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Alternate Weed Management in New York Vineyards

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Sustainability Concepts: *Managing weeds under the trellis to reduce competition for moisture and nutrients is a standard practice in viticulture. If not managed properly, losses in yield and fruit quality can result. During vineyard establishment, weed competition must be minimized to facilitate optimal vine growth both above and below ground. In mature vineyards, significant weed competition is undesirable from bloom to veraison. Weeds may harbor injurious pests such as cutworms. Broadleaved weeds may also serve as alternate hosts for tomato ringspot virus, a virus vectored by nematodes that can impact certain own-rooted hybrids. Conventional programs rely on the use of pre-emergence and post-emergence herbicides. The infiltration of herbicides into groundwater and a desire to reduce overall pesticide use has motivated NY growers to seek other less intrusive methods. Efficient sprayers for post-emergence application as well as tillage, mulching, under-the-trellis mowing and organic herbicides offer growers alternatives to conventional weed management techniques.*

Factors complicating weed control: Weed control issues will be different in every vineyard - some are managable but others are sometimes beyond the control of any grower due to year-to-year variability in climate and stores of weed seeds and propagules. These issues include:

Reducing the weed population preplant: An often over-

Best Management Practices:

- Before planting vines, use cover crops and/or tillage to prevent weeds from going to seed, thereby reducing the weed seed bank.
- If applying compost, use only materials that have been fully composted at weed seed-killing temperatures.
- Use spot treatments for persistent perennial weeds rather than treating the whole vineyard.
- Post-emergence-only programs with two well-timed applications in early June and mid-July have been effective in Lake Erie Region Concord vineyards.
- Be timely in cultivating. Small weeds are easier to control than large weeds.
- If cultivating, maintaining a shallow depth minimizes potential vine damage and helps to maintain soil structure.
- Cultivation and mowing can spread certain weeds (e.g. those with rhizomes or underground stems). Be aware of these weeds, work around them if possible, and control them by other means.
- Shielded, controlled-droplet applicators (CDAs) are effective in reducing spray volume, avoiding contact of post-emergence herbicides with vines, and eliminating drift.
- Sensor-controlled herbicide sprayers may be effective in directing post-emergence herbicides to weeds while reducing the amount applied to bare ground.
- If you choose organic herbicides, keep in mind that they've proven effective only on small, annual weeds. Those tested on Long Island have shown marginal results, and excellent coverage is a must.

looked but important part of long-term weed control is the reduction of the seed bank prior to planting of the vineyard. Many seeds are long-lived, and thus any strategy to reduce this population of seeds may be helpful over the long-term. Cover cropping and tillage to prevent weeds from going to seed are the most common methods. In a 2007 Long Island Ag Forum talk, Dr. Marvin Pritts, Cornell's Small Fruits Specialist, noted that multiple cover crops were more effective at reducing weed populations than a single cover crop. Suppressive cover crops that can be cycled rapidly (e.g. mustards) are particularly good. Typically in Long Island vineyards, Sudex (sorghum x sudan hybrid) is seeded as a cover preplant to suppress weeds and to boost soil organic matter. However, abiotic factors such as wind and rain can be responsible for carrying tufted weed seed (such as dandelion) several hundred feet to infest new areas. This type of seed dispersal can be very resistant to attempts to reduce weed seed load by cultural practices unless a wide buffer area surrounding the vineyard is relatively weed-free.

Growing season rainfall: Maintaining adequate weed control through the season can be challenging, particularly if rainfall is plentiful. Residual herbicides breakdown more quickly, and weed growth is lush and rapid. Cultivation under the trellis becomes less favorable as cultivating wet soils damages the soil structure. Irrigation also presents a challenge – as drip is the most common type of irrigation, weeds tend to congregate under the emitters. Fertigation further complicates this issue as N fertilizer in the irrigation water promotes weed growth.

Use of compost, organic mulches, or composted manure: All composting guidelines emphasize the importance of maintaining temperatures of 40 – 50 °C (104 – 122 °F) during the composting process so that weed seeds and seedlings are killed. Despite good intentions, compost is often a ready source of weed seeds. In our Long Island research vineyard, mugwort, a nasty, rhizomatous weed, was introduced with purchased compost. Organic mulches such as hay and straw can also be major sources of weed seed. Use of clean straw (know your source) can minimize this impact.

Cultivation and mowing: Cultivation and mowing are effective methods of spreading weeds such as nutsedge, both in the row middles and under the trellis. The mugwort in our research vineyard has spread rapidly due to mowing of the row middles, as tiny pieces of stem or rhizome cut and thrown by the mower will root readily.

Post-emergence-only weed control: Some growers choose to avoid pre-emergence herbicides in favor of a post-emergence-only approach. There are many post-emergence options including glyphosate, paraquat, glufosinate, Aim (carfentrazone-ethyl) and systemic grass herbicides such as Poast (sethoxydim) on bearing vineyards or Select (clethodim) and Fusilade (fluazifop-P-butyl) for non-bearing vines only. Several post-emergence organic herbicides are available (see the 'Organic herbicides' section below). Regardless of the material chosen, a good post-emergence program should provide effective control of summer annual weeds, reduce weed pressure in subsequent years by reducing the seed bank, provide suppression or control of most perennials, and result in a shift to winter annuals that provide green cover during winter. Post-emergence programs require timely application (targeted at small weeds), which may be difficult in rainy seasons.

In work done in two Lake Erie Region Concord vineyards, Dunst and colleagues evaluated post-emergence herbicides as a cost-effective alternative to pre-emergence strategies. They found that two well-timed applications of a broad spectrum post-emergence herbicide such as glyphosate, glufosinate, or paraquat, applied in early June and mid to late July, provided effective weed control through the growing season (1).

A potential long-term concern with this approach is glyphosate resistance. Common vineyard weeds like horseweed (*Conyza canadensis*) have developed glyphosate-resistant populations in areas where 'Roundup-Ready' crops are grown. In five years, this glyphosate-resistant weed has spread to nearly 100,000 acres of arable land. Horseweed seeds can easily be dispersed by wind into vineyards. This underscores the importance of rotating your choice of post-emergence herbicides from year-to-year and within a year. Scouting the vineyard one week after a post-emergence application will reveal pockets of healthy resistant weeds that would normally be dead or nearly dead.

More efficient applicators: Herbicides have traditionally been applied with dual nozzle herbicide sprayers using >25 GPA of water. New sprayer technology such as CDA applicators and sensor-controlled applicators can improve efficiency of post-emergence herbicide applications. These sprayers improve deposition, reduce spray drift and enhance operator safety. They may also allow the use of reduced herbicide rates.

Controlled droplet applicator (CDA) sprayers have a single, shielded nozzle that atomizes the spray solution (Figure 1). This fine mist circulates around inside the shield, providing good deposition. A brush skirt or plastic cover can be fitted over the shield to further reduce drift onto young vines and/or vines being retrained. According to Dr. Andrew Landers, the droplets are small and uniform in size, so they all stick to the plant, allowing lower rates of material to be utilized (4). Because CDAs use low volumes of water (<10 GPA), they are only suitable for applying glyphosate or glufosinate. Also, this technology is best used with smaller weeds. If weed growth is lush and grasses have lignified, often efficacy is reduced and a weed strip persists down the center of the vine row.

Sensor-controlled applicators have computer-controlled opti-

Figure 1. ATV-mounted controlled droplet applicator (CDA) sprayer applying post-emergence herbicide under the trellis at Fox Run Vineyards, Yates County (above). A close-up of the CDA sprayer and mounting system (left).

cal sensors that turn nozzles on and off. The infrared sensor senses chlorophyll in the plant, thus they function in either light or dark. Spraying in the evening is sometimes preferable as the wind often dies down. These applicators are designed for post-emergence applications and are best used before weed growth is out of control. In the annual *NY & PA Pest Management Guidelines for Grapes*, Landers further explores height of the boom from the ground and correct selection of nozzles as a means of further reducing drift. Generally, drift increases with increased boom height from the ground and with smaller droplets.

Cultivation techniques: The advantage of cultivation is total avoidance of herbicides. Potential disadvantages include possible damage to trunks and roots, loss of soil organic matter by oxidation, increased soil compaction and erosion. The biggest obstacle however is the labor cost associated with this practice, though a number of growers have committed to this practice entirely or as a supplement to other weed control techniques.

Cultivation must be done in a timely manner and is often harder in rainy seasons due to time constraints, soil conditions and lush weed growth. Smaller weeds are easier to cultivate than larger, bulkier, more lignified weeds. Shallow cultivation is also preferred as it minimizes both potential damage to soil structure and potential pruning of grapevine roots.

Equipment: There are many different types of under-the-trellis cultivation implements. For vineyards that hill up, certain types of hoes might perform hill up/take down duty as well as weed control. There are cutter blades that slice off the weeds from their root system, heavy duty rotary hoes as well as tine or finger weeders, disc rotary cultivators and knife rotary cultivators. Adding to the confusion, many of these can be front, rear or side mounted and driven as a single or double mounted unit. How does one choose? Price and fit with your tractor and vineyard configuration are obvious considerations. An aggressive implement that really disturbs the soil may be slightly better in terms of weed control but slightly worse in terms of soil and root destruction.

Is night cultivation to reduce weed pressure a viable strategy? Vigorous cultivation exposes weed seeds to a split-second of red light before burial again, which starts the germination process for many seeds. Cultivating in the dark removes this germination stimulus. So if you feel confident about cultivating under the trellis with only the tractor headlights and/or have insomnia, you may be able to reduce weed seed germination with night cultivation (5).

Organic herbicides: Replacing conventional herbicides with organic versions is a goal for some growers; however, cost and efficacy are major issues. Many of these materials have been evaluated by Dr. Senesac at LIHREC (6).

Corn gluten meal, labeled as a pre-emergence herbicide, is sold under many trade names. Dr. Senesac has tested CGM for crabgrass control in turf. Results indicated that weed control reported in earlier studies was actually due to a fertilizer effect – CGM is a very soluble form of N, as much as 10% actual. The herbicidal properties reported for this material have been based primarily on controlled greenhouse studies. Though rigorous field studies in eastern U.S. vineyards are lacking, work in California as well as anecdotal observations suggest that this is not a worthwhile investment for commercial vineyards. If interested in CGM, try it on a small area first.

Scythe (pelargonic acid) is a soap-based post-emergence herbicide, and the company has applied for organic status for the product. We have used this several times in our research vineyard on Long Island, where it killed weeds quickly (though a high volume of water >60 GPA was required). However, it is not systemic, so weeds recover quickly, particularly if well watered. Its pungent aroma is bothersome to some people.

Acetic acid (vinegar) and citric acid products are post-emergence herbicides that have generated a lot of interest. Dr. Senesac has extensively tested various formulations of acetic acid. A 20-30% solution may control weeds, but as with Scythe, regrowth of perennial weeds was immediate and significant – the products are also costly. One product has applied for organic status. Note that this is not off-the-grocery-shelf vinegar but rather a labeled material formulated as an herbicide. It would be illegal and risky to simply throw vinegar in your spray tank. Citric acid products are not available as stand-alone herbicides - instead, they are partners with either acetic acid or clove oil. LIHREC has not tested citric acid on its own, but it would act similarly to acetic acid, i.e. a fast-acting burn-down with no residual or systemic action.

Clove oil, cinnamon oil, and pine oil qualify as minimum risk pesticides and fall in the same category as above: expensive, contact-only herbicides that work well only on small broadleaf weeds.

Long Island Vineyard Manager Compares Under-the-Trellis Weed Control with Glyphosate vs. Cultivation

In an effort to reduce herbicide use, Long Island Vineyard Manager Ben Sisson conducted his own demonstration trial comparing post-emergence weed control with glyphosate to cultivation with a Braun cutter blade. He found that under-row cultivation was best suited to dry years and small acreages, and weeds were best controlled when small. The frequent passes made this an expensive option even with a two-sided unit. Damaging feeder roots, releasing sequestered carbon, and the need to do occasional hand follow up around the trunks also must be taken into consideration. Two applications per year of glyphosate, using a shielded CDA sprayer, provided adequate control. Sisson noted the post-emergence strategy resulted in persistent weed cover which might not suffice for blocks around winery buildings where aesthetics are important. To avoid glyphosate damage to vines, thorough suckering and half-length grow tubes around young vines and shoots for trunk renewal were necessary. Sisson felt both systems accomplished his goal of eliminating pre-emergent herbicide use, the major objective of the trial. When the methods were combined, however, he observed that weed control was the worst, and in fact was unacceptable.

Mulch under the trellis: Work in California by Dr. Clyde Elmore evaluated the mowing of row middle cover crops with clippings thrown under the trellis as a mulch for weed control (2, 3). This likely would be less effective in climates with significant rainfall during the growing season. Mulch under the trellis would be expensive, likely introduce weed seed and require careful attention to irrigation and fertilization practices.

Plastic mulches have sometimes been used when establishing vineyards but expense, disposal and water management are challenges. Textile mulches, including reflective ones, are being researched worldwide. In a 2006 experiment in a New England vineyard, Cornell viticulturist Dr. Justine Vanden Heuvel examined several geotextile materials as well as quahog (clam) shells for their reflective ability in an effort to promote ripening. In terms of weed control, both textile mulches prevented weed growth underneath the row in the year they were applied, but weed growth occurred underneath some of the fabric when it was left out for a second year in the vineyard. The crushed quahog shells also prevented weed growth in the year of application; however weeds pushed through the shells in the second season. Quahog shells also interfered with the subsequent application of pre-emergence herbicides because the herbicide was deposited on top of the shells

while the weeds emerged from the soil under the shells. Dr. Vanden Heuvel noted that in vineyards around southern New England, weed growth has been controlled for several years where a thicker application of crushed shells (>2 inches) was applied (8). While this exact methodology is not applicable for many growers, it highlights the concept that innovation and use of local resources can be part of the solution.

Under-the-trellis mowing: Mowing under the trellis is attractive from an environmental and labor saving viewpoint. Commercial units with small side decks that pivot around vines under the trellis are available for mounting on a tractor or an ATV. These units effectively cut weeds within several inches of the vine trunk. However, lower growing weeds such as dandelion and annual bluegrass can persist and form a nice carpet. Consequently, the long-term effect of this type of weed cover on vine health and productivity is unknown. We have monitored plots in a commercial setting for two seasons, but we have not been able to draw any conclusions from this work, due in part to the long-term nature of the project (7).

Under-the-trellis groundcovers or living mulches: The concept of 'living mulches' involves the establishment of cover crops or ground-covering species that meet the goal of being minimally competitive with the crop while providing significant suppression of weeds during the growing season. We have examined two species under the trellis, *Poa annua* (annual bluegrass) and subterranean clover. The bluegrass was far too competitive with vines, while the clover was not winter hardy. Winter annual species are preferred as their life cycle is completed in spring, allowing for competition with emerging summer weeds but little competition with vines during the critical bloom-to-veraison period. We are currently evaluating the following species in the Long Island research vineyard and three commercial vineyards: knawel; rabbitfoot clover; red sandspurry; and black medic. The goal is to allow or overseed naturalized low-growing winter annual vegetation to determine if these species can become dominant in the under-trellis area. If this can be accomplished, they might be managed with minimal herbicide inputs. This work is currently being done with partial funding from Northeast SARE.

Other possibilities: There is a plethora of ideas about alternative weed control techniques:

- *Grazing* – Perhaps suited to smaller organic growers but not feasible for larger operations.
- *Thermal weeding with flames or steam* – Propane flamers have been tested and work, but they are labor intensive and the expense of fuel and the safety of the applicator are significant issues. Which is more environmentally responsible – herbicides or an energy intensive practice such as flaming or steaming? A real point for debate.
- *Biological control* – A few weeds such as groundsel are susceptible to diseases that reduce their populations, but this kind of research is very slow and species specific. The notion that this could be commercially effective over a broad range of weed species is a long way off.
- *Soil modification* – There has been some promotion of the idea that certain species prefer certain soil conditions, so modifying soil will help to address weed control. Good in theory but weeds are often tolerant of a range of soil conditions. Also, soil conditions which discourage weed growth may also discourage vine growth.

Summary: Clearly, there is great interest in reducing or eliminating the use of herbicides in NY vineyards. However, cost and efficacy must be resolved, particularly for larger operations. Each business has a unique combination of vineyard design, training system, management strategies and soils that will help to dictate which techniques are feasible. Grower philosophy, interest and commitment are also paramount to the success of alternative weed control techniques.

Grower resources: There is a wealth of information on alternative weed control techniques. Scientific journals have many papers from work done on a range of commodities. Weed control in organic production is a particular challenge, thus many organically approved techniques have been tested in these systems. The internet offers much information, though it must be viewed with a skeptical eye as scientific studies, anecdotes and opinion are all well represented. For more information on cultivation, flame and steam weeding, use of essential oils as herbicides and overall philosophy of organic weed management, see Lanini, W.T. Organic Weed Management in Vineyards at http://www.nswg.org/tomlanini.htm. We acknowledge this article as providing a useful overview of techniques and help in creating the flow of this article.

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