

Vineyard Evaluation of Five Beneficial Insect-Attracting Native Plant Ground Covers as a Strategy to Improve and Sustain IPM in Wine Grapes

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Abstract: Arthropod pest management in Washington wine grapes is low input and based on conservation biological control (CBC). Sustainability depends on maintenance of year-round populations of pest natural enemies (PNE) in and near vineyards. Restoration of native habitat, primarily plants upon which endemic natural enemies depend for resources, should help maintain and sustain PNE populations in grapes. We have recently identified a number of native plant species attractive to a variety of PNE, with potential as ground covers for enhancing and sustaining CBC in wine grape vineyards. This project established, 5 native plant ground covers (*Achillea millefolium* (Yarrow), *Asclepias speciosa* (Showy Milkweed), *Eriogonum compositum* (Northern buckwheat), *Eriogonum heracleoides* (Parsnip buckwheat), *Monardella odoratissima* (Coyote mint)) in a WSU wine grape vineyard at Prosser, WA. The project also obtained data on the abundance of arthropod pests and natural enemies in the vineyard comparing native plant and resident vegetation plots. This project is also notable in that prison inmates contributed for the first time in Washington to agricultural research by processing and evaluating leaf samples for arthropods. This project addresses wine grape industry priority areas by being biologically intensive and enhancing environmental sustainability of wine grape production in eastern Washington.

Project Description: Conservation biological control (CBC) of insects and mites is the central element of integrated pest management (IPM) in Washington wine grapes. However, sustainability of this low pesticide-input IPM varies from location to location and season to season. All of the arthropod pests that affect wine grapes in eastern Washington are endemic and regulated by natural enemies. These natural enemy communities occupy native habitats and vegetation, which in eastern Washington are primarily within the dominant shrub-steppe ecosystem. A good way to get predators and parasitoids of wine grape pests closer to vineyards thereby improving efficacy and sustainability of CBC, is to provide the habitat and resources they need either within the crop and/or very close by. Principal needs of natural enemies are shelter, food and hosts for progeny and the provision of these elements in agroecosystems is essential for effective and sustainable CBC of pests. Shelter, food and hosts for progeny are provided by native plants that have co-evolved with pests and their natural enemies. In addition, native plants are also key to the survival and sustainability of other beneficial but threatened insects including pollinators like native bees,

wasps and butterflies. Native plants in eastern Washington are drought-adapted and require little to no supplementary moisture, a pre-requisite for widespread adoption in regional vineyards. In the Pacific Northwest virtually nothing is known concerning the relationships and associations of pest natural enemies with specific native plants, although a companion project is beginning to yield data. Wine grape vineyards in eastern Washington are often located in irrigated former shrub-steppe habitat and may be at some distance from natural areas of shrub-steppe. Field and plot studies conducted on > 100 native plants in eastern Washington during 2011-12 identified five species (*Achillea millefolium*, *Asclepias speciosa*, *Eriogonum compositum*, *Eriogonum heracleoides*, *Monardella odoratissima*) with substantial attraction to a range of natural enemies of wine grape pests and potential for use as vineyard ground covers. This project has begun the process of evaluating the impact of ground covers based on these five native plant species, on pest and natural enemy populations as well as crop parameters in wine grape vineyards.

OUTPUTS: Work Completed

Establishment: Ground cover plots of 5 native plant species (*Achillea millefolium* (Yarrow), *Asclepias speciosa* (Showy Milkweed), *Eriogonum compositum* (Northern Buckwheat), *Eriogonum heracleoides* (Parsnip Buckwheat), *Monardella odoratissima* (Coyote Mint) were successfully established in mid May 2013 on the Roza vineyard property of WSU-Prosser. Forty plants of each species were established in each plot (~3' x 18') bordered on each of two sides by 3 grapevines. All plants were seedling plugs except for *A. speciosa*. This species was obtained by digging up dormant roots locally and planting them. Ground cover plots were separated by non-planted grass/weed plots. Three plots were established for each plant species in each of two grape varieties (Chardonnay and Merlot). Drip irrigation was provided for the ground cover plants in 2013 but not 2014. Missing plants of all species were replaced with new plugs (or dormant roots [*A. speciosa*]) in October 2013. Establishment of ground cover plants was evaluated after 4, 8 and 52 weeks and 17 months (Table 1). Establishment and survival was good for all species except *A. speciosa* and *M. odoratissima*. The summer of 2014 was particularly hot and dry so the high survival of *A. millefolium*, *E. heracleoides* and *E. compositum* in the absence of supplemental irrigation is noteworthy. Some evidence of new seedling establishment was also seen with these species and data on this will be collected in 2015.

	planted on	week 4	week 8	1 year	17 months	Percentage
	5/16/2013	6/21/2013	7/17/2013	5/22/2013	9/30/2014	survival
<i>A. speciosa</i>	240	145	115	113	100	41.7
<i>E. heracleoides</i>	240	229	221	236	228	95
<i>E. compositum</i>	240	239	236	212	201	83.7
<i>A. millefolium</i>	240	238	238	234	232	96.7
<i>M. odoratissima</i>	240	227	217	105	87	36.2

Table 1. Summary of native plant survival in vineyard plots.

Arthropod monitoring: In each ground cover plot, six leaves were taken randomly from mid-canopy on 4 occasions (June 23, July 7, July 21 and August 4) by collecting at least one leaf from each of the grapevines bordering the plot. Control samples consisted of at least six samples of leaves from grapevines adjacent to grass/weed plots. Three yellow sticky cards were randomly placed mid-canopy in the grapevines in each plot on the same dates and removed after two weeks. Leaf samples were stored at 5 C until examined under a stereomicroscope. All arthropods were identified, counted and recorded. A select group of motivated inmates at the Walla Walla State Penitentiary (WSP) were trained by us in insect and mite identification during April 2013 and 2014 and conducted all arthropod assessments of grape leaves. A random set of 4-5 samples (i.e. ~10% of the samples collected) were duplicated and read in the WSU Entomology lab to verify the accuracy of WSP assessments.

Results: Spider mites and leafhoppers were the only grapevine pests that occurred in significant numbers in the plots. Numbers of mites were mostly < 10 mites per leaf which is well below the economic threshold. There were no significant differences between mite numbers on grape leaves from different native plant plots ($P = 0.9$ ANOVA). Similarly there were no significant differences between numbers of leafhoppers from different native plant plots. Numbers of all beneficial insects (all groups combined) generally averaged between 30-50 per sticky trap during the summer in all native plant plots except *A. millefolium* (Yarrow) where numbers were significantly greater ($P < 0.001$, Fig. 1). Examination of data on abundance of parasitic wasps also showed significantly greater numbers in Yarrow plots in both grape varieties ($P < 0.001$, Fig. 2). Greater numbers of *Anagrus* (leafhopper parasitoids) were also found in Yarrow plots. Many other kinds of beneficials (e.g. lacewings, ladybeetles) showed a trend towards higher abundance in native plant plots compared to control plots although differences were not statistically significant.

Key Outcomes:

Five native plant species (Yarrow, Milkweed, Northern Buckwheat, Parsnip Buckwheat, Coyote Mint) selected after three years evaluation for high attractivity to beneficial insects, are beginning to show potential as vineyard ground covers in a trial at WSU-Prosser. All were successfully established from plugs or rootstocks with Yarrow and the two buckwheats showing the greatest rates of survival. All species survived without supplemental irrigation in the second year of establishment. Flowering occurred in all species in 2014 and some differences were detected in the abundance of beneficial insects occurring in vines in different ground cover plots. Yarrow plots, which had the greatest numbers of flowers over the longest period of time, had significantly greater numbers of beneficial insects in adjacent grapevines compared to other ground cover plots. The bulk of these beneficial insects were parasitic wasps including the leafhopper parasitoids, *Anagrus* spp. There was a trend of increased abundance

of beneficial insects in native ground cover plots compared to resident vegetation plots.

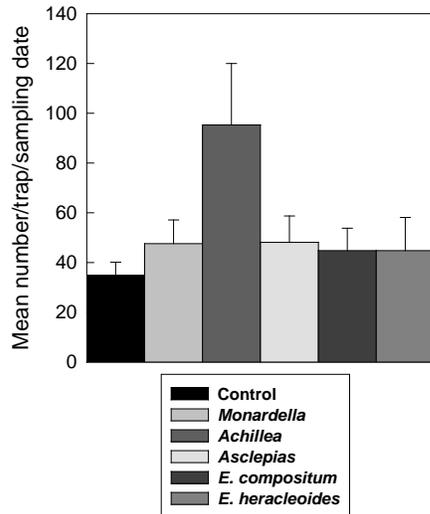


Figure 1. Beneficial insect (all groups) abundance in Merlot native plant plots during June-August 2014

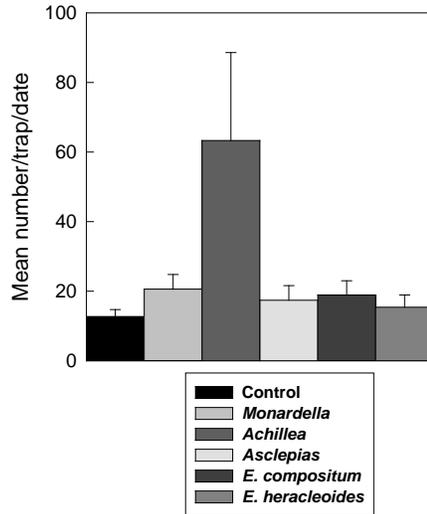


Figure 2. Parasitic wasp abundance in Merlot native plant plots during June-August 2014

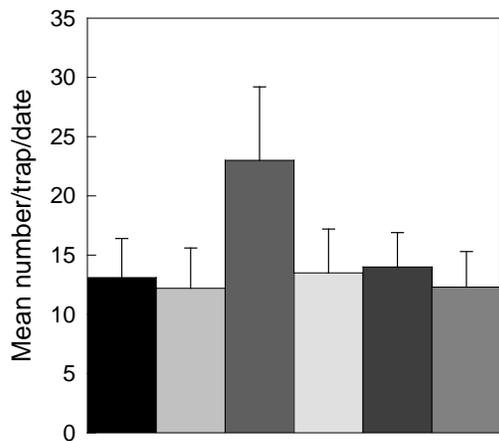


Figure 3. Parasitic wasp abundance in Chardonnay native plant plots during June-August 2014

Outputs: Conference Proceedings

Buckley, K., Seymour, L., Lauby, G. and James, D. (2014). Native habitat restoration in wine grape vineyards as a pest management strategy. *Entomological Society of America Annual meeting, Portland, OR.*

Buckley, K., Lauby, G., Seymour, L. and James, D.G. (2014). Native Habitat Restoration: An IPM strategy for vineyards. *Washington Association for Wine Grape Growers Annual Meeting (Poster).*

Book contribution

James, D.G. (2014). Pest management in Washington State vineyards: Case study. Pp. 26-27 *In Farming with Native Beneficial Insects: Ecological pest control solutions. The Xerces Society Guide. Storey Publishing MA.*

Scientific papers

James, D.G., Seymour, L.S., Lauby, G. and Buckley, K. (2014). Beneficial insects attracted to native flowering buckwheats (*Eriogonum Michx.*) in central Washington. *Environmental Entomology 43: 942-948.*

James, D. G., Seymour, L., Lauby, G. and Buckley, K. (2014). Beneficial insects associated with stinging nettle (*Urtica dioica* Linnaeus) in central Washington State. *Pan-Pacific Entomologist 91: 1-9.*

Olmstead, M. and D.G. James (2014). Cover-cropping in vineyards to manage pest populations effectively. *American Pomological Society (in Review).*

James, D. G., Seymour, L., Lauby, G. and Buckley, K. (2014). Beauty with benefits: Butterfly conservation in Washington State, USA, wine grape vineyards. *Journal of Insect Conservation* 19: 341-348

Presentations/Workshops (Invited)

James, D. G. (2014). Life histories, conservation and a charismatic link with nature. *Native Plant Society, Tri-Cities, WA. May.*

James, D. G. Seymour, L., Lauby, G. and Buckley, K. (2014). Beauty with Benefits: Butterfly conservation in Washington State, USA, wine grape vineyards. *UK Butterfly Conservation Conference, Southampton, England. April.*

James, T.S. and James, D.G. (2014). When plants talk, insects listen. *Cowiche Canyon Conservancy-Yakima Valley Community College Seminar Series. Yakima.*

Web sites

Web site: Vineyard Beauty with Benefits: Restoring Habitat for Beneficial Insects (Facebook) <http://www.facebook.com/pages/Vineyard-Beauty-with-Benefits-Restoring-Habitat-for-Beneficial-Insects/112777002135559?sk=wall>

Web site: Vineyard Beauty with Benefits: Developing vineyard refugia for beneficial insects and sustainable pest management in Washington State, USA. <http://www.wavineyardbeautywithbenefits.com/>



Figure 3. *Coyote mint (Monardella odoratissima)* established in the WSU-Prosser vineyard.

Impacts:

The short term impact of this project to the Washington wine grape industry is identification of native, drought-adapted plants that will establish, grow and survive well in vineyards, while serving as a resource and habitat for biological control agents responsible for controlling grape pests like spider mites, rust mites, leafhoppers, mealybugs and cutworms. Our selected native plants are now established and are beginning to yield data on beneficial insect abundance and impact and compatibility with grapevines over the next few years.

Currently, there are no commercially available, IPM-enhancing ground covers that will survive in eastern Washington vineyards without regular irrigation. The availability of one or more ground covers to fit this purpose will provide a significant and welcome benefit to viticulture in this region. Adoption of a native plant ground cover by wine grape growers is expected to be rapid (< 5 years) given the benefits already being demonstrated and the expected ease of cultivation and maintenance.

Long term benefits of resilient and hardy native ground covers on wine grape IPM will be considerable in terms of sustaining biological-based pest control. Substantial industry-wide decreases in pesticide inputs and environmental contamination are expected a decade after implementation, along with increases in farm profitability.

Additional Funding Applied For:

Funds to continue monitoring the WSU-Prosser wine grape vineyard ground cover trial are being sought from the Washington Association of Wine Grape Growers and the Washington Nursery Association. The latter agreed to fund continuation of this project from July 2015.

Graduate Students Funded: BIOAg funding partially supported a graduate student in this research, Katie Buckley (MS).

Recommendations for Future Research: Additional native plant species should be trialed for their suitability as vineyard ground covers. From our listing of high-ranking native plants in terms of beneficial insect attraction, there are at least an additional 12 species that may be suitable as ground covers. Some of these may perform as well or better than the five we have trialed to date.