Research Focus

Expanding the Use of Under-Vine Cover Crops in New York Vineyards

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Under-vine cover crops are being tested by growers and researchers as an alternative to weed-free strips maintained with herbicides or tillage. Shown here are weed-free under-row maintained with glyphosate (L), fescue (M) and chicory (R).

Photos courtesey of Justine Vanden Heuvel

The production of premium wine grapes requires continual fine-tuning of management strategies to adapt to changing weather and pest pressure. Increasingly, growers are favoring sustainable practices with the goal of reducing pesticide and fertilizer inputs. For example, the practice of maintaining herbicide strips under vines has recently been re-evaluated. Both growers and researchers have experimented with under vine cover crops as an alternative floor management technique. Studies with annual and perennial species of cover crops have found them to have varying degrees of impact on vine growth and productivity and improvement of soil health indicators. However, expected fruit quality benefits have not manifested in some of these studies. Two methods of sowing cover crop seeds under the vine row have been evaluated in the Finger Lakes and were found to have potential for use in commercial vineyards. For growers interested in an alternative to herbicides, under-vine cover crops may be an option.

Key Concepts

- Growers are interested in alternative under-vine management techniques as part of a movement toward environmental stewardship.
- Under-vine covers crops are an alternative to the use of herbicides or repeated cultivation.
- Researchers and growers have experimented with seeded annual and perennial species under vines.
- Some under-vine cover crops, including chicory and fescue species, can reduce vine size and are therefore best suited to vineyard blocks with excessive vigor. Other cover crops such as buckwheat appear to have little to no impact on vine size.
- Impacts on cluster architecture and fruit quality did not manifest as expected in studies on Long Island.
- Application of cover crops under the vines can be accomplished mechanically using equipment that growers may either already possess or that can be purchased and modified relatively inexpensively.

Part 1: Under-Vine Cover Crops in Long Island Viticulture

Why use green cover under the trellis? Prior to the late 1950's, New York vineyards were mechanically cultivated. Row middles were disked and grape hoes were used to 'hill up and take away' soil for weed control several times during the growing season. However, this was detrimental to soil organic matter as well as vine trunks and roots (11) and led to significant soil erosion. By 1964, over 75% of vineyards used herbicides, which were considered relatively effective and economical (10).

As grower diversified into wine grapes, a weed free strip under the trellis maintained with pre and post-emergence herbicides remained standard practice. Recently, cover crops have received more attention for their proven ability to reduce leaching of nitrates and pesticides compared to bare ground (4, 7, 8). This is particularly important on Long Island, where underground aquifers are the sole source of drinking water (5).

Selected cover crop studies in the eastern US. Row-middle cover crops are often used to improve soil structure, biodiversity, and nutrition as demonstrated by a NYFVI project in western New York(1). Experimentation with under-vine cover crops has been more recent.

In Virginia, perennial covers reduced vine vigor, which decreased canopy management costs and improved fruit quality (2, 16, 17). In the Finger Lakes, annual species such as buckwheat and annual ryegrass were evaluated for their impacts on yield, fruit quality and leaching of nitrates and pesticides (3).

In many regions of upstate NY, annual species are preferable because vines are hilled up for the winter. However, on Long Island, where hilling up is not practiced, trials have been conducted with perennial clover and fescue species. Based on collective results from these studies, we offer the following observations on under vine cover crops.

Are cover crops appropriate for newly planted and/or young vines? The first few years in the life of a vine are important for development of an extensive root system and above ground framework (training system) that will sustain the vine for years. Cover crops present too much competition for young vines, particularly in sandy and/or shallow soils. It is advisable to maintain a weed free zone around vines with herbicides and/or hand hoeing for at least 3-4 years, longer if vines are not filling their allotted trellis area.

Figure 1. *Under-vine fescue.* Photo by Alice Wise

Cover crop species. Unfortunately, few perennial species can thrive in the shady under-vine region. Based on suggestions from cover crop experts, on Long Island we experimented with clover and fescue. Dutch white clover (*Trifolium repens*) seeded @ 10 lbs/acre and red clover (*Triofolium pretense*) have been evaluated in trials. White clover grew to about 12", while red clover grew taller and interfered with the cluster zone. Subterranean clover (*Trifolium subterraneum*) is a low growing winter annual clover that dies back during summer and re-seeds itself (6). In past experiments on Long Island, poor establishment and winter kill occurred. With good preparation and a suitable location, sub-clover is worthy of another trial, particularly since there are new cultivars available. It reportedly has very good weed suppression.

We focused on low growing fescue species to minimize interference with the cluster zone of midwire cordon, VSP-trained vines. A local company sells a no-mow fescue mix comprised of 5 Festuca species, though the specific species and varieties vary from year to year. Seeded at @ 220 lbs/acre, this mix established well in one trial and poorly in another, likely due to a high percentage of weed seed. In one trial, we seeded single species of fescue, including chewing, hard fescue and creeping red fescue, all of which established well.

Annual species are more appropriate when hilling up soil around the base of vines is necessary for winter protection. Cornell associate professor Justine Vanden Heuvel and colleagues have experimented with annual covers in the Finger Lakes including buckwheat (*Fagopyrum esculentum*), tillage radish (*Raphanus sativus*), annual ryegrass (*Lolium multiflorum*), and chicory (*Cichorium intybus*) (3). Results from these studies indicate that different cover crops can have varying impacts on vine pruning weights (Table 1), but little to no impact on fruit composition (Brix, pH, TA).

Table 1. *Impacts of different under-vine cover crops on vine pruning weight (Vanden Heuvel 2017)*

Little to no impact	Moderate impact	Significant impact
Buckwheat	Tillage Radish	Chicory
Rosette-forming turnip	Alfalfa	Annual ryegrass
	Fescue	

**depending on weed composition*

Candidate blocks for under-vine covers. No-mow fescue is most appropriate for vigorous varieties and/or heavier soils, as it decreases vine pruning weights and nitrogen levels (14, 15, 16, 17). Clover may release nitrogen (N) and

Figure 2. *Under-vine dutch white clover.* Photo by Alice Wise

therefore is best suited for blocks on sandier soils or with smaller vines. In one Long Island vineyard, clover delayed ripening of Syrah compared to fruit from rows maintained with herbicide (15).

Seeding strategies. Seed in April or early May to ensure plots receive water via rainfall and have adequate time to germinate and grow before warm, dry summer weather sets in. Small areas can be hand seeded, but larger areas require the use of a hand crank or push spreader. After seeding, scratch in the seed with hoes, or tamp/roll the plots gently to ensure good contact with soil. This is particularly important for feathery light fescue seed. Part 2 discusses mechanical methods for seeding that are relevant for commercial operations.

Management. With proper site preparation and seeding, clover establishes well the first season. Escape weeds will infiltrate in the second season. By year three, plots will be primarily weeds. Consequently, periodic re-seeding is required to maintain a stand of clover.

The fescues are slow to germinate and growth is slow in year one. Control of escape weeds may be necessary via careful hand weeding or weed whacking. However, in year two, fescue plots fill in nicely. By year three, fescue becomes very dense. The cultivars in our trials grew to ~ 12″ before flopping over.

Dandelion, plantain, and other perennial species ready infiltrate cover crops stands, as does crabgrass. Taller weeds such as horseweed can interfere with the cluster zone on VSP-trained vines. Weed whacking or under-vine mowing can be used to trim weeds, which is usually necessary once or twice a season. For established plots, spring mowing will remove tall weeds and weed skeletons. Mowing can be accomplished with a dedicated under-vine mower or a combination of row middle mowing (2 passes/row, mowing close to vines) and weed whacking.

Impact on vine water status. Under-row cover crops may reduce water availability to vines — especially in sandy soils. In 2016-17, we measured vine water status (stem water potential) with a pressure chamber in three commercial vineyards (14).

In one experiment, a high water table at the site mitigated drought stress. In two others, supplemental irrigation was applied prior to the onset of significant drought stress.

In 2017, we installed shut-off valves in irrigation lines to withhold irrigation. However, periodic rainfall fell throughout the summer, so no significant water stress was observed. Though in 2016 drought stress symptoms appeared in fescue plots, we have not yet been able to quantify drought stress with pressure chamber readings.

Vine nutrition. Fescue has consistently reduced vine nitrogen levels and occasionally potassium levels compared to vines maintained with glyphosate (14, 15). Careful monitoring is required to ensure vines have adequate nutrition. Clover, on the other hand, is a legume that provides nitrogen when incorporated. In one Long Island trial, clover died back during a summer drought triggering a release of nitrogen, evident visually and in lysimeter water samples (15). The unpredictable release of nitrogen from cover crops could be an advantage or a disadvantage.

Vine and fruit impacts. Small increases in fruit quality can translate to large increases in bottle price (9). Excessive vine vigor can lead to unripe flavors and aromas, particularly in reds (12, 13).

Figure 3. *Under-vine mower* Photos by Alice Wise

Our studies verified that fescue consistently reduces vine pruning weights. In a 2017 trial with Merlot, vine pruning weight, shoot number and cane weight were significantly lower in fescue plots compared to herbicide plots (14).

Judicious irrigation and/or nitrogen can be used to boost vigor if necessary. As for clusters, fescue sometimes reduced berry set but rarely affected other cluster characteristics. In 2017, berries per cluster were significantly lower in fescue vs

herbicide plots. This would be an advantage for a compact, rot susceptible cultivar. However, through 5 years of trials in various vineyards, cover crops have not affected berry weights.

Fruit composition tests, including Brix, titratable acidity, pH and methoxypyrazine concentrations (a flavor compound prominent in unripe red fruit) have consistently shown no differences between cover crops and herbicides. Clover provided little or no benefit to fruit quality and quantity with one exception — clover significantly delayed ripening of Syrah compared to adjacent herbicide plots (15).

Cost. It is difficult to define an absolute cost for under vine cover crops because there are so many variables (14). Site preparation is an additional cost incurred with their establishment.

Clover seed is cheaper than fescue seed largely due to the seeding rate (10-20 lbs/acre for clover vs. 200+ lbs/acre for fescue). However, clover requires periodic re-seeding, thus long-term seed costs are roughly equivalent.

Additional irrigation and nitrogen fertilizer may occasionally be required to offset competition from green covers. On the other hand, savings will be realized through elimination of herbicide sprays. Labor costs of traditional herbicide strips compared to green covers are hard to gauge and depend on the number of herbicide vs. mowing passes required to reasonably maintain the under vine area and the type of equipment used.

Other Considerations

- Water – for well-drained soils, particularly on Long Island, it is advisable to have drip irrigation in blocks with seeded covers to avoid vine drought stress, especially if the water table at a given site is relatively low.
- Rodents – In some fescue plantings, rodent tunnels have been evident. One grower noted chewing damage on trunks. Mowing may discourage this.
- Frost – Green covers should be managed to minimize the risk of spring frost to the vines. In spring, mow to <2" to allow sunlight to warm soil. Tall covers may also block the drainage of cold air.
- Under-vine mowing – Depending on your choice of cover crop, height of the fruiting zone, and weed pressure, it may be necessary to mow under the vines. A handful of vineyards on Long Island practice this technique, including the Cornell research vineyard.

Summary. The use of under vine cover crops is most attractive to growers interested in alternative under-vine management and/or in blocks with excess vine vigor. Cover crops require planning, time, effort, and monitoring. This strategy is easy to implement and manage on a small scale. Growers with a large acreage and/or multiple properties may find it more difficult to adopt under vine covers due to the need for occasional maintenance.

Part 2: Developing a Mechanical Method to Apply Under-Vine Cover Crops in Commercial Vineyards

Over the past several years, Justine Vanden Heuvel's lab has been examining the impacts of using under-vine cover crops in Finger Lakes vineyards as an alternative to maintaining a vegetation-free strip underneath the vines. They have found a number of potential benefits of the practice, such as reduction of vine vigor, improved soil health measures including reduced bulk density, improved porosity and aggregate stability, and decreases in nitrogen and pesticide leaching (18).

Based on these results, there has been increasing interest among grape growers in the Finger Lakes and other regions of the eastern U.S. Under-vine cover crops are an alternative to herbicides, a tool to reduce the environmental impact of vineyard operations, and a practice that could potentially decrease management costs.

The need for mechanical methods for seeding. In all of these research trials, the cover crop seeding was done by hand. In order for the practice to be a viable option for growers at a commercial scale, we needed to figure out a way to mechanically apply cover crop seed to the area under the trellis.

Because this is a new practice, there is no commercially available equipment to apply seed just to a targeted portion of the vineyard floor. Most spreaders are designed to broadcast seed over a wide area directly behind the seed-

Figure 4*. Vicon spreader with modified banding spout.*
Photo by Hans Walter-Peterson

er, and not just to the sides. We realized that we needed to find a solution that either used equipment that growers already owned, or that could be purchased inexpensively, and likely modified in some way, in order to place the seed in the desired area.

As part of a project funded by the NY Farm Viability Institute, we tested two different methods of applying cover crops seed to the zone under the trellis.

One option was using a Vicon fertilizer spreader (Figure 4). These spreaders are already owned by many commercial growers. The spreader uses a swinging arm that moves horizontally to broadcast the material. A banding spout attachment can be installed on the spreader which is designed to increase the amount of material being placed in banded areas on either side of the spreader. The speed at which the spreader operates is controlled by the tractor PTO speed.

The second method we evaluated was to modify a standard rotary spreader with a set of chutes to direct the seed just to the sides of the spreader, rather than a 180°+ swath (Figure 5). The spreader is powered by an external 12V battery, and its speed is controlled by an electronic dial set by the operator.

***Figure 5**. Modified rotary spreader.* Photo by Hans Walter-Peterson

Method 1: Vicon spreader with banding spout attachment. Because the banding spout does not completely prevent seeds from being spread in the row middle, we wanted to quantify how much of the seed was delivered to the targeted area on the ground.

***Figure 6.** Vicon spreader with banding spout and simulated vineyard row. Parallel white lines on either side of the center line represent the area under the trellis with 8' row spacing. Yellow lines represent 9' row spacing.* Photo by Hans Walter-Peterson

To do this, we replicated the typical row spacing in most Finger Lakes vineyards (8 feet between rows) and targeted weed-free zones (approximately 30" wide) on a plastic tarp that was placed on the ground directly behind the spreader (Figure 6). We then ran the Vicon for 60 seconds, using an opening size from the hopper that was appropriate for the type of seed being evaluated (buckwheat). After 60 seconds, we measured the amount of seed that landed in the desired area compared to that which didn't.

When we set the PTO to 1200 RPM, we found that 25-30% of the seed fell into the simulated row middle, and only approximately 70-75% of the seeds landed in the desired area under the trellis (white set of lines in Figure 6). When we increased the PTO speed to 1500 RPM, less seed fell into the row middle, but a significant amount (~15%) fell beyond the area under the trellis and into what would have been the adjacent row middles.

We had similar findings using annual ryegrass seed—a significant amount of seed did not make it to the bands under the trellis even when we used the banding attachment.

Based on these findings, we would have to recommend that growers would need to increase their seeding rates by approximately 30% in order to make up for the loss of seeds in the row middle. If a grower already has this equipment and is willing to use higher seeding rates in their vineyard, this method of application might be acceptable, depending on the cost of the seed that is being

***Table 3.** Pros and cons of each seeding method*

Method	Advantages	Disadvantages
Vicon with banding spout	• Larger hopper can hold more seed, cover more acreage in single trip • Already owned by some growers; banding spout attachment is relatively inexpensive ($400-500)	• Relatively high seed loss to row middles; must compensate with higher seeding rate, increasing cost/acre • More difficult to calibrate
Modified rotary spreader	• High percentage of seed is placed under the trellis. • Inexpensive system (~$500-600 total) • Easy to calibrate	• Smaller hopper means more stops to fill, or must expand the hopper • Custom fabrication required; may not be easy to find in some areas

applied. Growers should consider the costs of this method to determine if it makes sense for their particular operation.

Table 3. *Buckwheat seed distribution (by weight) using Vicon spreader with banding spout attachment at two PTO speeds and three heights from the ground. 'Left' and 'Right' indicate simulated zone under the trellis. 'Center' refers to simulated row middle. 'Outside' refers to percentage of seed that fell beyond the targeted area.*

RPM (PTO shaft)	Height (in)	Left	Center	Right
1200	24"	36.2%	29.6%	34.2%
1200	28"	37.9%	25.9%	36.2%
1500	20"	35.4%	26.3%	38.3%
1500	24"	31.0% (15.2% outside)	18.4%	21.2% (13.9% outside)
1500	28"	30.6% (15.4% outside)	18.1%	21.5% (14.4% outside)

Method 2: Modified rotary spreader. The modifications made to the rotary spreader involved creating a shroud around the spinning rotor to prevent the seeds from dispersing out the back of the unit, and only allowing them to escape from the rotor on the sides of the unit (Figure 7). We modified the rotary spreader by placing a shroud around the spinning rotor that channeled seeds to the sides of the unit and preventing them from dispersing out the back of the unit. While we have not yet quantified the distribution of seeds as we did with the Vicon spreader, we have observed little loss of seed to the row middle with this system. The size of the seed will have an effect on loss in the row middle, with smaller seed like grasses being able to slip between the edges of the rotor and the housing more easily than larger buckwheat seeds.

Figure 7. *Underside of rotary spreader showing shroud around the rotor and side discharge chutes.* Photo by Hans Walter-Peterson

We found that calibrating seeding rate is easier with this spreader than with the Vicon. Once the gate in the hopper is set and a rotary speed selected, the operator can place buckets on each chute and the run the spreader for 30 or 60 seconds. After weighing the seed collecting in each bucket during that time, the operator can adjust the gate to change the feed rate from the hopper. More detail on the calibration and set up of this system can be found in our YouTube video.

Summary. After working with both of these methods, we have found that each has their advantages and disadvantages. Growers should consider the pros and cons to each method, including the costs of the equipment, seed, maintenance of the cover crop, as well as the desired outcomes for using under-vine cover crops, before committing to the practice on a large scale.

As with any new vineyard management practice, we recommend that growers interested in this technique evaluate the impacts of it on a small scale before making a wholescale commitment to it.

In the Finger Lakes, a new project led by Justine Vanden Heuvel is providing growers in the region with the opportunity to try seeding under-vine cover crops on a small portion of their own vineyard using our modified rotary spreader.*

**Please contact Justine Vanden Heuvel (justine@cornell.edu) or Steve Lerch (sdl5@cornell.edu) if you are interested.*

Supplemental Resouces

- NY Cover Crop Guide
- Finger Lakes Grape Program – Planting Cover Crops in the Vineyard Video

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