Final Report
This is year 3 of a 3 year proposed project.
For the Washington State Grape & Wine Research Program

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Project Title: GRAPEVINE MITES: CURRENT STATUS IN EASTERN WASHINGTON VINEYARDS

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Summary of Project Results:
A survey of the mite fauna in eastern Washington vineyards over a three year period (2013-15) indicated that spider mites occured in about 50% of vineyards but the majority of these (> 75%) had non-damaging populations. The few vineyards that had damaging populations may have created mite outbreak situations by regularly using neonicotinoid insecticides. Willamette Spider Mite is present in some central Washington vineyards and was responsible for more than half of the damaging mite populations observed in this study. Pacific Spider Mite may be present in Washington vineyards. A new eriophyid mite, Blister Mite, was recorded in commercial vineyards in central Washington for the first time. Rust mites occurred at low, non-damaging levels during this survey. A diverse fauna of predatory mites (at least seven-eight species of phytoseiids and tydeids) occurred in about 50% of vineyards and is likely in part responsible for low spider mite populations.

I Project Summary: 1. What is the current issue and why does it need to be researched?
During the past decade mites appear to have decreased in importance as wine grape pests in eastern Washington. Spider mites, principally twospotted mite (*Tetranychus urticae*) and McDaniel's mite (*Tetranychus mcdanieli*) were significant pests in Washington vineyards in the late nineties and early this century. The decline in their pest status appears to be associated with the reduced use of broad-spectrum insecticides (e.g. Carbaryl, Lorsban) documented for Washington vineyards (Prischmann et al. 2005, Ferguson et al. 2007). Spider mite outbreaks in vineyards are now uncommon, populations likely controlled by stronger communities of natural enemies associated with reduced pesticide inputs (Prischmann and James 2003). In 2005 the reduction in spider mite problems was replaced by outbreaks of other mites, specifically eriophyid or rust and bud mites (Walton et al. 2007). These had likely been suppressed by the former pesticide regime. Fortunately, their impact was short-lived with strategic applications of sulfur pre bud-burst, sufficient to maintain populations below damaging levels. Currently, spider, rust and bud mites can be considered occasional, minor pests but the potential for local problems still exists if broad-spectrum sprays are used

or natural enemy populations decline. The threat of new grapevine mite pests is also real. Additional eriophyid mite species (blister mites, leaf curl mites) have recently been detected in some Yakima Valley vineyards. The distribution of these mites in eastern Washington vineyards and their potential to cause economic damage is unknown. An additional spider mite species (Willamette mite, *Eotetranychus willamettei*) was discovered in 2012 with high densities causing leaf damage, warranting miticide applications, in an Oregon vineyard near Walla Walla. This detection was considered unusual since this species is considered to prefer more humid, cooler regions like the Willamette Valley where it is endemic. The possibility exists that the Walla Walla version of Willamette mite is better adapted to hot, dry conditions, posing an increased threat to eastern Washington grapes. Whether Willamette mites are present in other eastern Washington vineyards is unknown. The current status of grapevine mites in eastern Washington vineyards is imperfectly known. Grower preparedness and sustainability of current status will benefit from a better understanding of the species present and their relative abundance. An assessment of the incidence and abundance of predatory mites is also important so we can assess the role that biological control is playing in maintaining sub-economic levels of mites. The threat posed by 'new' mite species also needs to be evaluated.

2. What are the basic methods and approaches used to collect data that are used to inform target audience?

Extensive surveying and sampling for mites in Washington vineyards was last conducted during 2001-2002, when ~ 50 vineyards in four regions were visited and evaluated (Prischmann et al. 2005). A similar approach will be taken this time. Vineyards will be selected in the same four regions (Walla Walla, Yakima Valley, Columbia River and Quincy Basin) and sampled in the same way. Inmates at Washington State Penitentiary (WSP) will be utilized to examine grape leaves and record data (at no cost to the project). Some samples will be examined by staff at WSU-Prosser. Information on sprays applied at each vineyard will also be obtained. Vineyards where 'new' mite species have been seen in recent years, together with additional vineyards nearby, will be sampled during June-August for the presence of these mites, to determine the extent and density of infestations. These samples will be examined by WSU-Prosser staff.

3. What ultimate goals does the project hope to achieve?

This project is guaranteed to result in an improved understanding of the current status of grapevine mites in eastern Washington vineyards. Processing of the large number of samples emanating from this research (> 2000 leaves/season) is made possible by recruitment and training of a select group of enthusiastic, fastidious and conscientious inmates at WSP. Employment of scientific technicians to do the proposed work at WSU-Prosser would double the budget. This project will benefit the Washington wine grape industry by providing information on the current status of mite populations in eastern Washington vineyards. This information will hopefully confirm the sustainability of natural regulation of mites in vineyards and provide details on how it is being achieved. This knowledge in turn, may allow fine tuning of the system to ensure sustainability and identify factors that may cause disruption. Information on 'new' potential pest mite species that may exist in some vineyards will provide forewarning and allow measures to be put into place to ameliorate threats to grape production.

II Materials, Methods and Experiments Conducted to Meet Stated Objective(s):
Leaf samples (20 leaves/vineyard block) were collected during June-August (when spider mite populations are at their greatest) in 2013, 2014 and 2015 from 79 vineyard blocks in the Walla Walla, Yakima Valley, Columbia River and Quincy Basin regions (Table 1). Leaves were placed in individual plastic bags, labeled, and stored in coolers (<15ºC) for transport to either WSU-Prosser or the Washington State Penitentiary (WSP) in Walla Walla. The majority of leaf samples in 2013 and 2014 were examined by a small group of selected and motivated inmates at WSP who were specially trained by an experienced technician (Lorraine Seymour) during early summer to identify mites and other arthropods.

Major Research Accomplishments:
Objectives
1. *Survey the incidence and abundance of pest and beneficial mites on grapevines in eastern Washington.*
2. *Map the distribution of 'new' potential pest mite species in eastern Washington Grapes and assess their importance.*

Survey
The following announcement was placed in Washington State University's 'Viticulture and Enology Extension News as well as on other industry online resources.

MITE SURVEY IN WA

Researchers at WSU-IAREC are conducting a survey to understand the various mite populations present in the major winegrape regions of WA.

If you have had mite problems in the past, or are noticing any leaf-bronzing in your vineyard, and are interested in participating in this study, please contact Lorraine Seymour at: Lseymour@wsu.edu or 509-832-2821.

Limited responses were received and most of our sampling site choices were made by us.

Ninety five leaf samples were obtained from 79 wine grape vineyard blocks in the Walla Walla, Yakima Valley, Columbia River and Quincy Basin regions during June - August 2013-2015 (Table 1).

Location	Number of vineyards	Number of samples	Dates (2013)
Paterson	**1**	**4**	**July 25**
Grandview	**2**	**5**	**Aug 8 & 23**
Zillah	**3**	**3**	**Aug 9**
Mattawa	**4**	**6**	**Aug 26**
Quincy	**3**	**3**	**Aug 26**
Wallula gap	**1**	**1**	**Aug 27**
Red Mountain	**4**	**5**	**Aug 30, Sep 3 & 4**
Lyle	**1**	**1**	**Sep 4**
The Dalles	**1**	**1**	**Sep 4**
Walla Walla	**4**	**4**	**Aug 28**
Prosser	**1**	**3**	**Oct 1**
Kennewick	**1**	**3**	**Aug 20**
TOTAL (2013)	**26**	**39**	

Location	Number of vineyards	Number of samples	Dates (2014)
Paterson	**2**	**5**	**June 16, July 2, 17**
Prosser	**1**	**1**	**Aug 14**
Basin City	**1**	**1**	**July 17**
Mattawa	**3**	**3**	**June 17, Aug 4**
Horse Heaven Hills	**3**	**3**	**July 24, 28**
Red Mountain	**6**	**5**	**July 2, Aug 19**
Lyle	**3**	**3**	**June 25, 27**
Walla Walla	**9**	**9**	**July 18, Aug 6**
TOTAL (2014)	**28**	**30**	

Location	Number of vineyards	Number of samples	Dates (2015)
Tri-Cities	**1**	**2**	**June 16, 30**
Red Mountain	**5**	**5**	**June 17, 23, July 7, 22**
Benton City	**3**	**3**	**June 23, July 22**
Sunnyside	**3**	**3**	**June 29**
Prosser	**7**	**7**	**July 8, 13, 14**
Alderdale	**6**	**6**	**Aug 4, 10**
TOTAL (2015)	**25**	**26**	
TOTAL (2013-15)	**79**	**95**	

Table 1. Sampling and site details for the mite survey during 2013, 2014 and 2015

Spider mites were found in 41 (51.9%) of the 79 vineyard blocks sampled during the three year study. The majority of these blocks (31) had non-damaging populations of less than 5 spider mites per leaf. Population levels in the remaining 10 blocks varied between 26-242 spider mites per leaf (see 2014 and 2015 progress reports for annual data). These data indicate that economically damaging populations of spider mites are uncommon in Washington wine grape vineyards (~13% of vineyard blocks sampled in three years). Of the 41 instances where spider mites were found, 14 (34.1%) comprised McDaniel spider mite, 6 (14.6%) comprised Twospotted spider mite and 5 (12.2%) comprised Willamette spider mite. Mixed populations of McDaniel and Twospotted spider mites occurred in 4 blocks (9.7%) while spider mite species was undetermined in 22 blocks (53.6%) because only nymphs or eggs were found. Willamette (5 blocks) and McDaniel spider mites (4 blocks) were responsible for 9 of the 10 blocks in which economically damaging populations of spider mites occurred. The remaining block had a mixed population of McDaniel and Twospotted spider mites.

Prior to commencement of this study in 2013, we knew of only two spider mite species present in eastern Washington wine grape vineyards, Twospotted spider mite (*Tetranychus urticae*) and McDaniel's spider mite (*Tetranychus mcdanieli*). During 2013 sampling we detected the presence of Willamette spider mite (*Eotetranychus willamettei*) in a Red Mountain vineyard. Confirmed by mite systematist Frederic Beaulieu, Canadian National Collection of Insects, Ottawa, this was the first record of Willamette spider mite on grapes in central Washington. *Eotetranychus willamettei* was also found in 2013 at a vineyard near Walla Walla just over the state line in Oregon. Both detections of this species involved damaging levels of mites (20-25 mites/leaf). In 2014 Willamette spider mite was found in three additional vineyards bringing the number of wine grape vineyards infested with this

species in eastern Washington and eastern Oregon to five (Red Mountain, Walla Walla, Horse Heaven Hills). In all instances to date, Willamette mite infestations have been characterized by large numbers (25-113 mites per leaf) occurring in late July and August, in the virtual absence of predatory mites. No new occurrences of Willamette mite were detected in 2015 and it does not appear that this species is colonizing Washington vineyards aggressively. However, it is perhaps pertinent to note that half of the incidents of damaging spider mite populations seen during this study were caused by Willamette spider mite.

McDaniel's spider mite has historically been considered the dominant spider mite species in Washington grapes and the data from this survey support this. However, Dr Beaulieu has tentatively identified most of our supposed *T. mcdanieli* as the Pacific spider mite (*Tetranychus pacificus*). The Pacific spider mite is the major spider mite pest of grapes in California. Clearly it is important that we clarify the species identity of our spider mites in Washington grapes and are currently engaging the services of another mite systematist for a second opinion. Pesticide susceptibilities and resistance profiles differ between McDaniel and Pacific spider mites and correct identification of spider mite pests is key to optimal efficacy of both chemical and biological control.

Neonicotinoid insecticides are frequently used by Washington grape growers and research conducted by us almost a decade ago showed the neonicotinoid insecticides imidacloprid (Admire, Provado™) has the potential to increase fecundity and populations of spider mites (James and Price 2002). A link between imidacloprid use and damaging spider mite populations was suspected in at least one of the incidents of damaging spider mite populations seen during this study. Other neonicotinoid insecticides (thiamethoxam, dinotefuran acetamaprid, thiacloprid) are also registered for use in grapes and may also cause spider mite outbreaks although this has not been researched. In at least one of the three vineyards high dust levels and hot, windy conditions likely exacerbated spider mite problems in 2014. However, the extremely hot, dry conditions of 2015 (hottest summer on record!) did not appear to produce increased spider mite problems.

Blister mite or Erineum mite (*Colomerus vitis*), an eriophyid mite similar to Rust and Bud mite, was confirmed in 2014 for the first time occurring at high densities in commercial vineyards in eastern Washington. Although previously known from backyard grapevines, significant populations had not been known from commercial vineyards. In 2014, large populations of blister mites were found in two vineyards at Basin City and Paterson. Blister mites as their name suggests, cause blistering of grape leaves, a single mite capable of causing a large blister. Leaves may become completely blistered. However, damage is cosmetic only. Blister mite damage looks ugly but will not affect grapevine health, production or quality. Its occurrence in eastern Washington particularly during the hot season of 2014 is unusual because it usually prefers moister, cooler conditions than we experience. Thus, it occurs more commonly in the Willamette Valley. It is likely that Blister mite has always been present in eastern Washington but its presence in commercial vineyards has been suppressed by climate, natural enemies and the use of sulfur. Predatory mites are very effective at regulating Blister mites and were present at both vineyards with Blister mites in 2014, albeit only in low numbers. No blister mites were detected in 2013 or 2015.

Rust mites were present in 38 (40.0 %) of the sampled vineyards at levels from a mean of 0.03 to 1258 per leaf. The majority of infestations comprised very low numbers < 10 per leaf with the single sample of 1258/leaf in 2013 being the only occurrence of more than 100/leaf. Rust mites during this survey were generally at levels unlikely to cause problems with restricted spring growth.

Predatory mites (Phytoseiidae) were present in 47 (49.5 %) of the sampled vineyards ranging in abundance from .03 to 7.0 mites per leaf. A number of species were present including *Galendromus occidentalis, Metaseiulus flumenis, Metaseiulus citri, Typhlodromus caudligans, Typhlodromus pyri and Euseius finlandicus.* All these species were seen in 2014 and all except *E. findlandicus* in 2013. Samples from 2015 have yet to be identified.

Tydeid mites (fungivores and predators) were found in 66 of the sampled vineyard blocks (69.5%) ranging in abundance from 0.05 to 39.2 mites per leaf. In most instances numbers ranged from 5-10 per leaf.

Sample processing at WSP

Inmates at the WSP worked on processing the leaf samples from these vineyards. Sub samples were taken in most instances and processed by staff at WSU-Prosser to determine accuracy of the inmates. Accuracy of the counts was good and by the end of the season our system of dropping off samples at the WSP and obtaining completed data sheets some days or weeks later was working effectively and well. Substantial interest and enthusiasm was shown by the inmates with many notes and questions relayed to us. The WSP personnel were also very pleased with the response of the inmates to this scientific task. It is clear that utilization of this 'committed' task force presents us with significant opportunities for leaf and sticky trap processing for arthropod identification and counts in the future.

Key Outcomes

1. Surveying grapevine mite incidence and abundance in eastern Washington grapevines was conducted during 2013-15 with 79 vineyard blocks surveyed and 95 leaf samples collected.
2. Spider mites, historically the most important mite pest of Washington grapes, were present in 51.9% of vineyard blocks sampled.
3. The majority of these blocks (75.6 %) had non-damaging populations of spider mites (< 5 mites/leaf).
4. Willamette spider mite was recorded from five wine grape vineyards.
5. Five of the 10 incidents of damaging spider mite populations detected were caused by Willamette mite.
6. A new spider mites species to Washington grapes, Pacific spider mite, may have been recorded (previously confused with McDaniel mite) from some vineyards but we are awaiting confirmation.
7. A new eriophyid mite, Blister mite was recorded for the first time at high levels in two eastern WA wine grape vineyards in 2014.
8. Rust mites were present in 40 % of vineyards and mostly at low, non-economic levels.

9. Phytoseiids (predatory mites) were present in 49.5 % of vineyard blocks and included six species.
10. Tydeid mites (predators, fungivores) were present in 69.5 % of vineyard blocks.
11. This survey indicates that spider mites are an infrequent pest problem in Washington grapes that are well regulated by a diverse population of predatory mites and other natural enemies. Occasional damaging populations may occur as a consequence of regular use of neonicotinoid insecticides. Willamette spider mite may become an important component of the vineyard mite fauna in Washington.
12. This research confirmed the potential of utilizing prison inmates to perform important but expensive scientific tasks like examining leaves for arthropods and recording these data.

Recommendations

*Studies on the apparent link between the regular use of neonicotinoid insecticides and economically-damaging spider mite outbreaks, need to be conducted. In particular, an assessment needs to be made on whether other neonicotinoids apart from imidacloprid, also cause increases in spider mite reproduction.

*Biological studies on central Washington strains of Willamette Spider Mite are needed to determine whether it differs from western Oregon strains in terms of function and survival under hot-dry conditions. These studies would indicate the economic damage potential of this mite in central Washington.

*Studies are needed to confirm whether Pacific Spider Mite exists in Washington vineyards.

LITERATURE:

Ferguson, H., O Neal, S. and Walsh, D. (2007). Survey says Great Grapes! Washington State University Extension Bulletin 2025E

James, D.G. and Price, T.S. (2002). Fecundity in twospotted spider mite (Acari: Tetranychidae) is increased by direct and systemic exposure to imidacloprid. Journal of Economic Entomology 95, 729-732

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Prischmann, D.A., James, D.G. and Snyder, W.E. (2005). Impact of management intensity on mites (Acari: Tetranychidae, Phytoseiidae) in southcentral Washington wine grapes. International Journal of Acarology 31, 277-288.

Walton, V., Dreves, A. J., Gent, D. H., James, D. G., Martin, R. R., Chambers, U. and Skinkis, P. A. (2007). Relationship between rust mites, *Calepitrimerus vitis* (Acari: Eriophyidae) and short shoot syndrome in Oregon vineyards. International Journal of Acarology 33: 307-318.

How have results been or expected to be disseminated to grape and wine industry stakeholders and audiences of interest?

Results from this project will be disseminated through multiple outreach programs. Our websites and Facebook pages as well as those of the WSU Viticulture and Enology program will be utilized to present findings and other information from the project. The online WSU Viticulture and Enology Extension Newsletter will be used to provide timely progress reports from the project and was used for this purpose in 2013 (http://wine.wsu.edu/research-extension/files/2010/07/2013-VEEN-Fall-Final.pdf). Outreach resources provided by

WAWGG will also be utilized (email noticeline, workshops, meetings etc). Research reports will be provided to industry and scientific journals and presentations/posters prepared for scientific and industry meetings.

Extension Bulletin:
James, D.G. (2013). Mites and microscopes: inmates helping with IPM. WSU Viticulture and Enology Extension News, Fall p 2.

Newspaper article: "Washington State Penitentiary's 'butterfly wranglers' aid wine industry" Walla Walla Union-Bulletin September 26 2013 http://union-bulletin.com/news/2013/sep/26/washington-state-penitentiarys-butterfly-wranglers/

Magazine articles: http://www.goodfruit.com/new-spider-mite-found-in-washington/
http://www.goodfruit.com/inmates-help-with-grape-research/

Project Budget Status:
No significant deviation from original expenditure plan. Approximately 50% of budget remaining as at December 2015.

Other Sources of Funding:
No other sources of funding