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Grapes: A Brief History

If asked to name the world's number one fruit (based on tons produced), most individuals would probably guess banana, orange or apple. While all of the previous are very important, none can rival the amount of grapes produced throughout the world. The varieties of ways in which grapes can be used coupled with the number of countries in grapes can be grown accounts for the fact the world produces about 72 million tons of grapes annually. Late August signals the beginning of grape harvest for many regions of Missouri and is a good time to take a closer look at this ancient fruit.

Grape culture (or viticulture) is probably as old as civilization itself. Archeological evidence suggests humans began growing grapes as early as 6500 B.C. during the Neolithic era. By 4000 B.C., grape growing extended from Transcaucasia to Asia Minor and through the Nile Delta of Egypt. King Hammurabi of Babylon probably enacted the world's first liquor law when he established rules for wine trade in 1700 B.C.

The Hittites are credited with spreading grape culture westward as they migrated to Crete, Bosporus and Thrace, as early as 3000 B.C. Later, the Greeks and Phoenicians extended grape growing to Carthage, Sicily, southern Italy, Spain and France. Under the influence of the Romans, grape production spread throughout Europe.

At the time of the fall of the Roman Empire, grape culture and wine making primarily were associated with monasteries. Later, the use of wine extended beyond religious rites and became entrenched in culture as a social custom. This increased demand for grapes, and grape culture grew steadily from the 16th to the 20th century.

The three primary uses for grapes are for wine, dried fruit (raisins) and fresh table grapes.

The world produces about 7.2 trillion gallons of wine each year, making it by far the most prevalent use of grapes. This value represents a 35% increase since the mid-20th century; Europe (Italy, France, Spain and Russia) accounts for 80% of total world production. Only about 14% of the wine produced worldwide is exported from its country of origin.

Raisins represent a formidable use of grapes as well. World-wide raisin production averages 800,000 tons per year. Since it takes about four pounds of grapes to produce one pound of raisins, the raisin industry uses about 3.2 million tons of grapes each year.

Fresh (table) grapes account for less than 12% of the world's total grape production. Since fresh grapes are highly perishable and transportation costs high, fresh grapes are consumed primarily in the country of their production. Europe and North America lead in fresh grape consumption. The average American consumes about eight pounds of fresh grapes each year.

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In This Issue

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Not all of the grapes consumed worldwide belong to the same species. Grapes belong to the Vitaceae family which contains 11 genera and about 600 different species. The genus Vitus is the only food bearing genus in the Vitaceae family and contains about 60 different species. These species are grouped into one of four different categories.

Native Grapes. When the first Europeans visited North America they found grapes growing so abundantly that they named the new land "vineland". Grape species native to North America include *V. labrusca, V. aestivalis, V. riparia, V.berlandieri*. Native species are known for their cold hardiness and disease resistance. Unfortunately, their fruits have lower sugar content, higher acid content (a poor combination for making good wine) and are "slip skin". The latter term refers to the tendency of the skin to separate from the remainder of the berry when eaten fresh. 'Concord', a cultivar with *V. labrusca* parentage, arguably is the most popular American-derived grape. Fanciers of 'Norton' ('Cynthiana') could make a formidable argument for their cultivar.

Early settlers often described native grapes as having an "animal den" aroma. Hence, throughout the history of our nation native grapes often were referred to as "fox grapes". Science has revealed that *V. labrusca* and cultivars derived from that native species contain methyl anthranilate, an earthy, musky smelling compound that (to most) imparts a disagreeable after-taste. Interestingly, science also demonstrated recently that methyl anthranilate is contained by secretions of the musk glands of foxes and dogs. Evidently, our fore-father had a very acute sense of smell.

European Grapes. The European grape (*V. vinifera*) is the species most often associated with the word "grape" and accounts for the majority of the world's wine production. The chemical composition of its fruits is superior to that of native grapes for winemaking, but European grape cultivars lack cold hardiness and are susceptible to a number of troublesome diseases. Columbus is credited with having introduced European grape to the Americas but the colonists' first attempts to grow it resulted in failure due to its sensitivity to cold temperatures. Today, production of *V. vinifera* in the United States is limited to regions with mild winters, long growing seasons and summers that are fairly dry with low relative humidity.

French-American Hybrids. The quest to produce grapes with superior wine-making qualities coupled with cold hardiness and disease resistance led to the development of French-American hybrids. Most arose by crossing species of European grape with various species of North American grape. These crosses gave rise to very productive hybrids having adequate cold hardiness to be produced in the Midwest along with the ability to tolerate many troublesome diseases. Indeed, it was French-American cultivars such as 'Chambourcin', 'Vidal Blanc', 'Seyval Blanc', 'Chardonel' and 'Vignoles' that led to the recent revitalization of Missouri's wine industry. In the development of these hybrids, *V. labrusca* purposefully was avoided as a parent to prevent it from passing it "foxy" flavor to its progeny.

Muscadine Grapes. Muscadine grapes (*V.rotundifolia*) are noted for their small berries that have a bold, musky flavor. They are nearly immune to insects and diseases but require a growing season of 200 days or more. Muscadine grape production is limited to states such as Florida, Mississippi, Louisiana and North Carolina, all of which have mild winters.

Grapes are fairly robust in their growth habit and have the ability to tolerate a wide range of soils, including those that are shallow and rocky. Detailed information on the cultural requirements of grapes in Missouri can be found in MU Extension publications G6085 (Home Fruit Production: Grape Culture) and G6090 (Home Fruit Production: Grape Training Systems).

Grape trivia:

- Botanically, grapes are considered to be a berry.
- The oldest grapevine in America is a 400 year old Muscadine vine in North Carolina.
- The grape industry contributes about $125 billion annually to the U.S. economy.
- The average American consumes eight pounds of grapes each year.
- About 25 percent of the grapes eaten in the U.S. are imported from Chile.
- The best selling grape in the U.S. is 'Thompson Seedless' which also is the source of golden raisins.
- Grapes are a good source of vitamins C and K; they also contain protein, carbohydrates, dietary fiber and minerals.
- Resveratrol, a substance found in grapes, has been linked to reduced colon cancer.

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Fall Maintenance for a Healthy Lawn

"Spring came very early this year and warm-season grasses such as zoysiagrass came out of winter dormancy about one month ahead of schedule. Pat Guinan, MU Extension Climatologist, indicated that March temperatures were 12 to 14 degrees higher than normal and placed this March as the warmest on record. He also commented that if March's temperatures were laid over April of this year, the monthly average for April would still be 5 to 6 degrees above normal. We also had 18 to 20 days above 100 depending on where you were in the state. After that final rain toward the end of May to the first part of June, we went into one of the most extended droughts on record". These were the facts for spring and summer of 2012. We were about 5 weeks ahead of ourselves on the horticultural and turfgrass side of things. Then the drought changed the color of landscapes from green to brown.

Spring of 2013 was much different. The cool/cold extended spring delayed many plants from budding out (tree foliage) as well as our warm season grasses like zoysiagrass and bermudagrass. The cooler temperatures were making us one of the coolest/coldest springs on record. To date, we have had no days over 100 and only two over 95 for Columbia, Missouri. We had a short period of drought and turfgrasses going dormant; but now, record rains and flooding have hit the southern half of the state. High temperatures in the 70s finished out July and August will appear to me mild as well - great weather for growing turfgrass and ornamentals. This year we were about 4 weeks behind and 180 degrees opposite from last year. Two very different years (at opposite ends of the spectrum) have occurred in two consecutive years.

Weather plays a role in how we manage ornamental plants and turfgrasses every year. Weather controls disease and insect cycles to emerge early in some years and much later in other years (e.g. 2012 and 2013). Keep in mind that weather is not the only instigator to our pest issues. Sometimes our pest issues are due to poor cultural practices.

So, this season has been very mild and lawns are actually looking pretty good for August. Despite the mild summer, there are still some fall management practices that need to be done in preparation for next year.

AERATION

Aeration is the practice of pulling soil plugs to open the soil surface for better nutrient and water movement. It is a practice that also helps to reduce compaction and thatch by spreading soil plugs on the surface. Soil plugs are crumbled and fall freely into aeration holes as well as spreading some soil into the thatch layer where soil microbes can feed on thatch debris. Aeration is a practice that can be done in both spring and fall and is the very best way to begin a fall fertilization program. Applications of fertilizer after aeration will move nutrients immediately into the root zone of your lawn. This practice has shown excellent results by improving turfgrass density and color of cool-season turfgrasses to recover from summer stresses. Spreading grass seed after aeration is also an excellent practice for lawns that have thinned some during the summer.

Aeration equipment can be found at local rental stores or garden centers. Machines that pull a ½ inch diameter plug three to four inches deep on three to four inch centers do an excellent job. Machines that force hollow tines into the soil are better than pull-type drums with spoontines. Not all machines will meet these specifications; however any amount of aeration is better than no aeration to kick-off fall fertilization. When using aeration equipment as a tool for preparing a seedbed, shallow divots ½ to 1-inch deep is only required. Creating lots of divots with multiple passes is best.

OVER-SEEDING

Power rakes are an excellent piece of equipment to prepare seedbeds prior to over-seeding. While the entire lawn may not need over-seeding, working thin areas with a power rake will create a fine seedbed to improve seed/soil contact, therefore improving seed germination. Some turfgrass managers and homeowners may decide to renovate the entire lawn. Spraying roundup to control existing vegetation is can be completed in August in order to prepare the seedbed in early September. Tilling the soil 4 to 6 inches deep can reduce soil compaction and prepare that fine seedbed.

Selecting cool-season grasses for Missouri boils down to a choice of two – a turf-type tall fescue blend or a mixture of turf-type tall fescue with Kentucky bluegrass (90%/10% by volume – fescue/bluegrass).

Blends (three to four varieties in equal portions) of turf-type tall fescues can give deep emerald green appearances with a slightly coarser texture than the bluegrasses. They tend to be a deeper rooting plant, therefore requiring less water than a bluegrass lawn. They are not as susceptible to dollar spot and summer patch, but generally will require some fungicides for the control of brown patch disease. Several varieties of turf-type tall fescues offer superior resistance to brown patch and therefore will improve turf quality. Tall fescues will tiller to help with recovery, but tend to be clumpy with severe thinning. Some newer turf-types do provide some short rhizomes (root extensions underground that will produce a daugh-

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ter plant). These are called Rhizomatous Tall Fescues or RTFs. Fescues grow well in full sun to partial shade.

Mixtures, such as turf-type tall fescues (in a blend) with Kentucky bluegrasses, combine the advantages or strengths of each species to mask the weaknesses of the other. Any grass seed mixture with perennial ryegrass should not exceed 20 percent perennial ryegrass, as they are not heat and drought tolerant and susceptible to most turfgrass diseases. Unfortunately, many seed mixtures available to homeowners at local garden centers contain large amounts of ryegrass (both annual and perennial).

So which varieties do you select once you decide on a blend or mixture to plant? Various resources provide recommendations for turfgrass varieties for Missouri. Garden centers, MU Extension publications, turfgrass specialists, and other lawn care experts are good sources for information about turfgrass selections. The difficulty for most individuals is to find the varieties suggested. Sometimes the best approach is to list what local sources carry and then cross-reference to the varieties recommended for Missouri or contact a specialist.

Blends and Mixtures Available

The number of seed products being sold over-the-counter and by distributors can be overwhelming to turfgrass managers and homeowners. However, by looking at the seed tags on products, several can be eliminated immediately. These include products that contain large percentages of ryegrasses. Many of these seed products are packaged for national sales and while they are excellent products for many areas of the country, they are not the best for the type of climate we deal with in Missouri (the Transition Zone). Concentrate more on the products that are tall fescue blends or mixtures of tall fescue and Kentucky bluegrass. By doing this the choices becomes more narrow and simplified.

Brand names of turf-type tall fescues to focus on include the following at various garden centers. These will generally have some of the better varieties acceptable for Missouri. They are included on Table 1.

Mixtures of tall fescue and Kentucky bluegrass have several nice combinations available at garden centers as well. Many seed companies manufacture the 90/10 combination of tall fescue and Kentucky bluegrass. Of all mixtures, this is possibly the best for Missouri. Some of these products are included on Table 2.

Several blends and mixtures listed above now include some of the rhizomatous tall fescues (RTFs). They include Revolution, Barenbrug's RTF Blend, and Turf Save Plus with RTF Plus Mix.

Heat and drought is always a major concern during Missouri summers for cool-season grasses. Heat tolerant

Table 1: Turf-type Tall Fescue Blends

Brand Name	Vendor
Revolution	Ace Hardware, Williams Lawn Seed
Winning Colors	Lebanon Turf, Hummert International, MFA
Independence	Hummert International
Barenbrug RTF Blend	Hummert International
All-Pro	MFA
George's "Magic Mix" Fescue Blend	R. G. Robinson
Pennington Ultimate Tall Fescue Blend	Lowe's, Wal-mart
The Rebels Blend	Lowe's, Wal-mart
Tri-Star Fescue Blend	Orscheln's Farm & Home
Lesco Fescue Blend	Home Depot
Scott's Classic Tall Fescue Blend	Lowe's, Home Depot

Table 2: Tall Fescue/Bluegrass Mixtures

Brand Name	Vendor
Fescue Blue Mix	Hummert International
Turf Saver Plus with RTF Plus Mix	Hummert International
Revolution Plus	Williams Lawn Seed
Winning Colors Plus	Lebanon Turf
Tournament Quality Ultra-Premium Fescue Plus Lawn Mixture	Lowe's
Tri-Star Low Water Lawn Seed	Orscheln's Farm & Home
Pennington Fescue/Bluegrass Lawn Seed Mixture	Lowe's, Wal-mart
Master Turf Ultimate Blue Lawn Seed Mixture	Wal-Mart

bluegrass is available in packaged mixes with tall fescue. Scott's "Pure Premium Heat-Tolerant Blue" includes one of these heat tolerant bluegrasses called, "Thermal Blue." Heat tolerant bluegrasses are genetic crosses between Texas Bluegrasses and Kentucky bluegrasses that are designed to provide heat and drought tolerance. They are recommended in areas where tall fescue and Kentucky bluegrass are presently recommended. This product should be available where other Scott's products are sold.

Shade's effect on turfgrasses is a very common question in many lawn situations. Many turfgrasses are tolerant of moderate shade; however no turfgrass is tolerant of total shade throughout the day. The following table does list some mixtures available for moderate shade. Just keep

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in mind that moderate shade should still allow at least three hours of direct sunlight daily. If you do not have this amount of direct sunlight daily, consider alternative ground covers.

Shade Mixtures (tall fescues, creeping red fescues, Ky. bluegrass and perennial ryegrass)

Brand Name	Vendor
Deluxe Shady Mix	Hummert International
Pennington Smart Seed Dense Shade Mixture	Home Depot, Lowe's, Walmart
Pennington Dense Shade Mixture	Home Depot, Lowe's, Walmart
Scotts Turf Builder Dense Shade Mix	Home Depot, Lowe's, Walmart
Scotts Turf Builder Dense Shade Mix for Tall Fescue Lawns	Home Depot, Lowe's, Walmart

The above information is intended to make the selection process for turfgrass seed less troublesome and giving you more confidence in your choices. Be sure to always check with your local garden centers first for availability of these products, since all stores do not carry complete product lines.

Fertilization

Fall fertilization should always start with a soil test to determine what the needs of the soil are, if any. Soil pH is also important as it affects nutrient availability to the plants. Soil test results will give you nutrient levels, soil pH and any information about lime requirements. A soil pH around 6.4 to 6.8 is optimum. Soil pH between 6.0 and 7.0 are acceptable. MU guide #G6954, Soil Testing for Lawns gives information on how to take and submit soil samples to the University of Missouri Soil Testing Labs. This guide sheet can be accessed through the Extension Publications Website at http://extension.missouri.edu/explore/.

Turfgrass managers and homeowners have a wide variety of fertilizers available to them for fall fertilization. Many organic fertilizers, such as Milorganite, Sustane, Earthworks, Nature Safe and Ringer are available and will provide an excellent source of slow released nitrogen. Organic fertilizers do require soil microbes to release nutrients, therefore as soil temperatures decrease by late Fall, performance of these fertilizers may drop off.

More inorganic types of fertilizers are available to turfgrass managers and homeowners and can be somewhat confusing. Many products have much higher amounts of nitrogen and most are soluble forms (quick release) of fertilizers. These types of fertilizers are there and gone after about three weeks. You will get a quick flush of green growth, then a quick tapering off of color and growth. Find fertilizers with a good balance of N-P-K (nitrogen/phosphorus/potassium) with a ratio somewhere around 3-1-2. Also look at the guaranteed analysis label on the bag and find a product with 30 to 70 percent slow-release nitrogen. This way your fertilizer is released over a longer period of time requiring fewer applications and allowing the plants more time to efficiently utilize available nutrients.

Total fertilizer rates for cool-season grasses in fall should be 2.5 to 3.0 lbs of nitrogen per 1,000 square feet. Amounts should be divided over two or three applications throughout the fall. Possible combinations would include a pound of nitrogen per 1,000 square feet in early September after aeration followed by 1.5 pounds of nitrogen per 1,000 square feet in late October. A second scenario would include a pound of nitrogen per 1,000 square feet applied in early September, October and November. Most fertilizers are complete fertilizers including phosphorus and potassium; therefore requirements for those nutrients should be based on soil test results. Soil test results indicating high to very high amounts of phosphorus and potassium may require applications of fertilizers with nitrogen alone or lower amounts of P and K.

Winterizing fertilizers are usually recommended as the final application in fall for cool-season grasses. Good winter fertilizers will have higher and equal amounts of nitrogen and potassium (first and third numbers of the fertilizer components). However, there are conflicting comments about applications of additional potassium for hardening off plants. Additional potassium does not increase plant tissue potassium if amounts of potassium in the soil are already high to very high. Application of winterizing fertilizers simply insures potassium levels will be sufficient for plants to harden off. If you regularly soil test and know that your potassium levels are high, then a winterizer fertilizer will not provide additional benefit for you. It is a practice of higher importance for warm season grasses (zoysia and Bermuda) in late summer (early September) as opposed to cool-season grasses in late Fall.

Fall aeration, fertilization and over-seeding can make a difference in the health and beauty of your lawn. These fall practices along with mowing tall (3.5 to 4.0 inches) can provide a deeper root system and up to 80 percent control of annual weeds throughout the following season.

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Detecting larval infestations and insecticidal options for Spotted Wing Drosophila, a significant pest of small fruit crops in Missouri

Spotted Wing Drosophila (SWD) is a very serious new invasive pest that attacks small fruit crops, some stone fruits (cherry, nectarine, peach), high tunnel tomatoes, and wild hosts (including pokeweed, autumn olive, crabapple, nightshade, Amur honeysuckle, and wild grape). Raspberries, blackberries, blueberries, and grapes are at the greatest risk. SWD flies look similar to the small vinegar flies that are typically found around or on fermenting fruits and vegetables. However, unlike those native vinegar flies, SWD females have a serrated egg-laying device (called ovipositor) to cut a slit into the skin of intact fruit to lay their eggs. This makes SWD a more significant pest. An identification and monitoring guide has been developed by the Lincoln University (LU) IPM program. It is available at: http://www.lincolnu.edu/web/programs-and-projects/ipm.

This article discusses how to detect larval infestations and management of SWD based on key IPM components listed below. A SWD control program starts with monitoring. If SWD is detected, chemical control is necessary to preserve the marketability of fruit. For commercial growers, some chemicals already used in your IPM program for similar pests should give effective control of SWD.

1. Monitor fields with traps and check them regularly.
2. Check trapped flies to determine presence and number of SWD.
3. If SWD are found and fruit are ripening or ripe, apply effective insecticides registered for that crop to protect the fruit until harvest is completed.
4. Continue monitoring to evaluate your management program, this time checking traps twice a week, and respond quickly if needed.
5. Use cultural controls where possible (mainly removing old, infested, or damaged fruit from the field) to reduce SWD food resources.
6. Stay informed. These recommendations are subject to change based upon new information.

Detecting Larval Infestations in Fruit

The following recommendations are largely based on guidelines provided by Michigan State University (MSU) and Oregon State University (OSU). A first sign of SWD infestation in raspberries may be noticed as red patches left on the receptacle when the berries are picked. The fruit of raspberries and blackberries may also begin to collapse in areas where the larvae are feeding inside. Opening the berries may reveal the larvae within the fruit, but it is time consuming to check individual berries. Fruit can be selected in 2 ways, either by collecting fruit at random, or by collecting only fruit you suspect is infested (i.e., the presence of oviposition scars and/or soft spots on the fruit).

(i) Sugar-water method: Place fruit in a plastic "zip-lock" bag and crush lightly to break the skin. Then add a sugar-water mixture (4 cups water to every 1/4 cup sugar). SWD larvae will float in the liquid and the fruit will sink. Detection of small larvae may require the use of a hand lens, and this works well with a light behind the bag to create backlighting

(ii) Salt-water method: A salt solution will irritate the larvae causing them to wiggle out of holes in the fruit. To prepare a salt-water solution, dissolve 1/4 cup plain salt in 4 cups warm water. Place fruit in a shallow white pan and cover with salt solution. Observe the fruit closely for at least 10-15 minutes to see larvae exiting fruit out of egg-laying holes. Detection of small larvae may require the use of a hand lens and good lighting. Count as quickly as possible while they are still alive and moving.

Insecticidal Control:

Because this pest is so new to Missouri, there has been no research on insecticidal treatments to manage SWD and therefore recommendations are based on findings from other states. Before you spray, confirm that you have SWD in your area by hanging out traps or checking fruit. Sprays must be timed to kill adults before they lay eggs, as sprays will not control larvae already in the fruit. Always read product labels to make sure pesticides are registered for use on the fruit or berry you are treating.

If monitoring indicates a need to spray, the ap-

Use of effective insecticides that are well timed and have good coverage can keep SWD controlled through harvest. However, given the potential for rapid population increase by SWD, especially during fall red raspberry season, means that active management through monitoring of flies and fruit infestation is critical. Always follow the specific label restrictions for raspberry / blackberry crops. The level of control achieved will depend on the SWD population, timeliness of application, coverage of fruit, and product effectiveness.

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plication should be made about 2 to 3 weeks before berry harvest. Depending on the residual effectiveness of the insecticide, a second application may be needed 5 to 10 days later. In the case of indeterminate fruiting berries such as raspberries or strawberries, sprays might need to be repeated to keep populations low during summer and fall. You can use monitoring traps to help you decide if and when additional sprays might be needed. Be sure to wait the interval specified on the pesticide label before harvesting fruit. Thus far an economic threshold for SWD has not been developed. MSU recommends a conservative approach in which fly capture on your farm triggers protection of fields if berries are at a susceptible stage.

For commercial raspberry and blackberry farmers – conventional. A number of registered insecticides have been very effective against SWD in laboratory trials, including some recent trials done at MSU. The most effective chemicals are organophosphate, pyrethroid, and spinosyn classes of insecticides. Under field conditions, insecticides with fast knockdown activity have performed well at protecting fruit. Insecticides with fast knockdown activity have performed well at protecting berries from SWD. These include Malathion which is an organophosphate insecticide; the pyrethroids Danitol, Mustang Max, and Brigade; and the spinosyns Delegate (spinetoram) and Entrust (organic). Delegate 25WG has been labeled for control of SWD in various crops in all States. Neonicotinoids such as Provado and Actara are considered weakly active on SWD flies and are not recommended for control (MSU info).

For commercial raspberry and blackberry farmers – organic. In bioassays conducted by MSU with Azera and Pyganic these options performed less effectively than Entrust. However, pyrethrum class insecticides can still be a valuable tool for organic growers because the Entrust label requires rotation to another product for resistance management. Pyganic or Azera can very well fit that need. Entrust is the only organic product with residual activity (5-7 days control). While it doesn't appear to provide residual control, Pyganic® applied at 5 day intervals at the high labeled rate has shown to reduce SWD populations in California. Organic growers in the Pacific Northwest have used 2-3 applications of Entrust (spinosad) effectively to protect fruit in the pre-harvest period alternated with Pyganic (pyrethrum) to extend the period of control and also to reduce the chance of resistance development.

For home-owners. The insecticide Spinosad (e.g., Monterey Garden Insect Spray) is effective and has the least negative environmental effects of currently available products. Some spinosad products are sold to be applied with a hose-end sprayer, but a compressed-air sprayer will give more reliable coverage. Fertilome® Borer, Bagworm, Tent caterpillar and Leafminer spray (spinosad 0.5%) and Green Light® (spinosad 0.5%) are also labeled for use in bushberries and caneberries against fruit flies. The organophosphate insecticide malathion is widely available and will also control SWD, but malathion is very toxic to bees and natural enemies of other pests in the garden so care must be taken to keep the application on the target plant and avoid drift and runoff. Improper application also can result in injury to cherry trees. Because of the potential negative impact of malathion in the garden, use it only where you are certain you will have a SWD infestation, either because you had a problem last year or from trapping and positively identifying insects this season as SWD.

Registrations and recommendations change, so keep informed through SWD websites and your local Extension educator. For all pesticides, consider REIs, PHIs, surface water and buffers, and safety to pollinators and other beneficial arthropods when selecting a product. Remember to rotate classes of insecticides to delay possible development of insecticide resistance. To address pollinator safety, make early morning or late evening applications of all products.

As with all uses of insecticide to control pest insects, the label is the legal document that provides the official guidance on the appropriate use pattern. Refer to the label and any supplemental labels for the full restrictions on use in your crop. A good place to locate all the most up-to-date information is through http://www.cdms.net/labelsmsds/LMDefault.aspx. If new supplemental labels are developed allowing expanded uses for SWD control, those will be posted at this site.

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APDFVersionofthisarticlecanbefoundhere:http://ipm.missouri.edu/MEG/2013/8/Detecting-larval-infestations-and-insecticidal-options-for-Spotted-Wing-Drosophila-a-significant-pest-of-small-fruit-crops-in-Missouri/Detecting_larval_infestations_in_fruits_and_insecticidal_options_forSWD.pdf

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Table 1. Insecticides for SWD control. Products are not complete listings of all available options. (H) signifies that the product is registered for homeowner use, (O) signifies an organically compatible insecticide. Not all products are labeled on all fruits; read label to ensure that your product matches the site. Alternate the MoA (mode of action) of the product you choose on a yearly basis to minimize resistance build-up.

Product name	Active Ingredient	Class	Mode of Action (MoA)	Pre-Harvest Interval
Azera (O)	Pyrethrins + Azadirachtin		3A (pyrethrins) and unknown (Azadirachtin)	0 days
Danitol 2.4 EC	Fenpropathrin	Pyrethroid	3A	3 days
Delegate[1]	Spinetoram	Spinosyn	5	1 day
Entrust[1]; Ferti-Lome[2] Borer, Bagworm, Tent caterpillar and Leafminer spray; Green Light[2] (H), (O)	Spinosad	Spinosyn	5	It varies depending on the crop
Malathion 8F (H)	Malathion	Organophosphate	1B	1 day
Mustang MAX[3]	Zeta – Cypermethrin	Pyrethroid	3A	1 day
Pyganic (H), (O)	pyrethrins		3A	0 days
Radiant SC[4]	spinetoram	spinosyn	5	1 day
Sevin (H)	carbaryl	carbamate	1A	7 days

[1]For use against SWD on various crops in all US states
[2]Labeled for use against fruit flies (SWD is a 'vinegar' fruit fly)
[3]For use against SWD in strawberry in 12 US states, MO is not included
[4]For use in all US states except NY

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Monitoring for Spotted Wing Drosophila

An Insect Pest of Berries and Other Fruits in Missouri

The Spotted Wing Drosophila (SWD) is a small vinegar or "fruit" fly that is about 2-3mm in length. For the past two years, it has been a problem in several areas of the U.S., including the Midwest.

For more information:
Contact Dr. Jaime Piñero
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Actual view (under dissecting microscope) of male SWD (see black dots) captured in sticky card.

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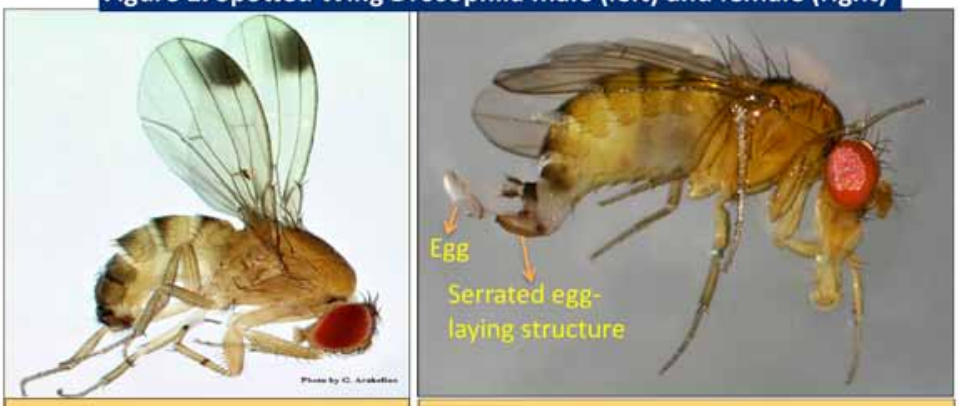
Figure 1. Spotted Wing Drosophila male (left) and female (right)



Spotted Wing Drosophila **males** have one **black dot on each wing**.

Female's wings lack the dot on the wings. They have a **serrated ovipositor** (egg-laying structure) at the tip of the abdomen.

The Spotted Wing Drosophila (SWD) (pronounced Dros-o-fill-ah) has caused economic damage to berries, grapes and soft-fleshed fruits, such as peaches. The SWD is also able to attack some vegetables, including tomatoes and peppers. Unlike most other vinegar flies that lay eggs on damaged or fermenting fruits, SWD females can cut into healthy fruit. They do this by using their serrated (saw-toothed) ovipositor (organ for depositing eggs) to inject eggs under the skin of the fruit (see Figure 1). The adult SWD lives for about two weeks; during this time, each female can lay more than 300 eggs. The larvae hatch and feed inside the fruits, causing them to rot (see Figure 2). This insect reproduces so quickly that a few adults can become thousands of flies in just a few months.

Figure 2. Decomposing blueberry fruit with SWD larvae

3rd Instar Larva Relative to Blueberry size.

It is very important that farmers learn how to monitor for this invasive pest. A simple trap can help you determine whether the SWD is present. The most effective and economical

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trap can be prepared using a clear plastic cup with a fitted lid. Bait this trap with a mixture of water, dry active yeast and sugar, as shown in Figure 3. Note that there are small holes in the sides of the trap that allow the flies to enter. A small yellow sticky card can be placed inside the cup. In that way, flies that are attracted by the bait will enter the trap and be retained by the card. This allows for easier fly identification, which is the purpose of this trap. For small acreage (or in a high tunnel), researchers suggest setting one trap for plots up to one acre. However, for larger farms, a minimum of three traps per five acres should be used. These monitoring traps need to be placed inside the vegetation, in the shade. It is also a good idea to put a trap in adjacent woods, where activity can occur earlier if there are plants bearing wild berries. Set traps just before the fruit starts to ripen. Check traps and replace yeast and sugar bait each week.

If you are interested in monitoring for this pest and need materials at no cost, please contact Dr. Jaime Piñero at PineroJ@LincolnU.edu or (573) 681-5522.

Figure 3. How to make a trap to monitor for SWD

Integrated Pest Management of Spotted Wing Drosophila with Emphasis in High Tunnel Grown Fall Bearing Primocane Raspberries

Spotted Wing Drosophila (SWD) has very quickly become a devastating pest of berry crops in Missouri. Adults were first detected in monitoring traps in late June, 2013. By early August, infestations to blackberry fruits had already been reported. By mid August, SWD was reported infesting crops state-wide. In addition to small fruit crops, this invasive insect pest also attacks some stone fruits (cherry, nectarine, peach), high tunnel tomatoes, and wild hosts (including pokeweed, autumn olive, crabapple, nightshade, Amur honeysuckle, and wild grape). Raspberries, blackberries, blueberries, elderberries and grapes are at the greatest risk.

SWD flies look similar to the small vinegar flies that are typically found around or on fermenting fruits and vegetables. However, unlike those native vinegar flies, SWD females have a serrated egg-laying device called ovipositor, to cut a slit into the skin of intact fruit to lay their eggs. This makes SWD a more significant pest. These crops also ripen later in the summer when the population increases, further increasing the risk.

Integrated Pest Management options to manage SWD in high tunnels include monitoring, sanitation, exclusion, and timely application of insecticide sprays. For the 2014 season, a monitoring program for susceptible crops is recommended throughout the harvest season.

Research aimed at identifying additional management options will be conducted by the LUCE IPM Program.

This article discusses IPM options to minimize larval infestations by SWD to high tunnel raspberries in the fall. It is very important that farmers also learn how to identify and monitor for SWD and how to detect larval infestations. An identification and monitoring guide is available at: http://www.lincolnu.edu/web/programs-and-projects/ipm. Because SWD most likely has come to stay, successful SWD control will require planning and implementation of a program that integrates multiple components.

EXCLUSION: In high tunnels, screening may protect individual plants or crops. In Japan, extremely fine mesh with openings less than 0.98 millimeter (0.039 inches) wide (18 mesh or finer) was able to protect blueberries. If screening is used, passive venting can be problematic thus; some means of increasing air flow such as using ventilation fans will be required. Mesh screens will exclude pollinating insects, and pollinator introduction will be needed if the crop is in bloom. Raspberries blossom and set fruit over a long period of time, especially with the primocane crop in a high tunnel, so it may not be practical to screen the crop without introducing pollinators into the tunnel. One option would be to use removable screens with Velcro allowing for attachment at fruit set and early development. If SWD is found by trapping inside the high tunnel, an insecticide application may provide SWD suppression for the rest of the season if exclusion is implemented.

CULTURAL CONTROLS: ***(i) Canopy and Water Management:*** Thin the plant row to 3-4 strong canes per square foot, eliminating weaker shoots and opening the canopy. Consider a trellising system that similarly opens the canopy. This may make plantings less attractive to SWD and will improve spray coverage. Leaking trickle irrigation lines should be repaired, and overhead irrigation should be minimized. Allow the ground and mulch surface to dry before irrigating. ***(ii) Sanitation:*** Removing over-ripe fruit from production areas as soon as possible can minimize SWD egg lay and larval development. Growers in other regions of the country have sent pickers through fields with one container to collect good fruit and another container to collect over-ripe fruit, again, to minimize egg-laying and larval development sites. This practice may better suited for small scale situations such as a tunnel. A final cleanup picking to remove the last berries from the bushes may be worthwhile. Infested fruit that remains in the field allows eggs and larvae to develop fully and, consequently, serves as a source for increased fly populations. The removal of wild host plants near production fields that could support SWD populations is another potential option. Two methods that worked well at eliminating SWD in infested fruits are bagging fruit inside clear or black plastic bags.

INSECTICIDAL CONTROL: This pest is new to Missouri so no research has been conducted within the state on most effective treatments to manage SWD. In addition, SWD populations are building in some regions of the State due to the rapid reproductive potential of this fly, so control actions ought to be taken immediately using recommendations based on findings from other states. But before you spray, confirm that you have SWD in your area by placing monitoring traps or by inspecting fruit. Sprays must be timed to kill adults before they lay eggs, as sprays

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AFTER HARVEST

Materials with longer pre-harvest intervals may be used immediately after harvest to knock back populations that will feed on any remaining overripe or dropped fruit. Residual activity has sometimes been reported to be shorter than what is listed above, so a close watch of traps for return of adults will be needed.

will not control larvae already in the fruit. After spraying an insecticide, take into account that fruit may still present infestations for a few more days given that eggs and larvae that were present in the fruit before spraying were not killed. Maintain monitoring traps, and re-apply insecticides as needed in accordance with label restrictions. Always read product labels to make sure pesticides are registered for use on raspberries.

Pesticide Use in High Tunnels: In the Midwest states, the pesticide regulatory agencies vary in their interpretation of whether a high tunnel is a type of greenhouse. For example, Indiana considers a high tunnel to be a form of greenhouse. That means the pesticides one selects for high tunnel use must be appropriately labeled for greenhouse use. Other states consider high tunnels to be the same as fields when it comes to pesticide use. In Missouri, an intermediate approach is followed: a high tunnel is considered to be a greenhouse when the sides are closed, but a high tunnel is considered a field planting when the sides are open.

SPECIFIC INSECTICIDE OPTIONS. For ***conventional farmers,*** the most effective chemicals are organophosphate, pyrethroid, and spinosyn classes of insecticides. Under field conditions, insecticides with fast knockdown activity have performed well at protecting fruit from SWD. Delegate 25WG and Radiant SC are reduced-risk, broad-spectrum insecticides that have been labeled for control of SWD in various crops in all states. Both products maintain populations of most beneficial insects, do not result in mite flareups , and have short reentry (4 hours) and pre-harvest (e.g., 1 day for Radiant on strawberry) intervals. Neonicotinoids such as Provado and Actara are considered weakly active on SWD flies and are not recommended for control (MSU info). For ***organic farmers,*** Entrust (spinosad) is the only product with residual activity (5-7 days control). Organic growers in the Pacific Northwest have used 2-3 applications of Entrust to effectively protect fruit in the pre-harvest period. It is important to note that Entrust provides ~5 days residual control and Pyganic provides ~2 days of control. Note also that Entrust has a 9 oz/acre seasonal maximum (see below for more details). In some studies by Michigan State University, Azera and Pyganic were found to be weakly active options compared with Entrust (spinosad). Because the Entrust label requires rotation to another product for resistance management, then Pyganic or Azera can very well fit that need. While it doesn't appear to provide residual control, Pyganic applied at 5 day intervals at the high labeled rate has shown to reduce SWD populations in California.

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Spotted Wing Drosophila...

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Table 1. Insecticides labeled for use in raspberries. Products are not complete listings of all available options. **OMRI** indicates an organically compatible insecticide. Where brand names or company names are used it is for the reader's information. No endorsement is implied nor is any discrimination intended against other products with similar ingredients. Read label to ensure that your product matches the site. Alternate the MoA (mode of action) of the product you choose on a yearly basis to minimize resistance build-up. For insecticides that work primarily through ingestion (e.g. spinosad), adding a small amount of cane sugar (2 tsp/gallon water) to the spray tank mix can improve results.

Class (IRAC)	Trade name	Active ingredient	REI	PHI (days)	Rate (per acre)	Comments
Carbamates (1A)	Sevin 80S	Carbaryl	12hrs	7	1-2 quarts	No more than 10 quarts/acre/year. Max of 5 applications/year. 7 day interval between applications
Organophosphates (1B)	Malathion 5EC	Malathion	12hrs	1	3 pints	Use higher rates when insect pressure is heavy. Max application rate is 3.2 pints per acre. Max of 3 applications/year. 7 day interval between applications
Pyrethroids and Pyrethrins (3A)	Bifenture	Bifenthrin	12hrs	3	8 – 16 oz.	Max of 32 oz./acre/year
Pyrethroids and Pyrethrins (3A)	Asana XL	Esfenvalerate	12hrs	7	4.8 – 9.6 fl. oz.	Max of 28.8 fl. oz./acre/year
Pyrethroids and Pyrethrins (3A)	Danitol 2.4EC	Fenpropathrin	24hrs	3	10-⅔ – 16 oz.	Max of 32 oz./acre/year 14 day interval between applications
Pyrethroids and Pyrethrins (3A)	Brigade 2EC	Bifenthrin	12hrs	3	6.4 oz.	Max of 32 oz./acre/year
Pyrethroids and Pyrethrins (3A)	Mustang Max	Zeta-cypermethrin	12hrs	1	4 oz.	Max of 24 oz./acre/season 7 day interval between applications
Pyrethroids and Pyrethrins (3A)	Pyganic EC5.0 OMRI	Pyrethrins	12hrs	0	16 – 64 oz.	Apply when non-targets including honey bees are least active. Pyrethrins degrade rapidly in sunlight.
Pyrethroids and Pyrethrins (3A)	AZERA OMRI	Pyrethrins + Azadirachtin	12hrs	0	2 Pints (32 fl. oz.)	Greenhouse and field use. Do not apply more than 1 time per day. Do not apply more than 10 times per season. Do notreapply within 3 days except under extreme pest pressure
Compounds of unknown or uncertain MoA	Aza-Direct OMRI	Azadirachtin	4hrs	0	maximum rate of 3½ pints/Acre	Greenhouse and field use. When pest pressure is heavy or plant canopy is dense, use higher rates and increase spray frequency stated in the label
Neonicotinoids (4A)	Actara	thiamethoxam	12hrs	3	2 – 3 oz.	Max of 6 oz./acre/season 7 day interval between applications
Spinosyns (5)	Delegate	Spinetoram*	4hrs	1	3 – 5 oz.	Max of 19.5 oz. /acre /season. Max of 6 applications/year. 4 day interval between applications
Spinosyns (5)	Entrust OMRI	Spinosad*	4hrs	1	1.25 – 2 oz.	Max of 9 oz./acre/season Max of 6 applications/ year. 5 day interval between applications

*Both spinosad and spinetoram are naturally derived substances created through a fermentation process. However, **spinetoram** is a mixture of chemically modified spinosyns J and L and therefore is **not approved** for certified organic production. Spinetoran is the active ingredient of Delegate 25WG and Radiant SC, two reduced-risk, broad-spectrum insecticides that have been labeled for control of SWD in various crops in all states. Both products maintain populations of most beneficial insects, do not result in mite flareups, and have short re-entry (4 hours) and pre-harvest (e.g., 1 day for Radiant on strawberry) intervals.

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Basil Wilt

Sweet basil is the herb synonymous with tomatoes, pesto, Italian dishes, and summer time. One of the biggest disappointments for herb gardeners is when the plants are about six to twelve inches tall, brown streaking appears on stems, and whole plants suddenly wilt and die. This disease is caused by a soil borne fungus, *Fusarium oxysporum f. sp. basilicum*, which was presumably introduced to North America on infected seeds from Italy in 1991 (Figure 1).

Many sweet basil (*Ocimum basilicum*) varieties, including the Genovese types, are susceptible to fusarium. Other species, such as camphor (*O. kilamandscharicum*) or lemon (*O. americanum* do not exhibit the characteristic wilting symptom of this disease, but they are hosts for the disease. Other plants in the mint family, such as rosemary and thyme also appear symptomless, but are fusarium hosts. In 199, Nufar was selected as the first Genovese basil resistant to fusarium wilt. Aroma 1 and 2 are also Genovese basil types resistant to this disease. Fusarium-resistant varieties are available from several mail order seed companies.

Fusarium is introduced into the growing medium (soil, potting mix, hydroponic systems) from contaminated seed and can persist in the soil for eight to twelve years. Asymptomatic plants, such as mints, will also carry over the inoculum from year to year. Currently there are no products registered to control this disease. Thus, the use of disease-resistant seed is recommended to prevent this disease. If susceptible basil varieties are planted, annual replacement of the growing medium is recommended for container grown plants. In the garden, rotate basil to a different part of the site each year and remove all plant debris after the final harvest.

Figure 1. Wilted basil plants infected with fusarium. Photo credit: University of Minnesota Extension

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September Gardening Calendar

Ornamentals

- **Weeks 1-4:** Continue planting evergreens now.
- **Weeks 1-3:** Cuttings of annuals can be taken now to provide vigorous plants for overwintering.
- **Weeks 1-3:** Herbs such as parsley, rosemary, chives, thyme and marjoram can be dug from the garden and placed in pots now for growing indoors this winter.
- **Weeks 2-4:** Except tulips, spring bulbs may be planted as soon as they are available. Tulips should be kept in a cool, dark place and planted in late October.
- **Weeks 2-3:** Begin readying houseplants for winter indoors. Prune back rampant growth and protruding roots. Check for pests and treat if necessary. Houseplants should be brought indoors at least one month before the heat is normally turned on.
- **Weeks 3-4:** Perennials, especially spring bloomers, can be divided now. Enrich the soil with peat moss or compost before replanting.
- **Weeks 3-4:** Divide peonies now. Replant in a sunny site and avoid planting deeply.
- **Weeks 3-4:** Lift gladioli when their leaves yellow. Cure in an airy place until dry before husking.
- **Week 3:** Poinsettias can be forced into bloom for Christmas if they are moved indoors now to a sunny windowsill. Each night, they must be kept in a cool, dark place where there is no light for 14 hours. This must continue until proper color is achieved in 6-10 weeks.

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September Gardening Calendar

Lawns

- **Weeks 1-4:** Cool season lawns are best fertilized in fall. Make up to 3 applications between now and December. Do not exceed rates recommended by fertilizer manufacturer.
- **Weeks 1-4:** If soils become dry, established lawns should be watered thoroughly to a depth of 4-6 inches.
- **Weeks 1-4:** Begin fall seeding or sodding of cool season grasses. Seedbeds should be raked, dethatched or core-aerified, fertilized and seeded. Keep newly planted lawn areas moist, but not wet.
- **Weeks 2-4:** Lawns may be topdressed with compost or milorganite now. This is best done after aerifying.
- **Weeks 3-4:** It is not uncommon to see puffballs in lawn areas at this time.
- **Weeks 3-4:** Newly seeded lawns should not be cut until they are at least 2 or 3 inches tall.

Vegetables

- **Weeks 1-2:** Egyptian (top-setting) onions can be divided and replanted now.
- **Weeks 1-2:** Sowing seeds of radish, lettuce, spinach and other greens in a cold frame will prolong fall harvests.
- **Weeks 2-4:** Keep broccoli picked regularly to encourage additional production of side shoots.
- **Weeks 2-3:** Pinch out the top of Brussels sprout plants to plump out the developing sprouts.
- **Weeks 2-3:** Harvest herbs now to freeze or dry for winter use.
- **Weeks 2-3:** Tie leaves around cauliflower heads when they are about the size of a golf ball.
- **Weeks 3-4:** Pinch off any young tomatoes that are too small to ripen. This will channel energy into ripening the remaining full-size fruits.
- **Week 4:** Sow spinach now to overwinter under mulch for spring harvest.

Fruits

- **Week 1:** Pick pears before they are fully mature. Store in a cool, dark basement to ripen.
- **Weeks 3-4:** Bury or discard any spoiled fallen fruits.
- **Week 4:** Paw paws ripen in the woods now.
- **Week 4:** Check all along peach tree trunks to just below soil line for gummy masses caused by borers. Probe holes with thin wire to puncture borers.

Miscellaneous

- **Weeks 1-4:** Autumn is a good time to add manure, compost or leaf mold to garden soils for increasing organic matter content.
- **Weeks 1-2:** Monitor plants for spider mite activity. Reduce their numbers by hosing off with a forceful spray of water.
- **Weeks 2-4:** Seasonal loss of inner needles on conifers is normal at this time. It may be especially noticeable on pines.

Gardening Calendar supplied by the staff of the William T. Kemper Center for Home Gardening located at the Missouri Botanical Garden in St. Louis, Missouri. (www.GardeningHelp.org)