

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

**Principal Investigator:** David G James, Assoc. Professor, Dept of Entomology, WSU-Prosser

**Cooperators:** Markus Keller, Professor of Viticulture, WSU-Prosser, Robert Branscum, Sustainable Practices Laboratory, Washington State Penitentiary, Walla Walla

**Key Words:** Beneficial insects, native plants, vineyards, sustainability, biological control, integrated pest management

**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*, *Asclepias speciosa*, *Eriogonum compositum*, *Eriogonum heracleoides*, *Monardella odoratissima*) in a WSU wine grape vineyard at Prosser, WA. The project also obtained baseline data on the incidence and abundance of arthropod pests and natural enemies in the vineyard to enable comparisons between native plant plots in future years. This project is also notable in that prison inmates contributed for the first time to agricultural research by processing and evaluating leaf samples for arthropods. This project addresses BIOAg and 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 (James et al. 2002, James and Prischmann 2011). 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 attendant suites of natural enemies (Prischmann et al. 2007). These natural enemy communities occupy native habitats and vegetation, which in eastern Washington are primarily within the dominant shrub-steppe ecosystem (James and Price 2004). 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 (Mader et al. 2011). 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 (James, 2011 and unpub 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*, *Asclepias speciosa*, *Eriogonum compositum*, *Eriogonum heracleoides*, *Monardella odoratissima*) were successfully established in mid May 2013 on the Roza vineyard property of WSU-Prosser. 40 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 to optimize establishment and growth. Ten emitters (WP JR, 0.5 GPH) delivered water to each plot from a single tube running down the center of the plots (22 inches between each emitter). Establishment of ground cover plants was evaluated after 4, 8, 13 and 17 weeks (Table 1, Fig. 1).

|                        | planted on | week 4    | week 8    | week 13   | week 17   | Percentage |
|------------------------|------------|-----------|-----------|-----------|-----------|------------|
|                        | 5/16/2013  | 6/21/2013 | 7/17/2013 | 8/21/2013 | 9/19/2013 | survived   |
| <i>A. speciosa</i>     | 240        | 145       | 115       | 114       | 110       | 46         |
| <i>E. heracleoides</i> | 240        | 229       | 221       | 218       | 214       | 89         |
| <i>E. compositum</i>   | 240        | 239       | 236       | 233       | 228       | 95         |
| <i>A. millefolium</i>  | 240        | 238       | 238       | 234       | 232       | 97         |
| <i>M. odoratissima</i> | 240        | 227       | 217       | 213       | 212       | 88         |

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

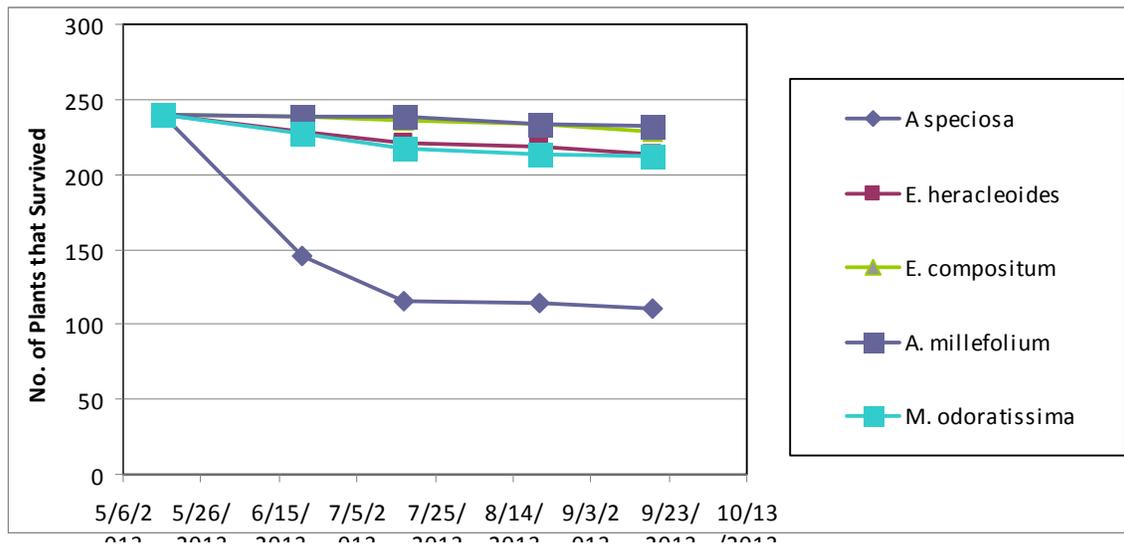


Figure 1. *Plant survival during the 3 months after planting*

Establishment and survival was good for all species (88-97%) except *A. speciosa* (46%). This was likely related to the fact that dormant roots rather than seedling plugs were used for this species. Missing plants of all species were replaced with new plugs (or dormant roots [*A. speciosa*]) in October 2013.

**Arthropod monitoring:** In each ground cover plot, six leaves were taken randomly from mid-canopy on 5 occasions (July 22, August 4, August 19, September 4, September 17) 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. Five yellow sticky cards were randomly placed mid-canopy in the grapevines 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 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 were the only grapevine pest that occurred in significant numbers in the plots. However, numbers only ranged from 0 to 7.5 mites per leaf which is well below the economic threshold (~ 15-20 mites/leaf). There were no significant differences between mite numbers on grape leaves from different native plant plots ( $P = 0.9$  ANOVA) (Fig. 2).

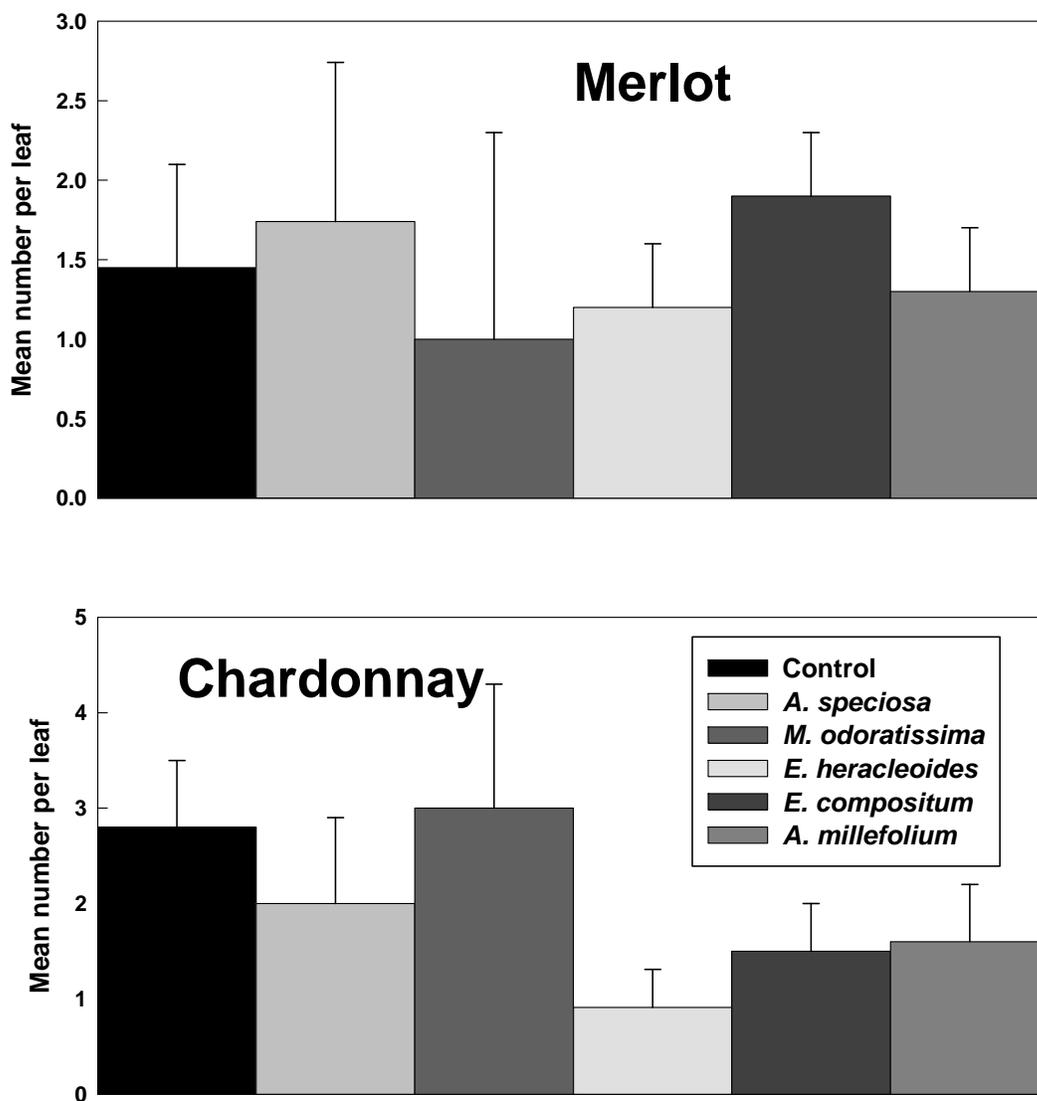


Figure 2. Abundance of spider mites on Merlot and Chardonnay grape leaves in different native plant plots during summer 2013. There were no significant differences between plots ( $P = 0.9$ ).

Sticky traps caught a mean of 92 beneficial insects per trap ( $n = 50$  traps). Dominant groups of beneficials included predatory thrips, parasitic wasps, mite-eating ladybeetles and the leafhopper parasitoid, *Anagrus* spp. The beneficial insect fauna of this vineyard is clearly robust and should allow good opportunities in future years to determine the influence of native plants on abundance.



Figure 3. Yarrow (*Achillea millefolium*) established in the WSU-Prosser vineyard.

***Publications, Handouts, Other Text & Web Products:***

James, D.G., Seymour, L., Lauby, G. and Buckley, K. (2013). Beauty with Benefits: Naturescaping Washington vineyards to sustain biological control and provide butterfly habitat. Proceedings of the [International Symposium on Biological Control of Arthropods](#), Pucon, Chile 195-197.

Buckley, K., James, D.G., Seymour, L. and Lauby, G. (2013). Habitat restoration as an IPM strategy in Washington vineyards. Entomological Society of America, Pacific Branch, Lake Tahoe, NV (Poster).

James, D.G. (2013). Research identifies native plant species that have the potential to improve biological pest management in vineyards. WSU Viticulture and Enology Extension News, Spring p 2-3.  
<http://wine.wsu.edu/research-extension/files/2013/04/2013-VEEN-Spring-FINALsmaller.pdf>

James, D.G. (2013). Mites and microscopes: inmates helping with IPM. WSU Viticulture and Enology Extension News, Fall p 2. <http://wine.wsu.edu/research-extension/files/2010/07/2013-VEEN-Fall-Final.pdf>

**Outreach and education activities:**

James, D.G. (2013). Pollination and Pollinators. Cowiche Canyon Conservancy Lecture Series, Yakima, WA.

James, D.G. (2013). Pollination and Pollinators. WSU Master Gardeners, Yakima.

James, D.G. (2013). Beauty with benefits: Naturescaping vineyards for biological control and vineyards. New Zealand Monarch Butterfly Trust Conference, Auckland, NZ, (March).



Figure 4. *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 should begin yielding data on impacts on beneficial insects 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 (e.g. James 2011, 2013) 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:** A new project (Implementation of Native Habitat Enhancement for Sustainable IPM and Butterfly Conservation in Washington Vineyards) was submitted to WSARE in October 2013. This project incorporates the vineyard plot work reported here but also aims to begin the process of implementation of habitat enhancement in commercial vineyards.

**Graduate student funded:** Funding from BIOAg helped support a PhD student, Katie Buckley.

**Recommendations for future research:** Clearly, this research is incomplete. The first year of this project was devoted to establishment of native plant ground covers in a vineyard setting and collection of baseline data on pest and natural enemy populations. Both objectives were completed and future research will now be directed towards obtaining data that compares the performance of the selected native plant ground covers in terms of beneficial insect attraction, pest reduction and impact on grape production. Information on the cultivation and agronomy of growing these native plants is another important aspect of future research.

#### **References cited:**

James, D. G. (2011). Attraction of beneficial insects to native plants in the Yakima Valley. *The Sweep Net* (April) pages 2-3. USDA-NRCS, Pullman Plant Materials Center.

James, D.G., Price, T.S., Wright, L.C. and Perez, J. (2002). Abundance and phenology of mites, leafhoppers and thrips on pesticide-treated and untreated wine grapes in Washington State. *Journal of Agricultural and Urban Entomology* 19: 45-54.

James, D.G. and Price, T.S. (2004). Field-testing of methyl salicylate for recruitment and retention of beneficial insects in grapes and hops. *Journal of Chemical Ecology* 30: 1613-1628.

James, D.G. and Prischmann, D.A. (2011). The impact of sulphur on biological control of mites in Washington State vineyards and hop yards. *Trends in Acarology: Proceedings of the XXII International Conference of Acarology* 477-482.

Mader, M., Shepherd, M., Vaughan, M., Black, S. H. and LeBuhn, G. (2011). *Attracting Native Pollinators (Xerces Society Guide)*. Storey Publishing, MA. USA. 371 pp.

Prischmann, D.A., James, D.G., Storm, C.P., Wright, L.C. and Snyder, W.E. (2007). Identity, abundance and phenology of *Anagrus* spp. (Hymenoptera: Mymaridae) and leafhoppers (Homoptera: Cicadellidae) associated with grape, blackberry and wild rose in Washington State. *Annals of the Entomological Society of America* 100: 41-52.