



Disease and Pest Control in Vineyards and Proper Use of Spray Technology

2009 was a bit of an acid test for disease control for wine growers in many areas of the East. It was a cool, wet and late growing season. If your disease control program held up then you are clearly doing something right. In fact, if you were squeaky clean, you may want to review your program to consider if you are overusing pesticides. If you had problems, then now is the time to review your control strategies and how to plug the holes in your program. There is a balance in every vineyard for control and lack of it and it will be determined by a seemingly infinite variety of variables, large and small. Control is also a moving target according to conditions of each particular vintage. Experienced growers intuit those conditions into a successful integrated pest management program for the season.

Wine makers need two qualities in grapes to make excellent wines: fully mature fruit and grapes that are free from defects. There is no compromise and this truth extends to all grape varieties, and types and styles of wines. In a given growing season, disease and pest control, along with proper canopy and crop management, probably have more impact on the quality of the vintage than any other aspect of viticulture. All of these practices are intimately related and interactive.

Preserving the integrity of fruit is one of the basics of making fine wine. In cool and moist climates keeping grapes free of disease and other flaws is a challenge. The post-industrial age introduced agriculture to the wonders of chemistry and machinery that has, in many ways, fooled us into believing that a simple topical application of some goop cooked up in a lab will make all of our problems go away. Vineyards are complex systems and in order to control the diseases that afflict the grapes and vines, it's necessary to take a systematic and integrated approach. There are many components necessary for a successful control strategy. It is not as easy as dumping something into a tank and spraying the vines. Spraying is an incredibly complex practice and there are literally dozens of decisions that need to be made before each spray application. You should have your own check list to make sure what you are doing will have the desired and optimal effect on the target organism. Experience will count a lot towards your skill and success of controlling the bad guys, especially in years like 2009. The best growers are empirical and aggressively proactive. They anticipate problems by watching the weather and their vines, thereby making potentially big problems small. It takes many years to develop the experience that will allow you to drift from standard practices – disease control by calendar and textbook. I suggest farming according to a conventional program based on a standard integrated pest management (IPM) guide and then make adjustments according to your experience and risk tolerance. Like almost everything in agriculture, IPM is a matter of risk assessment and tolerance. *Vinifera* varieties are by far the more sensitive grapes to almost all threats and require special attention and care. Tight-clustered varieties are susceptible to late season rots like botrytis, sour, bitter and ripe rots. Every little bit you know about plants their relationship to local diseases and pests will help you to mitigate the damage. Finally, viticulture cultural best practices should be the foundation of any grape IPM program.

The California vineyard industry supports a large number of certified pest advisors. They are licensed specialists who help growers to control the complex of disease, insect, weed and other threats to grapes. In the East, growers rely mostly on chemical vendors and cooperative extension personnel and publications to develop their own IPM program. Most growers have very little experience with pesticides and can easily mishandle or misuse them. Doing so may create a health and environmental hazard. Too many novice growers do not understand the implications of using pesticides and do not take their use seriously. I cannot express the amount of concern I have when a novice grower tells me that he uses the insecticide Sevin® in all his spray applications even if he doesn't see a target insect. They think all insects are bad and know that Sevin® is an insecticide so it is over applied. Our more is always better culture helps to drive these irresponsible decisions. It doesn't help that most of the new growers in the wine industry have no agricultural experience, nor have they acquired a pesticide applicator's license. This practice and attitude is wasteful, dangerous and completely irresponsible.

Implications of overusing something like Sevin are more than just the moral imperative to not over-apply pesticides – note that a restricted number of applications and/or total amount allowed are on many labels, consider financial aspects, effects of materials on secondary pests (ex: Sevin leads to mite outbreaks), public relations aspect (we scout our vineyards and apply insecticide only as needed) etc.

Disease and pest control begins long before the first spray application. It should be at the core of vineyard site selection, evaluation and design. The more passive preventative measures you can build into your site and design, the easier it will be to produce squeaky clean fruit later on. Seemingly innocuous decisions like fruit wire height, row direction, vine spacing, proximity to woods, soil capacity, rainfall amounts, humidity can all have subtle effects but in the aggregate exacerbate problems with diseases and pests. The better you understand your ecosystem and how to design a vineyard to fit comfortably into it will help you to lower the risk of significant problems and the need for pesticides.

The best passive measure a *vinifera* wine grower can take to reduce disease problems is to select a site with a low to moderate capacity soil that will grow a vine with a modest canopy. Generally, shade and moisture (rain and humidity) are conditions that promote diseases. All biological processes are influenced by temperature, that's why as you move from north to south, disease and insect problems tend to increase in severity. For example, there might be three flights of grape berry moth in the grape belt along Lake Erie and 4-5 in Virginia. Cold winter temperatures can help to reduce overwintering populations of some insect pests but that increasingly less reliable as winter warm with climate change.

Plan to avoid threatening organisms and situations completely in your choice of vineyard site, vineyard design, and grape varieties and rootstocks. Strive for a modest canopy size. For example, avoid wet soils, woods, low areas, bird sanctuaries, abandoned vineyards, etc. Optimize row direction for sun and wind benefits, etc.

But it is impossible to avoid all vineyard threats so know your enemy in order to effectively thwart their activities: study the biology of the diseases, insects, varmints, etc. It helps to know under which conditions each pest is the greatest threat. A good example is to compare a dry vintage like 2007 to a wet one, 2009. The latter had many more complications.

Develop an integrated approach to managing the threats to fruit integrity blending cultural practices with only the necessary, approved and correctly administered pesticides. Jim Travis used to tell us that using pesticides was a supplement to good cultural practices. That should be a fundamental truth in viticulture best practices. Pesticides should not be a crutch or band-aid used to prop up poor canopy/crop management practices. Begin with good cultural practices and use pesticides to fill the gaps according to the conditions of the season.

New growers should not attempt to cultivate wine grapes organically unless directed by a highly skilled consultant or vineyard manager. Organic wine grape growers tend to be experienced with a thorough understand of the vineyard ecosystem and the threats against it. It is best practiced in areas of relatively low rainfall and humidity during the growing season. In warmer, drier vintages, like 2007, experienced growers may shift their IPM programs towards organic products and practices according to their assessment of the growing conditions. Otherwise, all wine growers are encouraged to farm as sustainably as possible, applying the minimum amount and lowest toxicity of off-farm inputs into the vineyard.

Organic grape production is not for novices. You must have a thorough understanding of all pests, their biology, symptoms, potential for loss; you must scout more frequently; you must have a plan for remedial action (what will you do if you see powdery or black rot on fruit?), pest outbreaks must be addressed quickly – we see black rot in our organic plots and immediately remove the clusters for example; excellent and timely canopy management is integral particularly cluster zone leafing.

Find and read the best local/regional information resources available, including growers and published materials by your land grant university such as the *NY-PA Pest Management Recommendations for Grapes*. Virginia, Maryland, New Jersey, Ohio, Missouri and other states publish their own grape disease and pest guides. You can usually get a copy from your grape cooperative extension educator. Study these during the winter and make a plan to control diseases, insects, weed, vertebrate and other pests during the growing season. Review the previous season for gaps in control and figure out how to plug the holes. Since weather is so critical to the presence of disease and insect pests, growers should have access to accurate and timely weather data from sources that range from the local news to a data logger system on the farm.

Take a proactive, preventive approach to managing threats to the vineyard. What can you do before the problem arrives? Learn to scout for the threats. Know when a problem is likely to appear and how to identify it. As a general rule you cannot successful scout for diseases from the seat of a tractor. You need to get into the canopy to detect trouble spots. Growers should work with their crews in the vineyard. Only by being in the vines can you really see what's going on, and when you find something, make sure it is used a teaching example for others. The "Pocket Guide for Grape IPM Scouting in North Central and Eastern U.S." produced by Michigan State University Extension is an excellent ID guide for our region. Almost all vineyards have "hot spots" for problems, whether its winter injury, powdery mildew, or deer damage. Over time these should be identified and either ameliorated or monitored closely.

This article is the result of a feeling that I have that many of our control issues are related to a failure to properly select and apply pesticide products. Researchers state that up to 70 percent of the effectiveness of a pesticide depends on its proper application. Too many growers use

antiquated, improper or mis-calibrated equipment. The tools, equipment, and methods are as important as the pesticides themselves, which are designed to work when properly applied. Using pesticides is an incredibly complicated activity. It involves biology, physics, engineering, mathematics, and, above all, common sense. It has serious implications for personal and environmental health and you should care deeply about the consequences of your actions. There is a good chance that you have received minimal training in some, if not most of these disciplines. Before you hop on a tractor and charge into the field to do battle with fungi and insects, you need to educate and train yourself in many areas, not the least the very strict state and federal regulations that govern the use of pesticides.

For every pesticide there is a proper method and amount to handle and spray. It is your obligation as a responsible farmer to learn what is right for each and every material you use. Doing this not only reduces health risks and environmental impact but also will increase the effectiveness of the product. Read the label at least twice and understand it completely. If you do not understand something, ask an experienced fellow grower, vendor or extension educator. You'll get a ton of information if you *Google* any product.

Pesticides: there are usually a number of materials that are registered for use on a specific disease, insect or weed target. It is up to you to select the most effective material for the target organism and to apply in a proper and safe method. It is not uncommon to be controlling multiple diseases at a particular time during the growing season.

Apply pesticides sensibly by spraying only the affected, targeted area. Fruit rots sprays should be applied only in the fruit zone. Applications for grape berry moth should only be applied to affected outer rows or those near wooded areas. Japanese beetles attack new foliage so target sprays to the upper/top half of the canopy. Application amounts do not have to be even across nozzle positions. If the fruit zone/lower canopy is especially dense, use a larger nozzle at those positions to get better penetration and coverage. It should be the goal of every grape grower to use the minimum amount of pesticide to achieve a desired level of control of the target organism.

Horticultural spray adjuvants are products used with pesticides to modify their performance. For example, a surfactant (also known as a wetting agent) is designed to alter the surface tension of droplets allowing them to spread more evenly over a surface. Other adjuvants include buffers, drift retardants, stickers and penetrants. Each adjuvant has an intended use for which it was designed. Adjuvants have been the subject of debate in agriculture. Some believe they are just snake oil while others are certain of their benefits. Only you can pick the correct adjuvant and test it in your vineyard under real field conditions.

Proper calibration of all application devices is necessary to achieve the maximum efficacy of any pesticide. Many new growers are scared of calibration and sprayers because the formulas and charts are not always clear or intuitive, but it is necessary to learn. There are many variables in calibration and all must be correctly adjusted in order to achieve the desired result. Proper calibration begins at your desk with a good guide, a pencil and calculator. Since conditions in the field are constantly changing, so will your calibration needs. Calibration information is abundantly available but two good sources are the *NY-PA Pest Management Guidelines for Grapes* and the TeeJet catalog or web site. You will need information such as nozzle pressure, nozzle type, ground speeds, gallons per acre, row spacing, nozzle spacing and other data in order to properly calibrate a sprayer. There are no shortcuts to accurate calibration.

Getting the pesticide to the target starts with the right equipment. A tractor of sufficient horsepower on the ground and at the power take-off is necessary for the sprayer to work at optimal efficiency. The sprayer is one of the most important tools in vineyard management. If you are a serious wine grower you must use a serious sprayer. There are all manner of Jimmy-rigged machines and it is strongly suggest that you purchase a sprayer from a reputable manufacturer and dealer that is designed specifically for vineyard or orchard use. If purchasing a used sprayer, it should be carefully inspected to make sure it is in excellent working condition – hoses, belts, filters, pumps, tires, PTO shaft, etc. should all be examined.

There is so much to think about when calibrating and properly preparing a sprayer. Here are a few of the key items:

- Ground speed is typically 3 mph, slower with a big canopy (e.g. divided systems or vigorous vines). Don't believe the little sticker on the fender that tells you a gear and RPM for a ground speed. Measure it frequently using in-row vine spacing as your yardstick. Ground speed can vary tremendously with degree of slope.
- It is tempting to spray every other row and reduce GPA in the early season when shoots are short but the coverage just isn't as good and the early sprays are so important to the success of a season long IPM effort. Spray every row.
- The pressure needs to be within specifications. Different types of sprayers operate best at designated pressures. Airblast sprayers perform well from 80-100 psi. Boom canopy sprayers may be higher. Boom ground sprayers much less, as low as 10 psi. I encourage growers to measure pressure as close to the nozzles a possible. You can plumb a pressure gauge into one of the top positions of an airblast sprayer. Make it large enough that you can see it from the tractor seat.
- Most implements are designed to perform best at 540 PTO RPMs. Calibrate at 540 and stick to it in the field.
- Fans on airblast sprayers come in different sizes and some have variable fan speed adjustments and blade pitch. All of these should be adjusted for optimal performance. It is better to have too much speed/volume than too little, which will be a function of canopy size and other conditions, but too much can also compromise performance. Dr. Andrew Landers encourages growers not to force spray materials through the canopy by using more moderate fan speeds. A large visible spray plume is not a sign of effective application. Dr. Landers has designed the donut to restrict air intake and deflectors to direct air/materials toward their intended target area.
- Nozzles: there is so much to know about nozzles. Nozzles are tiny parts that can have a huge impact on the quality of your spray application. There is a correct nozzle for every use. Brass nozzle parts can wear over time and should be inspected regularly. Ceramic nozzle parts are more durable but expensive. Adjust rates of nozzle output according to the canopy density or if spraying the fruit zone. Botrytis sprays should soak clusters so a greater output nozzle should target the fruit zone. Tops of canopies are furthest from the nozzles so make sure they are getting covered since new leaf tissue is highly susceptible to disease, especially downy mildew. Nozzles come in all different types for specific uses. Flat fans are commonly used for boom sprayers for herbicide. Cone nozzles are most often used on airblast sprayers for fungicide applications. The little screens in front of the nozzles: make sure they are cleaned after each spray session.
- Filters should be cleaned and inspected at the end of each day.

- Test calibration with water regularly, at the beginning of the season and periodically during the season. Mark off a section of vineyard that is exactly one acre and use it as a check for your calibrated gallons per acre.
- Make sure all of your controls are working properly. When the sprayer is on, all designated nozzles are spraying. When turned off, all nozzles are off. No leakers.
- Use a well-defined driving pattern through the vineyard. Don't skip or double spray rows. Know where you've been and where you need to go. A pattern I used moving left across a field: turn left skip 2 > right skip 1 > left skip 2 > right skip 1 > left skip 2 > start another pattern to the right. Depending on vine row spacing, turning every other row may place a lot of strain on the universal joints of the PTO shaft. If you sense this is happening, it would be wise to use 2 or 3 row intervals. Rears Mfg. offers a double-jointed PTO shaft for narrow rows and tight turns.

I turn the PTO off when I turn. I know it is more work but I am fearful I will break the PTO shaft and it ensures that the sprayer is not on as I turn. This is an absolute requirement if you have a block on the road or near a neighbor. Spray drift is the number one complaint about farmers. People don't want to see it. It is also critical to avoid using sulfur when the wind is in the direction of the road or neighbors. The smell makes people irate.

- Evaluate spray conditions: wind can have a significant influence on coverage. It doesn't take much to blow materials away from its target. Spraying in the early morning or at night when there is no wind will improve coverage. We would typically start at 5 a.m. and spray until 9 or 10 a.m. Proximity to rain events will also impact spray application decisions.

If you haven't calibrated a sprayer before you should get someone with experience to help you. It is often very confusing to read in a book how to calibrate a sprayer. You must understand the basic formulas for calibrating a vine sprayer and a ground (herbicide) sprayer.

The proper sprayer should be matched to the size of the vineyard. A 50 gallon 3-point sprayer is not adequate to treat a 100 acre vineyard, nor is a 300 gallon pull-behind sprayer necessary for a two-acre vineyard. Get the right size and quality of equipment for the job it needs to do. At 80 gpa a 300 gallon sprayer will cover about four acres of full canopy. That's 32 acres in an eight hour day. Is that enough? A second sprayer for a large vineyard will get the protection on the vine when it is needed and provide insurance if one sprayer goes down. Airblast sprayers need adequate fan size for the type of canopy being sprayed and should have an excellent agitation system to keep materials in suspension. Tower sprayers seem to be very effective in Eastern vineyards, as are tunnel sprayers like the Lipco, which reduce drift and help to calm fears in more urban settings. The sprayer is one of the more expensive pieces of equipment you will purchase but also one of the most essential.

A dedicated, clear and functional work area for loading and cleaning sprayers is really helpful. A secure and waterproof building is necessary for storing pesticides. Of course a source of clean water is necessary. Water that is dirty, too acid (hard) or alkaline may create problems with nozzles, screens and filters, the ability to properly tank mix materials and even the efficacy of the pesticides. Vendors will have water conditioners that you can add to the spray tank.

Proper handling and loading of the spray tank is necessary for safety and efficiency. In general, wetttable powders first then liquids with adjuvants last. Some adjuvants, like Nufilm 17 should be premixed before adding into the sprayer. All during loading, vigorous agitation should be done in the tank and great care taken to moving parts, especially the PTO shaft. Proper PPE should be worn. Bags and plastic containers should be properly disposed of or recycled according to label instructions. Many departments of agriculture have container recycling programs (check their web sites for information).

Down time is the enemy of efficiency. If water is limited a 300-400 gallon nurse tank with a 3-4 inch fill spout and automatic shut off can be filling while you are out spraying. When you return, it's ready to go and will fill up your tank in just a few minutes.

Always perform a walk around safety and maintenance check before you drive the sprayer into the field, it's better to be proactive against potential hazards and problems.

Driving a tractor with a loaded sprayer can be a challenge. A full 300 gallon sprayer weighs well over a ton and can strain even a properly sized tractor going up hill and push it going downhill. Weather and ground conditions should be carefully evaluated before loading a sprayer. On a wet side hill tractor and sprayers are prone to slipping into a vine row. A loaded sprayer is extremely difficult to dislodge if it gets tangled up in the trellis. On a wet hill tractor tires can break traction and tractor and sprayer will start sliding down the hill. This is scary and dangerous. You should know the tolerances of your equipment and avoid risky situations. All of these scenarios point to the need for a very skilled driver for spray operations. At the first sign of any trouble, hit the kill switch or turn off the tractor ignition.

There is so much to do while spraying, it's a bit of sensory overload: keep track of the row pattern and wind direction, monitor tractor speed and RPMs, tank level and sprayer pressure, make sure that spray materials are on target, evaluate coverage and drift, stay in the row and watch for obstacles (rocks, holes, etc. can appear magically overnight), don't turn too sharply, sprayer on and off at proper time in and out of rows, and all the time listening because the sounds of equipment operation tell the operator a lot about status of the equipment. The worst noise you may ever hear in your life is a broken, live PTO shaft spinning wildly and clattering behind you. Your first instinct should be to kill the engine. Calibrate while you are spraying. The sprayer should have a way of measuring contents (site tube, see-through body, etc). This amount used should closely correlate to the area covered. It's helpful to know the size of each block in the vineyard so you can have an approximate idea of how much area you have sprayed and how much material you have used. It's very easy to calculate block sizes in vineyards using vine density data.

Airblast sprayers have a tendency to push more air (and thus spray material) to the starboard side of the spray due to fan rotation direction. Therefore, you won't always get even coverage on both sides of the row and in windy conditions it may be necessary to cheat the sprayer to one side. Check the fan intake area occasionally as it tends to clog with debris as the spray period lengthens.

At the end of a spray session spray the tank should be empty. Leftover spray material should never be dumped on the ground and allowed to run off.

Mix exactly what you need to avoid excess spray. This reiterates the need to fully understand what you are doing.

The sprayer should be properly cleaned and rinsed. Fluids, screens and filters should be checked. All grease fittings including pumps, PTO, tires and other moving parts should be serviced. Fill the sprayer on a timer and be ready to roll the next morning. One last chore: fill out the proper spray records for your spray activities for the day and place proper reentry signage in the fields - *spray records must be posted 30 days after the expiration of the REI.*

Dr. Andrew Landers, agricultural engineer at Cornell University, is the foremost expert on sprayer technologies in the U.S. He has developed amazing modifications to sprayers to make them more effective at delivering materials to target. He is currently working with grower cooperators to develop a dual tank spray system that can deliver different materials to separate zones of the canopy. For example, it makes no sense to spray a botrytis material on the entire canopy, yet separate passes are time consuming and expensive. His dual applicator allows one set of nozzles to be targeted at the fruit zone only for rot sprays while still covering the entire canopy for foliage sprays. His donut modification helps to reduce the intake volume of an airblast sprayer to keep the spray in the canopy instead of pushing materials through it. His deflectors help to guide materials towards the target and reduce the spray loss to drift. These are all relatively simple modifications.

Safety around the tractor and sprayer is paramount. There are lots of moving parts. Never wear any loose clothing or hair around the tractor/sprayer. Nothing dangling! Everything tight! Wear proper PPE when calibrating and spraying. All protective shields and guards should be in place when equipment is in operation. It's no fun going out to a restaurant and only hearing half of the conversation - after 20 years of tractor driving and spraying I have suffered significant hearing loss. Good ear protection for equipment operators is well worth considering. Years of experience in the vineyard have taught me that comfort and safety are related. Riding on a hot engine with wheels on a hot and humid day is not a comfortable experience. In years like 2009 growers were applying as many as 20 spray applications. A spray cab will provide some comfort from the elements and enhance health and safety by providing roll-over protection and protecting the operator from spray drift. AC and iPod are optional!

People who do not understand agriculture are often afraid of agriculture. A big spray plume near a residential area or a school is sure to cause trouble. But that's not the only reason to keep your materials on target. They will simply work better if they are not dispersed to non-target areas. Drift is something every grower should try their hardest to minimize. Drift reduction involves droplet size, weather conditions, proper material selection, equipment set up and more. Herbicide drift in particular can be damaging to non-target plants, including the vines you're a trying to cultivate. The *NY-PA Pest Management Guidelines for Grapes* has an excellent section on spray drift.

The contents of this short and superficial article are only the tip of the iceberg of what you need to know to properly protect your vineyard from disease and pest threats. I cannot strongly endorse enough the need for every wine grape grower to read the most recent edition of **New York and Pennsylvania Pest Management Guidelines for Grapes**, a cooperative publication from Cornell University and Penn State University, edited and updated each year by Tim Weigle and Andy Muza with the help of faculty and extension at both institutions. It should be a core

reference resource to any grape grower in the Eastern U.S. I particularly recommend pages 1 to 9 and 77 to the back cover (2009 edition) as invaluable information about every practical component and consideration in working with pesticides, including sprayer calibration, maintenance and cleaning, registered pesticide products in NY and PA, personal protective equipment, recycling pesticide containers and plastic mulch materials and much, much more. The manual is updated each spring and usually available in May.

An annual supplement to this guide is the disease control magnum opus from Dr. Wayne Wilcox, grape pathologist at Cornell. Each spring he releases his **Grape Disease Control** annual review of his pathology research, past year's observations, conclusions and recommendations and a review of new products. This, too, is essential reading for the serious commercial wine grower.

I strongly encourage all grape growers but especially commercial growers to take and pass the pesticide applicator's test and keep their license up to date. If you are a doctor, lawyer or businessman turned grape grower you do not know the details of safe pesticide handling and use. For your health and safety, and that of your family and employees, you owe it to everyone to acquire the proper knowledge to use these products safely and responsibly. You are producing a perishable FOOD product that will be consumed. You must keep your vineyard practices within all health and safety specifications. You can get information about the applicator's license at your county cooperative extension office. You should also be very familiar with all state and federal laws that regulate the use of pesticides.

Compliance with state and federal regulations that govern the use of pesticides is essential and too often not taken seriously by applicators. The U.S. Environmental Protection Agency has specific Worker Protection Standards that must be followed. Penn State Pesticide Education has personnel and programs to educate owners, operators and field workers about WPS. There is a lot of information available on the internet. While vineyards tend not to use restricted pesticides, all pesticide products must be handled and used with equal care and responsibility. Do not let the paperwork aspect of using pesticides fall through the cracks. Terms such as personal protective equipment, re-entry intervals, decontamination kits, central posting stations, etc. are very familiar to the responsible applicator.

In the wine universe California gets much the glory and attention, the truth is that growing grapes in arid climates is much easier than in cool, humid, wet and regions like ours. We simply have to be better growers to achieve similar results. Proper disease control and attention to application is just one of the areas that wine growers must excel in order to have a chance to succeed. No one is born with the knowledge to be a good spray applicator. It is something you must learn to do correctly. Anytime you are uncertain about the use of a pesticide, or calibration, or any aspect of applying pesticides, ask an experienced grower, trusted vendor or horticulture/viticulture extension educator. There are outstanding educators across the country like Alice Wise and Tim Weigle who understand the minutiae of proper pesticide handling, use and application. Don't make a mistake that you or your vines will regret. Stop. Read the label. Think and ask questions.

Author's note: I would like to thank Alice Wise, Cornell extension viticulturist on Long Island for her comments (*italics*) and review of this article. Alice is a virtual encyclopedia of knowledge about disease and pest control, pesticides, application and the complex social and economic issues that are inherent in farming today.

Reference Resources:

1. 2010 New York and Pennsylvania Pest Management Guidelines for Grapes. Available on-line at <http://ipmguidelines.org/grapes/> or order a copy at (607) 255-7282
2. Disease Management Guidelines for Organic Grape Production in the Lake Erie Region (Jim Travis and Bryan Hed): http://research.cas.psu.edu/erie/plant_path.htm
3. A Pocket Guide for Grape IPM Scouting in the North Central and Eastern U.S.: <http://www.ipm.msu.edu/GrapePocket.htm>
4. New York State IPM: <http://nysipm.cornell.edu/fruits/default.asp>
5. University of California IPM: <http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html>
6. Pest Application Technology (Andrew Landers): <http://www.nysaes.cornell.edu/ent/faculty/landers/pestapp/>
7. PA Department of Agriculture Pesticide Programs: <https://www.paplants.state.pa.us/Index.aspx>
8. Penn State University Pesticide Education: <http://www.pested.psu.edu/>
9. TeeJet: <http://www.teejet.com/english/home.aspx>
10. Spray adjuvants: <http://pubs.cas.psu.edu/FreePubs/pdfs/uo202.pdf>
11. Poison Control Center: <http://www.poison.org/>
12. Gemplers Supply: <http://www.gemplers.com/>
13. U.S. Environmental Protection Agency Worker Protection Standards: <http://www.epa.gov/pesticides/health/worker.htm>

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