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Groundcovers for Nebraska Vineyards

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In recent years, the use of herbicides and other chemicals to control weeds and pests in the vineyard has become heavily scrutinized as studies continue to show negative health and environmental effects related to these chemicals. The use of herbicides in the vineyard is mainly to control weeds in a three- to four-foot swath directly beneath the grapevines. This practice has been used for many years with the intention of reducing competition between weeds and grapevines. However, an alternative method of controlling weeds in the vineyard is to replace the weed-free strip with a permanent groundcover. Recent studies have shown less competition between grapevines and neighboring plant species than what was originally thought, especially in areas with higher precipitation (Krohn and Ferree, 2005; Wheeler et al., 2008; Bavougian, 2014; Loseke and Read, 2016).

The benefits of replacing herbicides in the vineyard extends far beyond the reduced use of chemicals. Groundcovers can enhance soil properties in a variety of ways, including increased water infiltration, reduced erosion, soil nitrate and ammonium pools, and nitrogen (N) mineralization rates (Celette et al., 2008; Steenwerth and Belina, 2008). Increased soil organic matter is often a benefit of planting groundcovers in addition to improving soil structure and the depth of low bulk density soil (Wheaton et al., 2008). Decomposing legumes or other cover crops also provide N to the vines, which can be especially important in the early part of the season when N demand is the highest.

Competition between grapevines and groundcovers may also prove beneficial in certain growing regions where vines tend to be excessively vigorous, which can cause self-shading and reduced vine balance (Wheeler et al., 2008). It is important to keep vines in balance to maintain consistent yields and fruit quality from year to year. Vines can become unblanaced when competing with native vegetation (i.e. weeds) for water and nutrients. Weeds can reduce grapevine growth by up to 40% (Winkler, 1962), and in a newly planted vineyard cover crops have been shown to limit growth by up to 80%. On the contrary, it has been shown that groundcovers and cover crops can be a valuable tool to control overly vigorous grapevines (Tesic et al., 2007; Giese et al., 2010; Hatch et al., 2011). A perennial groundcover can also have a positive impact on the quality of berries, and, in turn, on the quality of juice and wine (Morlat and Jacquet, 2003).

With over 30 wineries and nearly 1000 acres of grapes planted in Nebraska as of 2022, grape growers are embracing our harsh growing conditions to produce award winning wines. The results and recommendations from these groundcover experiments conducted by the University of Nebraska–Lincoln Viticulture Program (UNLVP) are the basis for this guide and can be used by both commercial and home grape growers.

UNL Project Background

The UNL Viticulture Program began a four-year study in spring 2014 to better understand the effect that native groundcover mixtures have on newly planted 'Edelweiss' grapevines. The experiment took place in eastern Nebraska at Oak Creek Vineyards located two miles southwest of

Raymond. Immediately after the vines were planted in a five-acre parcel, four groundcover mixtures, composed of legumes, forbs and grasses, were seeded both in the alleyways and in the grapevine rows. The groundcovers were successfully established by the end of the first year, where all of the plots had 90 to 100% cover. A temporary irrigation system was constructed prior to planting to aid with groundcover establishment in the first growing year. Throughout the four-year study a variety of data were collected including: groundcover rate of establishment, shoot length, pruning weight, grapevine leaf water potential, and harvest parameters such as cluster and berry weight, pH, titratable acidity (TA), and °Brix.

Results from this project demonstrated that groundcovers established around newly planted grapevines significantly hindered growth and yield of the vines. However, planting groundcovers at the end of the first year of grapevine establishment showed little to no effect on vine growth which reduces the need to control weeds with herbicides.

How to Choose Groundcover Species

A major consideration to the grape grower is the decision of which plant species to use as the groundcover. Perennial grasses are commonly used as a vineyard groundcover, because they are able to withstand vineyard traffic and tolerate mowing throughout the season. Some commonly used species include Kentucky bluegrass, perennial ryegrass, orchardgrass, and a variety of fescues. Groundcovers can either be planted as a monoculture of a single plant species, or a polyculture of many different species. Ideally, a polyculture groundcover would be used as it provides a variety of benefits throughout the season. For example, a groundcover mixture that contains both warm- -and cool-season grasses is beneficial, because the cool-season species will grow well early in the spring and late in the fall, whereas the warm-season grasses will flourish during the hot, dry months of summer. The key to a successful groundcover mixture is to keep the soil from being bare at any time during the year, which keeps native weed populations from becoming established.

Groundcovers should be chosen based upon their ability to establish quickly to prevent early season weed growth, yet deliver little competition with grapevines. Control of early season weed growth is important to growth of young vines (Bordelon and Weller, 1997), and fast establishment of the groundcover during the first year of planting is important. Slow-growing groundcovers have been related to an increased weed population in comparison to faster-growing groundcovers (Clement and DeFrank, 1998). Low-growing plant species are better suited for vineyard applications, because less frequent mowing is necessary, resulting in lower input costs and reduced soil compaction. Additionally, tall-growing groundcovers can reduce airflow through a vineyard, and cause an increase in disease incidence.

In eastern Nebraska, four groundcover mixtures have proven to be useful in vineyard applications (Table 1) as a result of this study. Plant species comprising each groundcover mixture were selected based upon their rate of establishment, low growth habit, ability to fix N, and resistance to wear and compaction. These groundcovers were developed specifically for vineyard applications by Stock Seed Farms, located near Murdock, Nebraska.

Establishment of Groundcovers

Groundcovers are typically planted in the fall, and take advantage of winter precipitation. As we demonstrated, it is not advised to establish groundcovers around newly planted vines, because the groundcovers can become too competitive and hinder the vine growth in the first year. The results from our study suggest the earliest that groundcovers should be planted around vines is in the fall following the first growing season. This allows young vines to grow unencumbered in the first season, and then the groundcovers can become established while the vines approach dormancy.

For successful and efficient establishment of the groundcovers, the seedbed must be properly prepared. Whether the vineyard has already been planted or not, it is advised to kill the native vegetation and weeds on the vineyard floor . This can be accomplished in two ways: a burndown herbicide application or cultivation. If the vineyard has not already been planted, the grower may decide to establish the groundcovers the year before vine planting. There is, however, little research showing how this practice may impact the growth of young vines.

Once the native weeds are killed, the soil should be worked to a depth of 3 to 5 inches until it is free of clods and plant debris has been well incorporated into the soil. This can be accomplished with the help of a harrow or drag to attain the proper smoothness and uniformity of the soil. For best results, the groundcover mixtures should be planted using a native grass drill. These drills have multiple seed boxes that accommodate the variety of seed sizes included a groundcover mixture (and they also have a packing wheel to ensure the soil is packed on top of the seed). The drill should be calibrated to ensure the proper seeding rate. Typically, most seed should be planted at ½” or less in depth. Planting seed around grapevines will not be possible with the drill, so hand seeding and the use of a hard rake to

Table 1. Recommended groundcover mixtures for Midwestern vineyard applications. Combining multiple species can prove to be more beneficial than single species groundcovers.

Plant Species	Scientific Name	Seeding Rate	Cost*
Roadside Mix (TRT 1)		0.50 lbs/1,000 ft² (21.8 lbs/acre)	$8.75/lb
Western yarrow	Achillea millefolium var. occidentalis		
Bird's-foot trefoil	Lotus corniculatus		
White clover	Trifolium repens		
Custom Native Mix (TRT 2)		0.75 lbs/1,000 ft² (30 lbs/acre)	$9.00/lb
Hard fescue	Festuca brevipila		
Sheep's fescue	Festuca ovina		
Sideoats grama	Bouteloua curtipendula		
Buffalograss	Buchloe dactyloides		
Blue grama	Bouteloua gracilis		
Orchard/Vineyard Mix (TRT 3)		2.15 lbs/1,000 ft² (100 lbs/acre)	$2.15/lb
Kentucky bluegrass	Poa pratensis		
White clover	Trifolium repens		
Creeping red fescue	Festuca rubra		
Hard fescue	Festuca brevipila		
Chewing's fescue	Festuca rubra ssp. commutata		
Perennial ryegrass	Lolium perenne		
Texoka Buffalograss (TRT 4)	Buchloe dactyloides Texoka	3 lbs/1,000 ft² (130.7 lbs/acre)	$12.00/lb
Companion Grass		0.75 lbs/1,000 ft² (30 lbs/acre)	$2.72/lb
Perennial ryegrass	Lolium perenne		
Red fescue	Festuca rubra		

*Prices are presented as 2017 wholesale rates. A producer would expect to pay an additional 15–20%.

Table 2. List of other plant species that may be useful as vineyard groundcovers.

Other Groundcover Species Considerations	Scientific Name	USDA Hardiness Zone	Reference
Creeping mazus	Mazus reptans	5–9	(Krohn and Ferree, 2005)
English pennyroyal	Mentha pulegium	5–9	
Strawberry clover	Trifolium fragiferum	3–9	
Dwarf creeping thyme	Thymus serpyllum	5–9	
Prostrate speedwell	Veronica prostrata	5–8	
Creeping red fescue	Festuca rubra	1–7	(Bavougian, 2014)
Purple vetch	Vicia benghalensis	3–7	(Costello and Daane, 1998)
Common barley	Hordeum vulgare	4–8	
Barnyardgrass	Echinochloa spp.	5–9	
Yellow foxtail	Setaria gracilis	5–8	
Bermudagrass	Cynodon dactylon	7–10	

Figure 1. Proper seedbed preparation is essential to successfully establishing groundcovers in the vineyard.

Figure 2. Native grass drill being used to plant groundcover mixtures between rows in the vineyard. Hand seeding is necessary between plants where the drill cannot be used.

Figure 3. Implementing an irrigation system is suggested to speed the germination and establishment of groundcovers, and reduce the potential for weed infestation.

incorporate seed into the soil might be necessary. After all seeding is complete, a lawn roller should be used in those areas where hand seeding took place to pack the loose soil to achieve proper soil-seed contact.

Implementing a temporary irrigation system to speed up germination and establishment of the groundcover seed can be beneficial, especially in arid regions. In the UNL trials, a temporary irrigation system was designed with rotary sprinklers mounted to the top of wood trellis posts. The groundcover plots were watered every day just before dawn when wind was at a minimum. At the end of the first season, the irrigation system was disassembled and groundcovers relied on natural precipitation to meet water needs. Once the grapevines reach the trellis wire, it is not recommended to use an overhead irrigation system, because this practice could greatly increase disease potential. If groundcovers are planted in an established vineyard, an irrigation system that does not wet grape leaves may need to be devised.

Groundcover Management

Oftentimes, growers will plant a groundcover in the vineyard, and not follow up with proper management. However, to maintain a healthy groundcover the grower should treat and manage it as an income producing crop. The vineyard groundcover should be considered an integral piece of the puzzle to maintain a healthy, profitable, and sustainable vineyard. Specific steps should be taken each year to maintain a healthy vineyard groundcover.

After the first groundcover growing season, soil tests should be taken throughout the vineyard. Soil tests should be taken in the fall after grape harvest, and can be used for monitoring the soil nutrients for both the grapevines and the groundcover. Soil test results should be assessed before making any fertilizer decisions and applications. The following fertilizer recommendations are given based upon groundcover requirements, but they do not specifically take into account vine nutritional needs. The grower should consider the nutrient requirements of the grapevines firstly, and then build a complementary nutrient regime for the groundcover.

For groundcovers consisting of both cool- and warm-season grasses, soil pH should be around 6.0. Lime only needs to be applied on established groundcovers when the pH is 5.0 or less (most grapes grow best at pH 5.5–7.0, and applications should not exceed 2 tons/acre. Yearly potassium and phosphorus applications can be applied in the fall or winter; however, making these applications as soon after grape harvest as possible will help promote the development of healthy root systems in the groundcovers. Nitrogen (N) applications should be carefully considered, and should primarily be based on the needs of the grapevines. If a major goal of the groundcover is to suppress overly vigorous vines, applying N will offset this effect, so would not be recommended. Additionally, N applications will cause groundcovers to grow more quickl; thus requiring more frequent mowing. Late summer and fall applications of N are also not recommended, because they encourage vines to put on new vegetative growth late in the season when they should be hardening off. When legumes are present in groundcover mixtures, N applications may need to be elim-

Figure 4. Mowing the groundcovers between the rows may be necessary both for aesthetic reasons and ease of vineyard management. If low-growing groundcovers are planted, little to no maintenance should be needed beneath the grapevines.

inated or made at very low rates. If soil test results suggest low N, 60 lbs/acre applications can be made in the winter or early spring.

Mowing is a cultural practice that can be used to help control weeds and improve the health of the groundcover (Figure 4). Consistent mowing helps the weeds' competitive ability, deplete carbohydrate reserves in the roots, and prevent seed production. Mowing should be done often enough so that weeds are not allowed to develop seeds; this keeps weeds in a vegetative state, thus allowing easier control. Weeds should be allowed to grow a bit before mowing (but prior to seed development) so the weed diminishes carbohydrate reserves from the roots. This can be an effective strategy of controlling or suppressing annual and biennial weeds, and can help reduce the spread of some perennial weeds. Mowing is also important to reduce fungal diseases in the vineyard. Groundcovers should not be allowed to grow above 2 feet in height, because this will reduce airflow through the vineyard and increase the incidence of fungal diseases.

Maintaining a proper mowing height is also important. This ensures that adequate leaf area is remaining so the groundcover is able to produce enough energy and recover from mowing. Mowing groundcovers too low can stress plants, deplete energy reserves, and eventually weaken and kill the groundcover. Optimal mowing heights range from 2 to 8 inches depending on the species of plants in the groundcover mixture. The grower will have to make a decision as to how to manage the groundcovers directly beneath the vines. These areas will not typically be accessible to normal mowing equipment, so more intense management practices may be necessary to control the height of groundcovers in these areas (e.g., hand-push mowing or weed trimmers). However, in UNL Viticulture Program research, groundcovers grown beneath the vines have been left unmanaged throughout the growing season and minimal disease problems have been found. A benefit of allowing the groundcovers beneath the vines to grow unencumbered is they will eventually flower and attract many beneficial pollinating and predatory insects to the vineyard.

Competition between Vines and Groundcovers

The most common argument against the use of groundcovers in the vineyard is the amount of competition that takes place between the vines and groundcovers. This includes competition for water, nutrients, sunlight, and space. In the UNL Viticulture Program experiment, groundcovers were planted immediately following the planting of the vines. This was done to confirm that planting groundcovers in the first year with the vines does in-fact have detrimental effects on vine growth and yield in following years. A variety of measurements were taken throughout the four-year project to gauge vine-groundcover competition including first-year vine weight, winter pruning weights, and harvest parameters (cluster numbers and weights, pH, titratable acidity, and °Brix). The following sections briefly summarize the key findings of this project.

Vine Growth

In the winter 2015, pruning weights were collected after the first year of vine growth. Following standard practice, the vines were cut back to the ground (leaving only 2–3 buds), and the entire above-ground portion of the vine was weighed. This provided an excellent indicator of total vine growth in the first year after establishment. As expected, the vines with the weed-free under-vine area (control) had the most growth in the first year, and also had the highest pruning weights. Groundcovers reduced vine weight by up to 67%.

Winter pruning weights were collected in March of 2016 and 2017 with the first harvest happening in 2016. It would be expected that the vegetative growth of the vines would increase dramatically across all treatments from the second to third year of growth. Interestingly, this was not the case in any of the groundcover treatments. The control was the only treatment that showed significantly greater pruning weights from 2015 to 2016. In Trt 2, the pruning

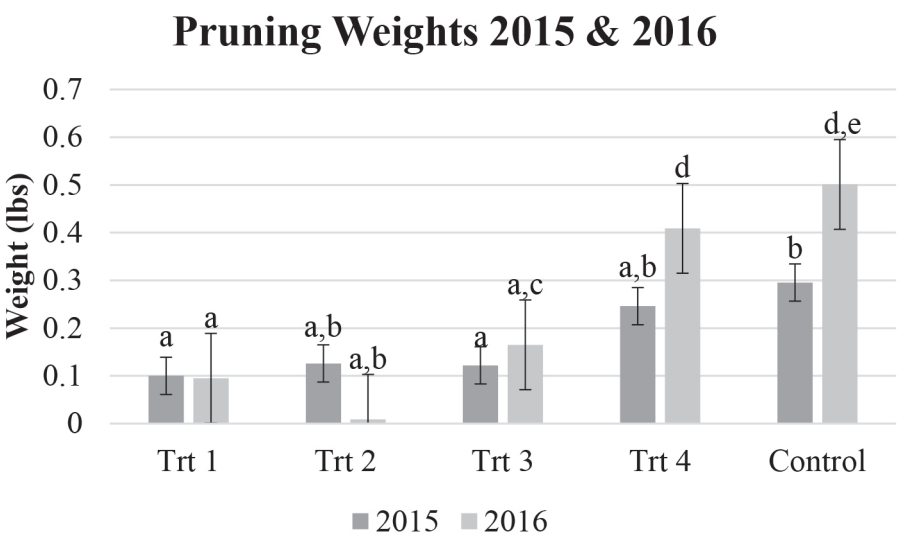

Figure 5. Chart of pruning weights in 2015 and 2016. Data were collected in winter of 2016 and 2017, respectively. Trt 1 = western yarrow, birds'-foot trefoil, and white clover; Trt 2 = hard fescue, sheep's fescue, sideoats grama, buffalograss, and blue grama; Trt 3 = Kentucky bluegrass, white clover, red fescue, hard fescue and chewing's fescue; Trt 4 = Texoka buffalograss; Control = weeds controlled by herbicide under-row.

*Columns in the same year with same letters are not significantly different at $p \leq 0.05$.

weights actually decreased from 2015 to 2016 (0.13 lbs down to 0.1 lbs) (Figure 5).

In 2015, the vines that were grown with a chemically controlled area beneath (control) had the highest pruning weights when compared to the four groundcover treatments (Figure 5). The control vines had an average of 0.3 lbs/vine, whereas the four groundcover treatments ranged from 0.1 lbs to 0.25 lbs/vine, with the greatest being Trt 4 and the lowest being Trt 1. However, there were no significant differences among any of the groundcover treatments. Trt 1 and Trt 3 both had significantly lower pruning weights compared to the control.

In 2016, a similar pattern emerged where the control had 193% higher pruning weights than the vines growing with the native grass groundcover treatment (Trt 2). The other three-groundcover treatments had reduced pruning weights, ranging from 20% to 136%. The control had an average of 0.5 lbs/vine. Treatment 2 (native grass) had the lowest pruning weights at 0.01 lbs/vine. These results clearly show the detrimental effect of planting groundcovers around newly planted vines which coincides with past studies finding that increasing soil coverage with a perennial grass groundcover reduces vine vigor (Morlat and Jacquet, 2003; Giese et al., 2010; Hatch et al., 2011).

Harvest—2016 and 2017

Number of Clusters per Plant

The average number of clusters per plant is important to grape growers for a few reasons, one of which and possibly the most important is in the ease of harvest. Many small clusters on a plant are more difficult and time consuming to hand harvest than if there are fewer, larger, and fuller clusters on the plants. It isn't possible, however, to gauge the size of the clusters by merely looking at the average cluster number per plant data. Typically, if there is an excessive amount of clusters on the vine the cluster size tends to diminish. All of the vines in each treatment showed an increase in number of clusters from 2016 to 2017. The largest change from year to year was found in the control treatment, which increased from 51 clusters per plant to 150 clusters per plant. Trt 1 increased from 46 clusters per plant to 112 clusters, Trt 2 went from 32 clusters to 54, Trt 3 increased from 53 to 11, and Trt 4 rose from 61 to 106.

Average Fruit Yield

From 2016 to 2017, the average cluster weight increased significantly in all of the treatments with the exception of Trt 2, which decreased. In 2016, Trt 2 had an average yield of 5.7 lbs, but dropped to 3.5 lbs in 2017 (Table 3). This result is concerning, because a drop in yield from the second to third year is abnormal. The drop alone is negative, but the total weight is also concerning. 'Edelweiss' grapevines should produce 20 to 30 lbs of fruit per plant after the third or fourth year they are planted. For example, the control produced 6.7 lbs per plant in 2016, and jumped up to 17 lbs in 2017, which would be the typical expectation for 'Edelweiss' vines.

The only groundcover treatment that was not different from the control was Trt 4, which was grown as a control in the first year and then was converted to a Texoka buffalograss groundcover treatment in the year following the planting of the vines (2015). This is one indication that planting a groundcover after the vines have one year to establish may

Table 3. Measured values for average number of clusters per vine, total cluster weight, average cluster weight, average weight of a single berry, soluble solids (°Brix), pH, and titratable acidity (TA) in 2016 and 2017. Trt 1 = western yarrow, birds'-foot trefoil and white clover; Trt 2 = hard fescue, sheep's fescue, sideoats grama, buffalograss, and blue grama; Trt 3 = Kentucky bluegrass, white clover, red fescue, hard fescue, and chewing's fescue; Trt 4 = Texoka buffalograss; Control = weeds controlled by herbicide under-row.

2016	Cluster Number	Avg Fruit Yield (lbs)	Avg Cluster Weight (lbs)	Avg Berry Weight (oz)	°Brix	pH	TA
Trt 1	46.1 a	6.0 a	0.13 a	0.06 a	15.8 a,b	3.2	10.3 a
Trt 2	32.3 a	5.7 a	0.13 a	0.06 a	15.8 a,b	3.2	10.3 a
Trt 3	53.3 a	5.2 a	0.13 a	0.06 a	15.9 a,b	3.2	10.2 a
Trt 4	60.9 a	5.2 a	0.13 a	0.06 a	15.9 b	3.2	10.0 a
Control	51.2 a	5.3 a	0.13 a	0.06 a	16.0 a	3.2	10.0 a
2017							
Trt 1	112.0 a	11.0 a	0.10 a,b,d	0.08 a	18.0	3.4	7.6 a,b
Trt 2	52.4 b	3.5 b	0.06 a,b	0.07 a	17.1	3.3	8.5 b
Trt 3	118.0 a	11.7 a,c	0.12 c,d	0.07 a	18.2	3.5	6.5 a
Trt 4	105.6 a	9.1 a,b	0.08 a	0.07 a	15.7	3.4	8.2 b
Control	150.5 a	17.3 c	0.11 d,c	0.07 a	17.0	3.4	8.2 b

*Values with the same letter in the same column indicate no statistical differences at p≤ 0.05.

Figure 6. Side by side comparison of vines at time of harvest in 2017. The herbicide sprayed control (top and bottom left) has significantly more canopy than the native grass treatment (top and bottom right).

limit the amount of competition between the vines and groundcovers, thus producing higher yields (Figure 6).

Fruit Characteristics

'Edelweiss' grapes are typically harvested before they are phenologically ripe when used for wine production. The level at which they are typically harvested is between 14 and 16 °Brix, depending on the winery's preference. In 2015, the fruit ranged from 15.1 °Brix (Trt 4) to 16.3 °Brix (control), and all samples fell within the recommended range (Table 3). The only significant difference between treatments was that Trt 4 had lower °Brix than the control; however, the difference was small and generally would not be considered significant to the wine maker. Soluble solids were higher across the board in 2017, ranging from 15.7 °Brix (Trt 4) to 18.2 °Brix (Trt 3) and exceeded the typical level wanted by a winery. However, the winemaker made the ultimate decision on when to pick these grapes. The optimum juice pH range for producing white wine with grapes grown in the Midwest is 3.2 to 3.4 (Dharmadhikari and Wilker, 2001). In 2016, juice pH in all of the treatments was slightly lower than the recommended range at 3.2; whereas, pH values in 2017 were higher than in 2016, with levels ranging from 3.3 to 3.5. The recommended range for titratable acidity (TA) is 7.0 to 9.0 g/L (about 0.9 to 1.2 oz/gal). In 2016, groundcover treatments had no significant effects on TA where the mean among treatments was 10.1 g/L (1.3 oz/gal). However, all samples were above the recommended range in 2016.

Final Recommendation

Planting groundcovers in the vineyard can be a valuable investment into the sustainability of many vineyard growing situations. This is especially true in growing regions where vines are overly vigorous and native weeds are controlled through the use of toxic herbicides. In more arid regions, groundcovers may become too competitive with neighboring grapevines. In these cases, groundcovers may not be the best management strategy. The grower can consider all of the circumstances presented in this guide and also talk to local Extension experts about which type of plant species will work best in their growing region.

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