. May be tank mixed with products that contain only captan as the active ingredient.

Table 6-4. Blueberry Management Program

Season and Pest	Product Name, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI) (hours)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Pre-Bloom Sprays - Green-tip on vegetative and flower buds (continued)					
Exobasidium leaf and fruit spot	The fungus Exobasidium causes green-to-pink spots on fruit that do not ripen normally, and spots on leaves that are light green above and white below. Affected berries are unsightly and not marketable. Fungicides applied for other diseases may provide some control. The disease is most severe in shaded locations with dense foliage and poor ventilation. For images of this disease, see: blueberries.ces.ncsu.edu/2019/05/exobasidium-leaf-and-fruit-spot.				
Flower thrips	Thrips rarely require treatment in southern high bush blueberries in North Carolina but can reach damaging levels in rabbiteye blueberries and late-blooming northern highbush like Duke. Thrips present in densities greater than 2 per flower in open rabbiteye blooms may justify treatment. Begin sampling bloom clusters for thrips at Stage 3. Sample 2 to 3 times a week from Stage 3 up to bloom. A minimum of 10 flower clusters per acre should be observed and either placed in a closed plastic bag at room temperature, soaked in alcohol, or shaken onto a white sheet of paper.				
	acetamiprid (IRAC 4A) (Assail 30SG)	4.5 to 5.3 oz	12	1	Do not use more than 26.7 oz (0.5 lb active ingredient) per acre per year.
	spinosad (IRAC 5) (Entrust SC)	4 to 6 fl oz	4	1	Entrust is **OMRI** listed. Do not apply more than 29 fl oz Entrust SC (0.45 lb active ingredient) per acre per year. For thrips, if additional treatments are required after two consecutive applications of Group 5 insecticides, rotate to another class of effective insecticides for at least two applications.Do not apply more than 9 oz Entrust (0.45 lb active ingredient) per acre per year.
	(Entrust)	1.25 to 2 oz	4	3	
	spinetoram (IRAC 5) (Delegate)	3 to 6 oz	4	3	Do not apply more than 19.5 oz of Delegate WG (0.305 lb ai spinetoram) per acre per year.
Plum curculio	novaluron (IRAC 15) (Rimon) 0.83 EC	20 to 30 fl oz	12	8	Rimon may be effective against plum curculio as a pre-bloom treatment.
Bloom Treatments - 10% to 20% bloom					
Pesticides can harm pollinating insects, so if pesticide applications are necessary during bloom, they should be made in the evening when bees are not foraging and to allow for the longest amount of dry time possible. See Table 5-1A. Relative Toxicity of Pesticides to Honey Bees for more information on specific active ingredients effects on bees.					
Twig blight	Same as Pre-Bloom Sprays				
Mummy berry	Same as Pre-Bloom Sprays				If mummy berry disease pressure is high this year or in previous years, apply fungicides every 7 to 10 days from budbreak through bloom. Foliar sprays using a minimum of 25 to 50 gallons per acre are most effective.
Flower blight	Anticipate flower blight caused by the fungus *Botrytis cinerea* when excessive rain occurs during bloom or following a freeze event that injures blossoms.				
	captan (FRAC M4) (Captan 50 WP)	4 lb	48	0	Do not combine with EC or WP formulations unless previous experience has proven them to be compatible and safe to plants. Damage has been observed in blueberries when captan has been applied in tank mixes or immediately before or after EC or oil formulations.
	captan (FRAC M4) (Captec 4L)	2.5 qt	48	0	Do not combine with EC or WP formulations unless previous experience has proven them to be compatible and safe to plants. Damage has been observed in blueberries when captan has been applied in tank mixes or immediately before or after EC or oil formulations.
	cyprodinil + fludioxonil (FRAC 9+12) (Switch 62.5 WG)	11 to 14 oz	12	0	Switch may not be applied by air.
	fenhexamid (FRAC 17) (Elevate 50 WDG)	1.5 lb	12	0	Elevate may not be applied by air.
Bloom Treatments - Full bloom					
Mummy berry	Same as Pre-Bloom Sprays				Note that Indar should not be used alone at full bloom or between bloom and harvest. Tank mix with Captan, Captec, or Ziram.
Fruit rots	captan (FRAC M4) (Captan 50 WP)	4 lb	48	0	Do not combine with EC or WP formulations unless previous experience has proven them to be compatible and safe to plants. Damage has been observed in blueberries when captan has been applied in tank mixes or immediately before or after EC or oil formulations.
	captan (FRAC M4) (Captec 4L)	2 qt	48	0	Do not combine with EC or WP formulations unless previous experience has proven them to be compatible and safe to plants. Damage has been observed in blueberries when captan has been applied in tank mixes or immediately before or after EC or oil formulations.
	ziram (FRAC M3) (Ziram 76 DF)	3 lb	48	approx. 30	Ziram cannot be applied later than 3 weeks after full bloom.
	metconazole (FRAC 3) (Quash 50 WDG)	2.5 oz	12	7	May be applied by ground (min. 20 gpa) or air (min. 10 gpa). Do not apply more than twice in a row, or more than 7.5 ounces per season, or more than 3 times per season.
	azoxystrobin (FRAC 11) (Abound 2.08 E)	6 to 15.5 fl oz	4	0	Do not make more than 2 sequential applications of any combination of strobilurin fungicides (Abound or Pristine) before alternating with a fungicide that has a different mode of action (captan, Ziram, Switch). Do not make more than 4 applications per season.
	cyprodinil + fludioxonil (FRAC 9+12) (Switch 62.5 WG)	14 oz	12	0	
	pyraclostrobin + boscalid (FRAC 11+7) (Pristine38 W)	18.5 to 23 oz	12	0	Do not tank mix Pristine with any other product (fungicide, insecticide, adjuvant, fertilizer) except Pristine may be tank mixed with products containing captan as the sole active ingredient.
	azoxystrobin + propiconazole (FRAC 3+11) (Quilt Xcel, Aframe Plus)	14 to 21 fl oz	12	30	Do not apply more than 82 fluid ounces per acre per season. May be applied by ground or air (minimum of 15 gpa).
	pydiflumetofen + fludioxonil (FRAC 7+12) (Miravis Prime)	9.0 to 13.4 fl oz (See label)	12	0	Do not make more than 2 sequential applications of any combination of before alternating with a fungicide that has a different mode of action. Do not make more than 2 applications by air per year.
Flower blight	Same as Bloom Treatments (10% to 20% bloom)				

Table 6-4. Blueberry Management Program

Season and Pest	Product Name, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI) (hours)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Petal Fall Treatments - Immediately after Bloom and 7 to 10 days after					
Fruit rots	Same as Bloom Treatments				Fruit rot treatments should be applied 7 to 10 days apart.
Flower thrips	Same as Pre-Bloom Treatments				
Cranberry fruitworm Cherry fruitworm	Fruitworm adults can be monitored with pheromone traps, and fruit should be observed for egg laying or evidence of tunneling. Treatments for fruitworms are most effective when timed to egg hatch, as larvae feed inside fruit. With the exception of Altacor, Asana, Avaunt, and bifenthrin, the materials listed below are not expected to have activity against plum curculio. Treatments for fruitworms should be made at petal fall and again 7 to 10 days after petal fall.				
	carbaryl (IRAC 1A) (Sevin) XLR Plus	1.5 to 2 qt	12	7	There are many carbaryl formulations.
	esfenvalerate (IRAC 3A) (Asana XL) 0.66 EC	4.8 to 9.6 oz	12	14	Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	acetamiprid (IRAC 4A) (Assail) 30 SG	4.5 to 5.3 oz	12	1	Allow 7 days between Assail treatments.
	spinosad (IRAC 5) (Entrust SC) (Entrust)	4 to 6 fl oz 1.25 to 2 oz	4 4	1 3	Entrust is OMRI listed. Do not apply more than 29 fl oz Entrust SC (0.45 lb active ingredient) per acre per year, including all application methods (soil, foliar, and seed treatments). Do not apply more than 9 oz Entrust (0.45 lb active ingredient) per acre per year.
	spinetoram (IRAC 5) (Delegate) WG	3 to 6 oz	4	3	Do not apply more than 19.5 oz of Delegate WG (0.305 lb active ingredient spinetoram) per acre per year.
	pyriproxyfen (IRAC 7) (Knack)	16 fl oz	12	7	Knack is an insect growth regulator and application must be timed carefully to egg hatch. Apply when egg laying begins and again at petal fall. Do not apply more than 32 fl oz of Knack (0.215 lb pyriproxyfen) per acre per calendar year.
	novaluron (IRAC 15) (Rimon) 0.83 EC	20 to 30 fl oz	12	8	Rimon is not labeled for cherry fruitworm.
	methoxyfenozide (IRAC 18) (Intrepid) 2F	10 to 16 fl oz	4	7	
	indoxacarb (IRAC 22) (Avaunt)	3.5 to 6.0 oz	12	7	
	chlorantraniliprole (IRAC 28) (Altacor)	3.0 to 4.5 oz	4	1	Altacor also has activity against plum curculio in blueberries. Do not apply Group 28 insecticides more than 3 times within a single generation of an insect pest on a crop.
	cyclaniliprole (IRAC 28) (Verdepryn 100SL)	8.2 to 11 fl oz	4	1	Limited efficacy data. Do not apply Group 28 insecticides more than 3 times within a single generation of an insect pest on a crop.
Plum curculio	Plum curculio is historically an infrequent pest of North Carolina blueberries but has become more common in recent years. The materials below are effective against both plum curculio and fruitworms. Treatments for plum curculio should be made at petal fall and again 7 to 10 days after petal fall.				
	phosmet (IRAC 1B) (Imidan)	1.33 lb	24	3	Imidan is the most effective material against plum curculio currently labeled. No more than 5 applications of Imidan can be made per year.
	bifenthrin (IRAC 3A) (Brigade WSB)	5.3 to 16 oz	12	1	Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export. There are also EC formulations of bifenthrin labeled in blueberries, but non-EC formulations may be preferred to reduce phytotoxicity risk.
	esfenvalerate (IRAC 3A) (Asana XL 0.66EC)	14.5 fl oz	12	14	Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	fenpropathrin (IRAC 3A) (Danitol 2.4 EC)	10.66 to 16 fl oz	24	3	No more than 2 applications of Danitol can be made per season.
	zeta cypermethrin + bifenthrin (IRAC 3A) (Hero)	4 to 10.3 fl oz	12	1	Hero is a premixed material and contains more than 1 active ingredient. Check labels carefully for the maximum amount of active ingredient than can be applied per acre per season. Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	novaluron (IRAC 15) (Rimon) 0.83 EC	20 to 30 fl oz	12	8	Rimon may be effective against plum curculio when applied pre bloom. Data on Rimon as a post bloom treatment for plum curculio are limited.
	indoxacarb (IRAC 22) (Avaunt)	6 oz	12	7	Do not make more than 4 applications of Avaunt per season. Do not use adjuvants with Avaunt. There are established residue levels for indoxacarb for export to the European Union but not for export to Canada.
	chlorantraniliprole (IRAC 28) (Altacor)	4.5 oz	4	1	
	kaolin (IRAC unknown) (Surround) WP	25 to 50 lb	4	0	Surround acts like a barrier and masks fruit from pest recognition and therefore requires good coverage for best efficacy. Surround may need to be reapplied in the case of rain. Because Surround coats fruit, it should not be used after fruit is fully sized or close to harvest. Surround is **OMRI** listed.
Leaf spots	fenbuconazole (FRAC 3) (Indar 75 WP) (Indar 2F)	2 oz 6 fl oz	12	30	Indar should not be used alone at full bloom or alone between bloom and harvest. Tank mix with captan, Captec, or Ziram. Indar is usually limited to 5 applications per acre per year.
	metconazole (FRAC 3) (Quash 50 WDG)	2.5 oz	12	7	May be applied by ground (minimum of 20 gpa) or air (minimum of 10 gpa). Do not apply more than twice in a row, or more than 7.5 ounces per season, or more than 3 times per season.
	propiconazole (FRAC 3) (Tilt 3.6E, Banner 41.8 EC, Propimax EC)	6 fl oz	12	30	
	azoxystrobin + propiconazole (FRAC 3+11) (Quilt Xcel, Aframe Plus)	14 to 21 fl oz	12	30	Do not apply more than 82 fluid ounces per acre per season. May be applied by ground or air (minimum of 15 gpa).
	pyraclostrobin + boscalid (FRAC 11+7) (Pristine 38 W)	18.5 to 23 oz	12	0	Do not make more than 2 sequential applications with any combination of strobilurin fungicides (Abound or Pristine) before alternation with a fungicide that has a different mode of action (captan, Ziram, Switch). Do not make more than 4 applications of strobilurin fungicides per season. Do not tank mix Pristine with any other product (fungicide, insecticide, adjuvant, fertilizer) except Pristine can be mixed with captan.

Table 6-4. Blueberry Management Program

Season and Pest	Product Name, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI) (hours)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Fruit Ripening through Harvest					
Spotted wing drosophila	Spotted-wing drosophila (SWD) females lay eggs in ripening and ripe soft skinned fruits, and larvae develop internally. Materials listed are likely to be effective against SWD based on current data. SWD treatments should begin when flies are present, and fruit start to ripen and continue weekly through the end of harvest. Rotate IRAC groups between successive sprays. Some management tools used for blueberry maggot are effective against SWD, and management of blueberry maggot and SWD should be integrated as much as feasible.				
	methomyl (IRAC 1A) (Lannate) LV	24 to 48 fl oz	48	3	No more than 4 applications of Lannate can be made per year.
	malathion, (IRAC 1B) (Malathion 8F)	2.5 pt	12	1	There are several malathion formulations. No more than 2 applications of Malathion 8F can be made per year. No more than 5 pounds of malathion active ingredient from any source can be applied per acre per year. Use caution if this is the material of choice for multiple insect pests.
	malathion, (IRAC 1B) (Fyfanon ULV AG)	10 fl oz	12	1	Apply by air only. No more than 3 applications of Fyfanon ULV AG can be made per year. No more than 5 pounds of malathion active ingredient from any source can be applied per acre per year. Use caution if this is the material of choice for multiple insect pests.
	phosmet (IRAC 1B) (Imidan)	1.33 lb	24	3	No more than 5 applications of Imidan can be made per year.
	bifenthrin (IRAC 3A) (Brigade WSB)	5.3 to 16.0 oz	12	1	No more than 5 applications of Brigade can be made per season. Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	fenpropathrin (IRAC 3A) (Danitol 2.4 EC)	10.66 to 16 fl oz	24	3	No more than 2 applications of Danitol can be made per season.
	zeta cypermethrin (IRAC 3A) (Mustang Maxx)	4 fl oz	12	1	No more than 6 applications of Mustang Maxx can be made per year. Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	zeta cypermethrin + bifenthrin (IRAC 3A) (Hero)	4 to 10.3 fl oz	12	1	No more than 46.35 fluid ounces of product can be applied per acre per year. Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	pyrethrins (IRAC 3A) (Pyganic 1.4 EC)	16 to 64 fl oz	12	0	Pyganic is **OMRI** listed but has limited residual activity and should not be used as the only SWD material.
	spinosad (IRAC 5) (Entrust SC)	4 to 6 fl oz	4	1	Entrust is **OMRI** listed. Do not apply more than 29 fl oz Entrust SC (0.45 lb active ingredient) per acre per year, including all application methods (soil, foliar, and seed treatments).
	(Entrust)	1.25 to 2 oz	4	3	Do not apply more than 9 oz Entrust (0.45 lb active ingredient) per acre per year.
	spinetoram (IRAC 5) (Delegate)	3 to 6 oz	4	3	No more than 19.5 ounces of Delegate can be applied per acre per year.
	tolfenpyrad (IRAC 21A) (Apta)	27 fl oz	12	3	Limited efficacy data. Do not make more than 3 applications per year.
	cyantraniliprole (IRAC 28) (Exirel)	13.5 to 20.5 fl oz	12	3	Minimum number of days between treatments is five. Do not apply a total of more than 0.4 lb ai/A of CYAZYPYR® or cyantraniliprole containing products per year.
	cyclaniliprole (IRAC 28) (Verdepryn 100SL)	11 fl oz	4	1	Limited efficacy data. Do not apply Group 28 insecticides more than 3 times within a single generation of an insect pest on a crop.
Blueberry maggot	Blueberry maggot fly activity typically begins in late May. Adults should be monitored with yellow sticky traps baited with ammonia food lures (ammonium acetate, ammonium carbonate, or ammonium bicarbonate). Check traps and change lures at least once per week. Treatments for blueberry maggot are not necessary unless adults have been observed in traps. Materials effective for SWD are also effective against blueberry maggot; additional treatments are not needed for blueberry maggot.				
	malathion, (IRAC 1B) (Malathion) 8F	2.5 pt	12	1	There are several malathion formulations. No more than 2 applications of Malathion 8F can be made per year. No more than 5 pounds of malathion active ingredient from any source can be applied per acre per year. Use caution if this is the material of choice for multiple insect pests.
	(Fyfanon ULV AG)	10 fl oz	12	1	Apply by air only. No more than 3 applications of Fyfanon ULV AG can be made per year. No more than 5 pounds of malathion active ingredient from any source can be applied per acre per year. Use caution if this is the material of choice for multiple insect pests.
	phosmet (IRAC 1B) (Imidan)	1.33 lb	24	3	No more than 5 applications of Imidan can be made per year.
	esfenvalerate (IRAC 3A) (Asana XL) 0.66 EC	9.6 oz	12	14	Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	fenpropathrin (IRAC 3A) (Danitol 2.4 EC)	10.66 to 16 fl oz	24	3	No more than 2 applications of Danitol can be made per season.
	zeta cypermethrin (IRAC 3A) (Mustang Maxx)	4 fl oz	12	1	No more than 6 applications of Mustang Maxx can be made per year. Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	zeta cypermethrin + bifenthrin (IRAC 3A) (Hero)	4 to 10.3 fl oz	12	1	No more than 46.35 fluid ounces of product can be applied per acre per year. Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	acetamiprid (IRAC 4A) (Assail 30SG)	4.5 to 5.3 oz	12	1	Assail is effective against blueberry maggot but should not be used alone for SWD management.
	imidacloprid (IRAC 4A) (Admire Pro)	2.1 to 2.8 fl oz (foliar)	12	3	Many formulations of imidacloprid are available. Admire Pro can be applied as either a soil or foliar treatment. Soil treatments are not recommended for blueberry maggot. Imidacloprid is not effective against SWD.
	flupyradifurone (IRAC 4D) (Sivanto Prime)	12 to 14 fl oz	4	3	Limited efficacy data. Sivanto Prime is labeled for blueberry maggot, but it should not be used alone for spotted-wing drosophila (SWD).
	spinosad (IRAC 5) (Entrust SC)	4 to 6 fl oz	4	1	Entrust is **OMRI** listed. Do not apply more than 29 fl oz Entrust SC (0.45 lb active ingredient) per acre per year, including all application methods (soil, foliar, and seed treatments).

Table 6-4. Blueberry Management Program

Season and Pest	Product Name, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI) (hours)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Fruit Ripening through Harvest (continued)					
Blueberry maggot (continued)	(Entrust)	1.25 to 2 oz	4	3	Do not apply more than 9 oz Entrust (0.45 lb active ingredient) per acre per year.
	spinetoram (IRAC 5) (Delegate)	3 to 6 oz	4	3	No more than 19.5 ounces of Delegate can be applied per acre per year.
	spirotetramat (IRAC 23) (Movento)	10 fl oz	24	7	Limited efficacy data. Movento is labeled for blueberry maggot, but it should not be used alone for spotted-wing drosophila (SWD).
	cyantraniliprole (IRAC 28) (Exirel)	13.5 to 20.5 fl oz	12	3	Minimum number of days between treatments is five. Do not apply a total of more than 0.4 pound ai/A of CYAZYPYR® or cyantraniliprole containing products per year.
	cyclaniliprole (IRAC 28) (Verdepryn 100SL)	11 fl oz	4	1	Limited efficacy data. Do not apply Group 28 insecticides more than 3 times within a single generation of an insect pest on a crop.
Post Harvest					
Leaf Spots	Same as Petal Fall Treatments.				Leaf spot treatments should be applied every 2 weeks post harvest. Later leaf spot treatments may by be omitted if leaf spot incidence is low.
Blueberry bud mite	Only treat for blueberry bud mite if damage was a problem in the previous year. Many varieties are resistant to blueberry bud mite and do not typically require treatment.				
	Post-harvest hedging, cultural control	NA	NA	NA	Summer topping or hedging immediately after harvest controls bud mite by removing old, infested fruiting twigs and is the control method of choice for early ripening cultivars.
	Variety selection	NA	NA	NA	Most highly susceptible blueberry varieties are no longer grown. Bud mite can occur on O'Neal and Legacy. Bud mite is generally only a problem on high bush, not rabbiteye varieties.
	oil superior-type, IRAC unknown (many formulations)	2 gal	4	0	Bud mite treatments should be applied after harvest and again 4 weeks later. Recent efficacy data are not available.
Sharpnosed leafhoppers	Sharpnosed leafhopper vectors blueberry stunt disease. To reduce disease transmitting populations of sharpnosed leafhopper, treatments should be timed to their flight activity. Sharpnosed leafhoppers can be monitored with yellow sticky traps. If present, blueberry stunt infected plants should be removed from fields.				
	acetamiprid (IRAC 4A) (Assail)	2.5 to 5.3 oz	12	1	Allow 7 days between Assail treatments.
	esfenvalerate (IRAC 3A) (Asana XL) 0.66 EC	4.8 to 9.6 oz	12	14	Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	imidacloprid (IRAC 4A) (Admire Pro)	1 to 1.4 fl oz (foliar)	12	3	Several formulations of imidacloprid are available. Admire Pro can be applied as either a soil or foliar treatment. Soil treatments are not recommended for sharpnosed leafhopper.
	thiamethoxam (IRAC 4A) (Actara)	3 to 4 oz	12	3	Allow 7 days between Actara treatments. Maximum 12 ounces per acre per season.
Scale insects	Scale insects are uncommon pests in NC blueberries but may be flared by SWD or blueberry maggot treatments. Only treat for scale insects if they are present.				
	flupyradifurone (IRAC 4D) (Sivanto Prime)	12 to 14 fl oz	4	3	Limited efficacy data. Sivanto Prime is labeled for blueberry maggot, but it should not be used alone for spotted-wing drosophila (SWD).
	spirotetramat (IRAC 23) (Movento)	10 fl oz	24	7	Limited efficacy data. Movento is labeled for blueberry maggot, but it should not be used alone for spotted-wing drosophila (SWD).
Japanese beetles	Japanese beetle feeding seldom requires treatment in North Carolina blueberries, and some pesticides applied for leafhoppers and other pests will also control Japanese beetles. Do not make additional pesticide treatments for Japanese beetle unless severe defoliation occurs.				
	acetamiprid (IRAC 4A) (Assail)	4.5 to 5.3 oz	12	1	Allow 7 days between Assail treatments.
	carbaryl (IRAC 1A) (Sevin) XLR	1.5 to 2 qt	12	7	There are many carbaryl formulations.
	phosmet (IRAC 1B) (Imidan)	1.33 lb	24	3	No more than 5 applications of Imidan can be made per year.
	esfenvalerate (IRAC 3A) (Asana XL) 0.66 EC	4.8 to 9.6 oz	12	14	Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	imidacloprid (IRAC 4A) (Admire Pro)	2.1 to 2.8 fl oz (foliar)	12	3	Several formulations of imidacloprid are available. Admire Pro can be applied as either a soil or foliar treatment. Soil treatments are not recommended for Japanese beetle.
Red humped and yellow necked caterpillars	Several species of caterpillars can feed on blueberries from late summer to early fall. These caterpillars can potentially defoliate bushes but are often not widespread throughout the planting.				
	Hand removal	NA	NA	NA	Hand removal is often sufficient to control populations because they are typically clustered on single or a few bushes.
	esfenvalerate (IRAC 3A) (Asana 0.66EC)	4.8 to 9.6 fl oz	12	14	Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	Bacillus thuringiensis sub. *kurstaki* (Bt) (IRAC 11A) Dipel DF	0.5 to 2.0 lb	4	0	There are many Bt formulations. Dipel DF is **OMRI** listed.
	chlorantraniliprole (IRAC 28) (Altacor)	3.0 to 4.5 oz	4	1	
Red imported fire ants	Fire ant baits should be applied when ants are actively foraging and take a few to several weeks to be fully effective. Fire ants can also be treated earlier in the season if present.				
	spinosad (IRAC 5) (Entrust SC)	0.5 fl oz /10 gal	4	1	Mound treatments provide local, short-term suppression of fire ants. Entrust is **OMRI** listed and may be used as a mound treatment for fire ants. Apply as a drench, using 1 gallon for mounds less than 8 inches in diameter, and up to 2 gallons for mounds larger than 8 inches in diameter. Do not apply more than 29 fl oz Entrust SC (0.45 lb active ingredient) per acre per year.
	(Entrust)	0.159 oz/10 gal	4	3	Do not apply more than 9 oz Entrust (0.45 lb active ingredient) per acre per year.
	pyriproxyfen (IRAC 7C) (Esteem Ant Bait 0.5% B)	1.5 to 2 lb	12	1	Baits provide the most long-term suppression of fire ants. Do not water for 24 hours after application. Do not use more than 0.218 lb pyriproxyfen active ingredient per acre per season.
	methoprene (IRAC 7C) (Extinguish Ant Bait 0.5% B)	1 to 1.5 lb	4	0	Baits provide the most long-term suppression of fire ants. Extinguish can be applied as a mound treatment or broadcast. Extinguish is labeled for use on cropland but Extinguish Plus is **NOT** labeled for use on cropland. Read labels carefully.

Table 6-4. Blueberry Management Program

Season and Pest	Product Name, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI) (hours)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Post Harvest (continued)					
Blueberry flea beetle	Blueberry flea beetles are an occasional pest in North Carolina blueberries and are active primarily post harvest. Damage is typically not economically significant, but when new shoots are eaten in the fall, yield for the following year will be impacted.				
	carbaryl (IRAC 1A) (Sevin) XLR	1.5 to 2 qt	12	7	There are many carbaryl formulations.
	phosmet (IRAC 1B) (Imidan)	1.33 lb	24	3	No more than 5 applications of Imidan can be made per year.
	acetamiprid (IRAC 4A) (Assail 30 SG)	4.5 to 5.3 oz	12	1	Allow 7 days between Assail treatments.
	esfenvalerate (IRAC 3A) (Asana XL) 0.66 EC	4.8 to 9.6 oz	12	14	Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	zeta cypermethrin (IRAC 3A) (Mustang Maxx)	4 fl oz	12	1	No more than 6 applications of Mustang Maxx can be made per year. Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	zeta cypermethrin + bifenthrin (IRAC 3A) (Hero)	4 to 10.3 fl oz	12	1	No more than 46.35 fluid ounces of product can be applied per acre per year. Note that there are residue concerns for some IRAC Group 3A materials on fruit intended for export.
	imidacloprid (IRAC 4A) (Admire Pro)	2.1 to 2.8 fl oz (foliar)	12	3	Admire Pro can be applied as either a soil or foliar treatment. Soil treatments are not recommended for blueberry flea beetles.
	thiamethoxam (IRAC 4A) (Actara)	3 to 4 oz	12	3	Allow 7 days between Actara treatments. Maximum 12 oz per acre per season.
	spinosad (IRAC 5) (Entrust SC)	4 to 6 fl oz	4	1	Entrust is **OMRI** listed. Do not apply more than 29 fl oz Entrust SC (0.45 lb active ingredient) per acre per year for all application methods (soil, foliar, and seed treatments).
	spinetoram (IRAC 5) (Delegate)	3 to 6 oz	4	3	No more than 19.5 ounces of Delegate can be applied per acre per year.

Further Information

Southeast Regional Blueberry Integrated Management Guide, www.smallfruits.org
NC State University Blueberry Portal, blueberries.ces.ncsu.edu

Caneberry Management Program

M. H. Favre, W. O. Cline, and S. M. Villani, Entomology and Plant Pathology

The Insecticide Resistance Action Committee (IRAC) and Fungicide Resistance Action Committee (FRAC) group insecticides into mode of action categories. These categories are listed following the pesticide and formulation names. To reduce the risk of resistance development, avoid successive applications of pesticides with the same IRAC or FRAC designation for the same pest. Organically acceptable insecticides (**OMRI** listed) are indicated in Comments and Precautions.

Insecticides should only be applied if the pest of concern is present in economically damaging levels. If insect injury does not result in greater loss than the cost of treatment, treatment is not justified. Therefore, a degree of insect presence should be tolerated, and insecticides should not necessarily be applied on a scheduled basis as may be appropriate for fungicides.

Pesticides should not be applied when bees are actively foraging. If necessary, apply insecticides and fungicides in the evening when bees are not active. Pay attention to pesticide label information regarding pollinator protection.

Many insecticide active ingredients are available in generic formulations. Generic products generally work similarly to their brand name counterparts, but formulation changes can impact efficacy and plant response. In general, information is provided for the most commonly used formulations of active ingredients available in multiple formulations. Carefully check the label of the product you plan to use in the event that it differs from those listed. The label is the law! Chemical names are subject to change; please check the active ingredient for all materials.

Table 6-5. Caneberry Management Program

SEASON	Pest	Product Name, Mode of Action Code, and Formulation	Rate of Formulation per Acre	Restricted Entry Interval (hours)	Preharvest Interval (PHI) (days)	Comments and Precautions
Late Winter or Early Spring When new growth is less than 0.5 inch long	Anthracnose, Spur blight, Cane blight	liquid lime-sulfur, FRAC M2 (Sulforix)	3 gal/100 gal	See label	See label	This is an important spray for anthracnose control. Make sure canes are thoroughly covered. Use a dilute spray solution.
		Copper-based products FRAC M1	See label	See label	See label	Many copper-based fungicides are available. May be used as a component in Bordeaux mixture.
	Raspberry crown borer	Removing infested plants is an important cultural control. In blocks with a history of raspberry crown borer, apply an insecticide **either in late October to early November or early April (1 application only)** to provide a barrier for larvae boring into canes as they emerge from overwintering hibernacula. Follow label instructions for water volume and application methods. Entomopathogenic nematodes have also shown some promise in treating raspberry crown borer, but these are best applied in the late fall (see later entry for guidance.)				
		bifenthrin, IRAC 3A (Brigade WSB)	16 oz	12	3	Do not exceed 0.2 lb bifenthrin (32 oz Brigade WSB) per acre per season. There are several other formulations of bifenthrin.
		esfenvalerate, IRAC 3A (Asana XL)	9.6 fl oz	12	7	
		chlorantraniliprole, IRAC 28 (Altacor)	3 to 4.5 oz	4	3	Do not apply more than 9 oz Altacor or 0.2 lbs of chlorantraniliprole containing products per acre per year.
		cyclaniliprole, IRAC 28 (Verdepryn 100SL)	8.2 to 11 fl oz	4	1	Apply as directed drench to base of plants.
Just Before Blooms Open	Anthracnose, Cane blight, Cane canker, Leaf spots, Spur blight	boscalid + pyraclostrobin, FRAC 7 + 11 (Pristine 38 WDG)	18.5 to 23 oz	12	0	Do not make more than 4 applications collectively of the strobilurin (FRAC 11) fungicides (Abound, Quilt Xcel, Cabrio, Heritage, and Pristine) per season.
		captan, FRAC M4 (Captan 50W) (Captan 80WDG) (Captec 4L)	4 lb 2.5 lb 2 qt	see label	3	Do not apply more than 20 pounds of Captan 50W or 12.5 pounds Captan 80WDG per acre per season. Different formulations of captan have different re-entry intervals. Check label.
		liquid lime sulfur (Sulforix)	2 qt/100 gal	2 qt/100 gal	see label	This should be a follow-up application to the later winter/early spring lime sulfur application. Apply prior to bloom. See label regarding phytotoxicity warnings.
		pyraclostrobin, FRAC 11 (Cabrio 20EG)	14 oz	12	0	For resistance management, do not make more than **4** applications collectively of the strobilurin fungicides (FRAC 11) (Abound, Quilt Xcel, Cabrio, and Pristine) per season. Strobilurin (FRAC 11) fungicides will also control rusts.
		azoxystrobin, FRAC 11 (Abound 2SC)	6 to 15.5 fl oz	4	0	
		azoxystrobin + propiconazole, FRAC 11 + 3 (Quilt Xcel)	14 to 21 fl oz	12	30	
		myclobutanil, FRAC 3 (Rally 40WSP; Sonoma 40WSP)	1.25 to 3 oz	24	1	
		propiconazole, FRAC 3 (PropiMax EC)	6 fl oz	12	30	
	Powdery mildew (powdery mildew should be more of a concern on raspberries than on blackberries)	azoxystrobin, FRAC 11 (Abound 2SC)	6 to 15.5 fl oz	4	0	For resistance management, do not make more than **4** applications collectively of the strobilurin fungicides (FRAC 11) (Abound, Quilt Xcel, Cabrio, and Pristine) per season. Strobilurin (FRAC 11) fungicides will also control rusts.
		pyraclostrobin, FRAC 11 (Cabrio 20EG)	14 oz	12	0	
		azoxystrobin + propiconazole, FRAC 11 + 3 (Quilt Xcel)	14 to 21 fl oz	12	30	
		myclobutanil, FRAC 3 (Rally 40WSP; Sonoma 40WSP)	1.25 to 3 oz	24	1	
		propiconazole, FRAC 3 (PropiMax EC)	6 fl oz	12	30	
		parraffinic oil (Organic JMS Stylet Oil)	3 to 6 qt/100 gal	4	see label	**OMRI listed.** There is also a non-organic formulated JMS Stylet Oil product. **DO NOT apply oil with captan. See label for other phytotoxicity warnings**
		potassium bicarbonate (Milstop)	2 to 5 lb	1	0	**OMRI listed.**
		potassium salts of fatty acids (M-Pede)	1 to 2% v/v solution	12	0	**OMRI listed.** **DO NOT apply with sulfur or within 3 days of a sulfur application.**
		sulfur (Kumulus DF)	6 to 15 oz	24	0	**OMRI listed for some manufacturers.** **DO NOT apply within 2 weeks of an oil treatment.**
	Strawberry bud weevil (Strawberry clipper)	Strawberry clipper females lay their eggs in flower buds and clip the pedicle, causing the bud to wilt and drop off the plant. However, many blackberry and raspberry varieties can compensate for bud injury, and strawberry clipper rarely requires treatment. **Insecticides effective against strawberry clipper are toxic to bees. Do not apply insecticides when bees are foraging.**				
		carbaryl, IRAC 1A (Sevin XLR Plus)	1 to 2 qt	12	7	

Table 6-5. Caneberry Management Program

SEASON	Pest	Product Name, Mode of Action Code, and Formulation	Rate of Formulation per Acre	Restricted Entry Interval (hours)	Preharvest Interval (PHI) (days)	Comments and Precautions
Just Before Blooms Open (continued)		bifenthrin, IRAC 3A (Brigade WSB)	8 to 16 oz	12	3	Do not exceed 0.2 lb bifenthrin (32 oz Brigade WSB) per acre per season.
		fenpropathrin, IRAC 3A (Danitol 2.4EC)	10.66 to 16 fl oz	24	3	Do not exceed 32 fl oz Danitol per acre per season.
		acetamiprid, IRAC 4A (Assail 30SG)	4.5 to 5.3 oz	12	1	
		spinosad, IRAC 5 (Entrust SC)	4 to 6 fl oz	4	1	Entrust is **OMRI** listed. Do not apply more than 29 fl oz Entrust SC (0.45 lb active ingredient) per acre per year.
		(Entrust)	1.25 to 2 oz	4	1	Do not apply more than 9 oz Entrust (0.45 lb active ingredient) per acre per year.
	Gall midge	Gall midge larvae can feed on developing buds, and damage can appear similar to cold injury. Fields with a history of gall midge damage may require treatment, but this is rare. Confirm gall midge presence before considering a treatment targeting this pest alone.				
		bifenthrin, IRAC 3A (Brigade 2EC)	3.2 to 6.4 fl oz	12	3	Do not exceed 12.8 fl oz Brigade per acre per season.
		fenpropathrin, IRAC 3A (Danitol 2.4EC)	10.66 to 16 fl oz	24	3	Do not exceed 32 fl oz Danitol per acre per season.
	Fire ants	Fire ants can be nuisance pests in caneberry plantings. **Optimal fire ant control programs for fruit make use of spring and fall broadcast bait applications.** Twice-a-year bait applications may be best in year one of a program to thoroughly suppress the ant population. In subsequent years, a single bait application 8 to 10 weeks before harvest may provide adequate ant control. Ant baits work best when soil is moist, but not wet. Active ant foraging is essential. Foraging activity can be gauged by placing a food item, such as a potato chip, near the mound for 30 minutes or disturbing the mound. If ants are feeding on the chip within 30 minutes, conditions are right to apply baits. Ideally, temperatures should be warm and sunny. Avoid application of ant baits when conditions are expected to be cold, overcast, rainy or very hot. **Treatment of individual mounds is often a necessary complement to broadcast bait use if the goal is to obtain short-term elimination of fire ants.**				
		pyriproxyfen, IRAC 7D (Esteem Ant Bait)	1.5 to 2 lb	12	1	Esteem Fire Ant Bait will take several weeks to reach full efficacy.
		s-methoprene, IRAC 7A (Extinguish Professional Fire Ant Bait)	1 to 1.5 lb / acre	4	0	To treat smaller areas, apply 3 to 5 tbsp/1000 sq ft or 3 to 5 tbsp/mound. Extinguish Professional Fire Ant Bait (0.5% methoprene) is a slow-acting bait; it will take several weeks for Extinguish Professional Fire Ant Bait to reach full efficacy. Extinguish Professional Fire Ant Bait is legal for use on 'crop land.' Caution, Extinguish bait with methoprene plus hydramethylnon is not labeled for use on cropland.
Bloom and Petal Fall Pesticides may be hazardous to pollinators. When making any pesticide application during bloom, apply material in the evening when bees are not foraging to allow for as long a dry time as possible. See Table 5.1. Relative Toxicity of Pesticides to Bees for more information.	Double blossom	Sprays during bloom are most important for control of double blossom. Begin sprays when first infected blossoms open and continue every 10 to 14 days through bloom. Rotate strobilurin (FRAC 11) fungicides with Switch to avoid resistance. It is important to protect primocanes as long as infected flowers continue to open.				
		azoxystrobin, FRAC 11 (Abound 2SC)	6.2 to 15.4 fl oz	4	0	For resistance management, do not make more than **4** applications collectively of the strobilurin fungicides (FRAC 11) (Abound, Quilt Xcel, Cabrio, and Pristine) per season. Strobilurin (FRAC 11) fungicides will also control rusts.
		azoxystrobin + propiconazole, FRAC 11 + 3 (Quilt Xcel)	14 to 21 fl oz	12	30	
		boscalid + pyraclostrobin, FRAC 7 + 11 (Pristine 38WDG)	18.5 to 23 oz	12	0	

Table 6-5. Caneberry Management Program

SEASON	Pest	Product Name, Mode of Action Code, and Formulation	Rate of Formulation per Acre	Restricted Entry Interval (hours)	Preharvest Interval (PHI) (days)	Comments and Precautions
Bloom and Petal Fall (continued) Pesticides may be hazardous to pollinators. When making any pesticide application during bloom, apply material in the evening when bees are not foraging to allow for as long a dry time as possible. See Table 5.1. Relative Toxicity of Pesticides to Bees for more information.	Double blossom (continued)	cyprodinil + fludioxonil, FRAC 9 + 12 (Switch 62.5 WG)	11 to 14 oz	12	0	
		Bordeaux mixture FRAC M1		24	1	Crop injury may occur with Bordeaux mixture under slow drying conditions or in hot weather. Some injury often accompanies the use of copper fungicides; if injury is excessive, discontinue use.
	Botrytis fruit rot	Apply at early bloom and repeat at full bloom. Rotate products to reduce the likelihood of resistance.				
		captan, FRAC M4 (Captan 50W) (Captan 80 WDG) (Captec 4L)	4 lb 2.5 lb 2 qt	48	3	
		fenhexamid, FRAC 17 (Elevate 50 WDG)	1.5 lb	12	0	
		iprodione, FRAC 2 (Rovral 4L)	1 to 2 pt	24	0	
		isofetamid FRAC 7 (Kenja 400SC)	13.5 to 15.5 fl oz	12	7	Do not make more than 2 sequential applications of Kenja 400SC or another fungicide containing a FRAC 7 a.i. before switching to another mode of action. Do not apply a third application of Kenja 400SC within 28 days of the second application.
		cyprodinil + fludioxonil, FRAC 9 + 12 (Switch 62.5 WG)	11 to 14 oz	12	0	
		Bacillus amyloliquefaciens strain D747, FRAC 44 (Double Nickel LC)	0.5 to 6 qt	4	0	**OMRI listed.**
		Bacillus subtilis strain QST 713, FRAC 44 (Serenade Optimum)	14 to 20 oz	4	0	**OMRI listed.**
		copper octanoate, FRAC M1 (Cueva)	0.5 to 2 gal	4	0	**OMRI listed.**
		Streptomyces lydicus WYEC108, FRAC 48 (Actinovate AG)	3 to 12 oz	1	0	**OMRI listed.**
	Cane canker, Cane blight, Spur blight	captan, FRAC M4 (Captan 50W) (Captan 80 WDG) (Captec 4L)	4 lb 2.5 lb 2 qt	see label	3	Re-entry interval depends on product/formulation
		pyraclostrobin, FRAC 11 (Cabrio 20EG)	14 oz	12	0	For resistance management, do not make more than **4** applications collectively of the strobilurin fungicides (FRAC 11) (Abound, Quilt Xcel, Cabrio, and Pristine) per season. Strobilurin (FRAC 11) fungicides will also control rusts.
		boscalid + pyraclostrobin, FRAC 7 + 11 (Pristine 38WDG)	18.5 to 23 oz	12	0	
		azoxystrobin, FRAC 11 (Abound 2SC)	6.2 to 15.4 fl oz	4	0	
		azoxystrobin + propiconazole, FRAC 11 + 3 (Quilt Xcel)	14 to 21 fl oz	12	30	
	Powdery mildew	See **"Just Before Blooms Open"**				
	Rednecked cane borer	Scout canes during winter pruning. If 10% or greater of the primocanes per row, or more, of the primocanes than will be removed through pruning, have rednecked cane borer galls, control is justified. Treat after first bloom or when adults are observed.				
	Strawberry clipper	See **JUST BEFORE BLOOMS OPEN**				

Table 6-5. Caneberry Management Program

SEASON	Pest	Product Name, Mode of Action Code, and Formulation	Rate of Formulation per Acre	Restricted Entry Interval (hours)	Preharvest Interval (PHI) (days)	Comments and Precautions
Post-Bloom	Anthracnose, Leaf spots, Rusts, Powdery mildew	See **JUST BEFORE BLOOMS OPEN excluding products containing propiconazole that have a 30 day pre-harvest interval**				Applications for these diseases should be made every 14 days after petal fall until harvest
	Double blossom	See **BLOOM AND PETAL FALL**				Additional treatments may be needed to protect primocanes if infected flowers continue to open.
	Japanese beetles	Caneberries can tolerate some foliar feeding by Japanese beetles, but little work has been done to determine when foliar feeding impacts yield. Do not use Japanese beetle pheromone traps as they attract beetles from outside fields. Treatment for Japanese beetles is not recommended unless significant foliar loss occurs.				
		carbaryl, IRAC 1A (Sevin XLR Plus)	1 to 2 qt	12	7	
		malathion, IRAC 1B (Malathion 8F)	2 pt	12	1	Make no more than 3 applications per year.
		fenpropathrin, IRAC 3A (Danitol 2.4 EC)	10.66 to 16 fl oz	24	3	Do not exceed 32 fl oz Danitol per acre per season.
		zeta-cypermethrin, IRAC 3A (Mustang Maxx)	4 fl oz	12	1	Do not make more than 6 applications per season.
	Leafrollers	Leafrolling caterpillars can feed on caneberry foliage. Foliage damage is typically not economically significant, but caterpillars can occasionally form webs on fruit. If caterpillars are impacting fruit, treatment may be justified.				
		spinosad, IRAC 5 (Entrust SC) (Entrust)	4 to 6 fl oz 1.25 to 2 oz	4 4	1 1	Entrust is **OMRI** listed. Do not apply more than 29 fl oz Entrust SC (0.45 lb active ingredient) per acre per year. Do not apply more than 9 oz Entrust (0.45 lb active ingredient) per acre per year.
		spinetoram, IRAC 5 (Delegate WG)	3 to 6 oz	4	1	Do not exceed 19.5 oz Delegate WG per acre per season.
		Bacillus thuringiensis (Bt), IRAC 11A (Dipel DF)	0.5 to 2 lb	4	0	Dipel DF is **OMRI** listed.
		chlorantraniliprole, IRAC 28 (Altacor)	3 to 4.5 oz	4	3	Do not apply more than 9 oz Altacor or 0.2 lbs of chlorantraniliprole containing products per acre per calendar year.
	Stink bugs, Plant bugs	Stink bug feeding does not typically damage berries, but they may be contamination pests during harvest. Plant bug and stink bugs may also feed on developing buds or shoots. Treatment is justified if insects are contaminating fruit.				
		esfenvalerate, IRAC 3A (Asana XL)	9.6 fl oz	12	7	Avoid applications when bees are foraging. Apply during evenings or early morning.
		fenpropathrin, IRAC 3A (Danitol 2.4EC)	10.66 to 16 fl oz	24	3	Do not exceed 32 fl oz Danitol per acre per season.
		thiamethoxam, IRAC 4A (Actara)	3 oz	12	3	Do not use more than 6.0 oz of Actara per acre or 0.094 lb active ingredient of thiamethoxam containing products per acre per year.
		cyclaniliprole, IRAC 28 (Verdepryn 100SL)	8.2 to 11 fl oz	4	1	Limited efficacy data. Do not apply Group 28 insecticides more than 3 times within a single generation of an insect pest on a crop.
	Spider mites	There is no research-based treatment threshold for spider mites in caneberries, but treatment is recommended when a random sample of leaflets from the planting has an average of 10 motile mites. Leaflets should be examined with a minimum 10x hand lens to determine mite counts. Spider mites are more significant pests of raspberries than blackberries. Insecticides used against other pests may flare spider mite populations, particularly IRAC 1 and 3 materials. Observe plants for spider mites following treatment with these materials.				
		hexythiazox, IRAC 10A (Savey 50 DF)	4 to 6 oz	12	3	Savey is primarily active against eggs and immature mites. Apply when populations are low. Do not make more than 1 application per year.
		etoxazole, IRAC 10B (Zeal Miticide)	2 to 3 oz	12	0	Do not make more than 1 application per season.
		acequinocyl, IRAC 20B (Kanemite)	31 fl oz	12	1	Do not use less than 50 gpa spray volume. Allow 21 days between treatments.
		bifenazate, IRAC 20D (Acramite 50WS)	0.75 to 1 lb	12	1	
		fenpyroximate, IRAC 21 (Portal)	2 pt	12	1	Allow 14 days between applications. Do not make more than 2 applications per year.
	Broad mites	Broad mites are emerging pests in blackberries and have been most problematic in primocane fruiting varieties. Significant populations have been observed in AR and NC. Broad mites cause leaf stunting and upward or downward cupping. Rule out other causes of leaf stunting (such as herbicide injury) and confirm broad mite presence before treating. Also note that **there is limited efficacy data for all these materials on broad mite in caneberries due to the emerging nature of this pest.** Available data suggest that more than one application, at 7-day intervals, is needed to control large broad mite populations.				
		abamectin, IRAC 6 (Agri-Mek SC)	3.5 fl oz	12	7	Two Agri-Mek SC applications should be made 7 days apart to be most effective. Use is limited to 2 applications. An approved non-ionic surfactant is required. Do not apply more than 10.25 fl oz of Agri-Mek per year.

Table 6-5. Caneberry Management Program

SEASON	Pest	Product Name, Mode of Action Code, and Formulation	Rate of Formulation per Acre	Restricted Entry Interval (hours)	Preharvest Interval (PHI) (days)	Comments and Precautions
Post-Bloom (continued)		etoxazole, IRAC 10B (Zeal Miticide)	2 to 3 oz	12	0	Do not make more than 1 application per season.
		acequinocyl, IRAC 20B (Kanemite 15SC)	31 fl oz	12	1	Do not use less than 50 gpa spray volume. Allow 21 days between treatments.
		fenazaquin, IRAC 21A (Magister SC)	32 to 36 fl oz	12	7	Do not make more than 1 application per year.
		tolfenpyrad, IRAC 21A (Apta)	27 fl oz	12	1	Do not make more than 2 applications per year.
		potassium salts of fatty acids (M-Pede)	1 to 2% v/v	12	0	M-Pede is **OMRI** listed.
Harvest	Botrytis fruit rot	boscalid + pyraclostrobin, FRAC 7 + 11 (Pristine 38 WDG)	18.5 to 23 oz	12	0	For resistance management, do not make more than **4** applications collectively of the strobilurin fungicides (Abound, Quilt Xcel, Cabrio, and Pristine) per season.
		cyprodinil + fludioxonil, FRAC 9 + 12 (Switch 62.5 WG)	11 to 14 oz	12	0	
		fenhexamid, FRAC 17 (Elevate 50 WDG)	1.5 lb	12	0	
		iprodione, FRAC 2 (several brands) 50 WG 4F	1 to 2 lb 1 to 2 pt	24	0	
		captan, FRAC M4 (Captan 50W) (Captan 80 WDG) (Captec 4L)	4 lb 2.5 lb 2 qt	see label	3	Include captan in this spray if ripe rot is a problem. Pristine will also control ripe rot.
	Fusarium wilt	Fusarium wilt has only recently been observed in southeastern NC counties, primarily in high-tunnel blackberry production. Wilting and plant death can occur. There are no chemical controls available. Prompt removal of symptomatic plants including roots may slow the progress of this disease. Where plants are removed, Fusarium in soil can infect replacement plants. https://content.ces.ncsu.edu/fusarium-wilt-of-blackberry				
	Flower thrips	Flower thrips can be a contamination pest at harvest. Fruit can be placed in a clear plastic bag before harvest and observed for flower thrips. There is no evidence at this time to suggest that flower thrips damage fruit or flowers and reduce yield.				
		zeta cypermethrin, IRAC 3A (Mustang Maxx)	4 fl oz	12	1	Do not make more than 6 applications per season.
		acetamiprid, IRAC 4A (Assail 30SG)	4.5 to 5.3 oz	12	1	
		spinosad, IRAC 5 (Entrust SC) (Entrust)	4 to 6 fl oz 1.25 to 2 oz	4 4	1 1	Entrust is **OMRI** listed. Do not apply more than 29 fl oz Entrust SC (0.45 lb active ingredient) per acre per year. Do not apply more than 9 oz Entrust (0.45 lb active ingredient) per acre per year.
		spinetoram, IRAC 5 (Delegate WG)	3 to 6 oz	4	1	Do not exceed 19.5 oz Delegate WG per acre per season.
	Spotted wing drosophila	Spotted wing drosophila (SWD) is a pest of soft-skinned fruit. Female SWD lay eggs in ripe and ripening fruit, which can appear externally undamaged. Spotted wing drosophila are present in damaging densities during typical blackberry and raspberry harvest periods in North Carolina, so preventative treatment, beginning when fruit begins to change color, is recommended. Treatments should be applied at least every 7 days, and mode of action (IRAC code) should be rotated between treatments. In addition to insecticide treatments, growers should also employ good cultural practices including: harvesting as frequently as possible, removing all ripe fruit from plants at each harvest, and storing all harvested fruit at temperatures below 41°F for as long as feasible before marketing.				
		malathion, IRAC 1B (Malathion 8F)	2 pt	12	1	Make no more than 3 applications per year. Formulations other than Malathion 8F have resulted in plant injury in caneberries when applied during hot weather.
		bifenthrin, IRAC 3A (Brigade WSB)	8 to 16 oz	12	3	Do not exceed 0.2 lb bifenthrin (32 oz Brigade WSB) per acre per season.
		fenpropathrin, IRAC 3A (Danitol 2.4EC)	10.66 to 16 fl oz	24	3	Do not exceed 32 fl oz Danitol per acre per season.
		zeta cypermethrin IRAC 3A (Mustang Maxx)	4 fl oz	12	1	Do not make more than 6 applications per season.
		spinosad, IRAC 5 (Entrust SC) (Entrust)	4 to 6 fl oz 1.25 to 2 oz	4 4	1 1	Entrust is **OMRI** listed. Do not apply more than 29 fl oz Entrust SC (0.45 lb active ingredient) per acre per year. Do not apply more than 9 oz Entrust (0.45 lb active ingredient) per acre per year.
		spinetoram, IRAC 5 (Delegate WG)	3 to 6 oz	4	1	Do not exceed 19.5 oz Delegate per acre per season.
		cyantraniliprole, IRAC 28 (Exirel)	13.5 to 20.5 fl oz	12	1	Minimum interval between applications is 5 days.

Table 6-5. Caneberry Management Program

SEASON	Pest	Product Name, Mode of Action Code, and Formulation	Rate of Formulation per Acre	Restricted Entry Interval (hours)	Preharvest Interval (PHI) (days)	Comments and Precautions
Harvest (continued)		cyclaniliprole, IRAC 28 (Verdepryn 100SL)	11 fl oz	4	1	Apply in the evening when flowers are present. Make no more than 3 applications per year. Minimum treatment interval is 5 days.
	Japanese beetles and green June beetles	carbaryl, IRAC 1A (Sevin XLR Plus)	2 qt	12	7	
		fenpropathrin, IRAC 3A (Danitol 2.4 EC)	10.66 to 16 fl oz	24	3	Do not exceed 32 fl oz Danitol per acre per season.
		zeta-cypermethrin, IRAC 3A (Mustang Maxx)	4 fl oz	12	1	Do not make more than 6 applications per season.
Just After Harvest and 14 Days Later	Leaf spots	captan, FRAC M4 (Captan 50W) (Captan 80 WDG)	4 lb 2.5 lb	see label	3	
		azoxystrobin + propiconazole, FRAC 11 + 3 (Quilt Xcel)	14 to 21 fl oz	12	30	Do not make more than 4 applications collectively of the strobilurin fungicides (Abound, Quilt Xcel, Cabrio, and Pristine) per season. Strobilurin (FRAC 11) fungicides will also control rusts.
		myclobutanil, FRAC 3 (Rally 40WSP; Sonoma 40WSP)	1.25 to 3 oz	24	1	
		propiconazole, FRAC 3 (PropiMax EC)	6 fl oz	12	30	
	Japanese beetle	**See Post Bloom**				Japanese beetle treatments are necessary post harvest only if feeding is removing greater than 10% of foliage on primocanes.
Late October or Early November	Raspberry crown borer	Raspberry crown borer treatments should be applied once per year, either in late fall or early spring. Applications during both time periods are not necessary.				
		bifenthrin, IRAC 3A (Brigade WSB)	16 oz	12	3	Do not exceed 0.2 lb bifenthrin (32 oz Brigade WSB) per acre per season.
		esfenvalerate, IRAC 3A (Asana XL)	9.6 fl oz	12	7	
		chlorantraniliprole, IRAC 28 (Altacor)	3 to 4.5 oz	4	3	Do not apply more than 9 oz Altacor or 0.2 lbs of chlorantraniliprole containing products per acre per calendar year.
		entomopathogenic nematodes (*Heterorhabditis bacteriophora* and other species)				While nematodes have been documented to reduce RCB densities, they appear roughly 50% as effective as conventional insecticides. Some nematode preparations are **OMRI** listed. Consult with vendor to determine appropriate treatment rates and conditions. Nematodes will most likely be most effective in North Carolina when applied in early April.
Dormant	Scale insects	Scale insects may be present on caneberries but are typically kept below economically damaging levels by parasitoids and predators. An open canopy minimizes scale populations. Examine plants after harvest and during pruning for scale, and if present in high numbers or resulting in sooty mold growth, consider a dormant season treatment.				
		potassium salts of fatty acids (M-Pede)	1 to 2% v/v	12	0	M-Pede is **OMRI** listed.
		imidacloprid, IRAC 4A, (Admire Pro, *many generic formulations)*	7 to 14 fl oz (soil) 2.8 fl oz (foliar)	12	7	Soil applications can be made via chemigation or as a soil drench. Drench applications should be made in at least 500 gpa. DO NOT MAKE SOIL OR FOLIAR APPLICATIONS PRE BLOOM OR WHEN BEES ARE FORAGING.
	Raspberry cane borer, Red neck cane borer	During winter pruning, examine canes for raspberry cane borer injury. Prune canes girdled by raspberry cane borer 2 to 3 cm below the lower girdle or gall. If evidence of boring is present below this cut, successive cuts should be made until no further injury is observed. Destroy or remove cuttings to prevent reinfestation.				
Special Rust Sprays	Cane and leaf rust, Orange rust	Begin applications in the spring just before orange rust pustules are formed on the lower leaf of brambles (use wild blackberries as indicators). Continue at 10- to 14-day intervals until the mean temperature remains above 77ºF. Infections can also occur in the late summer and fall. Chemicals are not very effective once systemic infection occurs; however, fungicide applications can be effective in preventing additional new infections.				
		boscalid + pyraclostrobin, FRAC 7 + 11 (Pristine 38 WG)	18.5 to 23 oz	12	0	Where orange rust has been a problem, alternate Rally and Cabrio or Pristine or azoxystrobin at 14-day intervals. For late leaf rust, begin when symptoms first appear, and continue on a 14-day interval.
		myclobutanil, FRAC 3 (Rally 40 WSP) 40 WSP, DF, WDG	1.25 to 3 oz	24	1	
		pyraclostrobin, FRAC 11 (Cabrio 20EG)	14 oz	12	0	Where orange rust has been a problem, alternate Rally and Cabrio or Pristine or azoxystrobin at 14-day intervals.

Table 6-5. Caneberry Management Program

SEASON	Pest	Product Name, Mode of Action Code, and Formulation	Rate of Formulation per Acre	Restricted Entry Interval (hours)	Preharvest Interval (PHI) (days)	Comments and Precautions
Special Rust Sprays (continued)	Cane and leaf rust, Orange rust (continued)	azoxystrobin, FRAC 11 (Abound 2SC)	6.2 to 15.4 fl oz	4	0	
		azoxystrobin + propiconazole, FRAC 11 + 3 (Quilt Xcel)	14 to 21 fl oz	12	30	
Special Treatments for Phytophthora Root Rot	Phytophthora root rot	mefenoxam, FRAC 4 (Ridomil Gold SL)	—	48	45	Apply 0.25 pint per 1,000 linear feet of row in a 3 feet wide band in the spring and fall after harvest. Ridomil Gold is registered for raspberries only. 45-day phi.
		fosetyl Al, FRAC 33 (Aliette WSP)	5 lb	12	60	Begin when growth is 1 to 3 inches long and continue at 45- to 60-day intervals through the growing season. Registered for blackberries and raspberries. Maximum of 4 applications per year. 60-day phi.
		phosphite fungicides, FRAC 33	See label	See label	See label	Several phosphorus acid products are registered for control of Phytophthora root rot, including Prophyt and Agri-Fos. See label for recommendations.
Preplant Treatments for Nematodes	Nematodes	1,3 dichlorophene 37% + chloropicrin 57% (Pic-Clor 60 EC)	19.5 to 44.5 gal	5	NA	Preplant interval should be 4 to 8 weeks, or longer if dissipation is slow. See label for additional information.
		metam sodium (Vapam)	75 gal	See label	NA	Preplant interval is a minimum of 4 weeks.

More information
Southeast Regional Caneberry Integrated Management Guide, www.smallfruits.org.
NC State Extension Caneberry Portal, rubus.ces.ncsu.edu.

Bunch Grape Insect Management

H. J. Burrack, L.J. Kraft, and M.H. Favre, Entomology and Plant Pathology

With a few exceptions, which are noted, wine grapes should be treated for insects only when damaging insect populations are present. Where treatment thresholds are known, these are provided. For many insect pests of wine grapes in the southeast, thresholds do not exist. Consult cooperative Extension personnel for management recommendations if insects for which there are no thresholds are present.

The Insecticide Resistance Action Committee (IRAC) and the Fungicide Resistance Action Committee (FRAC) group insecticides and fungicides into mode of action categories. These categories are listed following the pesticide and formulation names. To reduce the risk of resistance development, avoid successive applications of insecticides or fungicides with the same IRAC or FRAC code for the same pest. Organically acceptable insecticides (OMRI listed) are indicated in Precautions and Remarks.

Some insecticide active ingredients are available in several formulations and under several trade names. For simplicity, the most common trade names and associated rates are listed. This is not intended to encourage the use of these products over generic versions.

PLEASE NOTE: Bunch Grape Disease Management information is available in table 6-6B.

Table 6-6A. Bunch Grape Insect Management

When to Spray	Pest	Pesticide, IRAC, FRAC Code, and Formulation	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
Bud Swell	Grape flea beetle	Apply only if damaging numbers of adult beetles are present. If 4% or more of buds have been damaged by grape flea beetles, treatment is justified. Grape flea beetle adults emerge in early spring and feed on newly swollen buds and lay eggs. Larvae and adults from subsequent generations feed on leaves, but foliar feeding typically does not result in economically significant damage nor justify treatment.				
		carbaryl, IRAC 1A (Sevin XLR Plus)	1 to 2 qt	48 hours for all activities except grape girdling and cane turning. EXCEPTION: the REI is 144 hours (6 days) for grape girdling and cane turning.	7	Do not apply more than a total of 10 quarts Sevin XLR Plus per acre per crop per year.
		phosmet, IRAC 1B (Imidan 70W)	1.33 to 2.125 lb	14 days	7 (rates of 1.33 lb per acre or less) 14 (more than 1.33 lb per acre)	Do not apply more than 6.5 pounds Imidan (4.55 lb of phosmet) per acre per year.
		Cyfluthrin, IRAC 3 (Baythroid XL)	2.4 to 3.2 fl oz	12	3	Do not apply more than 3.2 fluid oz Baythroid XL (0.025 lb cyfluthrin) per acre per 14 day period. Do not apply more than 12.8 fluid oz Baythroid XL (0.1 lb cyfluthrin) per acre per crop season.
		fenpropathrin, IRAC 3 (Danitol 2.4EC)	5.33 to 10.66 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.
		spinosad, IRAC 5 (Entrust SC) (Entrust Naturalyte)	4 to 8 fl oz 1.25 to 2.5 oz	4	3	Do not apply more than 23 fl oz Entrust SC or 7.2 oz of Entrust Naturalyte (0.36 lb spinosad) per acre per season. Entrust is **OMRI** listed.
	Climbing cutworms	Scout for cutworm if damaged buds are observed. Look for cutworms at night. Cutworm treatment may be justified if greater than 4% of the buds examined are damaged and the variety does not have fruitful secondary buds. Spray in the evening if possible, as cutworms are active at night.				
		carbaryl, IRAC 1A (Sevin XLR Plus)	2 qt	48 hours for all activities except grape girdling and cane turning. EXCEPTION: the REI is 144 hours (6 days) days for grape girdling and cane turning.	7	Do not apply more than a total of 10 quarts Sevin XLR Plus per acre per crop per year.
		bifenthrin, IRAC 3 (Brigade 2EC)	3.2 to 6.4 fl oz	12	30	There are many generic formulations of bifenthrin. Do not make more than one application per year.
		cyfluthrin, IRAC 3 (Baythroid XL)	2.4 to 3.2 fl oz	12	3	Do not apply more than 3.2 fluid oz Baythroid XL (0.025 lb cyfluthrin) per acre per 14 day period. Do not apply more than 12.8 fl oz Baythroid XL (0.1 lb cyfluthrin) per acre per crop season.
		fenpropathrin, IRAC 3 (Danitol 2.4EC)	10.66 to 21.33 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.
		zeta-cypermethrin, IRAC 3 (Mustang Maxx)	2 to 4 fl oz	12	1	Do not apply more than 24 fl oz of product per season.
		spinetoram, IRAC 5 (Delegate WG)	3 to 5 oz	4	3	Do not exceed more than 5 applications of Delegate per year or 19.5 oz (0.305 lb ai of spinetoram) per acre per year.
		spinosad, IRAC 5 (Entrust SC) (Entrust Naturalyte)	4 to 8 fl oz 1.25 to 2.5 oz	4	3	Do not apply more than 23 fl oz Entrust SC or 7.2 oz of Entrust Naturalyte (0.36 lb spinosad) per acre per season. Entrust is OMRI listed.
		Bacillus thuringiensis (Bt), IRAC 11 (DiPel DF)	0.5 to 2 lb	4	0	There are many Bt formulations. DiPel DF is **OMRI** listed, but not all formulations are organically acceptable. Read label carefully.
		methoxyfenozide, IRAC 18 (Intrepid 2F)	8 to 16 fl oz	4	21 to 30, depending on application rate	Minimum application for airblast sprayers of 40 gpa. Do not apply more than a total of 48 fl oz of Intrepid 2F (0.75 lb ai) per acre per year.

Table 6-6A. Bunch Grape Insect Management

When to Spray	Pest	Pesticide, IRAC, FRAC Code, and Formulation	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
Bud Swell (continued)	Climbing cutworms (continued)	chlorantraniliprole, IRAC 28 (Altacor)	3 to 4.5 oz	4	14	Do not apply more than 9 oz of Altacor or 0.2 lbs active ingredient of chlorantraniliprole containing products per acre per calendar year.
	Mealybugs	Mealybugs can directly damage fruit by feeding within clusters. Some mealybug species can also vector viral pathogens in grapes. Treatments should be made early in the growing season to prevent establishment of later generations in clusters. Mealybugs within clusters after closing can be extremely difficult to control. Systemic insecticides such as IRAC 4A and 23 materials are more effective against less exposed mealybugs than non-systemic materials.				
		cyfluthrin, IRAC 3 (Baythroid XL)	2.4 to 3.2 fl oz	12	3	Do not apply more than 3.2 fluid oz Baythroid XL (0.025 lb cyfluthrin) per acre per 14 day period. Do not apply more than 12.8 fl oz Baythroid XL (0.1 lb cyfluthrin) per acre per crop season.
		clothianidin, IRAC 4A (Belay)	6 fl oz (foliar) 6 to 12 fl oz (soil)	12	10 (foliar) 30 (soil)	Belay can be applied either to the soil or as a foliar spray. Soil applications are typically active for a longer period of time but must be made early in the year. Soil applications are more effective when made via drip irrigation. Do not apply more than 0.2 lb active ingredient clothianidin per acre per year. Do not make more than one application per year.
		dinotefuran, IRAC 4A (Venom)	1 to 3 oz (foliar) 5 to 7.5 oz (soil)	12	1 (foliar) 28 (soil)	Venom can be applied either to the soil or as a foliar spray. Soil applications are typically active for a longer period of time, but must be made early in the year. Soil applications are more effective when made via drip irrigation.
		imidacloprid, IRAC 4A (Admire Pro)	1 to 1.4 fl oz (foliar) 7 to 14 fl oz (soil)	12	0 (foliar) 30 (soil)	Admire Pro can be applied either to the soil or as a foliar spray. Soil applications are typically active for a longer period of time but must be made early in the year. Soil applications are more effective when made via drip irrigation.
		buprofezin, IRAC 16 (Applaud)	9 to 12 oz	12	7	Apply when crawlers are active, or at 493 and 990 degree-days (base 50 F), starting at April 1 (early and peak activity of first generation). Do not apply more than 24.0 oz (1.05 lbs AI) of Applaud per acre per growing season.
		spirotetramat, IRAC 23 (Movento)	6 to 8 fl oz	24	7	Do not apply more than 12.5 fl oz (0.2 lbs AI) of Movento per acre per calendar year.
		horticultural oils (Omni Supreme Spray Oil) (JMS Stylet Oil) (Organic JMS Stylet Oil)	0.5 to 1% by volume 1 to 2% by volume 1 to 2% by volume	12		If mealybugs or ERM were of economic concern during the previous season and present during dormant scouting, a dormant oil treatment may be justified during bud swell. **Do not** apply oil treatments in combination with sulfur or within 30 days of sulfur application. **Do not** apply oils when temperature will exceed 90ºF or dip below freezing. Organic JMS Stylet Oil is **OMRI** listed.
At or Just Before Budbreak and new shoot sprays	Leafhopper/ sharpshooters (Pierce's Disease suppression)	Infections occurring early in the first half of the growing season are most likely to result in systemic infection of vines, so targeting vector controls to this period is most important. Vineyards in high risk areas should consider an early season soil application of a neonicotinoid (4A) insecticide for leafhoppers if plants symptomatic for Pierce's Disease have been observed in the vineyard or in nearby vineyards. This strategy provides longer term control than foliar treatments. Foliar treatments should be applied biweekly during the prebloom period and continue through midsummer.				
		cyfluthrin, IRAC 3 (Baythroid XL)	2.4 to 3.2 fl oz	12	3	Do not apply more than 3.2 fluid oz Baythroid XL (0.025 lb cyfluthrin) per acre per 14 day period. Do not apply more than 12.8 fl oz Baythroid XL (0.1 lb cyfluthrin) per acre per crop season.
		acetamiprid, IRAC 4A (Assail 30SG)	2.5 to 5.3 oz	12	3	Assail can only be applied as a foliar treatment. Do not exceed a total of 0.2 lb. active ingredient (10.6 oz. Assail) per acre per calendar year.
		clothianidin, IRAC 4A (Belay)	4 to 6 fl oz (foliar) 6 to 12 fl oz (soil)	12	10 (foliar) 30 (soil)	Belay can be applied either to the soil or as a foliar spray. Soil applications are typically active for a longer period of time but must be made early in the year. Soil applications are more effective when made via drip irrigation. Do not apply more than 0.2 lb active ingredient clothianidin per acre per year. Do not make more than one application per year.
		dinotefuran, IRAC 4A (Venom)	1 to 3 oz (foliar) 5 to 7.5 oz (soil)	12	1 (foliar) 28 (soil)	Venom can be applied either to the soil or as a foliar spray. Soil applications are typically active for a longer period of time but must be made early in the year. Soil applications are more effective when made via drip irrigation. See label for details.
		imidacloprid, IRAC 4A (Admire Pro)	1 to 1.4 fl oz (foliar) 7 to 14 fl oz (soil)	12	0 (foliar) 30 (soil)	Admire Pro can be applied either to the soil or as a foliar spray. Soil applications are typically active for a longer period of time but must be made early in the year. Soil applications are more effective when made via drip irrigation. There are several formulations of imidacloprid.
Prebloom	Flea beetle	See **Bud Swell** recommendations				
	Grape berry moth	Grape berry moth is present in North Carolina, but damage is uncommon. If grape berry moth presence is suspected, observe flowers and fruit for injury and consider monitoring moth presence with pheromone baited traps.				
		fenpropathrin, IRAC 3 (Danitol 2.4EC)	10.66 to 21.33 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.
		spinosad, IRAC 5 (Entrust SC) Entrust Naturalyte	4 to 8 fl oz 1.25 to 2.5 oz	4	3	Do not apply more than 29 fl oz Entrust SC or 9 oz of Entrust Naturalyte (0.45 lb spinosad) per acre per season. Entrust is **OMRI** listed.

Table 6-6A. Bunch Grape Insect Management

When to Spray	Pest	Pesticide, IRAC, FRAC Code, and Formulation	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
Prebloom (continued)	Grape berry moth (continued)	spinetoram, IRAC 5 (Delegate WG)	3 to 5 oz	4	3	Do not apply more than a total of 19.5 oz of Delegate WG (0.305 lb ai spinetoram) per acre per year.
		Methoxyfenozide, IRAC 18 (Intrepid 2F)	8 to 16 fl oz	4	21 to 30, depending on application rate	Minimum application of Intrepid for airblast sprayers is 40 gallons per acre. Do not apply more than a total of 48 fl oz of Intrepid 2F (0.75 lb ai) per acre per year.
		Indoxacarb, RAC 22 (Avaunt 30DG)	5 to 6 oz	12	7	Do not apply more than 12 oz Avaunt or 0.22 lbs AI Indoxacarb per acre per year.
		chlorantraniliprole, IRAC 28 (Altacor)	2 to 4.5 oz	4	14	Do not apply more than 9 oz of Altacor or 0.2 lbs active ingredient of chlorantraniliprole containing products per acre per calendar year.
	Leafhoppers/ Sharpshooters (Pierce's Disease suppression)	**If foliar and soil applications of group 4A pesticides are part of a management plan for Pierce's disease (i.e., Admire Pro applied via drip and Venom foliar), at least one application of a different IRAC insecticide should occur as a rotation between these treatments.** Synthetic pyrethroid insecticides (Group 3) and organophosphates (Groups 1A and 1B) are broad spectrum insecticides and have the potential to flare spider mite populations. Observe spider mites before and after treatments to determine if these populations increase.				
		malathion, IRAC 1B (Malathion 8F) (Malathion 57EC) (Malathion 5)	1.88 pt 1.5 pt 3 pt	72 hours for girdling and tying; 24 hours for other activities	3	Foliar treatment only.
		cyfluthrin, IRAC 3 (Baythroid XL)	2.4 to 3.2 fl oz	12	3	Foliar treatment only. Do not apply more than 3.2 fluid oz Baythroid XL (0.025 lb cyfluthrin) per acre per 14 day period. Do not apply more than 12.8 fl oz Baythroid XL (0.1 lb cyfluthrin) per acre per crop season.
		fenpropathrin, IRAC 3 (Danitol 2.4EC)	5.33 to 10.66 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.
		acetamiprid, IRAC 4A (Assail 30SG)	2.5 to 5.3 oz	12	3	Do not exceed a total of 0.2 lb. active ingredient (10.6 oz. Assail) per acre per calendar year.
		Clothianidin, IRAC 4A (Belay)	4 to 6 fl oz (foliar) 6 to 12 fl oz (soil)	12	10 (foliar) 30 (soil)	Belay can be applied either to the soil or as a foliar spray. Soil applications are typically active for a longer period of time but must be made early in the year. Soil applications are more effective when made via drip irrigation. Do not apply more than 0.2 lb active ingredient clothianidin per acre per year. Do not make more than one application per year.
		Dinotefuran, IRAC 4A (Venom)	1 to 3 oz (foliar) 5 to 7.5 (soil)	12	1 (foliar) 28 (soil)	Venom can be applied either to the soil or as a foliar spray. Soil applications are typically active for a longer period of time but must be made early in the year. Soil applications are more effective when made via drip irrigation.
		Imidacloprid, IRAC 4A (Admire Pro)	1 to 1.4 fl oz (foliar) 7 to 14 fl oz (soil)	12	0 (foliar) 30 (soil)	Admire Pro can be applied either to the soil or as a foliar spray. Soil applications are typically active for a longer period of time but must be made early in the year. Soil applications are more effective when made via drip irrigation. See label for application details.
	Grape phylloxera (foliar)	Grape phylloxera has root feeding and foliar feeding forms. Rootstocks used in grape propagation are resistant to root feeding forms and do not require treatment. Foliar phylloxera may be problematic in European-American hybrid varieties (e.g., Vidal, Seyval) and cause distinctive, wart-like galls on leaves. The mobile crawler stage of phylloxera is susceptible to insecticide treatment, but closed galls are not. Scouting for galls and crawlers should begin once leaves are expanded. If infested leaves are found in susceptible varieties, insecticide treatments should be timed to crawler emergence.				
		Fenpropathrin, IRAC 3 (Danitol 2.4EC)	10.66 to 21.66 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.
		Acetamiprid, IRAC 4A (Assail WSP)	2.5 oz	12	7	
		imidacloprid, IRAC 4A (Admire Pro)	1 to 1.4 fl oz (foliar) 7 to 14 fl oz (soil)	12	0 (foliar) 30 (soil)	Admire Pro can be applied either to the soil or as a foliar spray. Foliar treatments are likely to be more effective against foliar feeding phylloxera than soil treatments because they can be more closely timed to crawler emergence.
		Spirotetramat, IRAC 23 (Movento)	6 to 8 fl oz	24	7	Movento is also effective against root feeding phylloxera. Do not apply more than 12.5 fl oz (0.2 lbs AI) of Movento per acre per calendar year.
		Kaolin (Surround WP Crop Protectant)	25 lb	4		Surround is a barrier that reduces insect feeding. Harvest parameters may be altered and maturity may be delayed, especially in white wine varieties. Closely monitor harvest parameters to determine optimal time to harvest. Changes in harvest parameters can affect final taste. Wine grapes sprayed up to veraison will have minimal adherence to berries. Applications after veraison will adhere more on grape berries. Surround is **OMRI** listed.
Bloom	Flower thrips	Thrips damage is rarely economically significant in grapes, and many materials applied for leafhoppers, mealybugs, and phylloxera will effectively suppress thrips as well.				

Table 6-6A. Bunch Grape Insect Management

When to Spray	Pest	Pesticide, IRAC, FRAC Code, and Formulation	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
Postbloom (immediately after bloom)	Grape berry moth, grape flea beetle, and leafhoppers/ sharpshooters (Pierce's Disease suppression)	See **PREBLOOM** recommendations.				
	European red mite, twospotted spider mite	Sample for mites weekly using a minimum 10x hand lens. If greater than 50% of leaves observed have spider mites and no predatory mites are present, treatment is justified. Fast moving predatory mites can be distinguished from slower moving spider mites through direct observation. Rotate miticides between IRAC codes to minimize selection for resistance. Miticides should be applied in at least 50 gpa spray volume to ensure adequate coverage.				
		Abamectin, IRAC 6 (Agri-Mek SC)	1.75 to 3.5 fl oz	12 hours EXCEPT for grape girdling, cane turning, and tying grapes when REI is 96 hrs (4 days)	28	Abamectin is a restricted use product. Do not reapply within 21 days of initial application. Abamectin is an EC (emulsifiable concentrate), which can cause phytotoxicity in some crops. Check for possible plant injury before treating an entire field. Do not make more than 2 applications of Agri-Mek SC or other foliarly applied abamectin containing products per year.
		Etoxazole, IRAC 10B (Zeal)	2 to 3 oz	12	14	Zeal is a growth regulator and kills eggs and young mites. It is most effective if applied when mite populations are low. Do not make more than one application of Zeal per season.
		Fenbutatin-oxide, IRAC 12B (Vendex 50WP)	1 to 2.5 lb	48	28	Do not make more than 2 applications of Vendex per season.
		Acequinocyl, IRAC 20B (Kanemite)	21 to 31 fl oz	12	7	Do not make more than 2 applications per season.
		Bifenazate, IRAC 20D (Acramite 50WS)	0.75 to 1 lb	12 hours EXCEPT for grape girdling, cane turning, and tying grapes when REI is 120 hours (5 days)	14	Apply in a minimum spray volume of 50 gallons per acre. Do not make more than one application of Acramite per season.
		Fenpyroximate, IRAC 21A (FujiMite SC)	2 pt	12	14	Do not apply more than 2 pints of FujiMite per acre per season.
		Pyridiben, IRAC 21 (Nexter) (Nexter SC)	4.4 to 10.67 oz 7.5 to 17 oz	12	7	The maximum amount of pyridiben allowed per acre per season is 26.4 ounces. Do not make more than 2 applications of pyridiben per season.
	Spirodiclofen, IRAC 23 (Envidor 2SC)	16 to 34 fl oz	12	14	Do not make more than one application of Envidor 2SC per season.	
		Cyflumetofen, IRAC 25 (Nealta)	13.7 fl oz	12	14	Do not make more than 2 Nealta applications per season and rotate to another mode of action (IRAC 25) between treatments.
		Horticultural oils, IRAC Unknown many materials, including (Glacial Spray Fluid)	1 to 2 gallons per 100 gallons	4	60	Some oils are **OMRI** listed; check label. **Do not** use in combination with or immediately before or after spraying with fungicides such as Captan or any product containing sulfur. **Do not** use with carbaryl or dimethoate. **Do not** use with any product whose label recommends the use of no oils. Do not use in combination with NPK foliar fertilizer applications.
	Grape phylloxera (foliar form)	See **Prebloom** recommendations.				
1st Cover Spray (7 to 10 days after Postbloom Spray)	Grape berry moth, leafhoppers/ sharpshooters (Pierce's Disease suppression)	See **Prebloom** recommendations				**If foliar and soil applications of group 4A pesticides are part of a management plan for Pierce's Disease (i.e., Admire Pro applied via drip and Venom foliar), at least 1 application of a different IRAC insecticide should occur as a rotation between these treatments.** Current information indicates that in areas where Pierce's Disease is a problem, controlling leafhoppers and sharpshooters through July reduces the risk of Pierce's Disease. See labels for preharvest intervals.
	Japanese beetle, Green June beetles	Do not use Japanese beetle traps. Japanese beetle foliar feed only warrants treatment if it occurs on leaves below the top trellis wire. Green June beetles only require treatment if damaging otherwise sound fruit. Green June beetles are attracted to overripe, rotting fruit. Removal of damaged fruit will help reduce Green June beetle populations.				
		Carbaryl, IRAC 1A (Sevin XLR Plus)	2 qt	48 hours for all activities except grape girdling and cane turning. EXCEPTION: the REI is 144 hours (6 days) for grape girdling and cane turning.	7	Synthetic organophosphates (Groups 1A and 1B) are broad-spectrum insecticides and have the potential to flare spider mite populations. Observe spider mites before and after treatments to determine if these populations increase. Do not apply more than a total of 10 quarts Sevin XLR Plus per acre per crop per year.

Table 6-6A. Bunch Grape Insect Management

When to Spray	Pest	Pesticide, IRAC, FRAC Code, and Formulation	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
1st Cover Spray (7 to 10 days after Postbloom Spray) (continued)	Japanese beetle, Green June beetles (continued)	malathion, IRAC 1B (Malathion 8F)	1.88 pt	24	3	Synthetic organophosphates (Groups 1A and 1B) are broad-spectrum insecticides and have the potential to flare spider mite populations. Observe spider mites before and after treatments to determine if these populations increase. REI is 72 hours for girdling and tying. Injury may occur to grapes for applications made after bloom. Check for phytotoxicity in a small area before treating an entire field.
		Phosmet, IRAC 1B (Imidan 70W)	1.33 to 2.125 lb	14 days	7 (rates of 1.33 lb per acre or less) 14 (more than 1.33 lb per acre)	Do not apply more than 6.5 pounds Imidan (4.55 lb of phosmet) per acre per year.
		Fenpropathrin, IRAC 3 (Danitol 2.4EC)	10.66 to 21.33 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.
		Acetamiprid, IRAC 4A (Assail 30SG)	2.5 to 5.3 oz	12	3	Southeastern data for Assail on Japanese beetles are limited. Foliar applications of Group 4A insecticides should NOT be used following a long-acting soil application of any group 4A insecticide (i.e., Admire Pro, Venom, or Clutch). Do not exceed a total of 0.2 lb. active ingredient (10.6 oz. Assail) per acre per calendar year.
		Indoxacarb, IRAC 22 (Avaunt 30DG)	3.5 to 6 oz	12	7	Avaunt is also very effective against caterpillar pests such as cutworms and grape berry moth. Do not apply more than 12 oz Avaunt (0.22 lbs indoxacarb) per acre per year.
		Azadirectin, IRAC Unknown (Aza-Direct)	1 to 3.5 pt	4	0	Aza-Direct is **OMRI** listed. Data on Japanese beetle control are limited.
		Kaolin clay (Surround WP)	25 to 50 lb	4	0	Surround may delay fruit maturity, and therefore, anticipated harvest date. Fruit harvest characters should be carefully monitored if Surround is used to ensure timely harvest. Surround is **OMRI** listed.
Closing	Japanese beetle, Green June beetle	Same as **1st Cover**				
	Grape berry moth, Leafhopper/ sharpshooter (Pierce's Disease suppression)	Same as **Prebloom**				**Foliar applications of Group 4A insecticides should NOT be used following a long-acting soil application of any Group 4A insecticide (e.g., Admire Pro, Venom, or Clutch).** Current information indicates that in areas where Pierce's Disease is a problem, controlling leafhoppers and sharpshooters **through July** reduces the risk of Pierce's Disease. See labels for preharvest intervals.
2nd and Subsequent Cover Sprays (10- to 14-day intervals until the Preharvest Spray)	Phylloxera, Japanese and June beetles	Same as **1st Cover**				Check labels for preharvest intervals.
	Grape berry moth, Leafhopper/ sharpshooter (Pierce's Disease suppression)	Same as **Prebloom**				Current information indicates that in areas where Pierce's Disease is a problem, controlling leafhoppers and sharpshooters through July reduces the risk of Pierce's Disease. If Venom was applied as a soil treatment during prebloom, a second soil application is not permitted, but a foliar spray of Venom is permitted at this time. See label for further restrictions.
	Mites	Same as **Postbloom**				
	Grape rootworm, Southern grape rootworm	Grape rootworm larvae feed on roots. Adults are small, black weevils and make distinctive chain-like feeding markings on leaves. Foliar feeding does not result in yield reduction, but root feeding may reduce plant vigor over time. Treatments should be timed to adult activity, which typically peaks in June or July. Grape rootworms are sporadic pests in North Carolina and should not be treated preventatively.				
		Carbaryl, IRAC 1A (Sevin XLR Plus)	2 qt	48 hours for all activities except grape girdling and cane turning. EXCEPTION: the REI is 144 hours (6 days) for grape girdling and cane turning.	7	Do not apply more than a total of 10 quarts Sevin XLR Plus per acre per crop per year.
Preharvest (10 to 14 days before harvest)	Spotted wing drosophila	Spotted wing drosophila (SWD) do not necessarily cause significant damage in wine grapes. Growers are encouraged to monitor adult flies in vineyards and larvae in fruit and treat if present. Insecticides effective against SWD may also have activity against leafhoppers and beetle pests.				
		malathion IRAC 1B (Malathion 5EC)	3 pt	72 hours for girdling and tying; 24 hours for all other activities.	3	The maximum application rate is 1.88 lbs. active ingredient (3 pts. of this product) per acre; the maximum number of applications per year is 2; and the minimum retreatment interval is 14 days.
		beta-cyfluthrin, IRAC 3A (Baythroid XL)	2.4 to 3.2 fl oz	12	3	Do not apply more than 3.2 fluid oz Baythroid XL (0.025 lb cyfluthrin) per acre per 14 day period. Do not apply more than 12.8 fl oz Baythroid XL (0.1 lb cyfluthrin) per acre per crop season.
		fenpropathrin, IRAC 3A (Danitol 2.4EC)	10.66 to 21.33 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.

Table 6-6A. Bunch Grape Insect Management

When to Spray	Pest	Pesticide, IRAC, FRAC Code, and Formulation	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
Preharvest (10 to 14 days before harvest)	Spotted wing drosophila (continued)	zeta-cypermethrin, IRAC 3A (Mustang Maxx)	4 fl oz	12	1	Do not apply more than 24 fl oz of product per season.
		spinosad, IRAC 5 (Entrust SC)	4 to 8 fl oz	4	3	Do not apply more than 23 fl oz Entrust SC (0.36 lb spinosad) per acre per season. Entrust is OMRI listed.
		spinetoram, IRAC 5 (Delegate WG)	3 to 5 oz	4	3	Do not apply more than a total of 19.5 oz of Delegate WG (0.305 lb ai spinetoram) per acre per year.
	Grape root borer	Grape root borer is potentially the most significant pest of grapes in North Carolina, but they are not necessarily present in all vineyards. Grape root borer moths should be monitored with pheromone baited traps. Trap captures may begin in July and can continue through September. If moths are confirmed within a vineyard, mating disruption is the most effective control tool.				
		Mating disruption (Isomate GRB)	100 dispensers	NA	NA	Dispensers should be placed prior to the beginning of grape root borer moth flight activity and be left in the vineyard until the end of flight activity. Moth flight timing varies between vineyards but can be as early as July and last until October. Pheromone baited traps can help determine grape root borer populations and flight activity, but traps will not be effective if mating disruption is underway.
		Cultivation or soil mounding	NA	NA	NA	Use clean cultivation, mound soil (July 1 to Aug. 1 or at first moth emergence when using pheromone traps) or using tightly sealed plastic mulch 3 feet from the base of vines. This practice will inhibit adult emergence from the soil when well timed. Mounded soil needs to be removed by Sept. 1.
Harvest	Yellowjackets and bees	Check to make sure wasps are not nesting in vines. Spot treat or manually remove nests if present. Cover sprays for wasps or bees are not recommended, because treatments with short PHI will not provide control, and only foraging worker wasps or bees will be killed, leaving the rest of the nest for reinfestation. Damaged fruit should be removed to reduce attraction for other bees and wasps.				
	Spotted wing drosophila	See **Preharvest**				
	Multicolored Asian lady beetle	Multicolored Asian lady beetle, MALB, can be a contaminant pest at harvest. Sample at least 10 clusters per acre within a few days of harvest, place in a plastic bag for approximately 30 minutes and count beetles. Treatment thresholds vary by variety.				
		imidacloprid, IRAC 4A (Admire Pro)	1 to 1.4 fl oz	12	0	Several concentrations of imidacloprid (1.6F, 2F, 4F, and 4.6F) are available. Carefully read the label to determine the correct rate for target pests. Data on control with imidacloprid are limited.

More information

Bunch Grape Integrated Pest Management Guide, www.smallfruits.org.
NC State University Grape Portal, grapes.ces.ncsu.edu.

Bunch Grape Disease Management

S. M. Villani and W. O. Cline, Entomology and Plant Pathology

The Fungicide Resistance Action Committee (FRAC) groups fungicides into mode of action categories. These categories are listed following the pesticide and formulation names. To reduce the risk of resistance development, avoid successive applications of fungicides with the same FRAC code for the same pest. Some active ingredients are available in several formulations and under several trade names. For simplicity, the most common trade names and associated rates are listed. This is not intended to encourage the use of these products over generic versions.

Please Note: Pierce's Disease is caused by an endemic xylem-limited bacterial pathogen (*Xylella fastidiosa*). Fungicides are not effective against this disease. Suppression of Pierce's Disease relies on early- to mid-season use of insecticides to control leafhoppers and sharpshooters that transmit the pathogen from infected vines to nearby healthy vines. For suggestions on control of these insect vectors, see table 6-6A, Bunch Grape Insect Management.

Table 6-6B. Bunch Grape Disease Management Program

When to Spray and Disease/Pest	Pesticide, Formulation, and FRAC Code	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
Dormant Anthracnose, Black rot, Phomopsis	liquid lime sulfur, FRAC M2	10 gal	48	0	Needed only where anthracnose is a problem. Removal of mummies, rachises, and cankered/dead wood during the dormant period is most efficacious for reduction of black rot. A dormant application of lime sulfur may help reduce the overwintering inoculum of fungi that cause black rot and Phomopsis; however, in-season protection of young shoots is the best option.
Budburst Pierce's Disease	Various insecticides (see table 6-6A Insect Management)	--	--	--	See Bunch Grape Insect Management Table 6-6A for control of insect vectors (leafhoppers/sharpshooters) that spread Pierce's Disease bacteria (*Xylella fastidiosa)*.
New Shoots (7- to 10-day interval beginning at 1-inch shoot growth until Prebloom Spray) Phomopsis, Black rot, Powdery mildew, Downy mildew	mancozeb, FRAC M3 (various formulations) + sulfur (various formulations), FRAC M2	see label see label	24 24	66 0	The main target in the new shoot protection is Phomopsis. A powdery mildew fungicide is generally not needed in the first spray (1-inch shoot growth) unless the disease has been a problem in previous years. Sulfur will control powdery mildew and is a very economical option. Avoid sulfur on sulfur sensitive varieties. Some sulfur injury may occur on sulfur-tolerant varieties if the temperature exceeds 85ºF. The activity of sulfur is reduced at temperatures less than 65ºF. Do not mix sulfur and oil since it may result in injury.
Prebloom Phomopsis, Black rot, Powdery mildew, Downy mildew	mancozeb (various formulations) FRAC M3 *— PLUS —* sulfur (various brands), FRAC M2 *— PLUS (if conditions are favorable for powdery mildew development) —* quinoxyfen (Quintec 2SC) FRAC 43 *or* metrafenone (Vivando) 2.5SC), FRAC 48 *or* mefentrifluconazole (Cevya), FRAC 3 *or* myclobutanil (Rally 40 WSP), FRAC 3 *or* tebuconazole (Elite 45DF), FRAC 3 *or* triflumizole (Procure 480SC), FRAC 3 *or* tetraconazole (Mettle 125ME), FRAC 3 flutriafol (Rhyme), FRAC 3	see label see label 4 to 6.6 fl oz 10.3 to 15.4 fl oz 4 to 5 fl oz 3 to 5 oz 4 oz 4 to 8 fl oz 3 to 5 fl oz 4 to 5 fl oz	24 24 12 12 12 24 12 12 12 12*	66 0 21 14 14 14 14 7 14 7	Fungicide applications during the pre-bloom period are amongst the most important for powdery mildew, phomopsis, downy mildew, and black rot control. Where black rot is a problem, combine mancozeb with a sterol inhibiting fungicide (FRAC 3, aka DMI, SI fungicides). Captan is weak on black rot. Myclobutanil and tebuconazole are more active on black rot than triflumizole. To minimize the risk of resistance of the powdery mildew fungus to sterol inhibiting (SI fungicides, FRAC 3), limit use to 2 to 3 applications per season, use the maximum labeled rate and combine with sulfur. Note: quinoxyfen and metrafenone will work only against powdery mildew. Use lower rate of quinoxyfen with 14 day spray interval. FRAC 3 (DMI) fungicides do not have activity against downy mildew. Make sure to include a downy mildew fungicide in the tank mixture if applying a FRAC 3 during this application. *REI is 5 days for cane work.

Table 6-6B. Bunch Grape Disease Management Program

When to Spray and Disease/Pest	Pesticide, Formulation, and FRAC Code	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
Prebloom Phomopsis, Black rot, Powdery mildew, Downy mildew (continued)	*or* mancozeb (various formulations), FRAC M3	see label	24	66	**This section shows other options for management for Phomopsis, black rot, powdery mildew, and downy mildew.** **Resistant isolates of the pathogens causing downy mildew and powdery mildew to the QoI fungicides (Abound, Flint, Sovran, or Pristine) are widespread in the mid-Atlantic grape growing region. Do not rely on them for downy mildew and powdery mildew control. To help minimize risk of resistance, tank mix QoI fungicides with sulfur (but not on sulfur-sensitive varieties).**
	— PLUS — sulfur (various brands), FRAC M2	see label	24	0	
	— PLUS — azoxystrobin (Abound), FRAC 11	10 to 15.5 fl oz	4	14	Do not make more than 2 sequential applications of Flint, Sovran, Abound, Pristine, or Luna Experience before rotating to a non-QoI fungicide.
	or kresoxim-methyl (Sovran 50 WG), FRAC 11	3.2 to 6.4 oz	12	14	For both Pristine and Luna Experience, REI is 12 hours, but for cane work, REI is 5 days. See labels regarding phytotoxicity warnings for Pristine to Concord, Worden, Fredonia, or other *V. labrusca* or *V. labrusca* hybrids.
	or trifloxystrobin (Flint Extra), FRAC 11	3.0 to 3.8 fl oz	12	14	
	or mandestrobin (Intuity), FRAC 11	6 fl oz	12	10	These combination materials (Revus Top and Luna Experience) can be used by themselves; however, it is better to tank mix with broad-spectrum materials such as mancozeb, captan, and sulfur in order to minimize the risk of fungicide resistance development in your field.
	or boscalid + pyraclostrobin (Pristine 38W), FRAC 7 + 11	8 to 12.5 oz	12*	14	
	or azoxystrobin + Flutriafol FRAC 11 + 3 (Topguard EQ)	5 to 8 oz	12*	14	**A fungicide with downy mildew activity must be added to Inspire Super in this spray.** Do not apply more than 80 fluid ounces/acre per season.
	or mandipropamid, + difenoconazole, FRAC 40 + 3 (Revus Top)	7.0 fl oz	12	14	Do not make more than 2 sequential applications of Luna Experience or any other Group 7 or Group 3 fungicide before rotating to a fungicide in another group.
	or difenoconazole + cyprodinil (Inspire Super) FRAC 3 + 9	16 to 20 fl oz	12	14	Although Aprovia and Rhyme contain the same FRAC group as Botrytis fungicides, it does not have a label for Botrytis due to fungicide resistance risks.
	or fluopyram + tebuconazole (Luna Experience) FRAC 7+3	6 to 8.6 fl oz	12*	14	*REI is 5 days for cane work
	or benzovindiflupyr (Aprovia) FRAC 7	8.6 to 10.5 fl oz	12	21	Minimum retreatment interval is 14 days
	or benzovindiflupyr + difenoconazole (Aprovia Top) FRAC 7+3	8.5 to 13.3 fl oz	12	21	
	or flutianil (Gatten) FRAC U13	6.4 fl oz	12	14	Gatten is only labeled for powdery mildew. Combine with another fungicide (e.g, mancozeb) for control of other disease.
	or pydiflumetofen + fludioxonil (Miravis Prime) FRAC 7 + 12	9.2 to 13.4 fl oz	12	14	Do not make more than 2 applications of Miravis Prime at the highest rate per year.
Prebloom Downy mildew specific materials (not listed above)	mefenoxam + mancozeb (Ridomil Gold MZ), FRAC 4 + M3	2.5 lb	48	66	Ridomil MZ contains mefenoxam + mancozeb. Note: Use Ridomil products only when the environmental condition is strongly favoring downy mildew development. They have a very good kick-back activity; however, they are at high risk for resistance development.
	or zoxamide + mancozeb (Gavel 75 DF), FRAC 22 + M3	2 to 2.5 lb	48	66	Gavel 75 DF contains zoxamide + mancozeb.
	or mandipropamid (Revus), FRAC 40	8 fl oz	4	14	Revus products are very good protective materials for downy mildew, but they do not have any curative activity.
	or fenamidone (Reason 500SC), FRAC 11	2.7 fl oz	12	30	Do not add a crop oil to Revus if the Revus application is within 2 weeks of a sulfur or captan application.
	or cyazofamid (Ranman) FRAC 21	2.1 to 2.75 fl oz	12	30	
	or ametoctradin + dimethomorph (Zampro) FRAC 45+40	11 to 14 fl oz	12	14	
	or				

Table 6-6B. Bunch Grape Disease Management Program

When to Spray and Disease/Pest	Pesticide, Formulation, and FRAC Code	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
Prebloom Downy mildew specific materials (not listed above) (continued)	Phosphorous acid (e.g., phosphonate) Phostrol, Agri-Fos, Prophyt, FRAC P07	Please see the label	4	0	These phosphorus acid-based products have pre- and post-symptom activity, providing approximately 7 days protectant activity. They all have a 0-day PHI. Do not exceed a 0.6% spray solution concentration of Prophyt. Use lower rate of Agri-Fos in 100 gallons water per acre early in season, and higher rates in 150 to 200 gallons of water per acre in late season and when the canopy is thick. Other phosphorous acid (aka phosphite) fungicides may be available. See label for correct rates.
Prebloom Pierce's Disease	Various insecticides (see table 6-6A Insect Management)	--	--	--	See Bunch Grape Insect Management Table 6-6A for control of insect vectors (leafhoppers/sharpshooters) that spread Pierce's Disease bacteria (*Xylella fastidiosa)*.
Bloom Phomopsis, Black rot, Powdery mildew	See **Prebloom** recommendations				A bloom spray should be made if the time interval between the last prebloom spray and the postbloom spray is more than 10 days. Note: if you have historical issues with ripe rot or bitter rot, mix either captan, a QoI (FRAC 11), or mancozeb to your bloom application.
Bloom Botrytis	iprodione (various formulations), FRAC 2	See label	48	7	A spray for Botrytis during bloom may be beneficial in wet seasons and in vineyards with a Botrytis problem. Elevate, Endura, Iprodione, Inspire Super, Luna Experience, Vangard. should be rotated through the season to avoid resistance development. (Note: make sure to rotate FRAC code. The Botrytis fungus is known for developing fungicide resistance.) See product labels for complete information on resistance management and use restrictions.
	or				
	cyprodinil (Vangard 75 WG), FRAC 9	5 to 10 oz	12	7	
	or				
	fenhexamid (Elevate 50 WDG), FRAC 9	1 lb	12	0	
	or				
	pyrimethanil (Scala SC), FRAC 17	9 to 18 fl oz	12	7	Rate of Vangard and Scala depends on whether each is applied alone or in tank mixture with another fungicide. See label for specifics.
	or				
	boscalid (Endura 30W), FRAC 7	8 oz	12	14	Endura, Kenja, Inspire Super, and Luna Experience will also control powdery mildew.
	or				
	isofetamid (Kenja 400SC), FRAC 7	20 to 22 fl oz	12	14	**A fungicide with downy mildew activity must be added to Inspire Super in this spray.** Do not apply more than 80 fluid ounces/acre per season.
	or				
	difenoconazole + cyprodinil (Inspire Super) FRAC 3 + 9	16 to 20 fl oz	12	14	
	or				
	fluopyram + tebuconazole (Luna Experience) FRAC 7+3	6 to 8.6 fl oz	12 (5 days for cane work)	14	See labels regarding phytotoxicity warnings for Concord, Worden, Fredonia, or other *V. labrusca* or *V. labrusca* hybrids.
	or				
	boscalid + pyraclostrobin (Pristine WG), FRAC 7 + 11	18.5 to 23 oz	12 (5 days for cane work)	14	
	or				
	cyprodinil + fludioxonil (Switch 62.5 EG) FRAC 9+12	11 to 14 oz	12	7	
	or				
	pydiflumetofen + fludioxonil (Miravis Prime) FRAC 7 + 12	10.3 to 13.4 fl oz	12	14	For greatest control against gray mold, apply at the highest rate. Only 2 applications at this rate can be made per season.

Table 6-6B. Bunch Grape Disease Management Program

When to Spray and Disease/Pest	Pesticide, Formulation, and FRAC Code	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
Postbloom (7 to 10 days after the Prebloom Spray) Phomopsis, Black rot, Powdery mildew, Downy mildew, Bitter rot, Ripe rot	mancozeb (various formulations) FRAC M3	See label	24	66	During the postbloom period, berries are susceptible to black rot, powdery mildew, and downy mildew infection. Continue to apply mancozeb and sulfur as the backbone of your fungicide program and tank mix with an appropriate single-site chemistry.
	+				
	sulfur (various brands), FRAC M2	See label	24	0	For specific downy mildew products refer back to the **prebloom section.**
					See labels regarding phytotoxicity warnings for Concord, Worden, Fredonia, or other *V. labrusca* or *V. labrusca* hybrids and also for sulfur-sensitive varieties.
	PLUS one of the following (FRAC 3)				
	mefentrifluconazole (Cevya), FRAC 3	4 to 5 fl oz	12	14	
	or				
	myclobutanil (Rally 40WSP), FRAC 3	3 to 5 oz	24	14	
	or				
	tebuconazole (Elite 45DF), FRAC 3	4 oz	12	14	
	or				
	triflumizole (Procure 480SC), FRAC 3	4 to 8 fl oz	12	14	
	or				
	tetraconazole (Mettle 125ME), FRAC 3	3 to 5 fl oz	12	14	
	or				
	flutriafol (Rhyme) FRAC 3	4 to 5 fl oz	12 (5 days for cane work)	14	
	or				
	flutianil (Gatten) FRAC U13	6.4 fl oz	12	14	Gatten is only labeled for powdery mildew. Combine with another fungicide (e.g., mancozeb) for control of other disease.
	+				
	mancozeb (various formulations) FRAC M3	See label	24	66	
	or				
	mancozeb (various formulations) FRAC M3	See label	24	0	
	+				
	sulfur (various brands), FRAC M2				
	PLUS one of the following (FRAC 11)				
	azoxystrobin (Abound), FRAC 11	10 to 15.5 fl oz	4	14	
	or				
	kresoxim-methyl (Sovran 50WG) FRAC 11	3.2 to 6.4 oz	12	14	
	or				
	trifloxystrobin (Flint Extra), FRAC 11	3.0 to 3.8 fl oz	12	14	
	or				
	mandestrobin (Intuity), FRAC 11	6 fl oz	12	10	
	or				
	PLUS one of the following (pre-mixed formulations)				
	azoxystrobin + flutriafol (Topguard EQ), FRAC 11 + 3	5 to 8 fl oz	12 (5 days for cane work)	14	
	or				
	boscalid + pyraclostrobin (Pristine WG), FRAC 7 + 11	8 to 12.5 oz	12 (5 days for cane work)	14	
	or				
	pydiflumetofen + fludioxonil (Miravis Prime) FRAC 7 + 12	9.2 to 13.4 fl oz	12	14	
Postbloom Pierce's Disease	Various insecticides (see table 6-6A Insect Management)	--	--	--	See Bunch Grape Insect Management Table 6-6A for control of insect vectors (leafhoppers/sharpshooters) that spread Pierce's Disease bacteria (*Xylella fastidiosa)*.

Table 6-6B. Bunch Grape Disease Management Program

When to Spray and Disease/Pest	Pesticide, Formulation, and FRAC Code	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
1st Cover Spray (7 to 10 days after Postbloom Spray) Phomopsis, Black rot, Powdery mildew, Downy mildew, Bitter rot, Ripe rot	See **Postbloom** recommendations				**Note:** There is a 66-day PHI for mancozeb. Use captan in place of mancozeb in the last half of the season.
1st Cover Pierce's Disease	Various insecticides (see table 6-6A Insect Management)	--	--	--	See Bunch Grape Insect Management Table 6-6A for control of insect vectors (leafhoppers/sharpshooters) that spread Pierce's Disease bacteria (*Xylella fastidiosa)*.
Closing Botrytis fruit rot	See **Bloom recommendations**				At closing, add Elevate, Endura, Rovral, or Vangard to the appropriate cover spray for Botrytis control. See Bloom Spray for information on resistance management when using Elevate, Endura, Rovral, and Vangard.
Closing Pierce's Disease	Various insecticides (see table 6-6A Insect Management)	--	--	--	See Bunch Grape Insect Management Table 6-6A for control of insect vectors (leafhoppers/sharpshooters) that spread Pierce's Disease bacteria (*Xylella fastidiosa)*.
2nd and Subsequent Cover Sprays (10- to 14-day intervals until the Preharvest Spray) Ripe rot, Bitter rot	captan (various formulations), FRAC M4	See label	See label	0	If additional sprays are needed for powdery mildew control, use sulfur. On sulfur-intolerant varieties and when temperatures exceed 85ºF, use an SI fungicide (Rally, Elite, Procure, Rubigan, or Vivando) in rotation with quinoxyfen (Quintec 2 SC) to keep resistance from developing.
	+ sulfur (various formulations), FRAC M2	See label	24	0	
	+ Additional fungicides for powdery mildew, downy mildew, or ripe rot control (see **postbloom** recommendations)				
2nd Cover Pierce's Disease	Various insecticides (see table 6-6A Insect Management)	--	--	--	See Bunch Grape Insect Management Table 6-6A for control of insect vectors (leafhoppers/sharpshooters) that spread Pierce's Disease bacteria (*Xylella fastidiosa)*.
Veraison Botrytis	Same as **Bloom Spray**				Switch may reduce the severity of sour rot. Please make sure to rotate mode of action groups against Botrytis.
Preharvest (10 to 14 days before harvest) Ripe rot, Bitter rot, Botrytis	captan (various formulations), FRAC M4	See label	See label	0	The REI for captan varies with trade name.
	PLUS one of the following				
	iprodione (various formulations), FRAC 2; 50 WP or 4 F	See label	12	7	
	or cyprodinil (Vangard 75 WG), FRAC 9	10 oz	12	7	
	or fenhexamid (Elevate 50 WDG), FRAC 17	1 lb	12	0	
	or pyrimethanil (Scala SC), FRAC 9	18 fl oz	12	7	
	or boscalid (Endura 30W), FRAC7	8 oz	12	14	
	or cyprodinil + fludioxonil (Switch 62.5 WDG), FRAC 7 + 12	11 to 14 oz	12	7	
	or azoxystrobin (Abound 2 SC), FRAC11	11 to 15.4 fl oz	4	14	
	or kresoxim-methyl (Sovran 50 WG), FRAC 11	3.2 to 6.4 oz	12	14	See Pristine label for additional re-entry restrictions.
	or trifloxystrobin (Flint Extra), FRAC 11	3.8 fl oz	12	14	
	or boscalid + pyraclostrobin (Pristine 38W), FRAC 7 + 11	18.5 to 23 oz	12	14	
	or pydiflumetofen + fludioxonil (Miravis Prime) FRAC 7 + 12	13.4 fl oz	12	14	For greatest control against gray mold, apply at the highest rate. Only 2 applications at this rate can be made per season.

Table 6-6B. Bunch Grape Disease Management Program

When to Spray and Disease/Pest	Pesticide, Formulation, and FRAC Code	Amount of Formulation to Use per Acre	Reentry Interval (REI) (hours)	Preharvest Interval (PHI) (days)	Precautions and Remarks
Preharvest (10 to 14 days before harvest) Downy mildew	Prophyt, FRAC 33 *or* Phostrol, FRAC 33 *or* Agri-Fos, FRAC 33 *or* mandipropamid (Revus), FRAC 40	2.4 pt 2.5 to 5 pt 1.5 to 2.5 qt 8 fl oz	4 4 4 4	0 0 0 14	Phosphite fungicides are not very good protectants, but they have pre- and post-symptom activity. All have a 0-day PHI. Other phosphite fungicides may be available. Do not exceed a 0.6% spray solution concentration of Prophyt. Use higher rate of Agri-Fos in 150 to 200 gallons of water per acre late in the season when the canopy is thick. Other phosphorous acid (aka phosphite) fungicides may be available. Check label for correct rates.
Postharvest (14- to 21-day intervals from harvest until first killing frost) Downy mildew	copper compounds (various formulations), FRAC M1 *or* mancozeb, FRAC M3 75 DF, or 80 WP	See label 1.5 to 4 lb	See label 24		Premature defoliation may predispose vines to winter injury. Use shorter spray intervals when conditions are favorable for disease development. Copper may cause injury under cool, slow-drying conditions. Use mancozeb on copper sensitive varieties for downy mildew control. Use JMS Stylet Oil for powdery mildew control on sulfur-sensitive varieties. Do not use captan, sulfur, or copper within 2 weeks of a JMS Stylet Oil application. Prophyt or Phostrol can also be used for downy mildew control.
Postharvest (14- to 21-day intervals from harvest until first killing frost) Powdery mildew	sulfur (various formulations), FRAC M2 *or* JMS Stylet Oil, FRAC NC	See label 1.5 to 2% 1 to 2 gallons	See label 4		

For further information, see www.smallfruits.org.

Muscadine Disease Management Program

W. O. Cline, Entomology and Plant Pathology

For effective disease control, commercial growers should apply fungicides every two weeks from mid-May through mid-July, beginning prior to the onset of disease symptoms. Apply fungicides in sufficient water for thorough coverage – depending on sprayer type, for mature muscadine vineyards this may require 75-100 gallons of water per acre. Fungicides are generally not necessary in home plantings.

The Fungicide Resistance Action Committee (FRAC) groups fungicides into mode of action (MOA) categories. These categories are listed following the pesticide and formulation names. To reduce the risk of resistance development, avoid successive applications of products with the same MOA for the same pest. Organically acceptable insecticides (OMRI listed) are indicated in Precautions and Remarks.

Table 6-7A. Muscadine Disease Management Program

Timing	Pest(s)	Pesticide and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Minimum Interval Between Application and Harvest; Preharvest Interval (PHI)	Precautions and Remarks
Shoots 6 to 10 inches	Black rot, Bitter rot, Angular leaf spot, Powdery mildew	azoxystrobin, FRAC 11 (Abound 2.08 SC)	11 to 15.4 fl oz	4 hrs	14 days	Do not make more than 2 sequential applications of strobilurin fungicides (Abound, Flint, or Pristine) before alternating with nonstrobilurin fungicides (Captan, Nova, Rally, or Topsin M).
		myclobutanil, FRAC 3 (Nova, Rally 40 W)	3 to 5 oz	24 hrs	14 days	
		captan, FRAC M4 (Captan 50 WP)	2 to 4 lb	48 hrs	2 days (re-entry). See label	Do not combine with EC or WP formulations unless previous experience has proven them to be compatible and safe to plants. Damage has been observed in blueberries when captan has been applied in tank mixes or immediately before or after EC or oil formulations.
		captan, FRAC M4 (Captec 4L)	2 qt	48 hrs	2 days (re-entry). See label	Do not combine with EC or WP formulations unless previous experience has proven them to be compatible and safe to plants. Damage has been observed in blueberries when captan has been applied in tank mixes or immediately before or after EC or oil formulations.
		pyraclostrobin + boscalid, FRAC 11+7 (Pristine 38 W)	8 to 12.5 oz*	12 hrs/5 days	14 days	The REI for Pristine is 12 hours for all crop uses except cane tying, cane turning or cane girdling. These operations, not normally performed on muscadines, require a 5 day (5d) re-entry interval. *Recommended rates; higher rates up to 23 ounces per acre can be used when disease pressure is high.
		thiophanate-methyl, FRAC 1 (Topsin M70 WSB)	1 to 1.5 lb	48 hrs	7 days	
		trifloxystrobin, FRAC 11 (Flint 50 WG)	2 oz	12 hrs	14 days	Do not apply Flint fungicide to Concord grapes or injury may occur.
		EBDCs, FRAC M3 (Manzate Prostick, Penncozeb 75 DF, Dithane M45)	1.5 to 4 lb	24 hrs	66 days	Cannot be used within 66 days of harvest.
		triflumizole, FRAC 3 (Procure 480SC)	4-8 fl oz	12 hrs	7 days	Do not apply more than a total of 4 applications of Procure 480SC per crop per year. Do not apply more than a total of 32 fl oz (1 .0 lb ai) per crop per year. Apply in a minimum of 50 GPA.
		fluopyram + tebuconazole FRAC 3+7 (Luna Experience)	6-8.6 fl oz	12 hrs*	14 days	*Re-entry interval is 5 days for cane tying and training activities. Rotate to a different MOA after two applications.
		benzovendiflupyr FRAC 7 (Aprovia)	10.5 fl oz	12 hrs	21 days	Do not exceed 3 applications per year.
		isofetamid FRAC 7 (Kenja 400SC)	20-22 fl oz	12 hrs	14 days	Rotate to a different MOA after two applications. Do not apply a third application within 28 days of the second application.
		azoxystrobin + flutriafol FRAC 3+11 (Topguard EQ)	5-8 fl oz	12 hrs*	14 days	Re-entry interval if 5 days for cane tying and girdling activities.
		fluxapyroxad + pyraclostrobin FRAC 7+11 (Mervion)	4-5.5 fl oz	12 hrs	14 days	Do not tank mix with any other product. May cause injury on certain bunch grape cultivars, see label.
		cyprodinil + fludioxonil FRAC 9+12 (Switch 62.5WG)	11-14 oz	12 hrs	7 days	Do not make more than two applications by air.
		pydiflumetofen + fludioxonil FRAC 7+12 (Miravis Prime)	9.2-13.4 fl oz	12 hrs	14 days	Apply on a 21-day interval. Do not make more than two applications at the maximum rate.
		Triflumizole, FRAC 3 (Procure 480SC)	4-8 fl oz	12 hrs	7 days	Do not apply more than a total of 4 applications of Procure 480SC per crop per year. Do not apply more than a total of 32 fl oz (1 .0 lb ai) per crop per year. Apply in a minimum of 50 GPA.
	Powdery mildew only	wettable sulfur, FRAC M2 (Microthiol, other brands) 80 to 92% S	2 to 5 lb	24 hrs	1	Must be applied every 7 to 10 days. Dilute sulfur in 100 gallons of water per acre. Sulfur corrodes sprayers and trellis wires.

Table 6-7A. Muscadine Disease Management Program

Timing	Pest(s)	Pesticide and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Minimum Interval Between Application and Harvest; Preharvest Interval (PHI)	Precautions and Remarks
Bloom	Black rot, Bitter rot, Angular leaf spot, Powdery mildew	Same as **Shoots 6 to 10 inches** recommendations				
	Fruit rots, Sooty blotch	The bronze fresh-market cultivar 'Fry' is susceptible to sooty blotch.				
		azoxystrobin, FRAC 11 (Abound 2.08 SC)	11 to 15.4 fl oz	4 hrs	14	Do not make more than 2 sequential applications of strobilurin fungicides (Abound, Flint, or Pristine) before alternating with nonstrobilurin fungicides (Captan, Nova, Rally, or Topsin M).
		captan, FRAC M4 (Captan 50 WP) (Captec 4L)	2 to 4 lb	48 hrs	2 (re-entry)	Do not combine with EC or WP formulations unless previous experience has proven them to be compatible and safe to plants. Damage has been observed in blueberries when captan has been applied in tank mixes or immediately before or after EC or oil formulations.
		captan, FRAC M4 (Captec 4L)	2 qt	48 hrs	2 (re-entry)	Do not combine with EC or WP formulations unless previous experience has proven them to be compatible and safe to plants. Damage has been observed in blueberries when captan has been applied in tank mixes or immediately before or after EC or oil formulations.
		pyraclostrobin + boscalid, FRAC 11+7 (Pristine 38 W)	8 to 12.5 oz	12 hrs/5 days	14	The REI for Pristine is 12 hours for all crop uses except cane tying, cane turning or cane girdling. These operations, not normally performed on muscadines, require a 5 day (5d) re-entry interval.
		trifloxystrobin, FRAC 11 (Flint 50 WG)	2 oz	12 hrs	14	Do not make more than 2 sequential applications of strobilurin fungicides (Abound, Flint, or Pristine) before alternating with nonstrobilurin fungicides (Captan, Nova, Rally, or Topsin M). Do not apply Flint fungicide to Concord grapes or injury may occur.
		triflumizole, FRAC 3 (Procure 480SC)	4-8 fl oz	12 hrs	7 days	Do not apply more than a total of 4 applications of Procure 480SC per crop per year. Do not apply more than a total of 32 fl oz (1 .0 lb ai) per crop per year. Apply in a minimum of 50 GPA.
		fluopyram + tebuconazole FRAC 3+7 (Luna Experience)	6-8.6 fl oz	12 hrs*	14 days	*Re-entry interval is 5 days for cane tying and training activities. Rotate to a different MOA after two applications.
		benzovendiflupyr FRAC 7 (Aprovia)	10.5 fl oz	12 hrs	21 days	Do not exceed 3 applications per year.
		isofetamid FRAC 7 (Kenja 400SC)	20-22 fl oz	12 hrs	14 days	Rotate to a different MOA after two applications. Do not apply a third application within 28 days of the second application.
		azoxystrobin + flutriafol FRAC 3+11 (Topguard EQ)	5-8 fl oz	12 hrs*	14 days	Re-entry interval if 5 days for cane tying and girdling activities.
		fluxapyroxad + pyraclostrobin FRAC 7+11 (Mervion)	4-5.5 fl oz	12 hrs	14 days	Do not tank mix with any other product. May cause injury on certain bunch grape cultivars, see label.
		cyprodinil + fludioxonil FRAC 9+12 (Switch 62.5WG)	11-14 oz	12 hrs	7 days	Do not make more than two applications by air.
		pydiflumetofen + fludioxonil FRAC 7+12 (Miravis Prime)	9.2-13.4 fl oz	12 hrs	14 days	Apply on a 21-day interval. Do not make more than two applications at the maximum rate.
Every 2 weeks until harvest	Same as sprays for BLOOM					Tank mix Topsin M or Nova, Rally with Captan or Captec, OR alternate Topsin M or Nova, Rally with Abound, Flint, or Pristine.

Relative Effectiveness of Various Fungicides for Muscadine Grape Disease Control

Table 6-7B. Relative Effectiveness of Various Fungicides for Muscadine Grape Disease Control (E = excellent, VG = very good, G = good, F = fair, P = poor, NA = not recommended, UN = control unknown) These ratings are benchmarks, actual performance will vary.

Fungicide	PHI (days)	FRAC MOA	Bitter rot	Powdery mildew	Ripe rot	Macro-phoma rot	Black rot	Sooty blotch	Dead arm	Angular leaf spot
thiophanate-methyl **(Topsin- M)**	7 days	1	G	G	F	G	G	G	F	G
myclobutanil **(Rally)**	14 days	3	G	VG	NA	G	VG	G	UN	VG
triflumizole **(Procure)**	7 days	3	VG	VG	UN	VG	VG	UN	UN	VG
fluopyram + tebuconazole **(Luna Experience)**	14 days	3+7	VG	VG	UN	G	VG	UN	UN	E
benzovendiflupyr **(Aprovia)**	21 days	7	VG	UN	G	VG	VG	UN	UN	VG
isofetamid **(Kenja)**	14 days	7	VG	VG	G	E	VG	UN	UN	VG
azoxystrobin + flutriafol **(Topguard EQ)**	14 days	3+11	E	VG	G	VG	VG	UN	UN	E
fluxapyroxad + pyraclostrobin **(Mervion)**	14 days	7+11	E	VG	VG	VG	VG	UN	UN	E
pyraclostrobin + boscalid **(Pristine)**	14 days	7+11	G	VG	VG	E	VG	E	F	VG
kresoxim-methyl **(Sovran)**	14 days	11	G	G	G	G	G	G	F	G
azoxystrobin **(Abound)**	14 days	11	G	VG	VG	VG	VG	VG	F	VG
trifloxystrobin **(Flint Extra)**	14 days	11	G	VG	VG	E	VG	E	F	G
cyprodinil + fludioxonil **(Switch)**	7 days	9+12	E	VG	VG	E	VG	UN	UN	G
pydiflumetofen + fludioxonil (**Miravis Prime**)	14 days	7+12	E	VG	VG	E	VG	UN	UN	VG
copper oxychloride + copper hydroxide **(Badge)**	0 day (48 hrs re-entry)	M 1	NA	G	NA	NA	G	UN	UN	VG
wettable sulfur (**Microthiol** and other trade names)	0 day (24 hrs re-entry)	M 2	NA	VG	NA	NA	NA	F	NA	NA
Mancozeb + Zoxamide **(Gavel)**	66 days	22+M3	G	G	NA	G	G	UN	UN	G
Ziram **(Ziram)**	21 days	M 3	G	G	G	G	G	G	F	G
Captan **(Captan, Captec)**	0 days (72 hrs re-entry)	M 4	G	G	VG	G	G	G	F	G
EBDCs (includes **Maneb, Manex, Penncozeb, Manzate, Dithane M-45**)	66 days	M 3	G	G	G	G	G	G	F	G

Muscadine Insect Management

H. J. Burrack, L. J. Kraft, and M. H. Favre, Entomology and Plant Pathology

Insect management differs from disease management because some insect injury can be tolerated before economic damage occurs. Apply insecticides only if potentially damaging populations are present. Sampling techniques and tools are described when available. The Insecticide Resistance Action Committee (IRAC) groups insecticides into mode of action (MOA) categories. These categories are listed following the pesticide and formulation names. To reduce the risk of resistance development, avoid successive applications of products with the same MOA for the same pest. Organically acceptable insecticides (OMRI listed) are indicated in Precautions and Remarks.

Many insecticide active ingredients come in several formulations, or generic versions of the same formulation. In general, information is provided for the most commonly used formulations of active ingredients available in multiple formulations. Carefully check the label of the product you plan to use in the event that it differs from those listed. The label is the law!

Table 6-7C. Muscadine Insect Management

Pest	Pesticide and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI), hours unless otherwise noted	Minimum Interval Between Application and Harvest; Preharvest interval (PHI), days	Precautions and Remarks
Aphids	Aphids are not common pests in North Carolina muscadines and are typically only problematic in spring on new growth. Aphid populations in late summer do not typically justify treatment. Treatment is only justified when sooty mold is present or new growth is deformed.				
	acetamiprid, IRAC 4A (Assail 30SG)	2.5 to 5.3 oz	12	3	Do not exceed a total of 0.2 lbs active ingredient (10.6 oz product) per acre per calendar year.
	imidacloprid, IRAC 4A (Admire Pro)	1 to 1.4 fl oz	12	0	There are many formulations of imidacloprid. Read labels carefully for rate information.
	fenpropathrin, IRAC 3 (Danitol 2.4EC)	10.66 to 21.33 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.
Climbing Cutworms	Scout for cutworm if damaged buds are observed. Look for cutworms at night. Cutworm treatment may be justified if greater than 4% of the buds examined are damaged and the variety does not have fruitful secondary buds. Spray in the evening if possible as cutworms are active at night. **Only treat if cutworms are present.**				
	Bacillus thuringiensis (Bt), IRAC 11 (many formulations)	rates vary	4	0	Many Bt formulations are OMRI listed.
	carbaryl, IRAC 1A (Sevin XLR Plus)	1 to 2 qt	48 hours for all activities except cane turning. EXCEPTION: the REI is 144 hours (6 days) for cane turning.	7	Do not apply more than a total of 10 quarts Sevin XLR Plus per acre per crop per year.
	chlorantraniliprole IRAC 28 (Altacor)	3 to 4.5 oz	4	14	Use between 100 to 200 gallons per acre total spray volume. Do not apply more than 9 oz of Altacor or 0.2 lbs active ingredient of chlorantraniliprole containing products per acre per calendar year.
	fenpropathrin, IRAC 3 (Danitol 2.4EC)	10.66 to 21.33 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.
	methoxyfenozide, IRAC 18 (Intrepid 2F)	8 to 16 fl oz	4	21 to 30, depending on application rate	Minimum application for airblast sprayers of 40 gpa. Do not apply more than a total of 48 fl oz of Intrepid 2F (0.75 lb ai) per acre per year.
	spinosad, IRAC 5 (Entrust SC) (Entrust Naturalyte)	4 to 8 fl oz 1.25 to 2.5 oz	4	3	Do not apply more than 23 fl oz Entrust SC or 7.2 oz of Entrust Naturalyte (0.36 lb spinosad) per acre per season. Entrust is OMRI listed.
	spinetoram, IRAC 5 (Delegate WG)	3 to 5 oz	4	3	Do not exceed more than 5 applications of Delegate per year or 19.5 oz (0.305 lb ai of spinetoram) per acre per year.
Grape Berry Moth	Grape berry moth is present in NC and can occasionally damage muscadine grapes, but it is not uniformly distributed in the state. If grape berry moth presence is suspected, observe flowers and fruit for injury and consider monitoring moths with pheromone baited traps. Treatments are most effective when timed to egg hatch as predicted by pheromone trap captures.				
	bifenthrin, IRAC 3 (Brigade 2EC)	3.2 to 6.4 fl oz	12	30	There are many generic formulations of bifenthrin. Do not make more than one application per year.
	bifenthrin + imidacloprid, IRAC 3 + 4A (Brigadier)	5.1 to 6.4 fl oz	12	30	Do not apply more than 12.8 fl oz (0.10 lb of imidacloprid, 0.10 lb of bifenthrin) per acre per year as a foliar application.
	indoxacarb IRAC 22 (Avaunt 30DG)	5 to 6 oz	12	7	Do not apply more than 12 oz Avaunt or 0.22 lbs AI Indoxacarb per acre per year
	methoxyfenozide, IRAC 18 (Intrepid 2F)	8 to 16 fl oz	4	21 to 30, depending on application rate	Minimum application of Intrepid for airblast sprayers is 40 gallons per acre. Do not apply more than a total of 48 fl oz of Intrepid 2F (0.75 lb ai) per acre per year.
	spinosad, IRAC 5 (Entrust Naturalyte) (Entrust SC)	1.25 to 2.5 oz 4 to 8 fl oz	4	3	Entrust is **OMRI** listed. Do not apply more than 23 fl oz Entrust SC or 7.2 oz of Entrust Naturalyte (0.36 lb spinosad) per acre per season. Entrust is OMRI listed.
	phosmet, IRAC 1B (Imidan 70 W)	1.33 to 2.125 lb	14 days	7 (rates of 1.33 lb per acre or less) 14 (more than 1.33 lb per acre)	Do not apply more than 6.5 pounds Imidan (4.55 lb of phosmet) per acre per year.
	fenpropathrin, IRAC 3 (Danitol 2.4EC)	10.66 to 21.33 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.

Table 6-7C. Muscadine Insect Management

Pest	Pesticide and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI), hours unless otherwise noted	Minimum Interval Between Application and Harvest; Preharvest interval (PHI), days	Precautions and Remarks
Grape Berry Moth (continued)	chlorantraniliprole IRAC 28 (Altacor)	2 to 4.5 fl oz	4	14	Use between 100 to 200 gallons per acre total spray volume. Do not apply more than 9 oz of Altacor or 0.2 lbs active ingredient of chlorantraniliprole containing products per acre per year.
Grape Flea Beetle	Grape flea beetle larvae feed on developing buds during bud swell. If greater than 4% of buds observed are damaged by grape flea beetles, treatment may be justified. Apply only if damaging numbers of adult beetles are present.				
	bifenthrin + imidacloprid, IRAC 3 + 4A (Brigadier)	3.8 to 6.4 fl oz	12	30	Do not apply more than 12.8 fl oz (0.10 lb of imidacloprid, 0.10 lb of bifenthrin) per acre per year as a foliar application.
	carbaryl, IRAC 1A (Sevin XLR Plus)	1 to 2 qt	48 hours for all activities except cane turning. EXCEPTION: the REI is 144 hours (6 days) for cane turning.	7	Do not apply more than a total of 10 quarts Sevin XLR Plus per acre per crop per year
	fenpropathrin, IRAC 3 (Danitol 2.4EC)	5.33 to 10.66 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.
	phosmet, IRAC 1B (Imidan 70 W)	1.33 to 2.125 lb	14 days	7 (rates of 1.33 lb per acre or less) 14 (more than 1.33 lb per acre)	Do not apply more than 6.5 pounds Imidan (4.55 lb of phosmet) per acre per year.
Grape rootworm, Southern grape rootworm	Grape rootworm larvae feed on roots. Adults are small, black weevils that make distinctive chain-like feeding markings on leaves. Foliar feeding does not result in yield reduction, but root feeding may reduce plant vigor over time. Treatments should be timed to adult activity, which typically peaks in June or July. Grape rootworms are sporadic pests in North Carolina and should not be treated preventatively.				
	carbaryl, IRAC 1A (Sevin XLR Plus)	2 qt	48 hours for all activities except cane turning. EXCEPTION: the REI is 144 hours (6 days) for cane turning.	7	Do not apply more than a total of 10 quarts of Sevin XLR Plus per acre per crop per year.
Leafhoppers, Sharpshooters	Leafhoppers are important vectors of Pierce's Disease in *Vinifera* grapes, but Pierce's Disease is not a common problem of muscadine grapes. Var. Carlos has been observed with Pierce's Disease symptoms, but the disease does not appear to persist in plants over-winter. Therefore, leafhoppers should not be preventatively treated in muscadines. Large leafhopper populations can cause leaf stippling and yellowing, and populations of this size may result in economic damage and justify treatment.				
	acetamiprid, IRAC 4A (Assail 30SG)	2.5 to 5.3 oz	12	3	Assail can only be applied as a foliar treatment. Do not exceed a total of 0.2 lb. active ingredient (10.6 oz. Assail) per acre per calendar year.
	bifenthrin, IRAC 3 (Brigade 2EC)	3.2 to 6.4 fl oz	12	30	There are many generic formulations of bifenthrin. Do not make more than one application per year.
	bifenthrin + imidacloprid, IRAC 3 + 4A (Brigadier)	3.8 to 6.4 fl oz	12	30	Do not apply more than 12.8 fl oz (0.10 lb of imidacloprid, 0.10 lb of bifenthrin) per acre per year as a foliar application.
	dinotefuran, IRAC 4A (Venom)	1 to 3 oz (foliar) 5 to 7.5 oz (soil)	12	1 (foliar) 28 (soil)	Venom can be applied either to the soil or as a foliar spray. Soil applications are typically active for a longer period of time but must be made early in the year. Soil applications are more effective when made via drip irrigation. See label for details.
	fenpropathrin, IRAC 3 (Danitol 2.4EC)	10.66 to 21.33 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.
	imidacloprid, IRAC 4A (Admire Pro)	1 to 1.4 fl oz (foliar) 7 to 14 oz (soil)	12	0 (foliar) 30 (soil)	Admire Pro can be applied either to the soil or as a foliar spray. Soil applications are typically active for a longer period of time but must be made early in the year. Soil applications are more effective when made via drip irrigation. See label for application details.
	malathion, IRAC 1B (Malathion 8F) (Malathion 57EC) (Malathion 5)	1.88 pt 1.5 pt 3 pt	72 hours tying; 24 hours for other activities	3	Malathion may cause injury to berries if applied after bloom. Rates are based on 200 gpa spray volumes.
	phosmet, IRAC 1B (Imidan 70W)	1.33 to 2.125 lb	14 days	7 (rates of 1.33 lb per acre or less) 14 (more than 1.33 lb per acre)	Do not apply more than 6.5 pounds Imidan (4.55 lb of phosmet) per acre per year.
	thiamethoxam IRAC 4A (Actara)	1.5 to 3.5 oz	12	5	Do not exceed a total of 7oz of Actara or 0.109 lb of foliar applied thiamethoxam containing products per acre per season.

Table 6-7C. Muscadine Insect Management

Pest	Pesticide and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI), hours unless otherwise noted	Minimum Interval Between Application and Harvest; Preharvest interval (PHI), days	Precautions and Remarks
Japanese Beetle, Green June Beetle	Foliar feeding by Japanese beetles in established vineyards does not justify treatment unless it occurs on leaves below the top trellis wire. Fruit feeding by Japanese beetles is rare. Green June beetles are attracted to damaged, decomposing fruit but may also feed on undamaged fruit once in the vineyard. Removal of damaged fruit that will not be harvested will minimize Green June beetle populations and should be conducted before considering pesticide application.				
	acetamiprid, IRAC 4A (Assail 30SG)	2.5 to 5.3 oz	12	3	Southeastern data for Assail on Japanese beetles are limited. Foliar applications of Group 4A insecticides should NOT be used following a long-acting soil application of any group 4A insecticide (for example, Admire Pro, Venom, or Clutch). Do not exceed a total of 0.2 lb. active ingredient (10.6 oz. Assail) per acre per calendar year.
	bifenthrin, IRAC 3 (Brigade 2EC)	3.2 to 6.4 fl oz	12	30	There are many generic formulations of bifenthrin. Do not make more than one application per year.
	bifenthrin + imidacloprid, IRAC 3 + 4A (Brigadier)	5.1 to 6.4 fl oz	12	30	Do not apply more than 12.8 fl oz (0.10 lb of imidacloprid, 0.10 lb of bifenthrin) per acre per year as a foliar application.
	carbaryl, IRAC 1A (Sevin XLR Plus)	2 qt	48 hours for all activities except cane turning. EXCEPTION: the REI is 144 hours (6 days) for cane turning.	7	Do not apply more than a total of 10 quarts of Sevin XLR Plus per acre per crop per year.
	fenpropathrin, IRAC 3 (Danitol 2.4EC)	10.66 to 21.33 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season.
	imidacloprid, IRAC 4A (Admire Pro)	1 to 1.4 fl oz (foliar)	12	0	Admire Pro is applied as a foliar spray and as a soil treatment. Soil treatments are not recommended for Japanese and green June beetles.
	indoxacarb IRAC 22 (Avaunt)	3.5 to 6 oz	12	7	Do not apply more than 12 oz Avaunt or 0.22 lbs AI Indoxacarb per acre per year.
	Kaolin IRAC NA (Surround WP)	25 to 50 lb	4	0	Surround creates a barrier on plants and reduces insect attraction and feeding. In order to be effective, leaf and/or fruit surfaces should be coated thoroughly. Material should be reapplied at least 7 days apart to maintain coverage. **Not recommended** for use in fresh market grapes after bloom as white residue can remain until harvest. **Surround is OMRI listed.**
	phosmet, IRAC 1B (Imidan 70 W)	1.33 to 2.125 lb	14 days	7 (rates of 1.33 lb per acre or less) 14 (more than 1.33 lb per acre)	Do not apply more than 6.5 pounds Imidan (4.55 lb of phosmet) per acre per year.
Scale insects	Scale insects are occasional pests of muscadine grapes.				
	buprofezin, IRAC 16 (Applaud 70DF)	12 oz	12	7	Apply when crawlers are observed. Do not apply more than 24.0 oz (1.05 lbs AI) of Applaud 70DF per acre per growing season.
	spirotetramat, IRAC 23 (Movento)	6 to 8 fl oz	24	7	Do not apply more than 12.5 fl oz (0.2 lbs AI) of Movento per acre per calendar year.
Spider Mite	Sample for mites using a minimum 10x hand lens. There is no clearly defined threshold for mites in muscadine grapes. Treatment for *Vinifera* grapes is recommended when greater than 50% of leaves are infested. Fast moving predatory mites can be distinguished from slower moving spider mites through direct observation. Some insecticides, such as carbaryl, can flare mite populations, and care should be used with these materials when mites are present. Rotate acaricides between MOAs to minimize selection for resistance.				
	abamectin, IRAC 6 (Agri-Mek SC)	1.75 to 3.5 fl oz	12 hours EXCEPT for cane turning and tying grapes when REI is 96 hrs (4 days)	28	Abamectin is a restricted use product. Do not reapply within 21 days of initial application. Abamectin is an EC (emulsifiable concentrate), which can cause phytotoxicity in some crops. Check for possible plant injury before treating an entire field. Do not make more than 2 applications of Agri-Mek SC or other foliar-applied abamectin containing products per year.
	bifenazate, IRAC Unknown (Acramite 50WS)	0.75 to 1 lb	12 hours EXCEPT for cane turning and tying grapes when REI is 120 hours (5 days)	14	Apply in a minimum spray volume of 50 gallons per acre. Do not make more than one application of Acramite per season.
	cyflumetofen, IRAC 25 (Nealta)	13.7 fl oz	12	14	Do not make more than 2 Nealta applications per season and rotate to another mode of action (IRAC 25) between treatments.
	etoxazole, IRAC 10B (Zeal)	2 to 3 oz	12	14	Zeal is a growth regulator and kills eggs and young mites. It is most effective if applied when mite populations are low. Do not make more than one application of Zeal per season.
	fenbutatin-oxide, IRAC 12B (Vendex 50WP)	1 to 2.5 lb	48	28	Do not make more than 2 applications of Vendex per season.

Table 6-7C. Muscadine Insect Management

Pest	Pesticide and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI), hours unless otherwise noted	Minimum Interval Between Application and Harvest; Preharvest interval (PHI), days	Precautions and Remarks
Spider Mite (continued)	fenpyroximate, IRAC 21A (FujiMite 5EC)	2 pt	12	14	Do not apply more than 2 pints of FujiMite per acre per season.
	horticultural oils, IRAC Unknown many materials, including (Glacial Spray Fluid)	1 to 2 gallons per 100 gallons	4	60	Some oils are **OMRI** listed; check label. **Do not** use in combination with or immediately before or after spraying with fungicides such as Captan or any product containing sulfur. **Do not** use with carbaryl or dimethoate. **Do not** use with any product whose label recommends the use of no oils. Do not use in combination with NPK foliar fertilizer applications.
	pyridiben IRAC 21 (Nexter) (Nexter SC)	4.4 - 10.67 oz 7.5-17 oz	12	7	The maximum amount of pyridiben allowed per acre per season is 26.4 ounces. Do not make more than 2 applications of pyridiben per season.
	spirodiclofen, IRAC 23 (Envidor 2SC)	16 to 34 fl oz	12	14	Do not make more than one application of Envidor 2SC per season.
Stink bugs	Stink bugs are not a common pest of muscadine grapes, and there is no evidence that they directly damage fruit. If present at harvest, they may contaminate fruit, and under this scenario, they may justify treatment.				
	fenpropathrin, IRAC 3 (Danitol 2.4EC)	10.66 to 21.33 fl oz	24	21	Do not exceed 2.66 pints of Danitol per acre per season. Make no more than 2 applications of Danitol per season. Fenpropathrin (and other Group 3 materials)
	phosmet, IRAC 1B (Imidan 70 W)	1.33 to 2.125 lb	14 days	7 (rates of 1.33 lb per acre or less) 14 (more than 1.33 lb per acre)	Do not apply more than 6.5 pounds Imidan (4.55 lb of phosmet) per acre per year.
Grape Root Borer	Grape root borer is potentially the most significant pest of grapes in North Carolina, but they are not necessarily present in all vineyards. Grape root borer moths should be monitored with pheromone baited traps. Trap captures may begin in July and can continue through September. If moths are confirmed within a vineyard, mating disruption is the most effective control tool.				
	mating disruption (Isomate GRB)	100 dispensers	NA	NA	Dispensers should be placed prior to the beginning of grape root borer moth flight activity and be left in the vineyard until the end of flight activity. Moth flight timing varies between vineyards but can be as early as July and last until October. Pheromone baited traps can help determine grape root borer populations and flight activity, but traps will not be effective if mating disruption is underway.
	Cultivation or soil mounding	NA	NA	NA	Use clean cultivation, mound soil (July 1 or at first moth emergence when using pheromone traps) or using tightly-sealed plastic mulch 3 feet from the base of vines. This practice will inhibit adult emergence from the soil when well timed. Mounded soil needs to be removed by Sept. 1.
Grape tumid gallmaker	Grape tumid gallmaker adults are small flies. Their larvae, or maggots, infest clusters, leaves, or stems and cause the plant to create galls. Galls can be quite large and are often reddish. Infestations usually localized and do not typically require chemical treatment.				
	Hand removal	NA	NA	NA	Removal of affected plant parts is generally sufficient to prevent further infestation.
	spirotetramat, IRAC 23 (Movento)	6 to 8 fl oz	24	7	Do not apply more than 12.5 fl oz (0.2 lbs AI) of Movento per acre per calendar year.
Red Imported Fire Ant	Bait treatments can effectively manage fire ants, but they typically take 2 to 4 weeks to reach full efficacy. Baits must be applied when ants are actively foraging. Test for foraging by placing food near the nest. Check for ant activity after 30 minutes.				
	methoprene MOA 7A (Extinguish Professional Fire Ant Bait)	1 to 1.5 lb	4	0	

Further Information

Southeast Regional Muscadine Integrated Management Guide, www.smallfruits.org

Peach and Nectarine Spray Guide

D. F. Ritchie and J. F. Walgenbach, Entomology and Plant Pathology

Although many pesticides are registered for disease and insect control on peaches, the following spray program lists the ones that have performed well under North Carolina conditions. The rates of pesticides recommended should give control when pest pressure is moderate to severe, assuming they are applied correctly. Where the rate is given as a range, the lower rate can be used when pest pressure is low; the higher rate should be used when pest pressure is great. Thus, the following spray program is intended to be only a guide since pest and orchard conditions can vary from orchard to orchard and year to year.

The rates given are based on the use of rate per acre; 75 to 125 gallons of water per acre provides optimal spray coverage for pest/disease control in most orchards.

Note: For imported fire ant, treat active mounds off season with directed bait formulations like Clinch, Esteem, Extinguish, and Logic. Insect growth regulators will give complete control after 30 days. Always follow label directions for best results.

Table 6-8. Peach and Nectarine Spray Guide

When to Spray	Pest	Pesticide	REI (hrs)	PHI (days)	Formulation Per Acre	Remarks
Dormant Before buds swell in late winter	Leaf curl	**Fungicide:** chlorothalonil (Bravo Weather Stik) 6 F OR ziram (Ziram) 76 DF	 12 48	 NA 14	 4 pt 5 lb	Other chemicals registered for leaf curl include copper-containing compounds (consult labels). Copper provides adequate leaf-curl control when at least 2.0 pounds metallic copper equivalent/acre is applied before bud-swell. **See additional reentry restriction for chlorothalonil because of eye irritation risk**. To control white peach scale, 2 dormant oil sprays 2 weeks apart are necessary. Oil will NOT control leaf curl.
	Scale insect, mite	**Insecticide:** Oil (horticultural oil) + pyriproxyfen (Esteem) 35WP OR buprofezin (Centaur) 70WDG OR Diazinon (Diazinon) 50WP	 4 12 12 4 days	 NA 14 14 21	 2-3% soln. 4 to 5 oz 34.5 oz 2 lbs	Addition of an insecticide with oil (3% solution) will improve control of scales. An insecticide can be added with oil at dormant, or when crawlers appear at 3 to 4 wks after bloom. Allow 60 days between dormant and in-season application. NOTE: Heavy reliance on pyrethroid insecticides may flare scale populations, particularly San Jose scale.
Bloom	Brown rot, blossom blight	**Fungicide:** captan (Captan, Captec) 50 WP, 80 WDG, 4L OR chlorothalonil (Bravo Weather Stik, Echo 720) 6 F OR thiophanate-methyl (Topsin M, T-Methyl) + captan (Captan, Captec) 50WP, 80 WDG, 4L OR cyprodinil (Vangard) 75 WG	 24 12 12 12 12	 0 NA 1 0 0	 5 lb, 4 lb, 2.5 qt 3.125 pt 1.0 lb + 4 lb, 3.2 lb, 2 qt 5 oz	Fungicide sprays at full pink to early bloom and again at full bloom may reduce blossom blight, but another spray may be needed if bloom extends beyond 2 weeks. Demethylation inhibiting (DMI) fungicides (such as Tilt, PropiMax, Indar, Rally, Quash) are effective against blossom blight but are prone to resistance problems if used regularly. Resistance to any one of the DMI fungicides results in cross-resistance to the others. **It is recommended that DMI fungicides be saved for preharvest sprays and that they not be used in bloom and cover sprays.** Do not use more than 1 application of thiophanate-methyl if resistant strains are present. Vangard is another alternative to DMI fungicides during bloom.
		Insecticide: None				
Petal-Fall After petals are off but before fruit are showing	Scab, brown rot	**Fungicide:** captan (Captan, Captec) 50 WP, 80 WDG, 4L OR sulfur	 12 24	 0 0	 5 lb, 4 lb, 2.5 qt 9 lb actual sulfur	Including a fungicide at petal fall may enhance scab control.
	Plum curculio, catfacing insects, Oriental fruit moth	**Insecticide:** pyrethroid (see list in Table 6-9) OR phosmet (Imidan) 50 WP OR thiamethoxam (Actara) 25 WDG OR indoxacarb (Avaunt) 30WG OR cyclaniliprole (Verdepryn) 100SL OR thiamethoxam + chlorantraniliprole (Voliam Flexi) WDG	 12-24 24 12 12 4 12	 3-14 14 14 14 7 14	 — 3 lb 5 oz 5 oz 8.2 oz 6 oz	For the list of pyrethroids registered see IRAC MOA Group 3A in Table 6-9. Imidan has a 4-day re-entry interval, 14 days for general public (for instance, pick-your-own customers). Actara is not recommended for oriental fruit moth. Avaunt and Verdepryn are not recommended for catfacing insects (plant bugs and stink bugs), but plum curculio and oriental fruit moth only. Voliam Flexi is a pre-mix product.
Shuck Split to Shuck Fall After fruit are showing, but before 75% of the fruit have shucks off	Scab, brown rot	**Fungicide:** captan (Captan, Captec) 50 WP, 4 L OR chlorothalonil (Bravo Weather Stik, Echo 720) 6 F OR Sulfur OR pydiflumetofen + difenoconazole (Miravis Duo) 1.67 SC	 12 12 24 12	 0 NA 0 0	 5 lb, 2.5 qt 4 pt 9 lb actual sulfur 13.6 fl oz	Very critical period for start of scab control. Tank-mix of thiophanate-methyl 0.75 pound a.i./acre (Topsin M, T-Methyl) with captan or sulfur. First 2 sprays are very important for scab control. **Chlorothalonil cannot be used later than shuck split.** Where scab has been a problem, Miravis Duo may improve control. Limit Miravis Duo to no more than 2 applications.
	Plum curculio, catfacing insect	**Insecticide:** Same as in Petal-Fall				When cool weather delays shuckoff, a second application of insecticide in 7 to 10 days may be necessary to control catfacing insects. In most instances two insecticide applications at 10- to 14-day intervals are necessary for plum curculio.
Cover Sprays **Begin 7 to 10 days after shuck fall, continue 10 to 14 days, stopping at least 2 weeks before harvest**	Scab, brown rot	**Fungicide:** Same as SHUCK SPLIT				First through third cover sprays are very important for scab control on peach. NOTE: **Chlorothalonil cannot be used after the shuck split spray.** **Captan rate may be reduced to 1.5 to 2.0 lb a.i. if conditions are dry and disease is controlled.**
	Plum curculio, Stink bugs, Oriental fruit moth	**Insecticide:** pyrethroid (see list in Table 6-9) OR indoxacarb (Avaunt) 30 WG OR phosmet (Imidan) 50 WP OR spinetoram (Delegate) 25 WDG OR chlorantraniliprole (Altacor) 35 WDG OR cyantraniliprole (Exirel) 0.83SE OR cyclaniliprole (Verdepryn) 100SL OR thiamethoxam + chlorantraniliprole (Voliam Flexi) WDG	 12-24 12 24 12 4 12 4 12	 3-14 14 14 7 10 3 7 14	 — 6 fl oz 3 lb 5 fl oz 3 oz 17 oz 8.2 6 oz	Be sure to match the insecticide with the insect pest present in the orchard at the time of application. Avaunt is not for stink bugs Do NOT apply phosmet within 3 weeks of harvest. Delegate, Altacor and Exirel are primarily for oriental fruit moth control. For oriental fruit moth, lower rates of Verdepryn (5.5 oz) can be used. Do not exceed 14 oz of Voliam Flexi per season.

Table 6-8. Peach and Nectarine Spray Guide

When to Spray	Pest	Pesticide	REI (hrs)	PHI (days)	Formulation Per Acre	Remarks
Cover Sprays (continued)	San Jose Scale	buprofezin (Centaur) 70WDG	12	14	25 oz	In most orchards treated with oil and a scale-active insecticide before bloom, additional control measures are often not necessary. However, in orchards with a history of San Jose scale, targeting first generation crawlers at the second cover spray is highly recommended. If using an insecticide at both dormant and post bloom for scale, use a different mode of action.
		OR				
		pyriproxyfen (Esteem) 35WP	12	14	4 to 5 oz	
		OR				
		diazinon (Diazinon) 50WP	4 days	21	2 lbs	
	Brown marmorated stink bug	pyrethroid (see list in Table 6-9)	12-24	3-14	—	Peaches are highly attractive to BMSB. In the mountains and piedmont areas, where BMSB populations are highest, control may be required from May through harvest.
		OR				
		clothianidin (Belay) 2.13SL	12	21	6 fl oz	Do not apply more than 12 fl oz of Belay per acre per season.
		OR				
		dinotefuran (Venom) 70SG	12	3	4 oz	Do not apply more than 6 oz of Venom per acre per season.
		OR				
		thiamethoxam (Actara) 25WDG	12	14	4.5 oz	Do not exceed 11 oz of Actara per acre per season.
	Western flower thrips	methomyl (Lannate) 90SP	4 (days)	4	1 lb	Methomyl is highly toxic and precautions should be taken when applying this product.
		OR				
		flonicamid (Beleaf) 50SG	12	14	2.8 fl oz	
		OR				
		cyantraniliprole (Exirel) SE	12	3	13.5 to 20 fl oz	Cyantraniliprole and cyclaniliprole will both provide suppression of western flower thrips. Higher rates should be used.
		OR				
		cyclaniliprole (Verdepryn) 100SL	12	7	5.5 to 11 fl oz	
Preharvest Begin 2 to 3 weeks before harvest; apply fungicides at 7 to 10-day intervals. In periods of high disease pressure, closer spray intervals may be necessary.	Brown rot	**Fungicide:**				
		azoxystrobin (Abound) 2.08 F	4	0	12 to 15 fl oz	Do not make more than 2 sequential applications of these fungicides before alternating with a fungicide having a different mode of action. See Table 6-10 for Mode of Action Code. The frequency of precipitation during the ripening period should be used to determine the necessity for repeat fungicide applications and the rotation of fungicides having different modes of action. As fruit ripen, they become increasingly susceptible to brown rot.
		OR				
		azoxystrobin + difenoconazole (Quadris Top) 2.71SC	12	0	12 to 14 fl oz	
		OR				
		difenoconazole + cyprodinil (Inspire Super) 2.82EW	12	2	16 to 20 fl oz	
		OR				
		fenbuconazole (Indar) 2F	12	0	6.0 fl oz	
		OR				
		mefentrifluconazole (Cevya) 3.34F	12	0	5.0 fl oz	
		OR				
		metconazole (Quash) 50 WDG	12	14	3.5 to 4.0 oz	
		OR				
		penthiopyrad (Fontelis) 1.67SC	12	0	14 to 20 fl oz	
		OR				
		propiconazole (Bumper, PropiMax Tilt) 3.6 EC	24	0	4 fl oz	
		OR				
		pydiflumetofen + difenoconazole (Miravis Duo) 1.67 SC	12	0	13.6 fl oz	
		OR				
		pyraclostrobin + boscalid (Pristine) 38 WG	12	0	10.5 to 14.5 oz	
		OR				
		pyraclostrobin + fluxapyroxad (Merivon) 500 SC	12	0	4 to 6.7 fl oz	
		OR				
		trifloxystrobin + fluopyram (Luna Sensation) 4.2SC	12	1	5.0 to 7.6 fl oz	
	June beetle, Japanese beetle	**Insecticide:**				
		carbaryl (Sevin) 80 WSP	12	3	2.5 lb	
		OR				
		imidacloprid (Admire Pro) 4.6SC	12	0	1.4 fl oz	
		OR				
		acetamiprid (Assail) 30SG	12	7	5.3 to 7 oz	
Borer Spray	Peachtree borer	**Insecticide:**				Direct spray to tree trunks to the point of runoff. Best control will be achieved with two applications in mid July and mid August.
		pyrethroid (see Table 6-9)	12-24	3-14	See table 6-9	
		OR				
		Mating Disruption Isomate PTB Dual	—	—	150 dispensers	For mating disruption, dispensers should hung before moth flight begins, which starts about June 1.
Special Spray	Spider mites	**Miticide:** When mite populations increase to large numbers, they may cause severe injury. Examine outer leaves for mites and mottled appearance, especially during hot, dry periods.				
		Preventive Spray:				Apollo and Savey are ovicides and should be applied early in the season. Apollo and Savey have the same mode of action, so if resistance develops to one compound, populations will be resistant to both products. Do not apply more than once per year and preferably use once every other year.
		hexythiazox (Savey) 50 DF	12	28	3 to 6 oz	
		OR				
		clofentezine (Apollo) SC	12	21	4 to 8 oz	
		Curative Mite Spray:				
		bifenazate (Acramite) 50 WP	12	3	1 lb	Do not apply within 3 days of harvest.
		OR				
		abamectin (Agri-Mek) 0.7SC	12	21	2.25 to 4.25 fl oz	Include 0.25% horticultural oil (not dormant oil) or a nonionic surfactant with Agri-Mek. 21 day PHI.

Relative Effectiveness and Safety of Various Insecticides for Peach Insects

J. F. Walgenbach, Entomology and Plant Pathology

(E – excellent; G – good; F – fair; NC – no control or no data)††

Table 6-9. Relative Effectiveness and Safety of Various Insecticides for Peach Insects

IRAC† MOA Group	Insecticide Formulation and Rate per 100 Gallons Water	Days Between Last Spray and Harvest	Plum Curculio	Oriental Fruit Moth	Peachtree Borer	Stink Bugs	Scales (White Peach, San Jose)	Beetles (June, Japanese)	Thrips (Western flower thrips)	Safety*
1A	methomyl (Lannate 2.4 L) 1 pt	4	F	G	NC	F	NC	F	E	Danger, Poison
	carbaryl (Sevin 80 SP) 1.25 lb	3	F	G	NC	NC	NC	E	NC	Caution
1B	phosmet (Imidan 50 WP) 1.5 lb	14	E	G	NC	NC	NC	F	MC	Warning
3A	beta-cyfluthrin (Baythroid XL) 2.4 oz	7	G	E	G	E	NC	E	NC	Warning, Restricted
	Bifenthrin (Brigade 2EC, Fanfare 2EC) 5 oz (Brigade WSB) 9.6 oz	14	G	E	G	E	f	E	NC	Warning, Restricted
	cyfluthrin (Tombstone 2EC) 2.4 oz	7	G	E	G	E	NC	E	NC	Danger, Restricted
	esfenvalerate (Asana 0.66 EC) 5.8 oz	14	G	E	G	F	NC	G	NC	Warning, Restricted
	fenpropathrin (Danitol 2.4 EC) 16 oz	3	G	E	G	E	NC	E	NC	Warning, Restricted
	gamma-cyhalothrin (Proaxis 0.5EC) 3.8 oz	14	G	E	G	E	NC	E	NC	Caution, Restricted
	lambda-cyhalothrin (Karate 2.08CS) 1.9 oz	14	G	E	G	E	NC	E	NC	Warning, Restricted
	permethrin (Pounce 2.0 EC, 25 WP) 6 oz	7	G	E	G	G	NC	G	NC	Warning, Restricted
	zeta-cypermethrin (Mustang Maxx)	14	G	E	G	E	NC	E	NC	Warning, Restricted
4A	acetamiprid (Assail 30 SG) 7 oz	7	F	G	NC	F	G	G	NC	Caution
	clothianidin (Belay SL) 6 oz	21	G	NC	NC	E	NC	G	NC	Caution
	dinotefuran (Scorpion 35SL) 5.25 oz (Venom 70SG) 4 oz	3	G	NC	NC	E	NC	G	NC	Caution
	imidacloprid (Provado 1.6F) 3 oz	0	NC	NC	NC	F	NC	G	NC	Caution
	thiamethoxam (Actara 25WDG) 2.5 oz	14	E	F	NC	E	F	G	NC	Caution
5	spinetoram (Delegate 25WDG) 2.5 oz	7	NC	E	NC	NC	NC	NC	E	Caution
7C	pyriproxyfen (Esteem 35 WP) 5 oz	14	NC	F	NC	NC	E	NC	NC	Caution
16	buprofezin (Centaur 70WSB) 17 oz	14	NC	NC	NC	NC	E	NC	NC	Caution
22	indoxacarb (Avaunt 30 DG) 5 oz	14	E	G	NC	NC	NC	F	NC	Caution
23	spirotetramat (Movento 2SC) 8 oz	7	NC	NC	NC	NC	E	NC	NC	Caution
28	chlorantraniliprole (Altacor 35WDG) 2.5 oz	10	NC	E	F	NC	NC	NC	NC	Caution
	cyantraniliprole (Exirel 0.83SE) 17 oz	3	F	E	F	NC	NC	F	F	Caution
	cyclaniliprole (Verdepryn 100SL)	7	G	E	F	NC	NC	NC	F	Caution
29	Flonicamid (Beleaf 50SG) 2.8 oz	14	NC	NC	NC	NC	NC	NC	E	Caution
NC	oil 2 gal	NC	NC	NC	NC	NC	E	NC	NC	Caution

†† Development of insecticide resistance may result in products not preforming as well as rated.

† Insecticide Resistance Action Committee (IRAC) mode of action (MOA) group.

* Relative Toxicity (Safety):

Danger = most toxic to man

Caution = least toxic to man

Restricted = restricted use compound; may be applied only by licensed pesticide operators

Relative Effectiveness of Chemicals for Disease Control on Peaches and Nectarines

D. F. Ritchie, Entomology and Plant Pathology

(E = excellent; G = good; F = Fair; P = poor; NC = no control; NA = not applicable; ND = no data)

Table 6-10. Relative Effectiveness of Chemicals for Disease Control on Peaches and Nectarines

Fungicide/Bactericide and Rate per Acre per 100 gallons	Mode of Action Code	Days Between Last Spray and Harvest	Reentry Interval (REI)* (hours)	Leaf Curl	Blossom Blight	Brown Rot	Peach Scab	Bacterial Spot
azoxystrobin (Abound) 2.08 F — 14 fl oz	11	0	4	NA	F-G	G	G	NC
azoxystrobin + difenoconazole (Quadris Top)2.72 SC — 14 fl oz	11, 3	0	12	NA	G	G-E	G-E	NC
captan (Captan, Captec) 50 WP, 80 WDG, 4L — 5.4 lb, 3.2 lb, 2.5 qt	M4	0	24	NA	F	F-G	G	NC
chlorothalonil (Bravo Weather Stik, Echo 720) 6 F — 4 pt	M5	NA	12**	G	F-G	NA	G	NC
copper (Kocide 3000, Cuprofix ULTRA 40D, Badge 2.27 SC, Nordox 75WP) — 3.5 to 5.0 lb, 3.5 to 6.0 lb, 3.5 to 5.0 pt, 0.67 to 5.0 lb. See labels for specific rates & REI ***	M1	at least 21	48	F-G	NA	NA	NA	G
cyprodinil (Vangard) 75 WG — 5 oz	9	NA	12	NA	G	NA	NA	NC
difenoconazole + cyprodinil (Inspire Super) 2.82EW — 18 fl oz	3, 9	2	12	NA	G	G-E	G-E	NC
fenbuconazole (Indar) 2F — 6.0 fl oz	3	0	12	NA	G	G	P-F	NC
fenhexamid (Elevate) 50 WDG — 1.5 lb	17	0	12	NA	ND	F	P-F	NC
trifloxystrobin + fluopyram (Luna Sensation) 4.2SC 6.0 fl oz	11, 7	1	12	NA	G	G-E	G	NC
iprodione (Rovral) 4F — 1.5 lb, 1.5 pt ****	2	NA	24	NA	G	NA	NC	NC
mefentrifluconazole (Cevya) 3.34F — 5.0 fl oz	3	0	12	NA	G	G-E	ND	NC
metconazole (Quash) 50WDG — 4.0 oz	3	14	12	NA	G	G	F	NC
myclobutanil (Rally)40 WP — 6.0 oz	3	0	24	NA	G	F	NC-P	NC
oxytetracycline (FireLine, Mycoshield) 17 WP — 0.75 lb/100 gal	41	21	12	NA	NA	NA	NA	F-G
penthiopyrad (Fontelis) 1.67SC — 20 fl oz	7	0	12	NA	ND	F-G	P-F	NC
propiconazole (Bumper, PropiMax, Tilt) 3.6 EC — 4 fl oz	3	0	24	NA	G	G	NC-P	NC
pydiflumetofen + difenoconazole (Miravis Duo) 1.67SC 13.6 fl oz	7, 3	0	12	NA	G	G	G	NC
pyraclostrobin + boscalid (Pristine) 38 WG —14oz	11, 7	0	12	NA	G	G-E	F	NC
pyraclostrobin + fluxapyroxad (Merivon) 500SC — 6.0 fl oz	11, 7	0	12	NA	G	E	G	NC
pyrimethanil (Scala SC) 5SC — 1.0 pt	9	2	12	NA	ND	P-F	ND	NC
sulfur — 9 lb actual sulfur many brands	M2	0	24	NA	P-F	P	F-G	NC
thiophanate-methyl (Topsin M) 70 WSP, 4.5FL — 1 lb, 1.5 pt	1	1	12	NA	G	F-G	G	NC
ziram (Ziram) 76 DF — 4-6 lb	M3	14	48	G	P	P	P-F	P

* REI = reentry interval. Hours between last spray and reentry without using personal protective equipment. This time interval can vary depending on product formulation, always consult label of product being used.
** Consult chlorothalonil label for REI precautions related to risk of eye injury. May be applied through shuck split.
*** Rate of copper stated is for dormant spray. Rates must be sequentially greatly reduced to lessen foliar injury when used during the growing season. PLEASE READ LABELS FOR SPECIFIC RATES TO REDUCE RISK OF INJURY.
**** Rovral is not registered for use after petal fall.
Mode of Action Codes – fungicides having the same code have a similar mode of action and thus are not appropriate mixing or alternating partners for use in resistance management.

Nematode Control on Peaches

D. F. Ritchie, Entomology and Plant Pathology

Preplant Soil Fumigation — In light, sandy soil where root-knot and ring nematodes are present, preplant soil fumigation is imperative. If the nematode assay indicates the presence of root-knot or ring nematodes, it may be advantageous to fumigate the entire orchard site in **October to mid-November** before planting the trees in late winter to early spring. If the nematode assay does not indicate the presence of root-knot or ring nematodes, an 8- to 10-foot strip to be used for the tree row may be fumigated.

Table 6-11. Preplant Soil Fumigation (Danger – POISON)

Materials	Rate/treated acre*
1,3 dichloropropene (Telone II)	27 to 36 gallon
metam-sodium (Vapam HL, Sectagon 42) tarped	75 to 100 gallons

* Rate will vary depending on soil type. Follow manufacturer's directions for rate and application procedures.

Postplant Treatment (Bearing and Nonbearing Trees) — NO EFFECTIVE MATERIALS REGISTERED for postplant use.

Further Information

Southeastern Peach, Nectarine and Plum Pest Management and Culture Guide. University of Georgia Bulletin 1171 updated annually. extension.uga.edu/publications/detail.html?number=B1171.

Commercial Pecan Insect Control

**The information in this section for pecans is from the 2022 Commercial Pecan Spray Guide published by the University of Georgia.
For more information, visit pecans.uga.edu**

COMMERCIAL PECAN INSECT CONTROL (BEARING TREES)

Angel Acebes, Research Entomologist
Will Hudson, Extension Entomologist
Andrew Sawyer, Area Pecan Agent

ORCHARD SURVEY PROCEDURES

Insect and mite infestation levels should be estimated at least weekly based on thorough orchard sampling. Sample trees in all segments of each orchard. A good method is to sample every fourth tree in every fourth tree row (about 10% of the trees). Sample each major cultivar represented in the orchard. Sample a minimum of 10 terminals per tree. Check all compound leaves and the nut clusters on each terminal. Check as high in the tree as possible. Foliar pest counts should be made on compound leaves surrounding the nut clusters. Nut clusters should be inspected carefully for the presence of pests or damage. Hickory shuckworm damage should be monitored mid-season by examining fallen nuts for a whitish spot on the side. Pecan weevil populations should be monitored by survey traps.

PEST	PESTICIDE	MOA	AMOUNT PER ACRE	REI/PHI (Hours or Days)	TIMING AND REMARKS
Phylloxera	*Thiamethoxam* Centric 40WG	4A	2–2.5 oz	12 H/ 14 D	Treat trees with a recent history of heavy infestation and surrounding trees. Apply at budbreak with the first pre-pollination spray.
	imidacloprid Several formulations	4A	See label	12 H/ 7 D	**Note:** Other *imidacloprid* formulations are available. Read labels carefully to find the proper rate and maximum allowable limits.
Spittlebugs	*imidacloprid* Several formulations	4A	See label	12 H/ 7 D	Spittlebug infestations are easily recognized by the white, frothy masses on terminals or nut clusters. Definite thresholds have not been established and treatment is seldom needed.
Pecan Nut Casebearer	*chlorpyrifos* 4E Lorsban, Chlorphos	1B	1.5 pt	24 H/ 14 D	Light infestations causing occasional damage do not require control in most crop years. The most serious damage usually occurs in mid-May. Adult emergence should be monitored with pheromone traps. Place traps in orchards by mid-April. Begin sampling for nut casebearer in the first week of May. Pay particular attention to orchards not under a spray program the preceding year and orchards with a recent history of nut casebearer problems. Try to time sprays to stop injury before more than one nut per cluster is infested. It is recommended that broad-spectrum contact insecticides, such as *chlorpyrifos* and the pyrethroids, not be used in early-or mid-season to conserve beneficial insect populations. (See Special Considerations section.)
	spinosad Spintor 2SC	5	4–10 oz	4 H/ 1 D	
	diflubenzuron Dimilin 2L	15	8–16 oz	12 H/ 28 D	
	clothianadin Belay	4A	3–6 oz	12 H/ 21 D	
	methoxyfenozide Intrepid 2F	18	4–8 oz	4 H/ 7 D	
	methoxyfenozide + spinetoram Intrepid Edge	5 + 18	4–6.4 oz	4 H/ 7 D	
	tolfenpyrad Apta	21	17–27 oz	12 H/ 14 D	**DO NOT** apply more than 1 application. No more than 27 oz/A/season.
	cyantraniliprole + abamectin Minecto Pro	6 + 28	8–12 oz	12 H/ 21 D	No more than 2 consecutive applications, no more than 24 oz/A/season.
Mites	*abamectin* Agri-Mek SC, Abba, and others	6	See label for product-specific rates	12 H/ 21 D	A non-ionic surfactant or horticultural oil MUST be added to the tank.
	bifenazate Acramite 4SC	Unclassified	12–24 oz	12 H/ 14 D	See Timing and Remarks top of next page.

PEST	PESTICIDE	MOA	AMOUNT PER ACRE	REI/PHI (Hours or Days)	TIMING AND REMARKS
Mites (*continued*)	*spirodiclofen* Envidor 2SC	23	14–18 oz	12 H/ 7 D	Mites, especially the pecan leaf scorch mite, are normally late season pests. Mite damage appears as bronzed, scorched areas on the undersides of leaflets. Scorched areas begin at the leaflet midribs then spread out toward leaflet margins. Mites often build up on low limbs in the shaded, interior portions of trees then spread rapidly up and out. For heavy infestations, repeat the application in 5–7 days. Savey is an ovicide and should be tank-mixed with an adulticide. Zeal is primarily an ovicide/larvicide. Magister SC requires no more than one application per year.
	fenpyroximate Portal	21A	2 pt	12 H/ 14 D	
	pyridaben Nexter SC	21	5.2–10.67 oz	24 H/ 7 D	
	hexythiazox Savey 50DF	10A	3–6 oz	12 H/ 28 D	
	etoxazole Zeal SC	10B	2–3 oz	12 H/ 28 D	
	fenazaquin Magister SC	21	24–36 oz	12 H/ 7 D	
Yellow Aphids	**FOLIAR APPLICATIONS**				Yellow aphids may be present in orchards throughout the growing season. Populations are usually highest in April-May and again in August-September. In early season, DO NOT treat yellow aphids if they are the only insect problem. Rely on beneficial insects to suppress early season populations. In prolonged dry periods, lower, chronic aphid populations may require treatment to prevent the build-up of unacceptable levels of honeydew and sooty mold. WEEKLY SCOUTING IS VERY IMPORTANT IN TIMING APHID SPRAYS, ESPECIALLY IN LATE SEASON. Rotate among classes (MOA) of insecticides between treatments to avoid resistance development. Many generic formulations of *imidacloprid* are available. Read label carefully for recommended rate. *Imidacloprid* alone may not control yellow and black-margined aphids. It is suggested that pyrethroid materials (*cypermethrin*, *bifenthrin*, etc.) not be used, alone or in combination, in early- or mid-season applications. For PQZ, spray no more than 2 applications or 4.8 fl oz per acre per year. **DO NOT** apply more than 1 application of Apta, no more than 27 oz/A/season. Use the 14 oz rate for black pecan aphid control.
	acetamiprid Assail 30SG	4A	2.5–9.6 oz	12 H/ 14 D	
	afidopyropen Sefina	9D	3.0–6.0 oz	12 H/ 7D	
	clothianidin Belay	4A	3–6 fl oz	12 H/ 21 D	
	flonicamid Beleaf, Carbine	9C	2–2.8 oz	12 H/ 40 D	
	flupyradifurone Sivanto 200 SL	4D	7.0–10.5 oz	4 H/ 7 D	
	imidacloprid Several formulations	4A	See label	12 H/ 7D	
	pymetrozine Fulfill 50WG	9B	4 oz	12 H/ 14 D	
	pyridaben Nexter	21	5.2–10.67 oz	24 H/ 7 D	
	pyrifluquinazon PQZ	9B	2.4–3.2 oz	12 H/ 7 D	
	sulfoxaflor Closer SC Transform WG	4C	 1.5–2.75 oz 0.75–1.5 oz	12 H/ 7 D	
	thiamethoxam Centric 40 WG	4A	2–2.5 oz	12 H/ 14 D	
	tolfenpyrad Apta	21A	17–27 oz	12 H/ 14 D	

PEST	PESTICIDE	MOA	AMOUNT PER ACRE	REI/PHI (Hours or Days)	TIMING AND REMARKS
Yellow Aphids (*continued*)	SYSTEMIC APPLICATIONS				Admire can be applied through a drip irrigation system, as an emitter spot application, or as a shanked-in emitter adjacent application. See label for complete details. Apply Admire only to orchards where drip irrigation has been established for at least 5 years.
	imidacloprid Admire Pro	4A	7–14 fl oz	12 H/ 7 D	
Black Pecan Aphid	SAME INSECTICIDES AS FOR YELLOW APHIDS	See list for yellow aphids	See list for yellow aphids. Please note that some products have different rates for black pecan aphids.	See list for yellow aphids	Black pecan aphids may cause damage as early as May but are usually a serious problem only in late season. Damage appears as yellow spots on leaflets. Damaged spots later turn brown and 2–4 damaged spots per leaflet can cause leaflet drop. Carefully check all compound leaves on 10 terminals per tree, on at least 10 trees per orchard for the presence of black pecan aphids. Prior to July 1, treat if 25% of terminals have 2 or more black aphids. After July 1, treat if 15% of terminals have more than one black aphid and nymph clusters are found. Concentrate checks on susceptible cultivars such as Schley, Sumner, and Gloria Grande. Be sure to check all compound leaves on each terminal examined. *Gibberellic acid* is a plant growth regulator that prevents damage from black pecan aphid feeding and inhibits establishment in the orchard. It does not affect aphids directly and will not control any other pest, including yellow aphids. Three applications should be made at 2-week intervals, beginning in mid-July, applying 10 oz (or 5 oz of ProGibb LV Plus) each time.
	chlorpyrifos Lorsban, generics	1B	See label	24 H/ 14 D	
	gibberellic acid ProGibb 4% ProGibb LV Plus	N/A	10 oz 5 fl oz	N/A	
Hickory Shuckworm	*chlorpyrifos* 4E Lorsban, Chlorfos	1B	1–14 pt	24 H/ 14 D	Shuckworms are active throughout the season, but do not cause significant damage until June or later. Prior to shell hardening, larval feeding causes nuts to drop. After shells harden, feeding causes shucks to stick to the shells, reducing quality. If orchards have a history of shuckworm infestation, a spray should be applied in early June. In early August, 2–3 additional sprays should be applied. Initiate August sprays at half-shell hardening and repeat at 2-week intervals until shuck split if shuckworm activity continues. *Chlorpyrifos* and pyrethroids (Asana, Ambush, Mustang, etc.) applied for other pests will also control shuckworm. It is not necessary to spray in August if pecan weevil controls are applied. Please note the Special Considerations section regarding the use of pyrethroid materials.
	clothianadin Belay	4A	3–6 oz	12 H/ 21 D	
	diflubenzuron Dimilin 2L	15	8–16 oz	12 H/ 28 D	
	methoxyfenozide Intrepid 2F, Turnstyle	18	4–8 oz	4 H/ 7 H	
	methoxyfenozide + spinetoram Intrepid Edge	5 + 18	4–6.4 oz	4 H/ 7 D	
	tolfenpyrad Apta	21A	17–27 oz	12 H/ 14 D	**DO NOT** apply more than 1 application, no more than 27 oz/A/season.
	abamectin + cyantraniliprole Minecto Pro	6 + 28	8–12 oz	24 H/ 21 D	No more than 2 consecutive applications, no more than 24 oz/A/season.
	chlorantraniliprole + lambda-cyhalothrin Besiege	3 + 28	6–12.5 oz	24 H/ 14 D	Besiege contains a pyrethroid, and may flare aphids and mites if used in early or mid-season. The best fit is for late season shuckworm.

PEST	PESTICIDE	MOA	AMOUNT PER ACRE	REI/PHI (Hours or Days)	TIMING AND REMARKS
Pecan Weevil	*carbaryl* Carbaryl 80S Sevin 4F Sevin XLR	1A	3 lb 2–5 qt	24 H/ 14 D	Pecan weevil emergence may extend from July into October. Peak emergence is normally between August 10 and September 20. Emergence should be monitored in each infested grove with traps, knockdown sprays or a combination of these methods. Trees known to have a recent history of weevil problems should be selected for monitoring. If excessive nut drop results from pecan weevil feeding punctures before pecan shells begin to harden, spray at once. After pecan shells harden and nuts reach the "dough" or "gel" stage, treat when weevils emerge (especially following rains) and continue at 7–10 day intervals until emergence stops. APHID OR MITE POPULATIONS MAY BUILD UP WHERE *CARBARYL* IS USED. If these pests become a problem, apply aphicides or miticides as previously directed. **NOTE:** Several pyrethroids as well as *Imidan* are labeled for pecan weevil control. If these materials are used for weevils, they can be expected to be most effective where weevil populations are low. They may be adequate to prevent feeding injury from weevils emerging prior to shell hardening but their use could be risky under heavy weevil pressure after nuts reach the gel stage and are subject to weevil oviposition. (See Special Considerations section). Several products are available that combine a pyrethroid insecticide with an aphicide. These products may help suppress aphids while providing weevil control. Brand names include Endigo, Leverage, and others.
	Various pyrethroids Asana XL, Ammo, Baythroid, Brigade, Mustang Max	3	See label for product-specific rates	24 H/ 21 D	
Ants, including fire ants, Argentine ants, acrobat ants, and others	Baits Extinguish, Reemit 0.5 G, Altrevin, and others	Various	1.0–1.5 lb/A	Various	The best approach is to apply a bait twice per season, generally in late April–early May and again in September. If populations are large and active, follow the first bait application with a chlorpyrifos application as a ground spray directed at the herbicide strip. Repeat as necessary when ants interfere with irrigation equipment.
	chlorpyrifos	1B	4 pt/A	14 days	

KERNAL FEEDING HEMIPTERANS (Stink bugs and Plant bugs)

A complex of true bugs (stink bugs and plant bugs) attack pecan. They may be present in orchards all year but normally cause their most serious injury from late August through September. Prior to shell hardening, feeding injury causes nut drop. After shell hardening, their feeding causes black, bitter spots on kernels, reducing quality. They can continue to feed, through the hardened shells, until nuts are harvested. The presence and numbers of stink bugs and plant bugs should be noted in surveys throughout the season. Special attention should be paid to the true bugs in late-season orchard surveys. Treat when 1 stink bug is found per 40 terminals OR when 5 or more are found per knockdown spray on a sheet covering 20% of the area under a tree. Sprays for these insects are difficult to time properly because the bugs move in and out of orchards. Close checking is required to detect damaging populations. No materials have consistently given excellent stink bug control, possibly due to the difficulty in timing sprays. The pyrethroids are labeled for stink bug control. Please note the pre-harvest use restrictions of the products.

FIRE ANTS

Fire ants can build their colonies inside the herbicidal tree guards on young trees resulting in buildup of soil along the covered trunk which can be detrimental to the trees. Fire ants should be controlled or at least kept out of pecan trees. Lorsban 4E at 2 pts/A as a ground spray is labeled for fire ant control. Best approach is probably applying an ant bait in late spring (see more info in the table above).

BORERS: AMBROSIA BEETLES AND FLATHEADED APPLE TREE BORER

Although older trees can be attacked by ambrosia beetles, young trees (<5-yr old) are more susceptible to attacks by wood-boring beetles. Ambrosia beetles attack trees subjected to stress-inducing factors such as water-logged conditions, diseases, frost injury, etc. Thus, keeping trees healthy is the primary line of defense against ambrosia beetle infestations. Trapping for flight activity along orchard borders, using ethanol-baited log traps, is recommended to time the sprays in the spring. Once flight activity and attacks are detected, spraying pyrethroids on the tree trunks every 7–10 days can be done.

For flatheaded apple tree borer, treatment of *imidacloprid* by drenching or via the irrigation system on young trees could provide protection for about three years. Please see the maximum limits for neonicotinoids.

SCALE INSECTS

Scale populations build slowly, but can reach damaging levels before becoming obvious. Examine fallen limbs carefully during the season for scale presence. Preferred treatment is 1–2% horticultural oil spray, applied in November-December and again in February. For severe problems, an application of Esteem in June may be necessary.

OTHER INSECT PESTS

Pests such as pecan leaf casebearer, leaf miners, walnut caterpillar, fall webworm, pecan budmoth, nut curculio, shoot curculio, Prionus root borers, and others may occasionally cause economic injury to pecan. Growers should be able to identify these pests and their damage. Color photographs of all pecan pests and their injury can be found in the *Southern Pecan Growers Handbook* and online from the UGA Extension pecan team (Google search "ugapecans"). The publication is available at $30 per copy. For ordering information, visit: **extension.uga.edu/publications/for-sale.html**

Specific controls for occasional pests not covered in this spray guide can be obtained from your local county Extension agent.

SPECIAL CONSIDERATIONS

Alternative Formulations—Some pesticides listed in this publication are available in formulations other than the ones listed. If different formulations are used, apply an equivalent amount of actual toxicant per acre.

Pest Resistance and Chemical Use—The aphids and mites which attack pecan have demonstrated the ability to become resistant to insecticides applied for their control. The rate at which this resistance develops depends on the chemical used, the frequency of use, the duration of use, and the rates used. Aphid and mite exposure to effective materials should be minimized to prolong the effective life of the chemicals. It is suggested that no insecticide be applied until it is absolutely necessary (this can be determined by thorough sampling) and that chemicals be alternated as much as possible. Resistance to *neonicotinyl* insecticides has developed in some areas for both yellow- and black-margined pecan aphids. This class of insecticides includes *imidacloprid*, *thiamethoxam*, *acetamiprid*, and *clothianidin*. These materials no longer provide adequate control of resistant populations. Aphid and mite populations may flare following application of Sevin or pyrethroids. Growers should be alert for this response, and limit applications of these materials to the minimum necessary for weevil or stink bug control.

Supplemental Control Measures—Beneficial insects such as lady beetles and lacewings provide natural assistance in suppressing aphid and mite populations. Beneficials are of particular value in early season. Elimination of unneeded early-season insecticide sprays conserves existing populations of beneficial insects and reduces the potential for severe aphid problems later in the season. The planting of leguminous cover crops in tree-row middles promotes the build-up and retention of lady beetle populations in orchards. Crimson clover and Hairy vetch appear to be two of the best ground covers. If leguminous ground covers are planted, an herbicide strip should be maintained down each tree row and special attention should be paid to the increased water requirements that are likely to exist. Extraneous plant material resulting from the heavy growth of legumes must be removed or broken down prior to harvest or implementation of a program of row middle vegetation suppression (see Weed Control section).

Commercial Pecan Insect and Disease Spray Guide

COMMERCIAL PECAN INSECT AND DISEASE SPRAY GUIDE (NON-BEARING TREES)

Will Hudson, Angel Acebes, and Andrew Sawyer, Extension Entomology
Jason Brock and Tim Brenneman, Plant Pathology

TIME OF APPLICATION	PEST	PESTICIDE	MOA	AMOUNT PER ACRE	REI/PHI (Hours or Days)	INSTRUCTIONS AND REMARKS
			FOLIAR SPRAYS			
Bud Break When first buds open.	Foliar disease	Fungicide + *chlorpyrifos* Chlorphos, Lorsban	1B	+ half rate 1–2 pt 4–8 oz	24 H/ —	Spray sufficient volume for thorough coverage. For fungicide options, refer to the pre-pollination section for Pecan Disease Control. The phosphorous acid fungicides are particularly useful with their excellent activity on foliar diseases, highly systemic nature, and low risk of fungicide resistance. Scout for pecan bud moth injury at bud break and time sprays before larvae bore into the shoots.
	Pecan bud moth	*methoxyfenozide* Intrepid 2F	18	3–4 oz	4 H/ —	
		methoxyfenozide + spinetoram Intrepid Edge	5 + 18	4–6.4 oz	4 H/ —	
		abamectin + cyantraniliprole Minecto Pro	6 + 28	8–12 oz	12 H/ —	No more than 24 oz/A/season.
	Hickory shoot curculio	*chlorpyrifos* Lorsban, Chlorphos, etc.	1B	1.5–2 pt	24 H/ —	Apply sprays for shoot curculio at bud-break on the earliest cultivars and repeat at 10–14 day intervals.
Cover Sprays Three weeks after bud-break spray and every 4–6 weeks as needed.	Foliar disease	Fungicide + *chlorpyrifos* Chlorphos, Lorsban	1B	See above + 1–2 pt	24 H/ —	Spray sufficient volume for thorough coverage. Continue scouting for pecan bud moth injury and time sprays before larvae bore into the shoots. The phosphorous acid fungicides are particularly useful with their excellent activity on foliar diseases, highly systemic nature, and low risk of fungicide resistance.
	Pecan bud moth	*chlorpyrifos* Chlorphos, Lorsban, etc.	1B	1.5–2 pt	24 H/ —	
		diflubenzuron Dimilin 2L	15	8–16 oz	24 H/ —	
		Imidan 70WSP		1.5 lb		
		methoxyfenozide Intrepid 2F	18	4–8 oz	4 H/ —	
		abamectin + cyantraniliprole Minecto Pro	6 + 28	8–12 oz	12 H/ —	

Pecan Disease Control

**The information in this section for pecans is from the 2022 Commercial Pecan Spray Guide published by the University of Georgia.
For more information, visit pecans.uga.edu**

PECAN DISEASE CONTROL

Jason Brock and Tim Brenneman, Department of Plant Pathology

DISEASE	CHEMICAL & FORMULATION	MOA	RATE/ACRE	REI/PHI (Hours or Days)	COMMENTS
PRE-POLLINATION APPLICATIONS: EVERY 10–14 DAYS FROM BUD BREAK THROUGH NUT SET					
Scab; Downy Spot	*azoxystrobin* Abound Azaka	11	12 fl oz	4 H/ 45 D	See MOA info on next page.
	difenoconazole + azoxystrobin Quadris Top Amistar Top	3 + 11	10–14 fl oz	12 H/ 45 D	
	difenoconazole + tea tree oil Regev	3 + 46	8.5 fl oz	12 H/ 14 D	Minimum application interval is 14 days. Refer to label for other restrictions.
	fenbuconazole Enable 2F	3	8 fl oz	12 H/ Do not apply after shuck split or within 28 D of harvest	See MOA info on next page. Minimum application interval for Cevya is 7 days.
	kresoxim-methyl Sovran Narvos 50WDG	11	2.4–3.2 oz	12 H/ 45 D	
	mefentrifluconazole Cevya	3	5 fl oz	12 H/ 14 D	
	metconazole Quash	3	3.5 oz	12 H/ 25 D	
	phosphorous acid Kphite 7LP Phostrol ProPhyt FungiPhite Reliant Phiticide	33	2–8 pt 2.5–5 pt 2–5 pt 2–2.5 pt 4 pt 2–5 pt	4 H/ —	With group 33 products, higher rates are best for stand-alone sprays, but lower rates (2–3 pt) can be added to complement other fungicides. The phosphorous acid fungicides are particularly useful with their excellent activity on foliar diseases, highly systemic nature, and low risk of fungicide resistance. See MOA info on next page.
	phosphorous acid + tebuconazole Viathon	33 + 3	2–2.5 pt	12 H/ 0 D	
	propiconazole Orbit Propimax EC Bumper 41.8EC Topaz	3	8 fl oz	12 H/ Do not apply after shuck split	
	propiconazole + azoxystrobin Quilt Quilt Xcel	3 + 11	14–27.5 fl oz 14–21 fl oz	12 H/ Do not apply after shuck split or within 45 D of harvest	
	pyraclostrobin Headline	11	6–7 fl oz	12 H/ 14 D	

DISEASE	CHEMICAL & FORMULATION	MOA	RATE/ACRE	REI/PHI (Hours or Days)	COMMENTS
PRE-POLLINATION APPLICATIONS: EVERY 10–14 DAYS FROM BUD BREAK THROUGH NUT SET (*continued*)					
Scab; Downy Spot (*continued*)	*tebuconazole* Folicur 3.6F Tebuzole 3.6F Monsoon Orius 3.6F Toledo 3.6F	3	8 fl oz	12 H/ Do not apply after shuck split	**MOA Group 1:** Risk for resistance is high. Use should be limited. When conditions are very favorable for scab, use in combination with either a full rate of TPTH or Elast. Limit the use to 1 or 2 applications per season. Available as Topsin M 70WDG, Topsin M 70 WP, and Topsin M WSB, and Topsin M 4.5 FL. Topsin XTR is a premix of *thiophanate methyl* and *tebuconazole*. **MOA Group 3:** Resistance risk is moderate. For best results, tank mix *tebuconazole* with a surfactant. Do not add a surfactant if mixing with other fungicides. Increasing the rate of a Group 3 fungicide will be important if reduced sensitivity is known or suspected. Stand-alone use is not recommended where reduced sensitivity is known or suspected. **MOA Group 11:** Resistance risk is moderate. Do not make more than 2 sequential applications. If only using solo products, Group 11 fungicides should not be used in more than ⅓ of the total number of fungicide applications. If using Group 3 tank-mixed with other modes of action, they should not be used in more than ½ of the total number of fungicide applications. Stand-alone use is not recommended where reduced sensitivity is known or suspected. **MOA Group 30:** Resistance risk is low. **MOA Group 33:** Resistance risk is low. For best control apply in 100 GPA by ground. Three to five applications are generally recommended. Check labels for potential limitations on maximum number of applications or amount of active ingredient allowed per season. Do not use when there is a *phosphate* deficiency. Do not use these as stand-alone sprays for nut scab on very susceptible cultivars or high disease pressure. **MOA Group U12:** Resistance risk is low. Do not use on Moore, Van Deman, Barton, or Shawnee. Do not use a surfactant. Do not use with foliar *zinc* treatments. For any tank mix combination of Elast, TPTH, Group 3, or Group 11 fungicides, the rates provided are the lowest recommended and will provide excellent control of scab under most conditions. When disease pressure is elevated, the rate of either mixing partner can be increased.
	tetraconazole Andiamo	3	8.5 fl oz	12 H/ 30 D	
	tetraconazole + azoxystrobin Brixen	3 + 11	13–20 fl oz		
	tebuconazole + azoxystrobin Custodia Helmstar Plus	3 + 11	8.6–17.2 7.2–14.4	12 H/ 45 D	
	tebuconazole + trifloxystrobin Absolute	3 + 11	5–7.67 fl oz	12 H/ Do not apply after shuck split or within 30 D of harvest	
	flutriafol + azoxystrobin Topguard EQ	3 + 11	5.0–8.0 fl oz	12 H/ 45 D	
	tetraconazole + triphenyltin hydroxide Minerva Duo	3 + 30	16 oz	48 H/ 30 D	
	thiophanate methyl + TPTH or + Elast	1 + 30 or + U12	1 lb + half rate or + 25 fl oz	3 D/ Do not apply after shuck split	
	triphenyltin hydroxide (TPTH) + FRAC Group 3 fungicide	30 + 3	half rate + full rate	48 H/ 30 D	
Anthracnose	Anthracnose is a disease with a long latent period; symptom expression occurs many weeks after infection. Fungicides used for control of scab have been effective in suppressing anthracnose.				
POST-POLLINATION APPLICATIONS: EVERY 10–21 DAYS FROM NUT SET TO SHELL HARDENING					
Scab	*difenoconazole + pydiflumetofen* Miravis Top	3 + 11	13.6 fl oz	12 H/ 45 D	
	dodine Elast 400F	U12	48 fl oz	48 H/ Do not apply after shuck split	
	dodine Elast 400F + Group 3 OR Group 11 fungicide	U12 + 3	25–48 fl oz + full rate	48 H/ Do not apply after shuck split	

DISEASE	CHEMICAL & FORMULATION	MOA	RATE/ACRE	REI/PHI (Hours or Days)	COMMENTS
POST-POLLINATION APPLICATIONS: EVERY 10-21 DAYS FROM NUT SET TO SHELL HARDENING (*continued*)					
Scab (*continued*)	*dodine* Elast 400F + TPTH	U12 + 30	25–48 fl oz + 6–12 fl oz (liquid) *or* 3.75–7.5 oz (wettable)	48 H/ Do not apply after shuck split	**MOA Group 1:** Risk for resistance is high. Use should be limited. When conditions are very favorable for scab, use in combination with either a full rate of TPTH or Elast. Limit the use to 1 or 2 applications per season. Available as Topsin M 70WDG, Topsin M 70 WP, and Topsin M WSB, and Topsin M 4.5 FL. Topsin XTR is a premix of *thiophanate methyl* and *tebuconazole*. **MOA Group 3:** Resistance risk is moderate. For best results, tank mix *tebuconazole* with a surfactant. Do not add a surfactant if mixing with other fungicides. Increasing the rate of a Group 3 fungicide will be important if reduced sensitivity is known or suspected. Stand-alone use is not recommended where reduced sensitivity is known or suspected. **MOA Group 11:** Resistance risk is moderate. Do not make more than 2 sequential applications. If only using solo products, Group 11 fungicides should not be used in more than ⅓ of the total number of fungicide applications. If using Group 3 tank-mixed with other modes of action, they should not be used in more than ½ of the total number of fungicide applications. Stand-alone use is not recommended where reduced sensitivity is known or suspected. **MOA Group 30:** Resistance risk is low. **MOA Group 33:** Resistance risk is low. For best control apply in 100 GPA by ground. Three to five applications are generally recommended. Check labels for potential limitations on maximum number of applications or amount of active ingredient allowed per season. Do not use when there is a *phosphate* deficiency. Do not use these as stand-alone sprays for nut scab on very susceptible cultivars or high disease pressure. **MOA Group U12:** Resistance risk is low. Do not use on Moore, Van Deman, Barton, or Shawnee. Do not use a surfactant. Do not use with foliar *zinc* treatments. For any tank mix combination of Elast, TPTH, Group 3, or Group 11 fungicides, the rates provided are the lowest recommended and will provide excellent control of scab under most conditions. When disease pressure is elevated, the rate of either mixing partner can be increased.
	phosphorous acid Kphite 7LP Phostrol ProPhyt Reliant Phiticide	33	highest label rate	4 H/ —	
	propiconazole + azoxystrobin Quilt Quilt Xcel	3 + 11 3 + 11	20–28 fl oz 20–21 fl oz	12 H/ Do not apply after shuck split or within 45 D of harvest	
	tebuconazole + azoxystrobin Custodia Helmstar Plus	3 + 11	8.6–17.2 7.2–14.4	12 H/ 45 D	
	flutriafol + azoxystrobin Topguard EQ	3 + 11	5.0–8.0 fl oz	12 H/ 45 D	
	tebuconazole[4] *+ trifloxystrobin* Absolute	3 + 11	5–7.67 fl oz	12 H/ Do not apply after shuck split or within 30 D of harvest	
	difenoconazole + azoxystrobin Amistar Top	3 + 11	8–14 fl oz	12 H/ Do not apply after shuck split or within 30 D of harvest	
	tetraconazole + azoxystrobin Brixen	3 + 11	13–20 fl oz	12 H/ 45 D	
	tetraconazole + triphenyltin hydroxide Minerva Duo	3 + 30	16 oz	48 H/ 30 D	
	TPTH + Group 3 or Group 11 fungicide	30 + 3	6–12 fl oz (liquid) *or* 3.75–7.5 oz (wettable) + full rate	48 H/ 30 D	
	triphenyltin hydroxide (TPTH) Agri Tin Agri Tin Flowable Super Tin 80WP Super Tin 4L	30	7.5 oz 12 fl oz 7.5 oz 12 fl oz	48 H/ 30 D	
	ziram Ziram		6–8 lb	48 H/ 55 D	Ziram as a multi-site alternative in cases where resistance to other protectants is an issue.

POWDERY MILDEW: For powdery mildew, the scab fungicide program can be adjusted if needed. The FRAC Group 3 fungicides or mixes containing FRAC 3 fungicides are the best options. Combining sulfur (4-6 lb/A) with fungicides used for scab control is also an option. **DO NOT** mix sulfur with Elast.

ZONATE LEAF SPOT: For zonate leaf spot, the scab fungicide program can be adjusted if needed. The FRAC Group 3 fungicides or mixes containing FRAC 3 fungicides are the best options. Topsin M also provides suppression of Zonate leaf spot.

ANTHRACNOSE: Anthracnose is a disease with a long latent period; symptom expression occurs many weeks after infection. Fungicides used for control of scab have been effective in suppressing anthracnose, particularly FRAC Groups 3 and 11 and the phosphorous acid-based fungicides

NOTE: In orchards where any nuts have any amount of scab by mid-June or in orchards where 10% or more of the nuts have any amount of scab by early July, the following measures should be taken:

- The interval between fungicide sprays should not exceed 14 days until shellhardening.
- On varieties with a summer growth flush, the spray interval should be tightened so that no more than 10 days pass from the onset of the growth flush until a fungicide spray is made.
- If the 5-day forecast shows the probability for several days of rain, close the interval to have as much acreage as possible treated within 7 days of the storm.

AFTER SHELL HARDENING: Fungicide coverage for crop protection is necessary to shell hardening. Beginning in early August, monitor for shell hardening and adjust fungicide needs accordingly.

FOLIAR DISEASES: Maintaining leaf health past shell hardening is important. If leaf scab, zonate leaf spot, or another foliar disease is of concern, refer to the previous sections for fungicide options and recommendations. Pay attention to use limitations and fungicide resistance management guidelines. DO NOT use Topsin in consecutive applications for leaf disease control.

DISEASE	CHEMICAL & FORMULATION	MOA	RATE/ACRE	REI/PHI (Hours or Days)	COMMENTS
Phytophthora Shuck and Kernel Rot	A treatment is advised in orchards with a history of this disease (primarily Houston, Peach, and Macon counties) during periods of extended wetness and moderate temperatures (< 86° F) occurring between shell hardening and shuck split.				
	TPTH	30	full rate		
	phosphorous acid Fosphite, KPhite Phiticide, Phostrol Rampart	33	full rate	4 H/ —	The phosphite (phosphorous acid based) fungicides listed are EPA approved and considered to be very safe products. Check labels for potential limitations on maximum number of applications or amount of active ingredient allowed per season.
	MOA Group 11 fungicides	11	full rate		
	copper hydroxide Kocide 3000 Kocide 2000	M1	0.75–1.75 lb 1.5–3 lb	48 H/ —	Use higher rates when disease pressure is high and large, mature trees.

Strawberry Disease Control

W. O. Cline, Entomology and Plant Pathology

For more information and details, see the *Southeast Regional Strawberry Integrated Pest Management Guide* online at www.smallfruits.org.

Pre-Planting Disease and Weed Management

Table 6-12A. Pre-Planting Disease and Weed Management

Management Options	Amount of Formulation per Acre	Effectiveness[1]	Comments
Anthracnose Angular leaf spot Phytophthora crown rot Fusarium wilt (not reported in Eastern U.S.) Viruses	Disease-free plants	Importance: E Efficacy: E	Use of certified plants or plants produced in a similarly stringent program is the most important method to prevent these diseases.
Nematodes	Sample soil	Importance: G	Sample soils for nematode analysis through local state services to determine which fumigant or IPM management plan may be required.
Nematodes and soilborne pathogens (Pythium, Phytophthora, Fusarium, Rhizoctonia)	Crop rotation and cover crop selection	Importance: G Efficacy: G	Selected summer cover crops and rotating fields to other crops for 2 to 3 years can suppress nematode populations and reduce black root rot and other disease problems.
Weeds Root and crown rot disorders Nematodes (Black root rot; Phytophthora crown rot)	Pre-plant fumigation and laying down plastic mulch	Efficacy: E	See fumigation table below. Consult with custom applicators and/or Extension agents for product and rate recommendations.

[1] Effectiveness Ratings: The efficacy or importance of a management option is indicated by E = excellent, VG = very good, G = good, F = fair, P = poor, NC = no control.

Pre-Planting and Early Post-planting: Nematode Management

Table 6-12B. Pre-planting and Early Post-planting: Nematode Management

Management Options	Amount of Formulation per Acre	Effectiveness	REI	PHI	Comments
Nimitz or Fluensulfone 480EC	3.5 to 7 pt per treated acre	See comments	12 hr	See label	Nimitz is a “traditional contact nematicide.” It has not been extensively tested on strawberry in the Southeast and Mid-Atlantic states, but research on other crops in these areas and on strawberry elsewhere suggests moderate to good activity - not quite as effective as soil fumigant standards - against most major plant-parasitic nematode species. Apply via drip or incorporated spray at least 7 days before planting; only 1 application per year. Soil temperature must be 60ºF or above. Soil incorporation in the top 6 to 8 inches is critical. Irrigating (0.5 to 1 inches) 2 to 5 days after application is recommended.
Majestene (heat-killed *Burkholderia* spp. strain A396)	4 to 8 qt	See comments	4 hr	0 days	Majestene is a biological nematicide approved for organic strawberry production. It has not been extensively field-tested on strawberry in the Southeast and Mid-Atlantic states, but research to date suggests useful activity against root-knot, lesion, sting, stunt, ring, and reniform nematodes. Can be applied as a pre-plant incorporated, in-furrow or banded spray as long as spray volume is sufficient to thoroughly soak the root zone. However, Majestene can also be drip-applied prior to planting, at planting or shortly thereafter, and again later in the season. Higher rates are likely more effective, and repeated applications also increase the extent and duration of nematode control. If nematode populations are high, another product may also be necessary for control.

Fumigants

New labels require extensive risk mitigation measures including fumigant management plans (FMPs), buffer restrictions, worker protection safety standards, and other measures. Details are on the labels and see www.epa.gov/soil-fumigants. Some fumigants are registered on multiple crops but with crop- or soil-type specific rates; others are registered for specific crops or in certain states only. Follow all labels carefully.

Relative Efficacy of Currently Registered Fumigants or Fumigant Combinations for Managing Soilborne Nematodes, Diseases, and Weeds in Plasticulture Strawberries

Table 6-12C. Relative Efficacy of Currently Registered Fumigants or Fumigant Combinations for Managing Soilborne Nematodes, Diseases, and Weeds in Plasticulture Strawberries[1]

	Rate per Treated Acre[2]		Relative Efficacy[3]			
Product	**Volume (gal)**	**Weight (lb)**	**Nematodes**	**Disease**	**Nutsedge**	**Weeds: Annual**
Telone II (1,3-dichloropropene; 1,3-D)	15 to 27	153 to 275	E	P	P	P
Telone EC[3]	9 to 24[5]	91 to 242[5]	E	P	P	P
Telone C17 (1,3-D + chloropicrin)	32.4 to 42	343 to 445	E	G	P	P
Telone C35 (1,3-D + chloropicrin)	39 to 50	437 to 560	E	E	P	F
InLine (1,3-D + chloropicrin)[3]	29 to 57.6 (*See Label*)	325 to 645 *(See Label)*	E	E	P	G
Pic-Clor 60 (chloropicrin + 1,3-D)	48.6	588	E	E	P	G
Pic-Clor 60 EC[4]	42.6	503	E	E	P	G
Pic-Clor 80	34	440	G	E	P	F
Metam potassium[6]	30 to 62	318 to 657	F	G	P	VG
Metam sodium[6] (MS)	37.5 to 75	379 to 758	F	G	P	VG
Chloropicrin + MS[6]	19.5 to 31.5 + 37.5 to 75	275-444 + 379-758	F	E	F	VG
Chloropicrin	48.6	150 to 350	P	E	ND	ND
Tri-Pic 100EC[4]	8 to 24	100 to 300	P	E	ND	ND

[1] Fumigants with lower efficacy against weeds may require a complementary herbicide or hand-weeding program, although use of virtually impermeable film (VIF) or totally impermeable film (TIF) may increase weed control, particularly with chloropicrin + 1,3-D products or Paladin. Refer to the Herbicide Recommendation section of this guide for directions pertaining to herbicide applications. Telone can persist more than 21 days under cool or wet soil conditions.

[2] Rates can sometimes be reduced if products are applied with VIF or TIF.

[3] Efficacy Ratings: The efficacy of a management option is indicated by E = excellent, VG = very good, G = good, F = fair, P = poor, and ND = no data. These ratings are benchmarks; actual performance will vary.

[4] Product is formulated for application through drip lines under a plastic mulch; efficacy is dependent on good distribution of the product in the bed profile.

[5] Labelled rates are per *broadcast-equivalent* acre, NOT per treated acre.

[6] Metam potassium can be Metam KLR, K-Pam, Sectagon K54 or other registered formulations, and should be used in soils with high sodium content. Metam sodium can be Vapam, Sectagon 42, Metam CLR or other registered formulations.

Planting and Early Post-Planting: Disease Control

General Pesticide Information

FRAC/IRAC/HRAC codes — these acronyms refer to industry-sponsored committees addressing resistance to crop protection materials; Fungicide Resistance Action Committee (FRAC), Insecticides Resistance Action Committee (IRAC) and Herbicide Resistance Action Committee (HRAC). Pesticides affect their target pest in a variety of ways, and the way a pesticide kills the target organism is called the ***mode of action*** **(MOA).** Although pesticides have different names and may have different active ingredients, they may have the same MOA. Over time, pests can become resistant to a pesticide, and typically this resistance applies to all pesticides with the same MOA. When rotating pesticides, it is important to select pesticides with different MOAs. The FRAC/IRAC/HRAC have organized crop protection materials into groups with shared MOAs and given them specific codes, which appear on pesticide labels. The code **U** means the MOA is unknown. *When selecting pesticides, avoid successive applications of materials in the same MOA group to minimize potential resistance development*. MOA categories are listed in this guide to aid in the development of resistance management programs. More information about this topic can be found at www.frac.info, www.irac-online.org, and www.hracglobal.com.

Organic Materials Review Institute (OMRI; www.omri.org) listed materials are acceptable for production systems certified as organic. Organically acceptable materials (**OMRI** listed) are in the comments section.

Generics: Many pesticide active ingredients are available in generic formulations. For brevity, these formulations are not generally listed. Listed trade names are included to aid in identifying products and are not intended to promote the use of these products or to discourage the use of generic products. Generic products generally work similarly to their brand name counterparts, but formulation changes can impact efficacy and plant response. As with any new chemical, read and follow all label instructions. Chemical names are subject to change; please check the active ingredient for all materials.

The Pesticide Environmental Stewardship website is located at pesticidestewardship.org. Information on proper pesticide use and handling, calibration of equipment, reading pesticide labels, disposal, handling spills, and other topics is presented.

Pre-plant dips: Several products are registered as plant dips to manage pathogens or to protect plants just prior to field setting, but only a limited amount of research has been done with plant dips. In general, these treatments are not recommended except under specific circumstances; for example, if a disease has been diagnosed to be on the transplants. Products not labeled for dip treatments should not be used for dips, since poor plant performance has been observed in research trials.

Abound (FRAC 11) — Mix 5 to 8 fl oz/100 gal of water. Dip plants for 2 to 5 minutes. Transplant treated plants as quickly as possible. This treatment has been developed for bare root transplants with a known problem of anthracnose. The dip is a whole plant dip, and some growers do not re-use the water for fear of spreading bacterial angular leaf spot and other diseases. It is reasonable to expect these fungicides to have some Rhizoctonia suppressive activity, but there are no research results to demonstrate a benefit. For managing Rhizoctonia, a root dip should suffice, rather than dipping whole plants. Rhizoctonia (and the black root rot problem) builds up over time, and it is doubtful that a root dip would offer much benefit for season-long control. Growers must ensure root dip waste is properly disposed.

Switch 62.5WDG (FRAC 9 + 12) — Switch offers options for treating plants known to be infected with *Colletotrichum* species and has shown good efficacy in reducing losses due to the crown rot pathogen in bare root transplants (*Colletotrichum gloeosporioides*). Use 5 to 8 fl oz/100 gal water. Wash transplants to remove excess soil prior to dipping. Completely immerse planting stock in dip solution. Dip or expose plants for a minimum of 2 to 5 minutes. Do not reuse solution. Growers must ensure proper disposal of root dip waste. Plant treated plants as quickly as possible. Delayed planting could cause plant stunting.

Phosphites (FRAC P07) — Dip plants in 2.5 lb/100 gal (Aliette), 2 pints/100 gal (ProPhyt), or 2.5 pints/100 gal (Phostrol) for 15 to 30 minutes and then plant within 24 hours after treatment. This treatment should help to suppress Pythium and Phytophthora problems.

Little data are available for other plant dip products, including **Oxidate,** and it is doubtful that they offer management of root diseases. In most cases, root pathogens are internal to the tissue and are not controlled by surface disinfectants.

Fungicide Resistance Management Recommendations

Gray mold (Botrytis cinerea) – This fungal pathogen historically has a high potential to develop resistance, and recent data suggest a high percentage of strains are resistant to several important fungicides. Limit the number of times fungicides of the same group (same FRAC code) are applied in a single year, and tank-mix a broad-spectrum fungicide such as captan or thiram with single mode-of-action products.

It is currently suggested that the strobilurin (now called QoI; FRAC code 11) fungicides (Abound, Cabrio, Intuity, Merivon, Pristine, and Quadris Top) be saved for use in controlling anthracnose diseases (see below) when there is a high potential for disease pressure. Captan or thiram should help suppress anthracnose when utilized in Botrytis or other disease control applications, but the QoI fungicides are currently the most efficacious materials for control of anthracnose.

Powdery mildew — Monitor the field for the first signs of powdery mildew (leaf distortion and discoloration). Mildew in the fall does not appear to cause significant damage and may not reappear in the spring. *Therefore, most growers will not need to spray for powdery mildew.* However, fields have been observed in the fall with severe foliar disease incidence, and plant productivity may then be hampered, justifying control measures. Likewise, if powdery mildew pressure occurs in the spring and affects the fruit, the fruit will have a dull appearance and be unmarketable unless managed with fungicides. High tunnels favor powdery mildew development.

Anthracnose (*Colletotrichum* spp.) — Most plantings are rarely at risk for anthracnose. Thus, anthracnose fungicides may not be needed. In most cases, contaminated plant sources are identified before or soon after planting. Know your plant source. If present, anthracnose on plants can cause petiole lesions (black sunken areas) stunting and plant death. Fall fungicide applications will be required for *Colletotrichum* only if plant source problems are identified, usually appearing as symptomatic plants or discovered when assayed for quiescent infections. Research results show that QoIs are more effective against the fruit rot pathogen (‘*acutatum*’) compared to the crown rot pathogen (‘*gloeosporioides*’). Captan, Topsin M or Switch are as effective as the QoIs for controlling the crown rot pathogen. In general, it is most effective to save the QoI (FRAC 11) chemistry for spring applications to protect the fruit if anthracnose (‘*acutatum*’) is known to be present.

Table 6-13A. Planting and Early Post-Planting: Disease Management

Disease	Management Options	Amount of Formulation per Acre	Effectiveness[1]	REI	PHI	Comments (FRAC/IRAC Code)
Red stele; *Phytophthora* crown/ root rots	mefenoxam (Ridomil Gold SL)	1 pt/treated A	VG	see label	0 days	Apply in sufficient water in drip applications to move the fungicide into the root zone. Use proportionately less Ridomil Gold for band treatments. REI varies and is dependent upon method of application. **Do not exceed 3 pts/year. FRAC–4**
	mefenoxam (Ultra Flourish)	2 pt/treated A	VG	see label	0 days	Apply in sufficient water to move the fungicide into the root zone. Use proportionately less mefenoxam for band treatments. **Do not exceed 6 pts per crop. FRAC–4**
	metalaxyl (MetaStar 2E and generics)	2 qt/treated A	VG	see label	0 days	Apply in sufficient water to move the fungicide into the root zone. **Do not exceed 6 qt/treated A/year. FRAC–4**
	phosphites, e.g., Aliette WDG ProPhyt, Phostrol	Various rates; see label	F	see label	0 days	Rates differ for foliar and drip applications. Phosphite-based chemicals are not as effective as Ridomil Gold. Consider phosphites if the pathogen is known to be resistant to mefenoxam or if root systems are poor AND foliage is healthy for chemical uptake. **FRAC–P07**
***Rhizoctonia* sp. (seedling root rot; basal stem rot)**	Abound	0.40 to 0.80 fl oz/1,000 row feet	F	4 hr	0 days	This is a drip irrigation application method. Can be considered especially for plug plants with poor root systems or plants placed into non-fumigated beds or beds with excess water in heavy soils. **FRAC–11**
Powdery mildew only	Powdery mildew is not a common problem at this time of year; it may come in on transplants but usually does not persist or present an economic problem in open fields. There is a greater risk of powdery mildew in high tunnels. FRAC 11 products or product mixtures with FRAC 11 fungicides are labeled for use against powdery mildew but are not recommended for powdery mildew management in order to optimize FRAC 11 fungicide use for anthracnose fruit rot control.					
	Procure 50WS Procure 480SC	4 to 8 oz 4 to 8 fl oz	E	12 hr	1 day	Check label for prohibited rotational crops. Do not plant leafy or fruiting vegetables within 30 days after application. Do not plant bulb or root vegetables within 60 days after application. Do not plant cotton, small cereal grains and all other crops not registered within one year of application. **FRAC–3**
	Rally 40WSP	2.5 to 5 oz	E	24 hr	0 days	Rally is registered for control of leaf spot, leaf blight, and powdery mildew. **FRAC–3**
	Rhyme	5 to 7 fl oz	E	12 hr	0 days	Rhyme is registered for control of powdery mildew and for drip application to manage charcoal rot. **FRAC-3**
	Sulfur (multiple formulations)	See label	G	24 hr	1 day	Spray as needed. Avoid using in middle of a hot sunny day that may cause leaf burning. See label. **FRAC–M2**
	Quintec	4 to 6 fl oz	E	24 hr	1 day	Do not use more than 4 times per crop and no more than 2 times in a row. Rotate with other mildewcides. See label. **FRAC–13**
	Protocol	1.33 pt	G	24 hr	1 day	Premix of 2 active ingredients, thiophanate-methyl (**FRAC–1**) and propiconazole (**FRAC–3**). No more than 2 sequential applications should be made before alternating with fungicides that have a different mode of action.
Anthracnose fruit rot ('acutatum')	Pristine WG	18.5 to 23 oz	E	12 hr	0 days	Premix of two active ingredients, pyraclostrobin (**FRAC–11**) and boscalid (**FRAC–7**). See resistance management notes above.
	Merivon	5.5 to 8 fl oz	E	12 hr	0 days	Premix of two active ingredients, pyraclostrobin (**FRAC–11**) and fluxapyroxad (**FRAC–7**). See resistance management notes above.
	Luna Sensation	4.0 to 7.6 fl oz	E	12 hr	0 days	Premix of 2 active ingredients, trifloxystrobin (**FRAC-11**) and fluopyram (**FRAC-7**). See resistance management notes above.
	Cabrio 20EG	12 to 14 oz	E	24 hr	0 days	Active ingredient, Pyraclostrobin (**FRAC-11**).
	Abound	6.2 to 15.5 fl oz	E	4 hr	0 days	Failure in management of some 'acutatum' populations has been observed with Abound and similar products. **FRAC–11**
	Miravis Prime	11.4 to 13.4 fl oz	E	12 hr	0 days	
	Inspire Super	16 to 20 fl oz	E	12 hr	0 days	
	Orbit, Tilt and multiple generics	4 fl oz	G	24 hr	0 days	No more than 2 sequential applications should be made before alternating with fungicides that have a different mode of action. Active ingredient propiconazole (**FRAC–3**).
	Quadris Top	12 to 14 fl oz	G	12 hr	0 days	Premix of 2 active ingredients, azoxystrobin (**FRAC–11**) and difenoconazole (**FRAC–3**). No more than 2 sequential applications should be made before alternating with fungicides that have a different mode of action.
	Protocol	1.33 pt	G	24 hr	1 day	Premix of 2 active ingredients, thiophanate-methyl (**FRAC–1**) and propiconazole (**FRAC–3**). No more than 2 sequential applications should be made before alternating with fungicides that have a different mode of action.
Anthracnose crown rot ('gloeosporioides' crown rot)	Captan 50W Captan 80WDG	3 to 6 lb (50W) 1.87 to 3.75 lb (80W)	F	24 hr	1 day	In plantings known to be infected with the anthracnose crown rot pathogen, consider applying captan plus Topsin-M at 10- to 14-day intervals, for a total of 2 to 3 applications in the fall. **FRAC–M4**
	Captec 4L	1.5 to 3.0 qt/100 gal	F	24 hr	1 day	**FRAC–M4**
	Topsin-M 70WP	1 lb	F	12 hr	1 day	For suppression only. See notes above on resistance management. **FRAC–1**
	Quadris Top	12 to 14 fl oz	G	12 hr	0 days	Same as above. **FRAC–3 + 11**

[1] Effectiveness Ratings: The efficacy or importance of a management option is indicated by E = excellent, VG = very good, G = good, F = fair, P = poor, NC = no control, and ND = no data. XX indicates that use of this chemical can increase the disease.

Note: A treated acre is the amount of area under the plastic, i.e., in most strawberry fields there is about one acre under plastic on two acres of land.

New Leaf Growth to Pre-Bloom: Disease Management

Table 6-13B. New Leaf Growth to Pre-bloom: Disease Management

Disease	Management Options	Amount of Formulation per Acre	Effectiveness[1]	REI	PHI	Comments (FRAC/IRAC Code)
Botrytis crown rot	**Botrytis crown rot** may occur during warm winter periods after early bloom is killed by frost and colonized by *Botrytis*. The pathogen typically grows down the flower stem (peduncle) and colonizes the upper crown tissue, causing death of the leaf petioles, particularly if plants are large or planted densely.					
	Rovral 4F and generics (iprodione)	1.5 to 2 pt	VG	24 hr	see comments	Do not apply after first fruiting flower, and do not make more than 1 application of Rovral per season. Crown rot control during the early winter and prior to bloom may be the most effective use of the one Rovral application allowed in strawberries. **FRAC–2**
	Switch 62.5 WG	11 to 14 oz	VG	12 hr	0 days	See resistance management information above. **FRAC–9 + 12**
	Captan 50W	3 to 6 lb (50W)	F	24 hr	1 day	See notes below. **FRAC–M4**
	Captan 80WDG	1.9 to 3.8 lb (80WDG)				
Botrytis	Remove dead and dying leaves just before bloom		Importance: F Efficacy: G			Symptomatic leaf removal is effective but may not be economical if fungicides are heavily used for Botrytis management. If anthracnose fruit rot is present, hand-pruning plants may create more anthracnose disease problems. Do not use QoI fungicides - these should be saved for use as fruit develop and to avoid selection of resistant populations.
	Leaf spots, Leaf blights and Powdery Mildew generally do not become economically important diseases in the fall or early spring. Thus, fungicides are generally not required for these problems. Thresholds have not been established, so the need for fungicides should be determined on a farm-by-farm basis depending on the disease pressure present. Phomopsis and leaf spot may be associated with plant sources; therefore, disease incidence can vary from year to year. Warm wet weather favors disease progress. See previous notes on powdery mildew under “Planting and Early Post-planting: Disease Management.” In the spring, monitor fields closely observing the underside of strawberry leaves to determine if powdery mildew is present. FRAC 11 products or mixtures with FRAC 11 fungicides are labeled but not listed to manage powdery mildew and leaf spots in order to optimize FRAC 11 fungicide use for anthracnose fruit rot control.					
Phomopsis leaf blight	Captan 50W	3 to 6 lb	F	24 hr	1 day	When foliar symptoms appear, make 1 or 2 captan applications plus Topsin-M at a 10- to 14-day interval for better control than captan products alone would provide. Do not apply more than 24 lb captan active ingredient per acre per year. **FRAC–M4**
	Captan 80WDG	1.87 to 3.75 lb	F	24 hr		
	Captec 4L	1.5 to 3.0 qt/100 gal	F	24 hr		
	Topsin-M 70WP	1 lb	G	12 hr	1 day	See note above on resistance management. **FRAC–1**
	Rally 40WSP	2.5 to 5 oz	VG	24 hr	0 days	Rally is registered for control of leaf spot, leaf blight, and powdery mildew. Do not apply more than 30 oz per acre. **FRAC 3**
Common leaf spot, leaf scorch, leaf blight (e.g., Mycosphaerella, Phomopsis, Gnomonia)	Captan 50W or Captan 80 WDG	1 lb (50W); 1.6 lb (80WDG)	G	24 hr	1 day	When foliar symptoms appear, make 1 or 2 captan applications plus Topsin-M at a 10- to 14-day interval for better control than captan products alone would provide. Do not apply more than 24 lb captan active ingredient per acre per year. Do not tank mix captan products with highly alkaline pesticides, such as Bordeaux mixture. See resistance management notes above. **FRAC–M4, FRAC–1**
	Captan 50W or Captan 80 WDG plus Topsin-M 70WP	1 lb		24 hr	1 day	
	Captan 50W Captan 80 WDG	3 to 6 lb 1.87 to 3.75 lb	F	24 hr	1 day	**FRAC–M4**
	Thiram SC	2.6 qt	F	24 hr	1 day	**FRAC–M3**
	Rally 40WSP	2.5 to 5 oz	VG	24 hr	0 days	Rally is registered for control of leaf spot, leaf blight, and powdery mildew. Do not apply more than 30 oz per year. **FRAC–3**
Powdery mildew only	Procure 480SC	4 to 8 fl oz	E	12 hr	1 day	Check label for prohibited rotational crops. Do not plant leafy or fruiting vegetables within 30 days after application. Do not plant bulb or root vegetables within 60 days after application. Do not plant cotton, small cereal grains, and all other crops not registered within 1 year of application. **FRAC–3**
	Rally 40WSP	2.5 to 5 oz	E	24 hr	0 days	Rally is registered for control of leaf spot, leaf blight, and powdery mildew. Do not apply more than 30 oz per year. **FRAC–3**
	Rhyme	5 to 7 fl oz	?	12 hr	0 days	Rhyme is registered for control of powdery mildew and for drip application to manage charcoal rot. **FRAC-3**
	Quintec	4 to 6 fl oz	E	24 hr	1 day	Do not use more than 4 times per crop and no more than 2 times in a row. Rotate with other mildewcides. Rotation to non-registered crops less than 30 days after application is prohibited. **FRAC–13**
	Torino	3.4 oz	?	4 hr	0 days	Do not make more than 2 applications per year. Do not apply more than once every 14 days. **FRAC–U06**
	Tilt and other generics	4 fl oz	G	12 hr	0 days	No more than 2 sequential applications should be made before alternating with fungicides that have a different mode of action. **FRAC–3**

Table 6-13B. New Leaf Growth to Pre-bloom: Disease Management

Disease	Management Options	Amount of Formulation per Acre	Effectiveness[1]	REI	PHI	Comments (FRAC/IRAC Code)
Angular (bacterial) leaf spot (*Xanthomonas fragariae*)	Basic copper sulfate (various formulations)	See labels	P	48 hr	0 hr	Angular (bacterial) leaf spot can be a serious problem during cool, wet conditions. These compounds provide some control unless conditions highly favor disease. Repeat applications at 7- to 10-day intervals. Discontinue when phytotoxicity appears, usually after 4 to 5 applications. NOTE: All copper sulfate, copper hydroxide and other copper products labeled for strawberry can be used but check label for the proper rate because different products will contain different percentages of active ingredient. **FRAC–M1.**
	copper hydroxide (various formulations)	See labels	P	24 hr	0 days	
	copper salts of fatty and rosin acids (various formulations)	See labels	P	12 hr	0 days	
	cuprous oxide (various formulations)	1.05 to 4.2 lbs a.i. (various formulations)	P	12 hr	0 days	
Red stele; Phytophthora crown/root rots	mefenoxam (Ridomil Gold SL and other formulations)	1 pt	VG	12 hr	0 days	Strawberry plants initiate considerable root growth in the early spring. Time control applications in problem fields when new growth begins in the spring. Apply in sufficient water to move the fungicide into the root zone. Use proportionately less fungicide for band treatments (e.g., for drip applications). **FRAC–4**
	Ultra Flourish	2 pt				
	metalaxyl (MetaStar and generics)	2 qt/treated A	VG	48 hr	0 days	
	phosphites (e.g., Aliette, ProPhyt, Phostrol)	Various rates; see label	G	12 hr	0 days	The phosphite-based chemicals are not as effective as Ridomil Gold. Consider phosphites if the pathogen is known to be resistant to mefenoxam or if strawberry plants have poor root systems but sufficient foliage for chemical uptake. **FRAC–33**

[1] Effectiveness Ratings: The efficacy or importance of a management option is indicated by E = excellent, VG = very good, G = good, F = fair, P = poor, NC = no control, and ND = no data. XX indicates that use of this chemical can increase the disease.

Early Bloom (10%) and into Harvest: Disease Management

W. O. Cline, Entomology and Plant Pathology

The primary diseases of concern at early bloom and into harvest are **Botrytis fruit rot (BFR)** and **anthracnose fruit rot (AFR)**. Most growers rarely experience anthracnose problems and may not need an anthracnose management program. Several **key principles** should be kept in mind:

1. Captan, Thiram, and Switch offer a broad spectrum of disease control. Switch is modest against AFR in NC research.
2. Elevate should not be used more than twice per season due to resistance concerns. It is effective against Botrytis but no other fungal pathogens.
3. High-risk fungicides of the same chemical class (FRAC group) should not be applied in consecutive applications.
4. Bloom sprays are the most important for managing Botrytis, because 90% of fruit infection occurs through the flower at bloom. Bloom sprays are also critical for AFR.
5. Fruit rot diseases develop rapidly during wet periods or in poorly ventilated locations. Control is easier when initiated before the problem develops. Spray coverage is important and dependent on nozzle condition, tractor speed, pressure, and plant density. Spray coverage can be checked with water sensitive cards.

Table 6-14. Early Bloom (10%) and into Harvest: Disease Management

Disease	Management Options	Amount of Formulation per Acre	Effectiveness[1]	REI	PHI	Comments (FRAC/IRAC Code)
Botrytis gray mold	Captan 50W	3 to 6 lb (50W)	G	24 hr	1 day	See suggested schedule above. Do not apply more than 24 lb of captan active ingredient per acre per year. **FRAC–M4**
	Captec 4L	2.5 qt	G	24 hr	1 day	
	Switch 62.5WG	11 to 14 oz	E	12 hr	0 days	Do not apply more than twice per season due to resistance management. See resistance management notes. **FRAC–12, FRAC–9**
	Ph-D WDG OSO5% SC	6.2 oz	G	4 hr	0 days	Do not apply more than twice per season due to resistance management. **FRAC-19**
	Thiram	2.6 qt	G	24 hr	3 days	Make 3 to 5 applications at 10-day intervals. Thiram is a broad-spectrum fungicide similar to captan. **FRAC–M3**
	Elevate 50WDG	1.5 lb	E	4 hr	0 days	Do not apply more than twice per season due to resistance management. Under light pressure, 1.0 lb Elevate plus captan may be used (see label). **FRAC–17**
	Fontelis	16 to 24 fl oz	E	12 hr	0 days	Do not apply FRAC-7 products more than twice per season due to resistance management. Some matted row cultivars may show phytotoxicity (see label). **FRAC-7**
	Kenja 400SC	13.5 to 15.5 fl oz	E	12 hr	0 days	Do not apply FRAC-7 products more than twice per season due to resistance management. Some matted row cultivars may show phytotoxicity (see label). **FRAC–7**
	Scala	18 fl oz 9 fl oz	G	12 hr	1 day	Use lower rate only in a tank mix with another fungicide active against gray mold (e.g., captan or Thiram). **FRAC–9**
	Luna Tranquility	16 to 27 fl oz	E	12 hr	0 day	Do not use any FRAC 9 or 7 products more than twice per season for resistance management. **FRAC–9, FRAC–7**
	Luna Sensation	6 to 7.6 fl oz	E	12 hr	0 day	Do not use any FRAC 11 or 7 products more than twice per season for resistance management. **FRAC–11, FRAC–7**
Botrytis gray mold and Anthracnose fruit rot (acutatum) Products in this section are labeled for both Botrytis and anthracnose.	Pristine WG	18.5 to 23 oz	E	12 hr	0 days	Do not apply more than 2 applications per acre per crop year. **FRAC–11, FRAC–7**
	Luna Sensation	6 to 7.6 fl oz	E	12 hr	0 day	Do not use any FRAC 11 or 7 products more than twice per season for resistance management. **FRAC–11, FRAC–7**
	Merivon	8 to 11 fl oz	E	12 hr	0 days	Do not apply more than 2 applications per acre per crop year. **FRAC–11, FRAC–7**
	Captan 50W	3 to 6 lb (50W)	G	24 hr	1 day	For better control and resistance management, use captan applications plus Topsin-M (see label). See suggested schedule above. Do not apply more than 24 lb of captan active ingredient per acre per year. **FRAC–M4**
	Captan 80 WDG	1.87 to 3.75 lb (80WDG)				
	Miravis Prime	11.4 to 13.4 fl oz	E	12 hr	0 days	
	Inspire Super	16 to 20 fl oz	E	12 hr	0 days	

Table 6-14. Early Bloom (10%) and into Harvest: Disease Management

Disease	Management Options	Amount of Formulation per Acre	Effectiveness[1]	REI	PHI	Comments (FRAC/IRAC Code)
Anthracnose fruit rot (acutatum)	Abound	6.2 to 15.5 fl oz 6.0 to 15.5 fl oz	VG (failure found in some fields)	4 hr	4 hr	See notes to manage risk of developing fungicide resistance. In recent research, Abound and similar products have performed less well than Cabrio/ Pristine. **FRAC–11**
	Luna Sensation	4 to 7.6 fl oz	E	12 hr	0 days	Do not use any FRAC 11 or 7 products more than twice per season for resistance management. **FRAC–11, FRAC–7**
	Miravis Prime	11.4 to 13.4 fl oz	E	12 hr	0 days	
	Inspire Super	16 to 20 fl oz	E	12 hr	0 days	
	Merivon	5.5 to 8 fl oz	VG	12 hr	0 days	See notes to manage risk of developing fungicide resistance. **FRAC–11, FRAC–7**
	Pristine WG	18.5 to 23 oz	VG	12 hr	0 days	See notes to manage risk of developing fungicide resistance. **FRAC–11, FRAC–7**
	Cabrio EG	12 to 14 oz	VG	12 hr	0 days	See notes to manage risk of developing fungicide resistance. **FRAC–11**
	Tilt and multiple generics	4 fl oz	G?	12 hr	0 days	Registered for Anthracnose Fruit Rot only. No more than 2 sequential applications should be made before alternating with fungicides that have a different mode of action. Not registered for Anthracnose crown rot control. **FRAC–3**
	Quadris Top	12 to 14 fl oz	G	12 hr	0 days	Premix of 2 active ingredients, azoxystrobin (**FRAC–11)** and difenoconazole (**FRAC–3)**. No more than 2 applications should be made per season for resistance management.
	Protocol	1.33 pt	G	24 hr	1 day	Premix of 2 active ingredients, thiophanate-methyl (**FRAC–1)** and propiconazole (**FRAC–3)**. No more than 2 applications should be made per season for resistance management.
Anthracnose crown rot ('gloeosporioides')	Captan 50W Captan 80WDG	3 to 6 lb (50W) 1.87 to 3.75 lb (80W)	F	24 hr	1 day	In plantings known to be infected with the anthracnose crown rot pathogen, consider applying captan plus Topsin-M at 10- to 14-day intervals, for a total of 2 to 3 applications in the fall. **FRAC–M4**
	Captec 4L	2.5 qt	F	24 hr	1 day	**FRAC–M4**
	Topsin-M 70WP	1 lb	F	12 hr	1 day	See note on resistance management. **FRAC–1**
	Quadris Top	12 to 14 fl oz	G	12 hr	0 days	Same as above. **FRAC–3, FRAC–11**
Powdery mildew (only)	Procure 50WS	4 to 8 oz	E	12 hr	1 day	Check label for prohibited rotational crops. Do not plant leafy or fruiting vegetables within 30 days after application. Do not plant bulb or root vegetables within 60 days after application. Do not plant cotton, small cereal grains and all other crops not registered within one year after application. **FRAC–3**
	Procure 480SC	4 to 8 fl oz				
	Rally 40WSP	2.5 to 5 oz	E	24 hr	1 day	Rally is registered for control of leaf spot, leaf blight, and powdery mildew. Do not apply more than 30 oz per year. **FRAC–3**
	Rhyme	5 to 7 fl oz	?	12 hr	0 days	Rhyme is registered for control of powdery mildew and for drip application to manage charcoal rot. **FRAC–3**
	Quintec	4 to 6 fl oz	E	24 hr	1 day	Do not use more than 4 times per crop and no more than 2 times in a row. Rotate with other mildewcides. Rotation to all other crops within 1 year after application, unless Quintec is registered for use on those crops, is prohibited. **FRAC–13**
	Torino	3.4 oz	VG	4 hr	0 days	Do not make more than 2 applications per year. Do not apply more than once every 14 days. **FRAC–U06**
Powdery mildew and Anthracnose (acutatum)	Abound	6.2 to 15.5 fl oz	VG	4 hr	4 hr	Do not use any FRAC 11 products more than twice per season for resistance management. **FRAC–11**
	Pristine WG	18.5 to 23 oz	VG	12 hr	0 days	Do not use any FRAC 11 products more than twice per season for resistance management. **FRAC –11, FRAC–7**
	Luna Sensation	6 to 7.6 fl oz	E	12 hr	0 day	Do not use any FRAC 11 or 7 products more than twice per season for resistance management. **FRAC–11, FRAC–7**
	Cabrio EG	12 to 14 oz	VG	12 hr	0 days	Do not use any FRAC 11 products more than twice per season for resistance management. **FRAC–11**
	Tilt and multiple generics	4 fl oz	G	12 hr	0 days	Registered for Anthracnose Fruit Rot only. No more than 2 sequential applications should be made before alternating with fungicides that have a different mode of action. Not registered for Anthracnose crown rot control. **FRAC–3**
	Quadris Top	12 to 14 fl oz	G	12 hr	0 days	Premix of two active ingredients, azoxystrobin (**FRAC–11)** and difenoconazole (**FRAC–3)**. No more than 2 applications should be made per season for resistance management.

[1] Effectiveness Ratings: The efficacy or importance of a management option is indicated by E = excellent, VG = very good, G = good, F = fair, P = poor, NC = no control, and ND = no data. XX indicates that use of this chemical can increase the disease.

Relative Effectiveness of Various Chemicals for Strawberry Disease Control

W. O. Cline, Entomology and Plant Pathology

Table 6-15. Effectiveness of Various Chemicals for Strawberry Disease Control

Fungicide	FRAC Code	Relative Control Rating (Efficacy)[1, 2]												
		Angular Leaf Spot	Anthracnose (crown root)	Anthracnose (fruit rot)	Botrytis crown	Botrytis fruit rot	Common leaf	Leaf blight	Leather rot	Mucor fruit rot	Phytophthora	Powdery Mildew	Red stele root rot	Rhizopus rot
copper (various)	M01	P[P]	NC	NC	P	NC	P[P]	NC	P[P]	NC	NC	NC	NC	NC
sulfur (various)	M02	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	G[R]	NC	NC
thiram (Thiram SC)	M03	NC	G	G	F	G	F	F	F	F	NC	NC	NC	F
captan (Captan 50W, others)	M04	NC	F	G	F	G	F	F	F	F	NC	NC	NC	F
thiophanate-methyl (Topsin M 70WP)	1	NC	G[R]	NC	G[R]	G[R]	G	G	NC	XX	NC	F[R]	NC	NC
iprodione (Rovral 4F)	2	NC	NC	NC	VG[R]	VG[R]	G	NC	NC	XX	NC	NC	NC	NC
flutriafol (Rhyme)	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	E	ND	ND
myclobutanil (Rally 40WSP)	3	NC	NC	NC	NC	NC	VG	VG	NC	NC	NC	E	NC	NC
propiconazole (Tilt, others)	3	NC	F	F	NC	NC	F	ND	NC	NC	NC	G[R]	NC	NC
tetraconazole (Mettle 125ME)	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	E	ND	ND
triflumizole (Procure 50WS, Procure 480SC)	3	NC	NC	NC	NC	ND	ND	ND	NC	NC	NC	E[R]	NC	NC
thiophanate-methyl + propiconazole (Protocol)	1 + 3	NC	G[R]	G[R]	G[R]	G[R]	G	G	NC	XX	NC	G[R]	NC	NC
isofetamid (Kenja 400SC)	7	NC	NC	NC	E[R]	E[R]	NC	NC	NC	NC	NC	G[R]	NC	NC
penthiopyrad (Fontelis)	7	NC	NC	NC	E[R]	E[R]	NC	NC	NC	NC	NC	G[R]	NC	NC
fluopyram + pyrimethanil (Luna Tranquility)	7 + 9	NC	NC	NC	E[R]	E[R]	NC	NC	NC	NC	NC	G[R]	NC	NC
pyrimethanil (Scala)	9	NC	NC	NC	G[R]	G[R]	NC	NC	NC	NC	NC	NC	NC	NC
Strobilurins: azoxystrobin (Abound; others)	11	NC	G	G/E	F	F	F	NC	VG	NC	NC	F	NC	NC
mandestrobin (Intuity)	11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	E	ND	ND
pyraclostrobin (Cabrio EG)	11	NC	G	VG/E	F	F	F	NC	VG	NC	NC	F	NC	NC
azoxystrobin + difenoconazole (Quadris Top)	11 + 3	NC	G	G	F	F	G	ND	F	NC	NC	G	NC	NC
azoxystrobin + propiconazole (QuiltXcel)	11 + 3	NC	VG	G	NC	NC	ND	ND	NC	NC	NC	G	NC	NC
pyraclostrobin + boscalid (Pristine)	11 + 7	NC	G	E	VG[R]	VG[R]	VG	VG	NC	ND	NC	F	NC	ND
pyraclostrobin + fluxapyroxad (Merivon)	11 + 7	NC	G	E	E[R]	E[R]	VG	VG	NC	ND	NC	F	NC	ND
trifloxystrobin + fluopyram (Luna Sensation)	11 + 7	NC	G	E	E[R]	E[R]	VG	VG	NC	ND	NC	F	NC	ND
cyprodinil + fludioxonil (Switch)	12 + 9	ND	G	F	VG	E	P	P	NC	ND	NC	ND	NC	ND
pydiflumetofen + fludioxonil (Miravis Prime)	7 + 12	ND	G	E	E	E	G	ND	ND	ND	NC	G	NC	ND
Difenconazole + cyprodinil (Inspire Super)	3 + 9	ND	G	G	G	G	ND	ND	ND	ND	NC	G	NC	ND
quinoxyfen (Quintec)	13	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	E	NC	NC
fenhexamid (Elevate 50 WDG)	17	NC	NC	NC	E[R]	E[R]	NC	NC	NC	NC	NC	NC	NC	NC
polyoxin D (Ph-D; OSO; 5%SC)	19	ND	ND	ND	G	G	ND	ND	ND	ND	ND	ND	ND	ND
cyflufenamid (Torino)	U06	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	VG	NC	ND
mefenoxam (Ridomil Gold SL, Ultra Flourish)	4	NC	NC	NC	NC	NC	NC	NC	VG[R]	NC	VG	NC	VG	NC
metalaxyl (MetaStar 2E, others)	4	NC	NC	NC	NC	NC	NC	NC	VG[R]	NC	VG	NC	VG	NC
fosetyl-Al (Aliette, others)	P07	NC	NC	NC	NC	NC	NC	NC	F	NC	F	NC	F	NC
phosphites (ProPhyt, Phostrol, others)	P07	NC	NC	NC	NC	NC	NC	NC	F	NC	F	NC	F	NC

[1] These ratings are benchmarks; actual performance will vary. Efficacy ratings do not necessarily indicate a labeled use for every disease.

[2] Efficacy Ratings: The efficacy or importance of a management option is indicated by E = excellent, VG = very good, G = good, F = fair, P = poor, NC = no control, and ND = no data. XX indicates that use of this chemical can increase the disease.

[P] Phytotoxicity could occur.

[R] Not effective if pathogen is resistant to the fungicide.

Strawberry Insect Management

H.J. Burrack and M. H. Favre, Entomology and Plant Pathology

Examine strawberry plants for insects and mites prior to and following transplant. Consider treating if damaging populations of early season pests, such as cutworms and spider mites, are present. Initiate a weekly insect and mite sampling program in early spring, prior to flowering. Base treatments on comparison of field counts to treatment thresholds, when available.

Insecticide Resistance Action Committee (IRAC) mode of action (MOA) groupings are listed following insecticide names. Materials in the same IRAC grouping have the same mode of action. When selecting insecticides, avoid successive applications of materials in the same IRAC group to minimize potential resistance development. Organically acceptable materials (**OMRI** listed) are noted under Precautions and Remarks.

Many insecticide active ingredients are available in generic formulations. Generic products generally work similarly to their brand name counterparts, but formulation changes can impact efficacy and plant response. In the following table, information is provided for commonly used formulations of active ingredients available in multiple formulations. Carefully check the label of the product you plan to use in the event that it differs from those listed. The label is the law!

Table 6-16. Strawberry Insect Control

Season	Pest	Insecticide, IRAC Group (Formulation)	Amount of Formulation per Acre	Restricted Entry Interval (hours)	Pre harvest interval (days)	Precautions and Remarks
Post Transplant	Cyclamen mite	Cyclamen mites are rare in North Carolina strawberries and are typically introduced on infested plants. Inspect plants closely upon receipt and post transplant.				
		fenpyroximate IRAC 21 (Portal)	2 pt	12	1	Make no more than 2 applications of Portal (0.20 lb active ingredient) per year. Allow 14 days between applications.
		abamectin, IRAC 6 (Agri-Mek SC)	3.5 fl oz	12	3	**There is limited data on cyclamen mite control in strawberries.** Labeled for suppression only. Make 2 applications 7 to 10 days apart when mites first appear. Do not exceed 14 fluid ounces per acre in a calendar year. Do not repeat treatment within 21 days of second application. Do not use in strawberry nurseries.
	Crickets	Cricket feeding on foliage rarely requires treatment, but crickets may occasionally damage fruit when grown in high tunnels during the winter and early spring.				
		carbaryl, IRAC 1A (Sevin XLR)	1 to 2 qt	12	7	Many formulations of carbaryl are available.
		malathion, IRAC 1B (Malathion 57 EC, other formulations)	1.5 to 3 pt	12	3	Only 4 applications can be made per year. Several malathion formulations are labeled in strawberries. Do not apply when bees are foraging.
	Cutworm	Small cutworms feed on leaves before damaging crowns. If cutworms are suspected but caterpillars are not observed, check plants in the evening because larvae are nocturnal.				
		carbaryl, IRAC 1A (Sevin XLR)	2 qt	12	7	Many formulations of carbaryl are available. Foliar applications for carbaryl can flare spider mites. Apply late in the afternoon when plants clipped at the base are first noticed.
		malathion, IRAC 1B (Malathion 8 Flowable)	1.5 to 2 pt	12	3	Malathion 8 Flowable can be applied via drip lines, allowing treatment under plastic. Other malathion formulations labeled in strawberries may not be applied in the same way.
		fenpropathrin, IRAC 3A (Danitol 2.4EC)	16 to 21.33 fl oz	24	2	Do not make more than 2 total applications per acre per year.
		spinosad, IRAC 5 (Entrust SC) (Entrust)	 4 to 6 fl oz 1.25 to 2 oz	 4 4	 1 1	Rotate to a different class of insect control products after 2 successive applications of spinosad. Do not apply more than 18 fl oz Entrust SC or 9 fl oz Entrust per acre per crop. Both formulations of Entrust mentioned here are **OMRI** listed.
		Bacillus thuringiensis (Bt), IRAC 11B2 (Dipel DF)	2 lb	4	0	Dipel DF is **OMRI** listed.
		methoxyfenozide, IRAC 18 (Intrepid 2F)	6 to 12 fl oz	4	3	
		chlorantraniliprole, IRAC 28 (Coragen)	3.5 to 7.5 fl oz	4	1	Do not apply more than 30.8 fl oz of Coragen or 0.4 lb a.i. of chlorantraniliprole containing products per acre per calendar year.
	Slugs and snails	metaldehyde (Deadline Bullets)	25 lb	12	0	Repeated applications may be necessary.
		iron phosphate (Sluggo)	20 to 44 lb	0	0	Repeated applications may be necessary. Soil should be moist with no standing water when product is applied. Sluggo is **OMRI** listed.
Preharvest	Red imported fire ants	Bait treatments will control entire mounts, but treatments take between 2 and 4 weeks to be fully effective. Treat active mounds off season or before picking begins with directed bait formulations. Ensure that ants are actively foraging before applying baits. If mounds develop during harvest, drench treatments may reduce activity temporarily. Consult your Cooperative Extension agent for mound drench recommendations.				
		pyriproxyfen, IRAC 7C (Esteem Ant Bait 0.5% B)	1.5 to 2 lb	12	1	Do not water for 24 hours after application. Do not exceed 0.134 lb pyriproxyfen per acre per season
		methoprene, IRAC 7C (Extinguish Ant Bait 0.5% B)	1 to 1.5 lb	4	0	Extinguish can be applied as a mound treatment or broadcast. Extinguish is labeled for use on cropland but Extinguish Plus is **not** labeled for use on cropland. Read labels carefully.
	Aphids	Aphids are typically infrequent pests in strawberries. If aphids are present preflowering in numbers greater than 10 per newly expanded leaf, they should be managed before bloom. Harvest period populations are often controlled by natural enemies. Aphids typically only warrant preventative treatment, via soil applied insecticides, in nursery production to prevent virus transmission.				
		malathion, IRAC 1B (Malathion 57 EC, other formulations)	1.5 to 3 pt	12	3	Up to 4 applications can be made per year. Several malathion formulations are labeled in strawberries. Do not apply when bees are foraging.
		imidacloprid, IRAC 4A (Admire Pro, soil) (Admire Pro, foliar)	 10.5 to 14 fl oz 1.3 fl oz	12	 14 7	Admire Pro can be used as a soil or foliar treatment. Soil applications should be made through the irrigation system. **Do not** make imidacloprid applications when bees are foraging or within 10 days of bloom.

Table 6-16. Strawberry Insect Control

Season	Pest	Insecticide, IRAC Group (Formulation)	Amount of Formulation per Acre	Restricted Entry Interval (hours)	Pre harvest interval (days)	Precautions and Remarks
Preharvest (continued)		thiamethoxam, IRAC 4A (Actara)	1.5 to 3 oz	12	3	Do not apply material immediately prior to bud opening, during bloom, or when bees are foraging. Do not apply more than 12 oz of Actara or 0.188 lb active ingredient of thiamethoxam-containing products per acre per season.
		Flupyradifurone, IRAC 4D (Sivanto 200L)	7 to 10.5 fl oz	4	0	Do not make applications fewer than 10 days apart, apply in at least 10 gal per acre, and apply no more than 28 total fl oz per acre per year.
		Insecticidal soap (M-pede)	1 to 2 gallons per 100 gallons (1% to 2% v/v)	12	0	Rate is per 100 gallons of water to make a 1% to 2% solution v/v. Test for phytotoxicity effects on a limited area before widespread use. **OMRI** listed.
	Strawberry bud weevil (Strawberry clipper)	Preventative treatments for strawberry clipper are not recommended. **Materials effective against strawberry clipper are also toxic to bees**. Follow pollinator protection language on pesticide labels carefully.				
		Carbaryl, IRAC 1A (Sevin XLR)	1 to 2 qt	12	7	Do not apply when bees are foraging, but Sevin XLR is relatively less bee toxic compared to other carbaryl formulations when dry.
		Bifenthrin, IRAC 3A (Brigade WSB)	6.4 to 32 oz	12	0	Do not apply when bees are foraging. Do not apply more than 80 ounces of product per acre per year.
		Fenpropathrin, IRAC 3A (Danitol 2.4EC)	16 to 21.33 fl oz	24	2	Do not apply when bees are foraging.
		Acetamiprid, IRAC 4A (Assail 30 SG)	4 to 6.9 oz	12	1	Do not make more than 2 applications per year. Do not apply when bees are foraging.
		spinosad, IRAC 5 (Entrust SC) (Entrust)	4 to 6 fl oz 1.25 to 2 oz	4 4	1 1	Rotate to a different class of insect control products after 2 successive applications of spinosad. Do not apply more than 18 fl oz Entrust SC or 9 fl oz Entrust per acre per crop. Both formulations of Entrust are **OMRI** listed.
	Twospotted spider mite	Coverage is important for spider mite management. Materials should generally be used at the high label rate, in high volumes of water (200 gallons per acre recommended) and applied using high pressure or electrostatic equipment. Mites should be treated if they exceed 5 per leaflet prior to harvest.				
		Abamectin, IRAC 6 (Agri-Mek SC)	3.5 fl oz	12	3	Make 2 applications 7 to 10 days apart when mites first appear. Do not exceed 14 fluid ounces per acre in a calendar year. Do not repeat treatment within 21 days of second application. Do not use in strawberry nurseries.
		Hexythiazox, IRAC 10A (Savey 50 WP)	6 oz	12	3	One application per season. Will control eggs and suppress small mites. Do not use in nurseries.
		Etoxazole, IRAC 10B (Zeal)	2 to 3 oz	12	1	One application per season. Zeal is an ovicide/larvicide and should be applied early in the mite life cycle.
		acequinocyl, IRAC 20B (Kanemite 15 SC)	21 to 31 fl oz	12	1	Minimum application volume is 100 gallons of water per acre. Allow 21 days between treatments. Do not make more than 2 applications per season.
		Bifenazate, IRAC 20D (Acramite 50WS) (Vigilant 4SC)	0.75 to 1 lb 12 to 16 fl oz	12 12	1 1	Make only 2 applications of bifenazate per crop per year, with up to 2 crop cycles per year. Use in a minimum of 100 gallons per acre (ground application).
		Fenpyroximate IRAC 21 (Portal)	2 pt	12	1	Make no more than 2 applications of Portal (0.20 lb active ingredient) per year. Allow 14 days between applications.
		Spiromesifen, IRAC 23 (Oberon 2SC)	12 to 16 fl oz	12	3	Do not apply more than 48 fluid ounces (0.75 lb active ingredient) or make more than 3 applications per acre per season.
		Cyflumetofen, IRAC 25 (Nealta)	13.7 fl oz	12	1	Use only 2 applications (0.36 lb active ingredient cyflumetofen) per crop per season. Do not apply successive Nealta applications closer than 14 days apart.
		Potassium salts of fatty acids (M-Pede)	1 to 2% v/v	12	0	Applications in at least 100 gallons per acre recommended. M-Pede is **OMRI** listed.
		Rosemary & peppermint oils (Brandt Ecotec Plus)	1 to 4 pt per 100 gallons by volume	0	0	Because oils lack the residual activity of conventional acaricides, they may need to be applied repeatedly for control. Brandt Ecotec Plus is **OMRI** listed.
		Predatory mites (*Phytoseiulus persimilis* and others)	30,000 to 60,000 mites per acre	NA	NA	Release 2 to 3 mites per plant when mite populations are low. Predatory mite releases must be initiated at or before twospotted spider mites reach threshold levels (2 to 5 mites per leaflet) and spider mite populations must be followed closely after predatory mite releases. Consult commercial insectaries for predatory mite release rate and species recommendations. Other predatory mite species may also provide good control of twospotted spider mites in NC strawberries.
	Whitefly	thiamethoxam, IRAC 4A (Actara)	3 to 4 oz	12	3	Do not apply material immediately prior to bud opening, during bloom, or when bees are foraging. Do not apply more than 12 oz of Actara or 0.188 lb active ingredient of thiamethoxam-containing products per acre per season.
		Spiromesifen, IRAC 23 (Oberon 2SC)	12 to 16 fl oz	12	3	Do not apply more than 48 fluid ounces (0.75 lb active ingredient) or make more than 3 applications per acre per season.

Table 6-16. Strawberry Insect Control

Season	Pest	Insecticide, IRAC Group (Formulation)	Amount of Formulation per Acre	Restricted Entry Interval (hours)	Pre harvest interval (days)	Precautions and Remarks
Harvest	Sap beetle	**Materials effective against sap beetles are toxic to bees**. Follow pollinator protection language on labels carefully.				
		Bait buckets and fruit removal	NA	NA	NA	Cultural control is the most effective form of sap beetle management. Sap beetles are attracted to the odor of overripe fruit. Thorough picking will reduce sap beetle populations and can eliminate the need for treatment. Culls should be disposed of offsite or buried. Bucket traps baited with rotting fruit or bread dough placed outside the field will attract sap beetles and can be used to determine when populations are present or to lure insects from field. Buckets should be checked and emptied at least weekly. Baits should be disposed of offsite or buried.
		Novaluron IRAC 15 (Rimon 0.83EC)	6 to 12 fl oz	12	1	Rimon is an insect growth regulator and is effective at reducing populations of immature sap beetles. Do not apply more than 36 fl oz (0.23 lb active ingredient novaluron) per acre per year.
	Spotted wing drosophila	Female spotted wing drosophila (SWD) lay eggs in ripening and ripe soft-skinned fruits. SWD injury in spring bearing strawberries has been inconsistent in previous years, but summer and fall fruiting strawberries are at high risk of infestation. If SWD are active during strawberry harvest, treatments should be applied weekly and reapplied in the event of rain. **Many materials effective against SWD are toxic to bees**. Follow pollinator protection language on labels carefully. Apply SWD treatments in the evening or night when bees are not actively foraging.				
		Malathion, IRAC 1B (Malathion 57 EC, other formulations)	1.5 to 3 pt	12	3	Only 4 applications can be made per year. Several malathion formulations are labeled in strawberries. Do not apply when bees are foraging.
		Bifenthrin, IRAC 3A (Brigade WSB)	6.4 to 32 oz	12	0	There are many bifenthrin formulations. Do not apply when bees are foraging. Do not apply more than 80 ounces of product per acre per year. Brigade is effective against adult sap beetles.
		Fenpropathrin, IRAC 3A (Danitol 2.4 EC)	16 fl oz	24	3	Do not apply when bees are foraging. Do not make more than 2 applications per season.
		spinosad, IRAC 5 (Entrust SC) (Entrust)	 4 to 6 fl oz 1.25 to 2 oz	 4 4	 1 1	Rotate to a different class of insect control products after 2 successive applications of spinosad. Do not apply more than 18 fl oz Entrust SC or 9 oz Entrust per acre per crop. Both formulations of Entrust are **OMRI** listed.
		Spinetoram, IRAC 5 (Radiant SC)	6 to 10 fl oz	4	1	Do not apply more than a total of 30 fl oz of Radiant SC (0.2343 lb of spinetoram) per acre per year. Do not make more than 3 applications per year.
		Cyantraniliprole, IRAC 28 (Exirel)	13.5 to 20.5 fl oz	12	1	Do not apply more than 0.4 lb of cyazypyr or cyantraniliprole containing products per acre per year.
		Cyclaniliprole, IRAC 28 (Verdepryn 100SL)	11 fl oz	4	1	Apply in the evening when flowers are present. Make no more than 3 applications per year. Minimum treatment interval is 5 days.
	Corn earworm, European corn borer	Corn earworm and European corn borer larvae can feed on strawberry fruit. This damage is most common in warm years. Watch for eggs on strawberry fruit near the stem end. Adult moths can be monitored using pheromone traps if there is significant concern. Trap captures would indicate when there is potential for infestation. **Many materials effective against caterpillar pests are toxic to bees**. Follow pollinator protection language on labels carefully.				
		Bacillus thuringiensis (Bt), IRAC 11B2 (Dipel DF)	0.5 to 2.0 lb	4	0	Dipel DF is **OMRI** listed.
		Novaluron IRAC 15 (Rimon 0.83EC)	9 to 12 fl oz	12	1	Rimon treatments must be timed to egg hatch. Do not apply more than 36 fl oz (0.23 lb active ingredient novaluron) per acre per year.
		Chlorantraniliprole IRAC 28 (Coragen)	3.5 to 7.5 fl oz	4	1	Do not apply more than 30.8 fl oz of Coragen or 0.4 lb active ingredient of chlorantraniliprole containing products per acre per calendar year.
		Cyclaniliprole, IRAC 28 (Harvanta 50SL)	10.9 to 16.4 fl oz	4	1	Do not make more than 3 applications per year.
	Tarnished plant bugs or Lygus bugs	Lygus bugs are typically only present in North Carolina strawberries at the end of the spring season, although they may be more problematic in day-neutral, ever-bearing, or other strawberry season extension systems. Lygus bug injury results in malformed fruit and can resemble poor pollination. Lygus injury can be distinguished from poor pollination based on seed size. The seeds of Lygus damaged fruit are all the same size, while poor pollination results in varied seed sizes. **Many materials effective against lygus bugs are toxic to bees**. Follow pollinator protection language on labels carefully.				
		Bifenthrin, IRAC 3A (Brigade WSB)	6.4 to 32 oz	12	0	There are many bifenthrin formulations. Do not apply when bees are foraging. Do not apply more than 80 ounces of product per acre per year.
		fenpropathrin, IRAC 3A (Danitol 2.4EC)	10.66 fl oz	24	2	**Do not** apply when bees are foraging. Do not apply more than two applications totaling 42.66 fl oz of Danitol 2.4 EC (0.8 lb active ingredient) per acre per crop per year.
		novaluron IRAC 15 (Rimon 0.83EC)	9 to 12 fl oz	12	1	Apply when adults appear in the field and just prior to egg hatch. Do not apply more than 36 fl oz (0.23 lb active ingredient novaluron) per acre per year.
	Flower thrips	Treatment is only necessary when thrips injury is present on berries. Thrips injury, which resembles bronzing on the stem end of berries, will typically not be present until the end of the season, if at all. **Materials effective against thrips are toxic to bees**. Follow pollinator protection language on labels carefully.				
		spinosad, IRAC 5 (Entrust SC) (Entrust)	 4 to 6 fl oz 1.25 to 2 oz	 4 4	 1 1	Rotate to a different class of insect control products after 2 successive applications of spinosad. Do not apply more than 18 fl oz Entrust SC or 9 oz Entrust per acre per crop. Both formulations of Entrust are **OMRI** listed.
		spinetoram, IRAC 5 (Radiant SC)	6 to 10 fl oz	4	1	Do not apply more than a total of 30 fl oz of Radiant SC (0.2343 lb of spinetoram) per acre per year. Do not make more than 3 applications per year.
	Spittlebug	Spittlebugs are occasional pests in strawberries and should only be treated if directly damaging fruit.				
		malathion, IRAC 1B (Malathion 57 EC, other formulations)	1.5 to 3 pt	12	3	Only 4 applications can be made per year. Several malathion formulations are labeled in strawberries. Do not apply when bees are foraging.
		fenpropathrin, IRAC 3A (Danitol 2.4 EC)	10.66 fl oz	24	2	Do not apply when bees are foraging. Do not apply more than two applications totaling 42.66 fl oz of Danitol 2.4 EC (0.8 lb active ingredient) per acre per crop per year.

Further Information

Southeast Regional Strawberry Integrated Management Guide, www.smallfruits.org.
Strawberry Growers Information Portal, strawberries.ces.ncsu.edu.