Shifts in Weed Community Composition in Response to Organic and Conventional Weed Control Practices in a California Vineyard

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Organic wine grapes are becoming increasingly more popular among consumers and winemakers, as evidenced by the fact that grapes represented 10% of 2002 organic commodity sales in California (Klonsky 2004). The rise in organic wine grapes may be driven partly by the increasing proximity between urban areas and vineyards as well as more stringent controls over water quality (Anonymous 2006). These water quality regulations encourage growers to reduce pesticide applications, shift their selection of pesticide, or adopt organic practices.

Integrated weed management (IWM) employs multiple tactics to control weed infestations, and can be useful in reducing problematic weeds. IWM in California vineyards typically involves the integration of post-emergence herbicides and pre-emergence herbicides (Agamalian 1992), with less emphasis on incorporation of non-chemical methods. Therefore, the aim of this research was to compare the organic weed control practice, soil cultivation, to the conventional practice, applications of the herbicide, glyphosate, in terms of their effects on weed community dynamics in a vineyard system. Objectives were to: 1) evaluate the efficacy of the practices in reducing weed biomass, 2) characterize the weed community, 3) monitor vine yield, growth, and nutrition under the influence of the practices, and 4) determine the effects of the practices on soil biological activity. An understanding of all aspects is important to growers who desire sustainable weed management practices that do not threaten production goals.

The experiment was conducted in a commercial winegrape vineyard in the Napa Valley of northern California from 2003 to 2005. The vineyard was established in 1996 with Merlot (clone 314) on 110R rootstock (*V. berlandieri* Planch. X *V. rupestris* Scheele). Vine spacing was 1.8 x 1.8 m, with east-west row orientation. Vines were trained as unilateral cordons to a vertical shoot positioning trellis system. The vineyard was drip-irrigated (40-80 kL ha^{-1} $week^{-1}$, May-October). The 0.84-m-wide section of soil in the vineyard row, where treatments were carried out, was level with the soil in vineyard the middles; vines were not elevated on berms. The vineyard was on Bale soil (fine-loamy, mixed, thermic Cumulic Ultic Haploxeroll).

The annual treatments were winter-spring glyphosate, spring cultivation, fall-spring cultivation, and fall cultivation-spring glyphosate, and were applied to the berm. Glyphosate[1] [*N*-(phosphono-methyl-glycine), Roundup UltraMAX] was applied at label rates with a tractor-mounted, 1.2-m-wide, boom sprayer with two fan-type nozzles directed beneath the vines on both sides of the tractor. Cultivations were done with a Radius Weeder[2] (Clemens cultivator). At peak plant biomass in the spring, the weed response to each treatment was measured using four randomly placed, 0.6-m^2 quadrats per row (two at the base of vine trunks, two between adjacent vines). In 2005, effects of weed management treatments on soil biology were also assessed. To determine cumulative effects of treatments on soil biological activity, we measured net nitrification and nitrogen (N) mineralization, potential N mineralization, and potential microbial respiration in 2005 only. Potential N mineralization provides information about the availability of N in the soil organic matter while potential microbial respiration indicates the lability of soil carbon (C). Soils with more labile C tend to support higher microbial activity. Vine nutrition was described annually by measuring boron, potassium, and phosphorus in grapevine petioles at bloom.

The weed control practices employed in this study did not affect soil microbial activity, but the soil ammonium pool in the spring was greater in the spring cultivation treatment than in other treatments. This was attributed decomposition of the weeds that had been recently incorporated into the soil by the Clemens. No effect of weed treatment was observed on vine nutrition, except potassium was lower in the fall-spring cultivation treatment than in the winter-spring glyphosate treatment. However, lower petiole K in cultivated rows was within adequate levels (>15 mg g^{-1} at bloom).

In general, cultivation alone was not as effective as glyphosate, but the overall effectiveness of each treatment in reducing weed biomass was not consistent among all years. For example, lower weed biomass occurred in the glyphosate-only treatment in two of three years. However, given that two passes with the Clemens cultivator (i.e., fall-spring cultivation) decreased weed biomass relative to one pass, it is possible that additional passes could bring about further reductions. Pairing fall cultivation with glyphosate was as effective at reducing weed biomass as two glyphosate applications in two of three years, suggesting that substituting a glyphosate application with cultivation may be an effective method of reducing herbicide use in vineyards. Treatment effects on weed community structure were evident. Persistent infestations of unique problematic species associated with glyphosate (curly dock), cultivation (annual sowthistle, field bindweed, spiny sowthistle), and a combination of both practices (panicle willowherb) suggest that alternating control practices among years may be important for preventing such weed shifts in California vineyards.