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Importance of Cleaning and Sanitation in the Winery – Part 3

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Editor's note: This is the third article in the "series" and deals with following issues:

Wine Spoilage Organisms

Microorganisms are associated with the production of many fermented food products including wine. In the process of wine production many microorganisms such as molds, yeast and bacteria are involved. In fact their participation is crucial to wine making. Some of these organisms are desirable and have a positive impact on wine quality while others produce off odors and flavors and thus contribute to wine spoilage.

By definition spoilage causing microbes are those found in a wrong place at a wrong time. This would obviously include organisms capable of producing off taste and foul odors but also include the desirable ones when they are found in an unwanted place and time. For example a good strain of yeast used in primary alcoholic fermentation would be considered a spoilage microbe when it found in a bottled wine with residual sugar. The challenge for the winemaker is to use only the desired microorganism when and where they are needed and control or eliminate all others (good and bad) during the rest of the wine making process.

To control the spoilage causing organism the winemaker needs to institute and a rigorous cleaning and sanitation program. A deeper understanding of the various spoilage causing organisms is essential to implementing a successful sanitation plan. The main spoilage microorganisms include yeasts, bacteria and mold. The process of winemaking can be viewed in three stages at which the microorganisms can

enter the process and negatively impact the wine quality.

The first stage is the raw material, mainly the grapes at harvest and their delivery to winery. How clean is the fruit? Is it healthy or diseased or damaged? Hand picked or machine harvested? The shipping distance, temperature of the fruit in transit and use of sulfur dioxide are all the factors that will influence the kinds of microbes, extent of their proliferation and the spoilage they would cause.

The next step is the processing of fruit and the fermentation. General sanitary status of equipment such as crusher, press, pumps, and hoses; the winery premises and the processing steps such as must settling and cold soak (red wine) will influence the entry of wine spoilage microorganisms. Generally, the fermentation is conducted by the wine yeast *Saccharomyces cerevisiae*. However, microbes originating from grapes and the winery environment also participate in primary alcoholic fermentation. Growth of undesirable microorganisms at this stage can cause spoilage of the product.

In the post fermentation period a wine is clarified, fined, stabilized, matured, and bottled. At this stage wine is susceptible to spoilage by various kinds of microorganisms. Control of these spoilage organisms is absolutely essential for producing high quality wines.

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Spoilage by yeast

Yeast is widely distributed in nature and many strains are found on grapes and the winery environment (floors, walls, equipment, containers etc). At this point it is important to define the terms wine yeast and the wild yeast. The term wine yeast refers to the strains of *Saccharomyces* which consistently complete fermentation without producing off flavors. These yeasts are relatively more alcohol, sugar and SO₂ tolerant than the wild yeasts. The term wild yeast refers to those non *Saccharomyces* strains which can partially ferment the must and produce various kinds of off flavors.

Can wine yeast be a spoilage causing yeast? The answer is yes. Recognizing its valued contribution to alcoholic fermentation, it also needs to be noted that its presence where it is not wanted constitutes spoilage. An example would be the wine yeast causes re-fermentation of bottled wine usually containing some residual sugar.

At harvest, a significant number of non *saccharomyces* strains are present on the surface of grapes. Commonly found strains include *Kloeckera*, *Hansenula*, and *Hanseniaspora* and less commonly present include species of *Metschnikowia*, *Candida* and *Pichia*. It is important to note that the presence of yeast *Saccharomyces* is extremely rare on grapes. Whether non *saccharomyces* strains are considered spoilage yeast is debatable. In un-inoculated fermentations these yeast certainly make significant contribution to the fermentation. Some winemakers like the complexity of flavors generated by these yeasts. However these yeasts are also capable of producing high levels of acetic acid and ester ethyl acetate which gives wine vinegar like aroma and is considered spoilage. These non *saccharomyces* strains are sensitive to ethanol and are dominated by the *saccharomyces* even in un-inoculated fermentations. They are also sensitive to sulfur dioxide and can be easily controlled by an appropriate dose of SO₂ to the must prior to fermentation.

When a wine is exposed to air during storage a layer of film can develop. This is caused by strains of yeasts such as *Candida* and *Pichia*. These organisms utilize ethanol and produce higher concentrations of acetaldehyde, acetic acid and ethyl acetate. Proper sanitation and wine storage in absence of air is important in avoiding the spoilage caused by the film forming yeasts.

Some non *Saccharomyces* yeast can complete fermentation but also cause spoilage. Species of the genera *Brettanomyces*, *Zygosaccharomyces* and *Schizosaccharomyces* belong to this group. *Brettanomyces* produces volatile phenols which gives wine medicinal, mousy and barnyard off-flavors. *Zygosaccharomyces* causes re-fermentation, turbidity, and high levels of acetic acid and esters. *Schizosaccharomyces* is rarely found in wine but can cause deacidification and lead to high pH. In order to control the spoilage yeasts proper sanitation is crucial.

Kinds of spoilage by yeast

Various spoilage causing yeasts have been briefly described above. Their activity can produce various kinds of wine faults. It is vital to understand them in order to realize the significance of cellar sanitation.

Re-fermentation

Many species of the yeast *Zygosaccharomyces* can cause re-fermentation of bottled wine containing sugar. The main spoilage causing species *Z.bailii* has many unusual properties. It can tolerate high concentrations of ethanol (.15%), and sugar (.70%) and shows resistance to high concentration of preservatives such as sorbic acid, benzoic acid and sulfur dioxide. The yeast is a main contaminant of grape juice concentrate, especially when stored at room temperature over extended period. Spoilage occurs when contaminated concentrate is used for sweetening the wine. A wine spoiled by *Z.species* can show turbidity, sediment increased level of succinic, and acetic acid and reduction in malic acid. To avoid the risk of spoilage by this organism winemaker should not use contaminated juice concentrate, and follow sterile filtration and sterile bottling.

Ester formation

Ester taint is associated with high levels of ethyl acetate and in some cases may also be due to methylbutyl acetate. In a wine containing >200mg/l ethyl acetate and 0.6g/l acetic acid the off odor is perceived as spoilage. High concentration of ethyl acetate was shown to be related the activity of the wild yeast such as *Hanseniaspora uvarum* in the early stages of fermentation. The potential for the taint to develop is significant when the must contains a high population (10⁶cells/ml) of *H.uvarum* in relation to *Saccharomyces*, in initial stages of fermentation.

To minimize the taint problem a winemaker should not use damaged and diseased fruit, settle and clarify the must, and inoculate with a high population of *Saccharomyces cerevisiae* and maintain sufficient level of free SO₂

Film forming yeast

During storage in a partially filled container, species of *Candida* and *Pichia* can develop a layer of film on wine surface. The cells appear as clumps which will develop into a film. As the cells grow the film layer becomes thick and sinks to the bottom. The yeast requires oxygen for their growth. They metabolize ethanol and produce acetaldehyde, acetic acid and ethyl acetate. The wine acquires oxidized aroma and may also have pronounced vinegar like odor. To prevent this type of spoilage a winemaker needs to store wine in completely filled containers, (no air in headspace) use inert gas during wine transfer, keep a blanket of inert gas in head space during short term storage maintain high SO₂. Some strains have been found to be resistant to high SO₂ and in this case SO₂ may not be effective. If containers become infected, they must be cleaned and sanitized with steam. Sanitation is the key to avoid spoilage problems.

Undesirable flavor formation

Many types of off odors are attributed to the activity of spoilage yeast. Wine contamination by *Brettanomyces* yeast can cause variety of off odors. These odors are often described as barnyard like, medicinal, band-aid like, wet dog, tar, tobacco, creosote, leathery, mousy, phenolic, spicy (4-ethyl phenol), and acetic. At high levels these odors are obviously objectionable. In smaller concentrations these odors are perceived as complex and not a fault by some winemakers.

The yeast is a slow fermenter but can complete fermentation. In sparkling wine production it can cause problems with riddling and can also cause gushing due to CO₂ generation.

The key to control this organism is to pay scrupulous attention to cleanliness and sanitation particularly at harvest. During processing the equipment should be periodically cleaned to prevent the build up of a large population. One should also avoid infected barrels for wine storage. The yeast is fortunately sensitive to SO₂ and therefore, can be controlled by maintaining appropriate levels of free SO₂ in wine during storage.

Another group of objectionable odors originate from the presence of sulfur compounds. Hydrogen sulfide is produced by yeast during fermentation. This compound has a rotten egg odor which is not pleasant. The formation of H₂S is dependent on yeast strain and many environmental factors. It is important to use a low H₂S producing strain of *Saccharomyces cerevisiae* to minimize this fault from developing in wine.

High levels of acetic acid also contribute to acetic spoilage aroma. Many microorganisms including wild yeast acetic and lactic acid bacteria are involved in acetic acid formation. Acetic acid is a major volatile acid in wine and its amount in wine is restricted by federal regulations.

Cold Hardiness - Part II Genetic Influences

By Andy Allen, MVEC Viticulture Advisor

In the previous article in this series, we looked at the progression of cold hardiness development over the course of the season and the environmental factors that are involved. While many environmental factors may influence cold hardiness development, we saw that hardiness level is primarily determined by air temperature, particularly those temperatures experienced in the previous 2-3 day period before cold hardiness measurements were taken. In this installment, we'll review the effects of one of the most important management decisions, that is, the choice of cultivars and rootstocks, on grapevine cold hardiness.

The ultimate level of cold hardiness that any plant can achieve is genetically determined, so first and foremost of the management decisions that influence cold hardiness is the type and cultivar of grape grown. With the exception of varieties of *Vitis rotundifolia*, or muscadine, cultivars derived from native American grape species are generally the cold hardiest of the commercially grown grapes. French-American hybrids, as a group, are rather variable but generally somewhat less cold hardy. This may be related to the percentage of *Vitis vinifera* versus the percentage of native species or cultivars that make up an individual hybrid's parentage. The *Vitis vinifera* cultivars are the least hardy as a group. As mentioned in the previous article (1), a study of bud cold hardiness levels in Washington state (6) showed that

Concord reached a stable hardiness level of -26° C (-15°F) while both Cabernet Sauvignon and White Riesling only reached a level of -23° C (-9.5° F). A similar two-year study in Virginia (11) found maximum cold hardiness levels of -26.9 and -28.8° C (-16.4 and -19.8° F) for Concord (years 1 and 2, respectively), -23.8 and -22.9° C (-10.8 and -9.2° F) for Riesling (years 1 and 2), and -21.2° C (-6.2°F) for Cabernet Sauvignon (both years). A survey of bud survival within many different grape cultivars in the upper Midwest (2) following a severe freeze event on January 19, 1994, during which low temperatures ranged from -17° F in Michigan to -24° F in Ohio and -26° F in Indiana, showed this same breakdown amongst cultivars, with American cultivars being generally hardier than hybrids which were hardier than *vinifera* cultivars. Some hybrid cultivars, such as Baco noir, DeChaunac, Leon Millot, Marechal Foch, Frontenac, LaCrosse, and Ventura were the hardiest of all the cultivars with 80 percent or higher bud survival, while others, such as Chambourcin, Vidal, and Chardonel, had only marginally better bud survival than the *vinifera* cultivars evaluated. At the Indiana site, all *vinifera* cultivars were killed to the ground while in Ohio many were killed to the snow line. Assessment of primary bud mortality in Virginia (9, 10) resulting from the same January 19 freeze event showed that Chardonel had 74 percent and Vidal had 40 percent primary bud survival while 5 white and 12 red *vinifera* cultivars had between 74 and 100 percent primary bud mortality. In this situation only 1 white *vinifera* cultivar, Petit Manseng, had primary bud survival comparable to the hybrid cultivars. Since a vineyard is a large investment and the vines will be subjected to winter freezes over the long-term, then in determining which cultivars to plant, a grower should first examine the historic weather data for his/her region looking at both the frequency of severe freeze events and the average coldest temperature per decade for at least the past 20 years. This will help determine the risk of freeze injury and the amount of hardiness required by the vines to survive these episodes. If a grower then chooses to plant more tender grapevine cultivars, he/she will know that there is an increased risk of winter injury to the vines and/or potential vine loss.

The choice of rootstock may also have an influence on cold hardiness of the vine. Rootstocks themselves differ in their cold hardiness. A study by Miller, et al (4) comparing cane and bud hardiness of C-3309, Kober 5BB, and SO4 showed that C-3309 canes acclimated

faster in the fall than those of 5BB in 2 of the 3 years the rootstocks were examined and were 3-7° C (1.7-3.9° F) hardier than 5BB from December through March in all 3 years. Canes of SO4 were intermediate in their hardiness. Differences in bud hardiness of the three rootstocks were variable and of a much smaller degree. A companion study by Miller, et al (5) comparing White Riesling grafted onto C-3309, 5BB and SO4 showed that vines grafted onto C-3309 had hardier canes and significantly fewer shootless nodes in one year of the four-year study. A similar study by Striegler and Howell (7) in Michigan of Seyval on its own roots compared to Seyval grafted to Seyval, 5BB and C-3309 showed differences in the number of shootless nodes both between Seyval on its own roots and grafted Seyval vines and between the individual rootstocks. All grafted Seyval vines had fewer shootless nodes than ungrafted vines while among the grafted vines, Seyval vines grafted to C-3309 had the fewest shootless nodes, Seyval grafted to Seyval had the most and Seyval vines grafted to 5BB were intermediate in number. Likewise, a study in Nebraska (3) of Gewürztraminer on its own roots and grafted onto six rootstocks (Riparia Gloire, St. George, C-3309, 110R, 1103P, and MG 420A) showed that vines grafted to C-3309 had the highest number of buds to survive a -24° C (-11° F) freeze, followed by MG 420A. However, these two rootstocks also hastened budbreak compared to own-rooted vines, whereas the other rootstocks delayed budbreak. In another study comparing potted own-rooted Seyval vines with potted Seyval vines grafted to Seyval, Riparia Gloire, Cynthiana, and St. George, Striegler and Howell (8) found that during the deacclimation phase vines grafted to Cynthiana had significantly hardier canes and the least number of shootless nodes of all the Seyval/rootstock combinations. Bud hardiness of vines on Cynthiana responded in a similar fashion but to a lesser degree, being significantly hardier than the buds of vines in the other treatments on only one date. From these studies, the effect of rootstocks on grapevine cold hardiness appears to be mainly an increase of a few degrees in the hardiness of the canes and a reduction in the number of shootless nodes with, in some cases, a lesser increase in bud hardiness. So while it appears that there may be some potential for the use of cold hardy rootstocks in growing more tender grape cultivars in a marginal climatic situation, further evaluation is needed before rootstocks can be chosen with that purpose in mind. Growers should also keep in mind that the use of rootstocks will involve additional cultural

practices such as covering or “hilling-up” graft unions in the fall for cold protection and “de-hilling” in the spring.

In the final installment of this series, we'll look at the effect of cultural practices on grapevine cold hardiness.

- 1) Allen, Andy. 2004. Grapevine cold hardiness – Part I. *Vineyard and Vintage View* 19(4):5-7.
- 2) Bordelon, B.P., et al. 1997. Grape bud survival in the Midwest following the winter of 1993-1994. *Fruit Varieties J.* 51:53-59.
- 3) Gu, S., et al. 2005. Performance of ‘Gewurztraminer’ on six rootstocks under marginal climatic conditions. In: (P. Cousins and R.K. Striegler, eds.) *Grapevine Rootstocks: Current Use, Research, and Application*. Proceedings of the 2005 Rootstock Symposium. Mid-America Viticulture and Enology Center, SMSU. Pp. 57-60.
- 4) Miller, D.P., et al. 1988. Cane and bud hardiness of selected grapevine rootstocks. *Am. J. Enol. Vitic.* 39:55-59.
- 5) Miller, D.P., et al. 1988. Cane and bud hardiness of own-rooted White Riesling and scions of White Riesling and Chardonnay grafted to selected rootstocks. *Am. J. Enol. Vitic.* 39:60-66.
- 6) Proebsting, E.L., et al. 1980. Seasonal changes in low temperature resistance of grape buds. *Am. J. Enol. Vitic.* 31:329-336.
- 7) Striegler, R.K. and G.S. Howell. 1991. The influence of rootstock on the cold hardiness of Seyval grapevines. I. Primary and secondary effects on growth, canopy development, yield, fruit quality and cold hardiness. *Vitis* 30:1-10.
- 8) Striegler, R.K. and G.S. Howell. 2005. Influence of rootstock on the cold hardiness of potted Seyval grapevines during acclimation and deacclimation. In: (P. Cousins and R.K. Striegler, eds.) *Grapevine Rootstocks: Current Use, Research, and Application*. Proceedings of the 2005 Rootstock Symposium. Mid-America Viticulture and Enology Center, SMSU. Pp. 94-105.
- 9) Wolf, T.K. and M.K. Warren. 2000. Crop yield, fruit quality, and winter injury of eight wine grape

cultivars in northern Virginia. *J. Am. Pom. Soc.* 54:34-43.

10) Wolf, T.K. and M.K. Miller. 2001. Crop yield, fruit quality, and winter injury of 12 red-fruited wine grape cultivars in northern Virginia. *J. Am. Pom. Soc.* 55:241-250.

11) Wolf, T.K. and M.K. Cook. 1992. Seasonal deacclimation patterns of three grape cultivars at constant, warm temperatures. *Am. J. Enol. Vitic.* 43:171-179.

The Development and Practical Management of Insecticide Resistance – Part II

By Daniel Waldstein, IPM Specialist Department of Fruit Science

Generally there are no more than a few insecticides available for proper control of a pest that are also economically viable for the grower and since growers are faced with the reality of fewer novel insecticides to use for pest control in the future, it is important to lengthen the effective life of insecticides already being used. This strategy for delaying resistance of currently used insecticides has been termed insecticide resistance management. It emphasizes a shift from continuous application of one insecticide to control a pest, to alternating insecticides with different modes of action and distinct chemical structures.

There are four major ways in which insecticides can be alternated in a spray program. These include tank mixing of the insecticides, alternating them within a pest generation, alternating them among pest generations, and spatial variation, also referred to as use of mosaics.

Insecticides can be tank mixed for a number of reasons. Synergists are a classic example. A synergistic combination exists when the toxicity of the two compounds is substantially greater than what would be expected from their additive toxicities (i.e., $2 + 2 = 10$) (Klaassen and Eaton, 1991). An example of a synergistic combination is the use of piperonyl butoxide with pyrethrin insecticides. Insecticides should not be included in a tank mix if they are not effective or have poor efficacy when used alone. Insecticide resistance management is best achieved with mixtures when the insecticides have high efficacy against the

target pest and are used at a full rate, however, using mixtures of highly effective insecticides at full rates may not be economically practical, especially when newly registered, expensive insecticides are used.

The second variation in applying different insecticides, alternating within a pest generation, has been widely used to slow the onset of insecticide resistance. For example, if I had three different insecticides and sprayed three times per generation for a particular insect pest, I would apply insecticide x, y, and z, for one generation and use the same combination for each subsequent generation. This type of spray program works for a variable population of insect pests because different parts of each generation are exposed to different insecticides. This strategy manages a heterogeneous population of pests that will eventually develop resistant to all three insecticides.

The third variation of insecticides in a spray program is the use of the same insecticide throughout one generation and a switch to a different insecticide on the next generation. For example, if there were three generations of a pest and three applications required per generation, I could spray compound x, x, x on the first generation, y, y, y on the second, and z, z, z on the third generation. Insects with genes resistant to insecticide x will survive in the 1st generation. In the 2nd generation, individuals with resistance allele x will be killed by insecticide y (assuming no cross-resistance between insecticide x and y). In the 3rd generation, individuals with resistance alleles x and y (rare individuals) will be killed by insecticide z. Individuals with resistance alleles for insecticide x and y are rare because the probability of having both is multiplicative. In other words, if the probability of an insect having x or y alone is 1 in 10,000, the probability of having both is 1 in 100,000,000. This type of spray program manages a homogeneous pest population where low levels of resistance to one insecticide develop but resistant insects are killed by alternating with non-cross-resistant insecticides in the next generation. Use of this tactic keeps the proportion of resistant insects in a population low over time by decreasing the competitive advantage of insects with resistance genes.

The fourth means for alternating insecticides is spatial variation or use of mosaics. In this case part of a field is sprayed with insecticide x, another part with y, and another with z. This may

result in a variable population where resistance to multiple insecticides develops, unless insect mobility is low or insecticides are applied over a large area. An example of a mosaic is with Bt (*Bacillus thuringiensis*) corn where a certain percentage of the field is planted in non-Bt corn.

It is important to remember that insecticide resistance is not the only means for insects to survive insecticide applications. Problems with timing, rates, precipitation, and spray coverage can also decrease the efficacy of insecticide applications.

Poor spray coverage can leave “lethality gaps” in the leaf canopy. Pests may be exposed to sub-lethal concentrations of an insecticide that are high enough to induce resistance combative mechanisms, but too low to cause mortality. Spray coverage can be maximized by not driving sprayers too quickly and using adequate volumes of water. The appropriate spray volume per acre can be determined using row volume calculations shown in the Midwest Commercial Fruit Spray guides. It is also important to prune in a manner that opens the grapevine leaf canopy. In addition to improving spray coverage, this contributes to increased light penetration for leaf photosynthesis and even fruit coloring.

Delaying resistance through resistance management techniques does not solely consist of alternating insecticide use. Whenever possible it is important to implement non-insecticide management techniques. This includes use of pesticide alternatives, cultural and biological controls.

Pheromone mating disruption is a good example of a pesticide alternative that can be used to decrease insecticide resistance pressure. Female insects emit a species-specific blend of chemicals known as a pheromone that attracts males for mating. The composition of many of these blends has been determined by analytical chemists, and the pheromones have been produced synthetically. Releases of synthetic pheromone can be used to mask the female’s pheromone and make it difficult for males to locate females for mating. This decreases mating success and causes a population reduction of the next generation of insect pests.

An example of a cultural management technique is the use of non-broadleaf ground covers (especially fescue) in row middles and mowing to

decrease tarnished plant bug damage. Nature's way of controlling one population of organisms such that it does not overtake the entire system is through biological control. This involves interactions between species to regulate populations and maintain a sustainable balance in the ecosystem. Biological control is more practical for insects that feed on foliage and not fruit. Foliage feeder control can be managed in a non-absolute manner unlike fruit feeding damage in which one hundred percent control is the desired outcome. A good practical example of biological control is the use of predatory mites for control of the European red mite. The use of selective insecticides that preserve predatory mites and other insect natural enemies is an important part of integrated pest management.

Although much has been learned in the past twenty years about insecticide resistance development and its management, there are many concepts that have yet to be fully understood. The sources of variation provided by the insecticides as well as the target pests create a complex interaction that contributes to management challenges. I have purposely kept the focus of these two articles [*Editor's note: see Part I of this series in the Winter 2004 issue.*] on insecticide resistance rather than pesticide resistance in general. Although fungicide and herbicide resistance have some factors in common with insecticide resistance, the numerous differences do not allow for broad generalizations applicable to all types of pesticide resistance.

When all is said and done, the development of new, non-cross-resistant insecticides remains an important aspect of insecticide resistance management. The goal of resistance management in light of the decreasing availability of new, effective, and affordable insecticides is to maximize the effective life of currently used products.

References:

Klaassen, C. D. and D. L. Eaton. 1991. *Principles of Toxicology*. In Amdur, M. O., J. Doull, and C. D. Klaassen (Eds.): *Casarett and Doull's Toxicology The Basic Science of Poisons, 4th ed.* McGraw-Hill Inc. New York. 17.

Raffa, K. F. and T. M. Priestler. 1985. Synergists as research tools and control agents in agriculture. *J. Agric. Entomol.* 2: 27-45.

History and Management of Green June Beetle and Japanese Beetle

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Green June Beetle

The green June beetle is native to the southeastern United States south of a line from Maryland to Nebraska. It is a pest of ripe fruit, vegetables, turf and pastures especially in areas where the fruit, poultry and livestock industries coincide. Adult green June beetles are $\frac{3}{4}$ to 1 inch long, metallic green from head to tip of wings, shiny green legs, underside is glittery green and the sides are brownish yellow. A mature larva is a "C"-shaped grub about 2" long, yellowish white with brown head and spines on the underside of the abdominal tip that form several parallel rows. At night, the grub may be found on the grass surface crawling on its back. From July to the following May, these white grubs feed on decomposed manure near the soil surface in pastures often uprooting and killing the grass. In May to June, the grub transforms in the soil to resting pupa. After a rain, adults emerge from soil and can be found feeding from late June to late August. Males make zig zag flights 3 feet above the grass searching for females producing an unidentified attractive odor called a pheromone. Mating groups can be observed in the grass or in trees from late June to early August. Mated females lay eggs in moist areas of pastures with decomposed manure (broiler and cow manure, milorganite, composted sewage, and rotting hay). After a week of mating and egg laying, adults deplete food reserves and actively search for food like ripe fruits and vegetables. Beetles feed in groups and emit a blend of plant odors: limonene, 2-phenyl-ethanol, methyl salicylate and methyl-2-methoxybenzoate (Johnson and Bryant, unpublished data). These odors elicit a strong aggregation behavior in green June beetles. We reported that feeding increased beetle longevity from 14 to 23 days and egg laying from 27 to 57 eggs per female.

Japanese Beetle

The Japanese beetle is a pest introduced from Japan to New Jersey where it first caused damage in 1916. The adult causes damage to

foliage, flowers and fruit of over 300 susceptible ornamental, landscape and fruit plants. The grubs feed on grass roots, especially fescue, from August to the following May. Adults are 3/8-inch long metallic green beetles with copper-brown wing covers. Five small white tufts project from under the wing covers on each side, and a sixth pair at the tip of the abdomen. The "C"-shaped grubs are about 1 inch long with a brown head and three pairs of legs. The spines on the underside of the last abdominal segment form a "V" shape. From August to the following May, these grubs feed on grass roots. From May to June, grubs begin changing in the soil to a pupa. After a rain, adults will emerge from the soil and can be seen feeding from late May to mid August. Females release a sex pheromone called furanone. Males make zig zag flights within one foot above the grass following this scent to the female and mate. Mating groups or pairs can be observed in the grass or on plants from early June to August. Mated females dig in soil under grass to lay eggs, especially fescue grass. Both sexes are attracted to a different set of floral odors than the green June beetle that contains a 3:7:3 blend of geraniol (9.50%; odor in rose, geranium, basil and lemongrass), eugenol (22.25%; odor in rose, allspice, basil or clove) and 2-phenylethyl propionate (9.50%; a rose odor).

In the past, it has taken 15 to 27 years for this beetle to spread across states east of the Mississippi River. By 1934, the Japanese beetle was reported as far west as St. Louis, Missouri (Fleming 1972, USDA Technical Bulletin No. 1449). 1999 survey results indicated Japanese beetles in nine counties in Missouri with a few areas having significant populations: Meramec Park in Franklin County and a golf course in Stone County. [Editor's note: *In 2004, Japanese beetles were found feeding on grapevine foliage in vineyards in Ste. Genevieve County.*] Since 2001, fruit growers and home owners in NW Arkansas and central and NE Oklahoma have experienced economic damage by the Japanese beetle. The National Agricultural Pest Identification System makes a map available on the Internet of the current distribution of the Japanese beetle infestation entitled, "Reported Status of Japanese Beetle in US and Puerto Rico" at: <http://ceris.purdue.edu/napis/pests/jb/imap/jbmap.html>.

The following are a few quoted historical statements about infestations of Japanese beetle in Missouri made by Michael E. Brown (State

Entomologist, Missouri Department of Agriculture Plant Industries Division) in his article titled, "A Brief History of Japanese Beetle, *Popillia japonica* Newman, in Missouri, 1934-1995" at: <http://www.ceris.purdue.edu/napis/states/mo/rpts/histmojb.txt>.):

"From years 1934 through 1968 trapping surveys were conducted and several areas were treated with insecticides in Missouri. ...Beetle numbers increased again in 1962 ...as a result more than 3000 acres were treated. ...During the 1970's and into the 1980's beetles continued to be captured mainly in the Tower Grove Park area of St. Louis and at the Gateway Arch of the downtown area. ... In 1985, traps were placed in Meramec State Park in Franklin County ... In 1988 more than 400,000 beetles were captured in approximately 100 traps (Meramec State Park). ... Beetle numbers increased again in 1994 when approximately 300 beetles were captured in the Kansas City area. ...Results of the survey for 1995 (Stone Co.) yielded 177,213 beetles, Greene Co. - 198 beetles from 6 locations. ...In general, the primary focus of survey efforts in recent years has been with nursery stock dealers, since this has been a primary means of movement of Japanese beetle into the state. In at least one case in 1994, live Japanese beetle grubs were found in the soil ball of nursery stock brought in from an infested area of the country. ...The heavy clay soils that are prevalent in many parts of the state should have some benefit in limiting suitable habitat available for the development of this potential harmful pest."

Mechanical Control

My research group is evaluating a new lure for monitoring and mass trapping of the green June beetle. In 2004, from 15 July to 27 August we captured a season total of 1,005 green June beetle adults per yellow vane trap in a fruit planting adjacent to a pasture in Springdale, Arkansas. Traps were each baited with Mix-M bait (Trécé, Adair, OK) charged with a patented floral odor blend of limonene (citrus odor), methyl salicylate (wintergreen odor), 2-phenyl-ethanol (rose of mild honey-like sweetness odor), methyl-2-methoxybenzoate and phenylacetaldehyde (Patent: Lopez, J.D., Jr., R.L. Crocker and T.N. Shaver. 2002. Attractant for monitoring and control of adult scarabs. US Patent # 6,440,406.).

Japanese beetle yellow vane traps may catch up to 75% of the beetles that approach them. Traps may lower beetle populations from 30% (1 trap per acre) up to 39% (10 traps per acre) if placed throughout a neighborhood. The trapped beetles must be emptied from the traps every two days to prevent them from rotting and releasing ammonia which is repellent to other Japanese beetles. If traps are used, place far away from susceptible plants. These traps are baited with two lures: the sex pheromone and the floral odors (noted above). Several companies sell complete Japanese beetle trap kits with these lures: Bag-A-Bug trap at \$5.44 (Spectrum Group, Division of United Industries, St. Louis, MO); Safer Japanese beetle trap for \$5.95; SurFire trap (no price found; Concep, Bend, OR); Trécé Xpando trap with an accordion-type collapsible base for \$11.25 and the standard Trécé Catch Can trap for \$19.50 (Trécé, Palo Alto, CA). These traps are available to homeowners in most garden centers and other stores in infested areas. In 1997, the Japanese beetle Trécé Xpando and Trécé Catch Can trap designs captured significantly more beetles overall than did either the Safer or SurFire trap designs but they cost two to three times more (Source: Alm, S. R. and C. G. Dawson. 2002. Evaluation of two prototype traps and existing trap designs for captures of Japanese beetles. *J. Economic Entomology* 96: 453-455.).

Chemical Control

Producers have sought after a control tactic that would prevent the native adult green June beetles from damaging ripe fruit and the grubs from uprooting pasture grass and hasten decomposition of hay bales. Presently, Sevin is the only labeled insecticide against green June beetle on ripe fruit. It stops green June beetle feeding in less than 1 day and kills green June beetles in 3 days. However, the formulation Sevin XLR has a 3 day PHI in apples and peaches, 7 day PHI on grapes and small fruits and causes spider mite outbreaks.

Traps alone are not likely to give satisfactory protection to plants being eaten by adult Japanese beetles and pesticides may be required. A list of recommended pesticides to use to prevent foliar and fruit damage by Japanese beetle adults or turf damage by the grubs can be obtained from the cooperative extension service. Currently, the foliar applied insecticides labeled against adult Japanese beetle on fruit (relative effectiveness) include: Pyrethrin (fair control) with a

12 hour preharvest interval (PHI); Malathion (fair control) has 1 day PHI on small fruit, 3 d PHI on grapes and 7 d PHI on peaches; Imidan (good control) has 7 day PHI on fruit; and Danitol (excellent control) has 14 d PHI on apple, grape and pear.

Additional information about green June beetle and Japanese beetle biology and descriptions of how to minimize damage using cultural (lists susceptible and resistant plants), mechanical (attraction traps), biological (bacteria, fungi, nematodes and parasites that kill grubs) and chemical control tactics:

- 1) "There's a new pest making its presence known in Missouri vineyards" Missouri Viticultural Advisory Volume 1 (1) July 19, 2004 by Andy Allen on Internet at: <http://mtngvr.smsu.edu/GrapeAdvisories/MVA1-1.pdf>
- 2) "Japanese beetle: Another defoliating pest on our horizon?" by Missouri Environment and Garden, News for Missouri's Gardens, Yards and Resources Volume 6 (14) on Internet at: <http://agebb.missouri.edu/hort/meg/archives/v6n14/meg2.htm>
- 3) "Managing the Japanese Beetle: A Homeowner's Handbook" by USDA at: http://www.pueblo.gsa.gov/cic_text/housing/japanese-beetle/jbeetle.html
- 4) "Common Questions About Japanese Beetles in Arkansas" (Shanklin et al. 2003, University of Arkansas Cooperative Extension Fact Sheet FSA7062);
- 5) "White Grub Control in Lawns" at: <http://agebb.missouri.edu/turf/lawnnews/grub.htm>
- 6) "Fruit & Rice IPM Fruit In Arkansas" at: <http://comp.uark.edu/~dtjohnso/japbeetle.html>
- 7) "Japanese Beetles" by University of Kentucky Entomology at: <http://www.uky.edu/Agriculture/Entomology/entfacts/trees/ef409.htm>
- 8) "Japanese beetle, *Popillia japonica* (Newman) on Grape" by The Virginia Fruit Web Site at: <http://www.ento.vt.edu/Fruitfiles/JBGrape.html>

VINEYARD PRUNING WORKSHOPS UPDATE

The viticulture program at MVEC once again conducted vineyard pruning workshops at three locations around the state. On January 11, 12, and 18 workshops were conducted at Les Bourgeois Winery in Rocheport, Adam Puchta winery in Hermann, and Chaumette Winery in Ste. Genevieve, respectively. Approximately 90 people were in attendance between the three locations, representing both existing and new vineyard operations. Although the skies were threatening during the workshop in Hermann, the rains held off until day's end, while in Ste. Genevieve, it was just another fine, bone-chilling cold day in January – perfect for working in the vineyard!



Dr. Keith Striegler demonstrates pruning concepts and practices to an eager crowd at Les Bourgeois Winery.

UPCOMING EVENTS

The annual Viticulture Field Day has been scheduled for Thursday, June 9 at the State Fruit Experiment Station, SMSU-Mountain Grove. Complete program details and registration information will be made available in the next newsletter.

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For a current calendar of events, check our
website at <http://mtngrv.smsu.edu> and click
on the news and events button.

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