FINAL REPORT

Washington State Grape and Wine Research Program
DUE June 30, 2018
by email to: ARCGrants@wsu.edu

(Brief presentation to be given at Research Review – January 18-19, 2018)

PROJECT TITLE: W**eed Management in Washington Wine Grapes: Where Do We Currently Stand and Where Can We Go in the Future**

Project Duration: 1 year
WRAC Project No.:

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Organization		Organization	
Description of participation:		Description of participation:	

FINAL REPORT

BUDGET AND OTHER FUNDING SOURCES

FINAL FINANCIAL REPORTING
BUDGET *13B 3619-5306*

	Year 1 FY	**Year 2 FY**	**Year 3 FY**
	Jul 17 – Jun 18	Jul XX – Jun XX	Jul XX-Jun XX
Total	$9020.00	N.A.	N.A.
Footnotes:			

Total Project Funding: $9020.00

Project Budget Status: This project was a single year project to support (i.e. salary and travel) the extension and outreach activities of a new weed scientist hired by Washington State University (WSU). Specifically, funds were allocated to support the research faculty member as they developed a survey to identify the current weed control practices employed in WA wine grape vineyards and determine which species were of specific concern (in order to develop future research programs). These funds were also provided to help the scientist develop an extension profile. Both of these tasks were accomplished during the course of the grant (July 2017 to June 2018). The survey was distributed and the responses were summarized and published in the Spring 2018 issue of VEEN. Two other VEEN articles were also published (Spring 2017 and Fall 2017) and the 2018 Pest Management Guidelines for Grapes in Washington was expanded and updated. A third component of the project was focused on initiating research to address weed-related concerns in vineyard was less successful. A project was developed to look at the effects of buried drip irrigation on weed community composition in a commercial vineyard was not completed because surface irrigation was applied repeatedly across all plots negating the intended treatment effects. Subsequent trials were developed to describe the perennialization process of field bindweed (*Convolvulus arvensis*) with the intention of understanding the physiological processes that control rhizome bud dormancy and manipulating them to improve control (ongoing).

Project Summary:

Weed control is a critical component of newly established and bearing vineyard production as weeds compete with the crop water, nutrients, and light, which can affect yield quantity and quality. In addition to direct interference, non-managed weeds can negatively affect orchard production by: blocking sprinklers, thereby resulting in micro-sites that are alternately drought- and flood-stressed; supporting populations of insect, rodent, and pathogenic pests detrimental to crop health; and interfering with harvest activities. Furthermore, the chemical products used for weed control can also have adverse effects on vine health if they are applied improperly or at a time when vines are susceptible to injury. Continuing research is needed to evaluate the most effective and sustainable practices managers to optimize (both environmentally and economically) wine grape management programs while reducing the development of herbicide-resistant, or other difficult to control, weed populations.

The primary goal of the project was to develop a survey that could be submitted to WA wine grape growers to describe current weed management practices and determine future weed control needs. Twenty-nine respondents responsible for managing 10,000 acres of vineyards (representing approximately 20% of the total wine grape acreage in WA) completed a voluntary 18 question survey designed to address these concerns. Results from the survey determined that pre- and post-emergence applied herbicides are widely used tools for managing unwanted vegetation under grape vines. Fifty-nine percent of the respondents indicated that they used pre-emergence herbicides for weed control, whereas 83% reported using post emergence products. In addition to herbicides, WA wine grape growers also utilized mowing, cultivation, hand-weeding, and cover crops to suppress weeds. With respect to problematic species and future weed control needs, summer broadleaf species were primarily considered to be a big problem in vineyards, specifically noting *Salsola tragus* (Russian thistle), *Tribulus terrestris* (puncturevine/goatheads/caltrops), *Conyza canadensis* (marestail), *Kochia scoparia* (kochia), *Amaranthus* spp (pigweed), C*entaurea* spp (knapweed). While the identification of new herbicides for use in wine grape systems is desirable, reducing the industry's reliance on chemical control strategies also appears to be of interest to the wine to the survey respondents. Cultivation practices can be an effective alternate weed management strategy; however, growers appear to be interested in minimizing soil disturbance.

The second major goal of the project was to increase the extension and outreach presence of WSU weed science in grape production systems. Consequently, three articles designed to address weed management related concerns were published in WSU's Viticulture and Enology Extension Newsletter (VEEN). The first paper, which was published in the 2017 spring edition of VEEN, entitled 'Understanding Herbicides and Resistance', described 1) the sites of action (SOA) available to grape growers in WA, 2) how herbicides in different Weed Science Society of America (WSSA) SOAs worked to control weeds, and 3) the number of species with resistance to each SOA occurring in the PNW. The second paper was published in the fall of 2017 and described pre-emergence herbicides for use in grapes in the PNW. The article also addressed the biological, physical, and environmental factors affecting herbicide efficacy. The third and last VEEN article, published in spring of 2018, described the results obtained from the previously described grower survey. The 2018 Pest Management Guide for Grapes in Washington was updated to include a new section describing the factors affecting herbicide efficacy such as: the kinds of weeds to be controlled, the size and age of weeds to be controlled, soil type and herbicide incorporation strategy, the quantity and quality of spray water, and the age and health of the vine.

Project Major Accomplishments:

According to the National Agricultural Statistics Service (NASS 2014), Washington (WA) is second only to California with respect to gallons of wine produced (24.5 million) in the United States. Consisting of more than 50,000 acres over 13 American Viticulture Areas (AVAs), WA wine grapes are a significant economic driver in many regions of the state; in 2013, the total economic impact of the WA wine industry approached $5 billion. The value of wine grapes, however, extend beyond pecuniary benefits; wines and wineries also support social networks and help to connect WA's urban citizens with its agricultural residents.

In order to protect yield quantity and quality, growers invest significant amounts of time and money into pest management, which includes weed control. According to the 2014 WA Pest Management Strategic Plan (PMSP) for wine grape production, the critical concerns regarding weeds and weed management include (Moyer and O'Neal 2014):

1. The lack of scientists dedicated to researching vineyard weed management needs and practices;
2. The need for updated, continuing education tools (for growers, third-party certification agencies/entities, county noxious weed control boards, etc…) describing the development, spread, and management of herbicide resistant weeds, particularly species resistant to glyphosate;
3. The desire for more research into the timing of pre-emergence (PRE) and post-emergence (POST) herbicide applications in order to improve weed control, minimize the potential for crop injury, and enhance the economic and environmental sustainability of chemical weed control strategies in WA vineyards; the evaluation of physical and cultural weed control practices to diversify weed control programs and support wine grape growers' commitment to sustainable crop production and integrated pest management.

In January 2017, Washington State University hired Dr. Lynn M. Sosnoskie, part time, to work in specialty crop systems in the Columbia Basin to study the biology, ecology, and management of weeds (including difficult to control perennial species and herbicide resistant weeds). This proposal represented Dr. Sosnoskie's introduction to the wine grape industry in WA and the groundwork for renewed weed science research in vineyards.

Objective(s) of the Proposed Research:

1. *Characterize existing vineyard weed management strategies across WA AVAs and identify current and potential weed threats, including herbicide resistant biotypes;*

2. *Develop/expand continuing education materials describing how weed biology and ecology affects the management of difficult to control weed species in WA grapes (including the development of herbicide resistance; herbicide stewardship; drift management, and crop safety; and best management practices (chemical, physical, cultural) for managing weed species.*

3. *Initiate research trials to evaluate the type and timing of management practices on weed control success.*

Objective 1: Weed Management Survey

In order to provide the most effective management information to grape growers, it is imperative that scientists assess the industry's current weed control strategies and concerns. Surveys of and face-to-face conversations with growers, consultants, and representative of third party agencies will be conducted to a) describe the diversity in chemical, physical, and cultural weed control

programs, b) determine which weedy pests are the most problematic, c) identify suspected herbicide resistant populations (Sosnoskie and Culpepper 2014).

A survey instrument was developed, reviewed by an expert panel (Michelle Moyer (WSU), Rick Boydston (USDA), Timothy Miller (WSU) and Marcelo Moretti (OSU)), revised accordingly, and submitted to the WSU Human Research Protection Program for review. The survey, which was conducted online at the Washington State University (WSU) Qualtrics website (https://surveys.wsu.edu/) was composed on 18 questions divided into five sections that captured the following information: 1) what AVAs are represented and how many acres are managed by the respondents, 2) what pre- and post-emergence herbicides are used underneath the trellis system, 3) what non-chemical weed management strategies are also employed, 4) which weeds are most problematic, and 5) what research needs are important to growers going forward. Links to the survey were forwarded to vineyard managers via the WSU Irrigated Agriculture Newsletter, mailing information managed by www.washingtonwine.org and www.wawinegrowers.org, and through social media (Facebook and Twitter).

Twenty-nine respondents responsible for managing 10,000 acres completed the survey. According to WSU estimates, this represents approximately 20% of the total wine grape acreage in the state. Survey Gizmo indicates that external surveys average response rates of 10-15% whereas internal surveys generate response rates of 30-40% (https://www.surveygizmo.com/resources/blog/survey-response-rates/). This questionnaire was developed and managed by WSU but distributed to a subset of members (i.e. vineyard managers) of the WA wine grape industry and is therefore characterized as an external survey. Most of the respondents the were from the Columbia Valley AVA (16%) (which is the largest AVA in WA), the Horse Heaven Hills AVA (24%), and the Walla Walla Valley AVA (11%). Three to 5% of the respondents managed grapes in each of the remaining WA AVAs excepting Columbia Gorge, Snipes Mountain, Naches Heights, and Ancient Lakes (0% of respondents reported working in these AVAs). Across all respondents, 57% of the wine grape acres were listed as bearing (43% non-bearing), 44% of the acres were listed as USDA certified organic or transitioning to organic (54% not under USDA organic certification), and 14% were listed as LIVE certified (86% not LIVE certified).

With respect to herbicides, 59% of respondents indicated that they had used pre-emergence (PRE) herbicides at some time during the last three years. Surflan (oryzalin, 26% of respondents), Matrix (rimsulfuron, 21%), Alion (indaziflam, 16%), and Chateau (flumioxazin, 5%) were the most commonly used product (Figure 1). Eighty-three percent of all respondents reported using post-emergence (POST) herbicides under the trellis system for weed control at some time during the last three years, with glyphosate containing products (43% of respondents) being the most common choice followed by Aim (carfentrazone, 20%), Rely (glufosinate, 17%), and Gramoxone inteon (paraquat, 5%) (Figure 2).

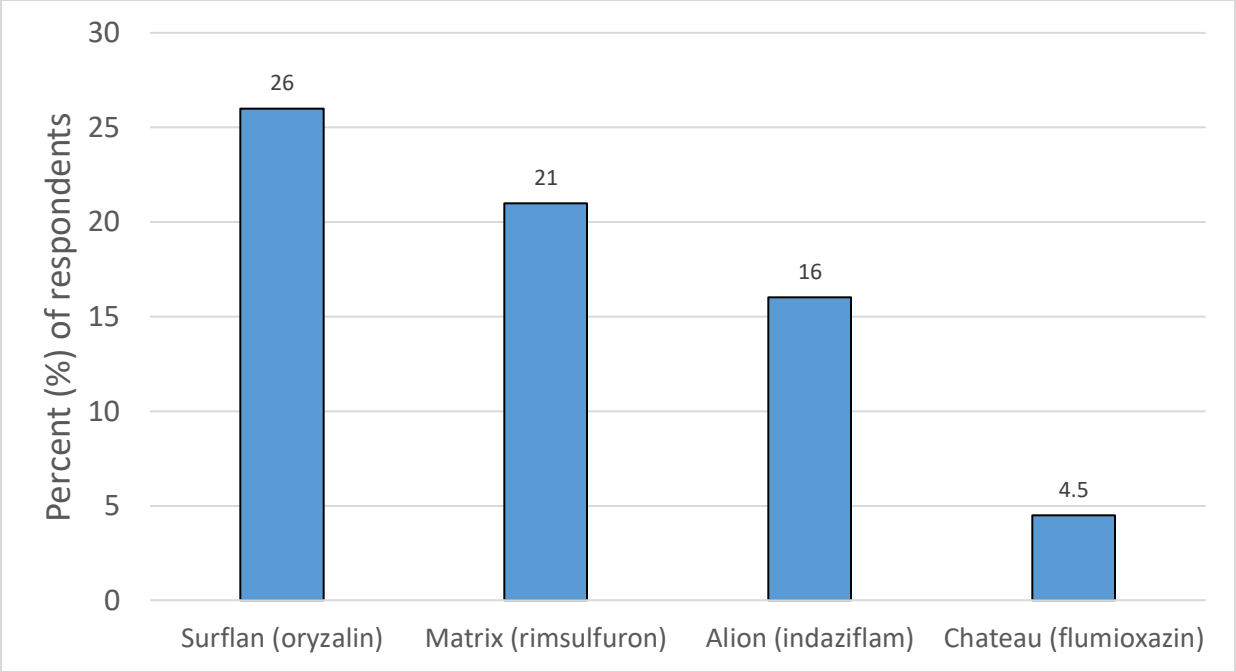

Figure 1. The most commonly used PRE herbicides in WA wine grapes according to a survey of wine grape growers and vineyard managers.

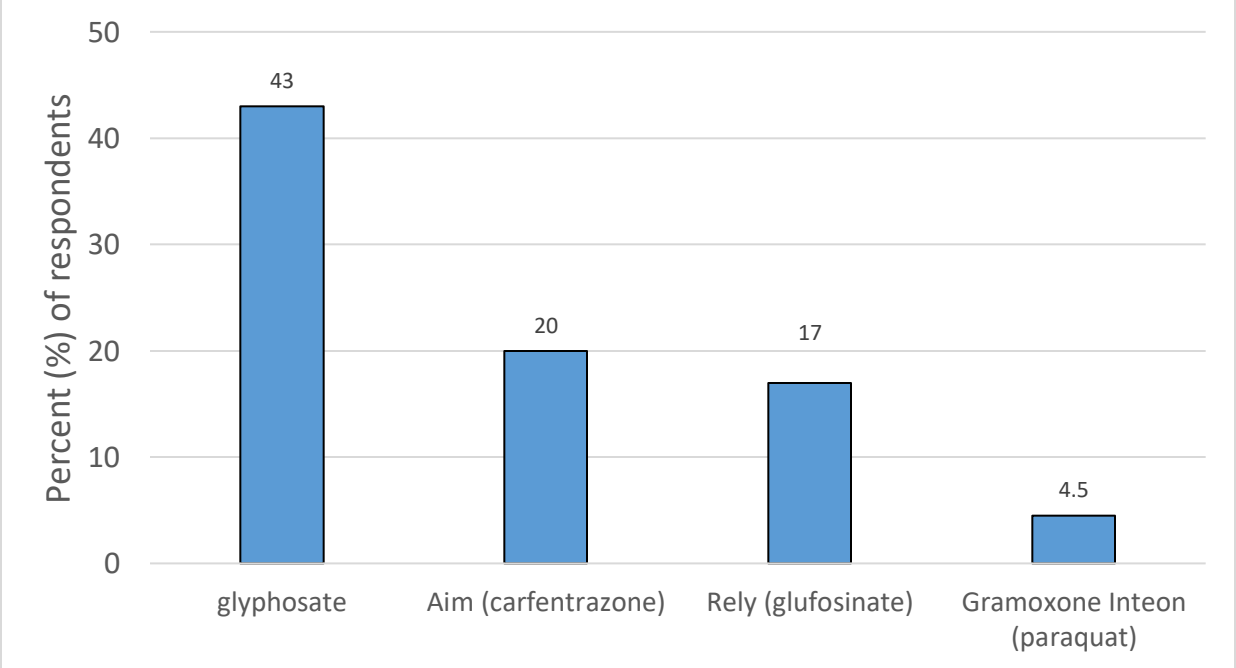

Figure 2. The most commonly used POST herbicides in WA wine grapes according to a survey of wine grape growers and vineyard managers.

Although herbicides appeared to be important components of weed management programs in WA wine grapes, they are not the only tools employed; 38%, 32%, and 28% of respondents also reported using cultivation and hand-weeding, respectively, for weed management under the trellis system. Weed control between the rows was achieved through a combination of mowing (43% of respondents), cover cropping (25%), cultivation (19%), hand-weeding (7%), and herbicide applications (7%).

According to the respondents, summer broadleaf species (e.g. pigweeds) were primarily considered to be a big problem in vineyards, whereas summer (e.g. crabgrass) and winter (e.g. annual bluegrass) grasses and winter broadleaves (e.g. filaree) were less significant concerns (Figure 3). Perennial broadleaves (e.g. field bindweed) were, primarily, reported to be a moderate concern and perennial grasses/or glass-like species (e.g. horsetail) were described as a big to serious problem (Figure 4).

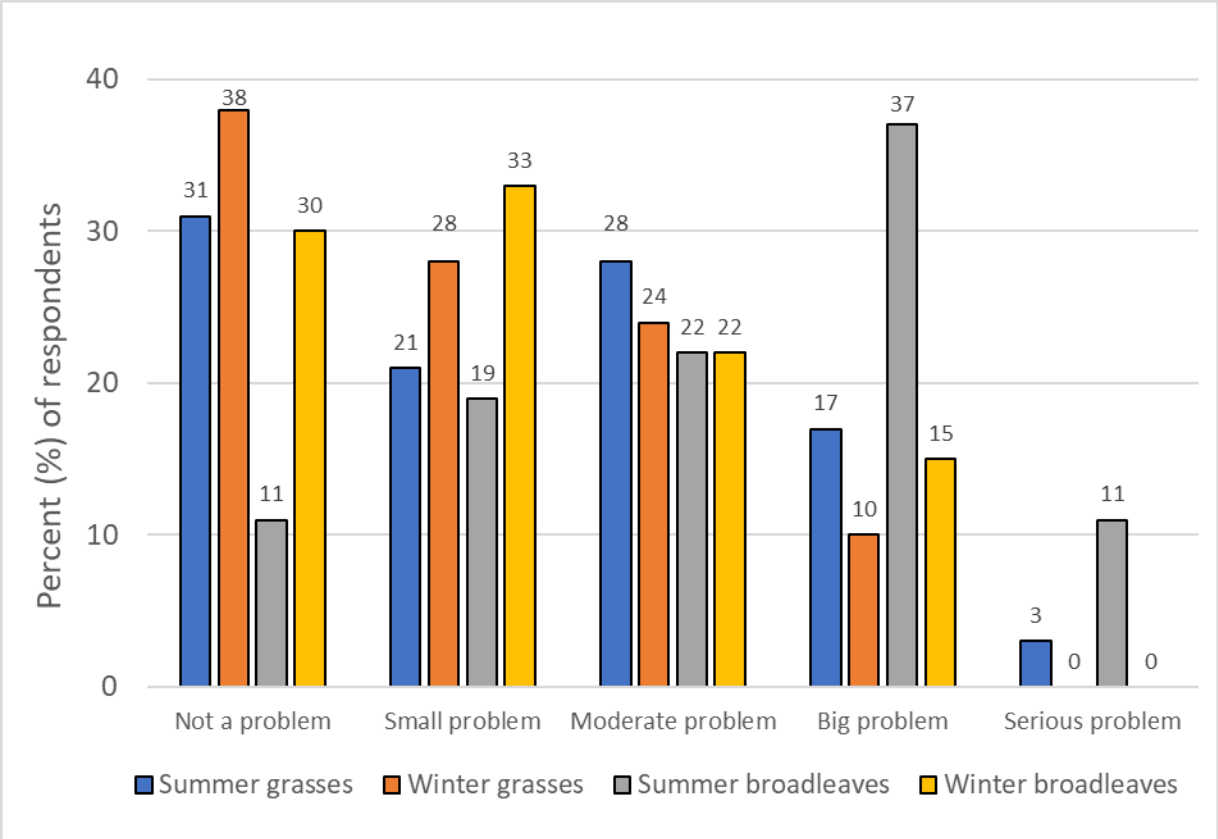

Figure 3. Importance of annual weed species in WA wine grapes according to a survey of wine grape growers and vineyard managers.

When asked to identify individual species of concern, growers specifically mentioned: *Salsola tragus* (Russian thistle), *Tribulus terrestris* (puncturevine/goatheads/caltrops), *Conyza canadensis* (marestail), *Kochia scoparia* (kochia), *Amaranthus spp* (pigweed), *Centaurea spp* (knapweed), and *Malva neglecta* (common mallow). With respect to herbicide (resistance in their vineyards, the respondents specifically noted*: Conyza canadensis, Kochia scoparia*, and *Salsola*

tragus. These results are not surprising as resistance to glyphosate has been reported for several listed species (Russian thistle, marestail, Kochia, and pigweeds) in the Western United States (http://weedscience.org/default.aspx). With respect to future management needs, growers indicated interest in: finding new, effective herbicide for weed control, but also reducing total herbicide use; evaluating new cultivation equipment while also improving the adoption of reduced tillage; and identifying weed suppressive cover crops (in particular, native plant species).

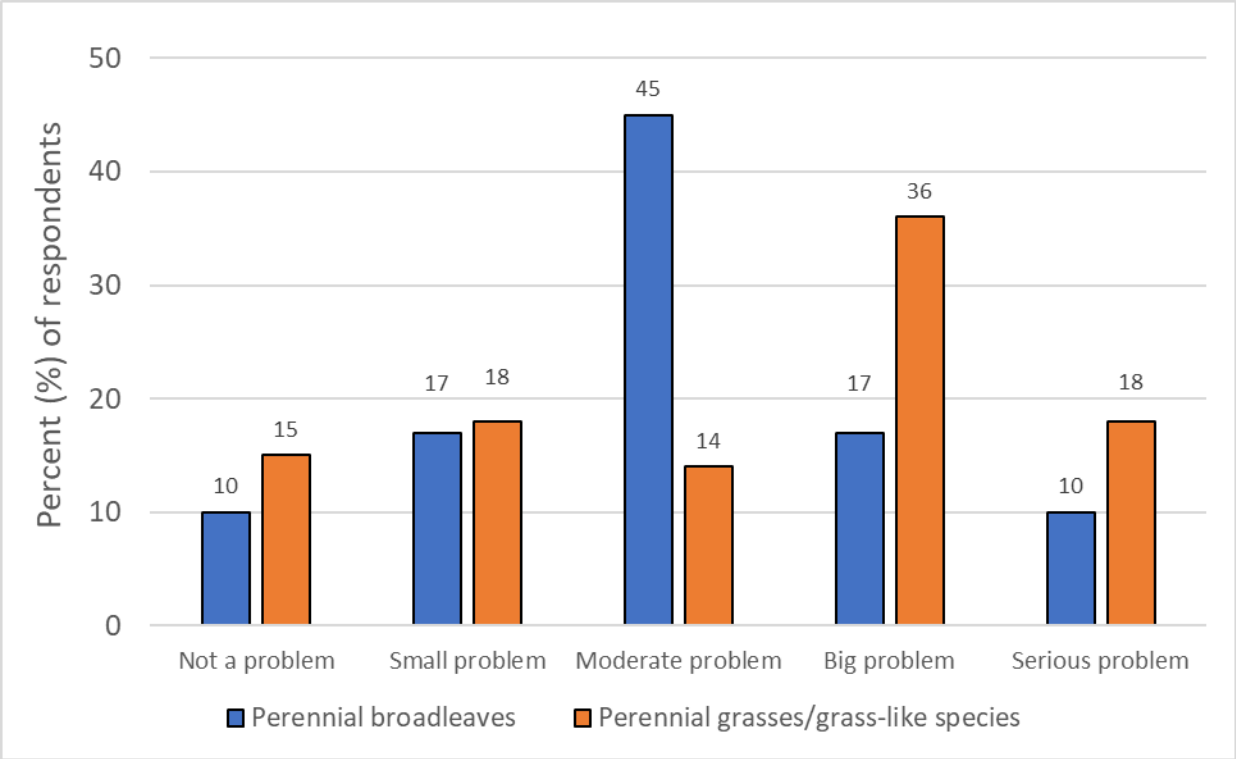

Figure 4. Importance of perennial weed species in WA wine grapes according to a survey of wine grape growers and vineyard managers.

The replies to this survey suggest that vineyard managers utilize a diverse set of strategies to manage weeds in their production systems. Tools include both pre- and post-emergence herbicides, mowing and cultivation, hand-weeding, and cover crop use. While the identification of new herbicides for use in wine grape systems is desirable, reducing the industry's reliance on chemical control strategies also appears to be of interest. Cultivation practices can be an effective alternate weed management strategy; however, growers appear to be interested in minimizing soil disturbance. Many of the species listed as specific concerns to growers are known to be resistant to glyphosate in other Western states, although resistance has not yet been confirmed in WA. Several of these species can also be widely dispersed by wind-blown seeds (marestail) or tumbling plants (Kochia and Russian Thistle). Several species (Centaurea spp., common mallow, Kochia, puncturevine, Russian thistle) are adapted to the drier environments that characterize the

Eastern side of the state. Future research efforts should be sure to address the influence of weed biology and physiology on management success.

Results indicate that some vineyards are interested in adopting practices that reduce their reliance on synthetic pesticides. The introduction of new herbicides has slowed while the increase in the numbers of species developing resistance to available products continues to increase. Research personnel should focus on maximizing the efficacy of available active ingredients while exploring the further incorporation of physical and cultural practices. It is important to remember that weeds can adapt to any control strategy, not just herbicides. Repeated use of mowing, cultivation, and hand-weeding can also shift weed communities towards species that are adapted to these tools. Consequently, weed management should be focused on increasing the diversity in control practices to reduce the influence of single selective forces in a system.

Objective 2: Develop extension and outreach materials

According to the 2014 Revision of the WA wine PMSP, the need for updated, continuing education was listed as a critical priority. This viewpoint was also echoed by a WA viticulturist during an e-mail exchange:

"The biggest thing I think we need in Eastern WA regarding weeds and herbicide is more education, i.e. why are weeds a problem, when is the best time to apply different herbicides to different weeds (winter annuals, summer annuals, biennials, perennials), which herbicides to use for new vineyard plantings, which weeds are developing resistance, which herbicides are best to use for specific weeds"

As a research and extension scientist, Dr. Sosnoskie has considerable experience with academic outreach. With respect to extension publications, she has authored 6 weed identification guide book entries, co-authored more than 30 articles, and given more than 80 scientific presentations. She has a significant online presence having created more than 50 scientific blog posts accessible through the University of California Weed Research and Information Center (http://wric.ucdavis.edu/) that have been viewed, collectively, several hundred thousand times.

During the year that Dr. Sosnoskie was employed at WSU (January 2017 to January 2018), she authored two VEEN Articles (Spring and Fall 2017 editions), presented at the 2017 Grape Seminar and Trade Show and updated/edited the 2018 Pest Management Guide for Grapes in Washington. Her commitment to WSU Extension both preceded and followed her tenure; she also presented at the 2016 Grape Seminar and Trade Show and wrote an article detailing the results from the weed management survey for the Spring 2018 edition of VEEN. More details about extension efforts are provided in the following section (Information Dissemination, Extension and Outreach Activities) of this report.

Objective 3: Weed management research

The final goal of the project was to design and conduct weed-science related research projects in grape production systems. A 2017 collaboration designed to look at the effects of buried drip

irrigation on weed community composition in a commercial vineyard was not completed because surface irrigation was applied repeatedly across all plots negating treatment effects.

Field bindweed is a perennial vine that can become established in perennial cropping systems. The persistence of field bindweed at a given site is enabled by the species extensive root system (which can extend 10-20 feet deep) and the presence of dormant buds on underground rhizomes that facilitate the species re-growth (Zouhar 2004). Field bindweed also produces long-lived seeds that can lie dormant in the soil for dozens of years. According to Zouhar (2004), '*The ability of field bindweed to establish from seed may be underestimated.*' In 2017 and 2018, greenhouse-based projects were initiated to describe the perennialization process of recently emerged field bindweed seedlings.

Bindweed seed was collected from the WSU-TFREC grounds in the summer of 2017 and planted in 3-gallon nursery pots in Fall 2017 (WSU TFREC) and Winter 2018 (WSU Pullman). The WSU TFREC greenhouse was unheated during the study. At 2, 4, 6, 8 and 10 weeks after emergence, five bindweed plants were harvested and the numbers of underground buds (developing on the roots) that give rise to new vines were quantified. Results from both studies indicated that perennial root buds were initiated between 4 and 6 weeks after seedling emergence, although temperature affected totals (figure 5). Similarly, the number of individual vines emerging also increased with time (Figure 6).

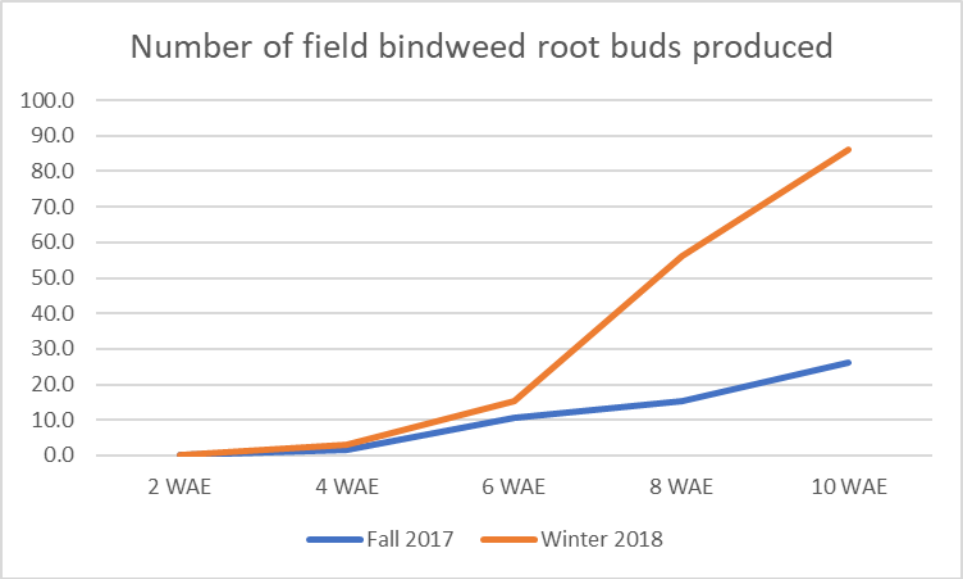

Figure 5. The number of bindweed root buds per plant as evaluated at 2, 4, 6, 8, and 10 weeks after seedling emergence (WAE). The Fall 2017 study was conducted in an unheated greenhouse while the Winter 2018 trial was conducted in a heated environment. The speed with which bindweed seedlings will transition to mature perennial plants will likely be faster under warmer conditions.

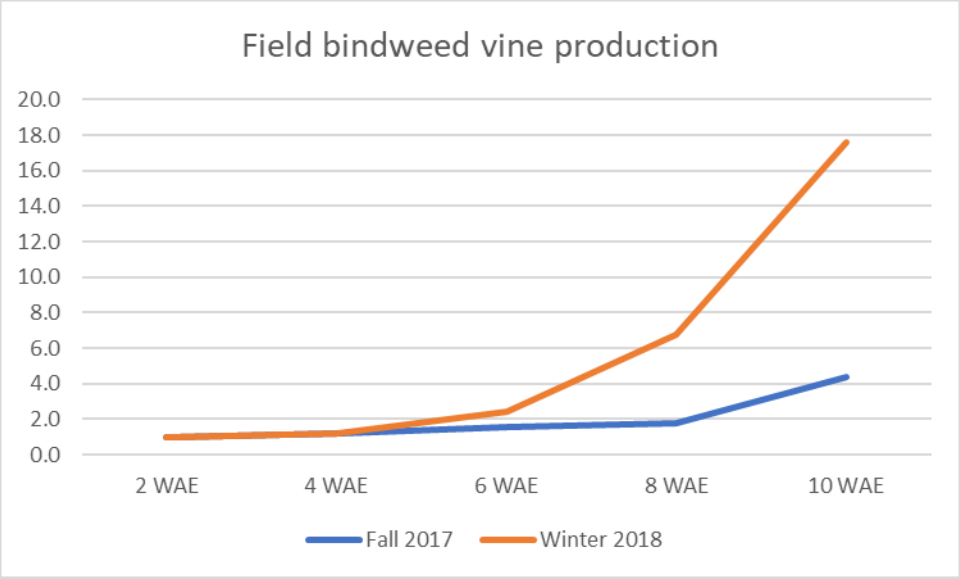

Figure 6. The number of bindweed vines per plant as evaluated at 2, 4, 6, 8, and 10 weeks after seedling emergence (WAE). The Fall 2017 study was conducted in an unheated greenhouse while the Winter 2018 trial was conducted in a heated environment. The speed with which bindweed seedlings will transition to mature perennial plants will likely be faster under warmer conditions.

Bindweed management recommendations state that seedlings are easy to control relative to mature vines. While rhizomes support the persistence of the species at a given site, seeds are responsible for disseminating the species to new habitats. Results from this study show that bindweed seedlings can become established and transition into perennial plants, quickly. Future research projects at WSU intend to increase our understanding of bindweed perennialization and use that information to develop management strategies that specifically target weaknesses in the species' physiology and development.

Information Dissemination, Extension, and Outreach Activities:

Dr. Sosnoskie was actively engaged with grape-related extension outreach from 2017 to 2018. With respect to publications, she authored three articles for WSU's Viticulture and Enology Extension Newsletter (VEEN). The first paper, which was published in the 2017 spring edition of VEEN, entitled 'Understanding Herbicides and Resistance', described 1) the sites of action (SOA) available to grape growers in WA, 2) how herbicides in different Weed Science Society of America (WSSA) SOAs worked to control weeds, and 3) the number of species with resistance to each SOA occurring in the PNW.
(http://wine.wsu.edu/wp-content/uploads/sites/66/2017/04/2017-VEEN-Spring.pdf?x64714)

The second paper was published in the fall of 2017 and described pre-emergence herbicides for use in grapes in the PNW. The article also addressed the biological, physical, and environmental factors affecting herbicide efficacy.
(http://wine.wsu.edu/wp-content/uploads/sites/66/2010/07/Fall-2017-VEEN.pdf?x64714)

The third and last VEEN article, published in spring of 2018, described the results obtained from the previously described grower survey. (http://wine.wsu.edu/wp-content/uploads/sites/66/2018/04/VEEN-Spring-2018-FINAL.pdf?x64714) A fourth publication (Fall 2018 edition) will specifically discuss the biology and ecology of the weeds listed as being serious concerns for wine grape growers.

Dr. Sosnoskie also spoke, personally, to grape industry personnel during her tenure. Speaking at both the 2016 and 2017 Grape Seminar and Trade Shows (https://www.grapesociety.org/) in at the Church of the Nazarene in Grandview, WA. She was also invited to speak about weeds and weed management at training day for Chateau St. Michelle on March 31st, 2017, at the Clore Center in Prosser, WA.

Regionally, Dr. Sosnoskie presented the results from the grower weed management survey at the Annual Meeting of the Western Society of Weed Science, March 12-15, at the Hyatt Regency Orange County in Anaheim, CA. (http://www.wsweedscience.org/wp-content/uploads/2018-WSWS-Program_AnaheimFINAL.pdf)

Lastly, Dr. Sosnoskie updated the 2018 Pest Management Guide for Grapes in Washington, which included a new section describing the factors affecting herbicide efficacy such as: the kinds of weeds to be controlled, the size and age of weeds to be controlled, soil type and herbicide incorporation strategy, the quantity and quality of spray water, and the age and health of the vine. Furthermore, Dr. Sosnoskie included an expanded discussion of each herbicide listed in the management guide. (http://cru.cahe.wsu.edu/CEPublications/EB0762/EB0762_18.pdf)

Literature Cited:

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<u>Appendix A</u>: Survey Questionnaire

Question 1: Do you commercially grow or manage wine grapes?

Yes___ No___

Question 2: Are you an individual who is responsible for making decisions regarding weed management (e.g., ordering herbicides, designing herbicide spray programs)?

Yes___ No___

Question 3: Are you an individual who is responsible for conducting in-crop weed management operations (e.g., spraying, mowing, cultivating)?

Yes___ No___

Question 4: What AVA(s) do you work in? (Select all that apply)

Ancient Lakes___ Columbia Gorge___ Columbia Valley___ Horse Heaven Hills___ Lake Chelan___
Lewis-Clark Valley___ Naches Heights___ Puget Sound___ Rattlesnake Hills___ Red Mountain___
Snipes Mountain___ Wahluke Slope___ Walla Walla Valley___ Yakima Valley___

Columbia Gorge (OR)___ Columbia Valley (OR)___ Walla Walla Valley (OR)___ Other Oregon AVAs___

Other AVAs, please specify
_____

Question 5: For the wine grape vineyard(s) that you work in, how many acres (in 2017) are:

Non-bearing
_____

Bearing
_____

Question 6: For the wine grape vineyard(s) that you work in, how many acres (in 2017) are:

Transitioning to USDA Certified Organic production

_____

Under USDA Certified Organic production

_____

I have no acres transitioning to or currently certified as organic

_____

Under LIVE certification

_____

I have no acres that are LIVE certified

_____

Question 7: Have you applied (within the past three years) pre-emergent (soil-applied) herbicides for weed control directly under the trellis system in wine grapes?

No_____
Yes_____

If yes, please mark which products you have used.

Trade Name (active ingredient) applied	Spring applied	Fall/early winter
Alion (indaziflam)	Yes___ No___	Yes___ No___
Casoron (dichlobenil)	Yes___ No___	Yes___ No___
Chateau (flumioxazin)	Yes___ No___	Yes___ No___
Devrinol (napropamide)	Yes___ No___	Yes___ No___
Goal (oxyfluorfen)		Yes___ No___
Karmex (diuron)		Yes___ No___
Kerb (pronamide)		Yes___ No___
Matrix (rimsulfuron)		Yes___ No___
Mission (flazasulfuron)	Yes___ No___	Yes___ No___
Princep (simazine)		Yes___ No___
Prowl (pendimethalin)	Yes___ No___	Yes___ No___
Solicam (norflurazon)	Yes___ No___	Yes___ No___
Surflan (oryzalin)	Yes___ No___	Yes___ No___
Other herbicide	Yes___ No___	

If yes, please specify:

_____

Question 9: Have you applied (within the past three years) post-emergent (foliar-applied) herbicides for weed control directly under the trellis system in wine grapes?

No_____
Yes_____

If yes, please mark which products you have used.

Trade Name (Active ingredient)

2,4-D	**Yes___ No___**
Aim (carfentrazone)	**Yes___ No___**
Fusilade (fluazifop)	**Yes___ No___**
Gramoxone (paraquat)	**Yes___ No___**
Poast (sethoxydim)	**Yes___ No___**
Reglone (diquat)	**Yes___ No___**
Rely (glufosinate)	**Yes___ No___**
Roundup, others (glyphosate)	**Yes___ No___**
Select (clethodim)	**Yes___ No___**
Venue (pyraflufen)	**Yes___ No___**

Organic herbicide **Yes___ No___**
If yes, please specify:
_____

Other herbicide **Yes___ No___**
If yes, please specify:
_____

Question 8: Do you have or suspect that you have herbicide-resistant weeds in your vineyard(s)?

Yes_____ No_____ Don't know_____

If you answered yes, what weed species and to which herbicides?
_____
_____
_____
_____
_____
_____
_____

Question 9: What other (non-chemical) strategies do you employ for weed control directly under the trellis system in wine grapes?

Cultivation	**Yes___ No___**
Flaming	**Yes___ No___**
Cover crops/mulches	**Yes___ No___**
Mowing or other mechanical removal strategy	**Yes___ No___**
Hand-weeding	**Yes___ No___**

Other, please specify:

_____

Question 10: What strategies do you employ for weed control between the trellis systems in wine grapes?

Herbicides	**Yes___ No___**
Cultivation	**Yes___ No___**
Flaming	**Yes___ No___**
Cover crops/mulches	**Yes___ No___**
Mowing or other mechanical removal strategy	**Yes___ No___**
Hand-weeding	**Yes___ No___**

Other, please specify:

_____

Question 11: How problematic are the following types of weed species in your vineyard(s)? Please rate use a scale from 1 – 5, where a score of 1 = not a problem and a score of 5 = a severe problem

	Rating
Summer annual grasses (e.g. barnyardgrass, crabgrass, foxtails)	**_____**
Winter annual grasses (e.g. annual bluegrass)	**_____**
Summer annual broadleaves (e.g. lambsquarters, pigweeds, nightshades)	**_____**
Winter annual broadleaves (e.g. Marestail/horseweed, filaree)	**_____**
Perennial grasses/grass-like species (e.g. equisetum/horsetail, nutsedge, quackgrass)	**_____**

Perennial broadleaves
(e.g. field bindweed, thistles, dandelions) _____

Please list any individual species that are a specific concern for you?

_____
_____
_____
_____
_____
_____
_____

Question 12: What are your most important research, regulatory and education needs with respect to weeds and weed management?

_____
_____
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_____
_____

We would like to THANK YOU for your responses. We sincerely appreciate the time you took to complete this questionnaire. The results from this survey will be used to develop future research trials at Washington State University to directly address wine grape weed science needs in the state.

Dr. Lynn M. Sosnoskie, a new Washington State University weed scientist located at the WSU TFREC in Wenatchee, is available to travel and meet with you to discuss your weed control needs in more detail.

Please contact her at:

lynn.sosnoskie@wsu.edu
229-326-2676 (text messages are okay)