Alternatives to Preemergence Herbicides in North Coast Vineyards

Kendra Baumgartner[a] and Lissa Veilleux[b], [a]USDA, ARS, Davis, CA; [b]Sustainable Agriculture and Research and Education Program, University of California, Davis, CA

Introduction

The California winegrape industry has taken a keen interest in finding alternatives to preemergence herbicides. One reason for this interest is the threat that preemergence herbicides pose to water quality. Preemergence herbicides have been found to contaminate both surface and ground waters due to the amount of time that they remain active (Pimentel et al., 1992). Growing concerns over water quality and impending legislation may make some preemergence herbicides unavailable to growers; alternatives may soon be a necessity. Another reason that the industry is interested in alternative methods is a current trend toward sustainable viticultural practices. Some winegrape growers in the region have reduced their use of preemergence herbicides in the name of sustainability. However, fear of ineffective weed control is still the largest reason farmers cling to more conventional methods (Barberi, 2002). Research into alternative methods can provide the evidence that some growers may require before converting to more sustainable methods.

The objectives of our research are to test the efficacy of several alternative weed control strategies on not only weed establishment, but also on grapevine yield, growth, and nutrition. First, we address the use of alternatives to preemergence herbicides used on the berms, where weeds that can compete with vines or grow into the canopy are directly controlled. Secondly, we address cover crop management in the middles. Understanding how management of the middles affects weed population dynamics on the berms may prove to be a helpful tool to aid growers in indirectly reducing weed pressure on the berms. We initiated two field experiments in November 2002 to address our objectives.

Methods

The two field experiments (berm study and middles study) were conducted in a commercial, drip-irrigated winegrape vineyard in the town of Oakville, Napa County, California, USA. The vineyard was established in 1996 with Merlot (clone 314) on 110R rootstock to a 6 x 6 ft. spacing. An annual, no-till cover crop of Zorro fescue (*Vulpia myuros* var. *hirsuta*) is maintained in between every row.

Berm Study

Seven weed control treatments (Table 1) were arranged in a randomized complete block design with five replicate blocks. Treatments were applied to the first 50 vines, with buffer rows (where no data is collected) in between treated rows (where data is collected). Each treatment was restricted to two practices that were carried out in a single pass per practice, in an effort to use the same number of weed control attempts per treatment.

Table 1: Weed control practices associated with experimental weed control treatments and the associated dates and rates of application.

Experimental Treatment	Practice	Date Applied	Rate Applied
1. Winter Round-up/Spring Round-up	Round-up[a]	22-02-03	0.28 kg a.i. ha^{-1}
(WRU/SRU)	Round-up	22-05-03	0.56 kg a.i. ha^{-1}
2. Fall Cultivation/Spring Cultivation	Clemens	27-11-02	in-row cultivation
(FC/SC)	Clemens	16-05-03	in-row cultivation
3. Fall Cultivation/Spring Matran	Clemens	27-11-02	in-row cultivation
(FC/SM)	Matran[b]	22-05-03	3.72 l a.i. ha^{-1}
4. Fall Cultivation/Spring Round-up	Clemens	27-11-02	in-row cultivation
(FC/SRU)	Round-up	22-05-03	0.56 kg a.i. ha^{-1}
5. Winter Matran/Spring Matran	Matran	22-02-03	2.48 l a.i. ha^{-1}
(WM/SM)	Matran	22-05-03	3.72 l a.i. ha^{-1}
6. Native Vegetation	Mow	18-04-03	mow
(NV)	Mow	15-05-03	mow
7. Spring Cultivation Only	Mow	15-05-03	mow
(SC)	Clemens	16-05-03	in-row cultivation

[a]Active ingredient: Glyphosate
[b]Active ingredient: Clove Oil

Aboveground weed biomass per species was collected at peak biomass in June 2003. Four random samples were taken from each treatment berm using a 0.25 x 0.25m quadrat. Two samples were taken from around vine trunks and two from in between vine trunks. Total aboveground weed biomass, broadleaf versus grass biomass, annual versus perennial biomass, and weed diversity were compared across treatments using ANOVA (Proc Mixed, SAS Institute, 1996) with block and block interactions treated as random effects.

From the grapevines, yield data were collected in September 2003 from six adjacent vines per replicate vineyard row. Pruning weights were collected in November 2003 from the same vines from which yields were measured. Vine nutrient status was assessed in spring 2003. From each replicate vineyard row, 75-100 petioles were collected, dried, ground, and analyzed for N, P, K, Mg, Zn, and B. Yield per vine, average cluster weight, number of clusters, pruning weights, number of shoots, yield to pruning weight ratio and leaf petiole nitrogen, phosphorus, potassium, boron and zinc were compared across treatments using ANOVA (Proc Mixed) with block and block interactions treated as random effects.

Middle Study

For this experiment, three cover crop management treatments and a standard control were arranged in a randomized complete block design with four replicate blocks. Cover crop treatments included:

1) an annual, tilled cover crop of triticale (x *Tritisosecale*),
2) an annual, no-till cover crop of Zorro fescue (*Vulpia myuros* var. *histuca)*, crimson clover (*Trifolium incarnatum)*, and blando brome (*Bromus hordeaceus* ssp. *Molliformi),*
3) a native perennial, no-till cover crop of California barley (*Hordeum brachyantheum)*, California brome (*Bromus carinatus)*, molate red fescue (*Festuca rubra)*, blue wild rye (*Elymus glaucus)*, and white yarrow (*Achillea millefolium*).

The control was a standard, clean-floor treatment, which was disked twice annually. Treatments were applied to 50 consecutive vines of three consecutive rows. The inner berm and middle served as data collection areas, creating one buffer berm and one buffer middle on either side of the area were data was collected. Two Roundup applications peryear were used to control weeds under the vines in every block.

In late May, aboveground weed biomass per species was collected as described above from one berm and one middle per replicate row. Total aboveground weed biomass, broadleaf versus grass biomass, annual versus perennial biomass, and weed diversity were compared across treatments using ANOVA (Proc Mixed) with block and block interactions treated as random effects.

Results and Discussion

Berm Study

The Winter Roundup/Spring Roundup treatment was most effective at controlling weeds, as measured by aboveground biomass. Weed control was significantly better than that of the Winter Matran/Spring Matran treatment, the natural vegetation treatment, and the Spring cultivation treatment. All three treatments with a Fall cultivation resulted in intermediate weed control (Figure 1).

There was no significant difference between grass and broadleaf weeds for any of the treatments (P = 0.5362; data not shown). All treatments had similar proportions of grass and broadleaf weeds, except for the Winter Matran/Spring Matran treatment, which had significantly higher grass weed biomass than broadleaf weed biomass. Interestingly, the biomass of broadleaves for this treatment was almost as low as that of the Winter Roundup/Spring Roundup treatment.

Annual weed biomass was higher than perennial weed biomass in every treatment (P = 0.0013; data not shown). Perennial weed biomass was, in fact, only a fraction of the total biomass for all treatments, so patterns of differences in annual weed control closely mimic those of total weed control in Figure 1.

There were no significant differences in any of the grapevine yield or growth parameters. Among the petiole nutrient analyses, there was a significant difference for only one nutrient, potassium, which was significantly lower in all three treatments with a Fall cultivation (P = 0.0093;data not shown).

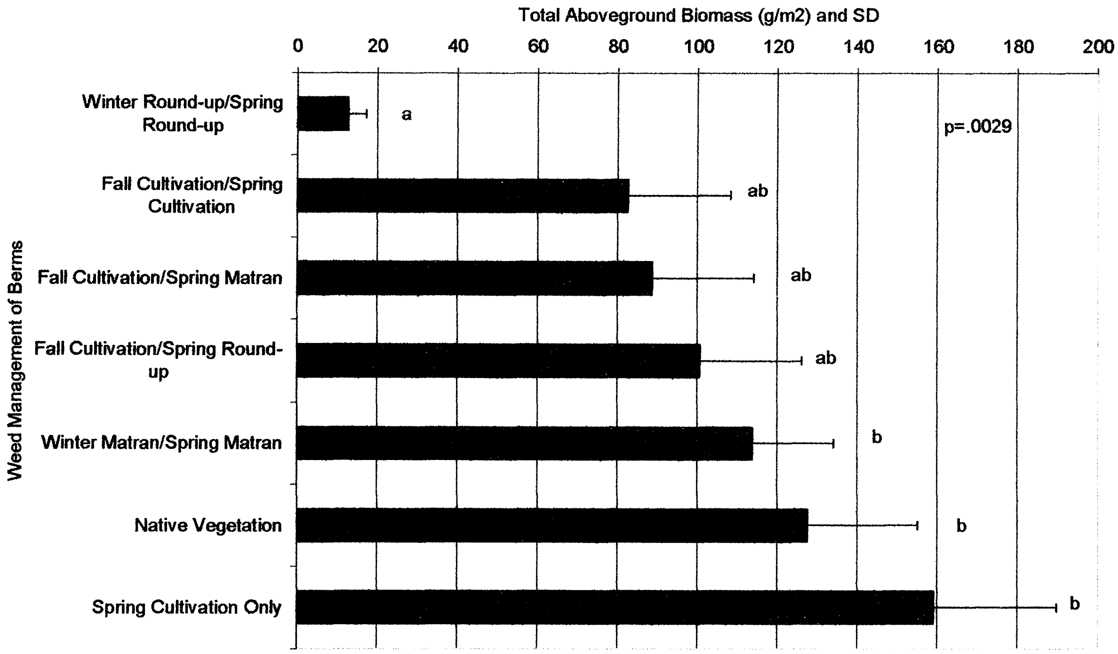

Figure 1: The effect of weed management on total aboveground biomass of weeds. Bars with no letter in common indicate a significant difference in weed control between the associated treatments.

To summarize these results, based on total weed biomass, the most effective weed control treatment was the Winter Roundup/Spring Roundup treatment. The least effective were Winter Matran/Spring Matran, Spring cultivation, and the natural vegetation control. Intermediate were the three treatments with a Fall cultivation. Matran applications appeared to be very effective against broadleaves, but were least effective against grasses. Although the Matran applications did not control grasses, the dominant grass weed was the cover crop (Zorro fescue), a low stature grass. Given that Matran controlled the more problematic broadleaves, this treatment was still successful. Finally, although there were differences in weed control efficacy among treatments, there was no effect of weed management on grapevine yield or growth.

Middle Study

There was a significant difference in the aboveground weed biomass on the berms compared to in the middles for only one treatment, the perennial, no-till cover crop. For this treatment, weed biomass in the middles was more than three times that of the berms. When weed biomass was compared across all middles, the weed biomass was significantly higher in the perennial, no-till cover than in all other treatments. However, when weed biomass was compared across all berms, there were no significant differences among treatments, although there were more weeds in the berm adjacent to the perennial, no-till cover (Figure 2).

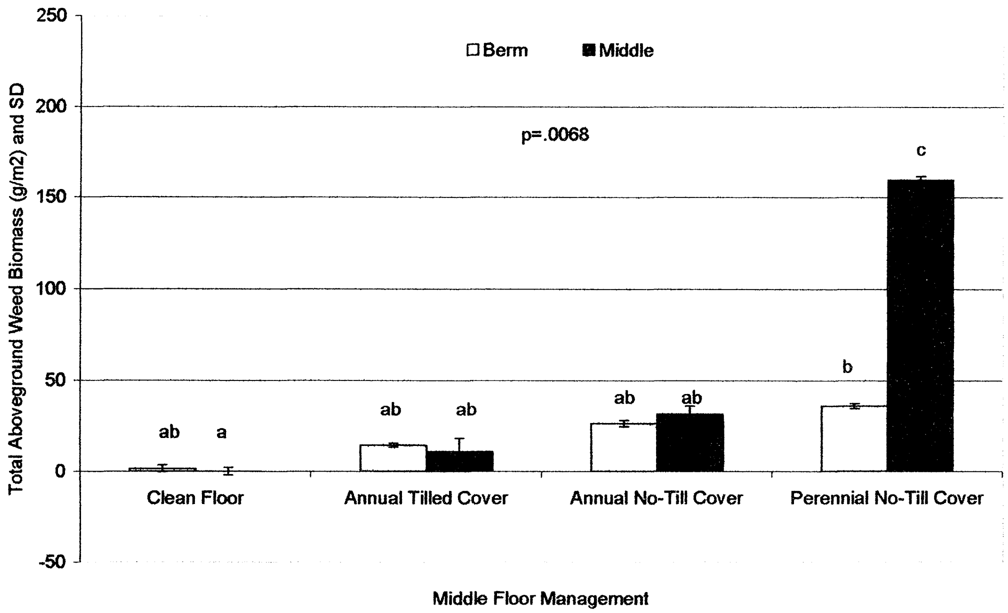

Figure 2: The effect of middle management on aboveground weed biomass on middles and adjacent berms. Again, bars with no letter in common indicate significant differences between associated treatments.

Broadleaf biomass was generally higher than grass biomass in every treatment in both locations (berm and middle), but, these differences were not significant (P = 0.1108;data not shown). While annual weed biomass was higher than perennial weed biomass in all treatments, the difference was significant only in the middles for the perennial, no-till cover crop (P = 0.0008;data not shown).

In summary, weed biomass in the middles was significantly lower in both annual cover crop treatments than in the perennial cover crop treatment. Among the three cover crop treatments, the vigorous annual cover crops had the highest cover crop biomass and the lowest weed biomass in the middles. Their ability to compete with weeds in the middles was associated with lower weed biomass in the adjacent berms. Over time, the perennial, no-till cover crop will likely develop a denser canopy enabling it to compete better with weeds in the middles.

Literature Cited

Barberi, P. 2002. Weed management in organic agriculture: are we addressing the right issues? *Weed Research* **42**: 177-193.

Pimentel, D; Aacquay, H; Biltonen, M; Rice, P; Silva, M; Nelson, J; Lipner, V; Giordano, S; Horowitz, A; D'Amore, M. 1992. Environmental and economic costs of pesticide use. *Bioscience* **42**: 750-761.