Progressive Crop Consultant

The Leading Magazine For Ag Professionals

January/February 2019

Clonal Paradox Rootstocks Hold Their own in Tehama County Howard Trial

A Nitrogen Fertilization Tool for Drip Irrigated Processing Tomatoes

2018 Armyworm Season in Rice

California Citrus Network:

An Online Forum to Facilitate Communication and Information Exchange Regarding California Citrus

JANUARY/FEBRUARY 2019

VINEYARD REVIEW

pages 21-42

JCS MARKETING PUBLICATION

Volume 4 : Issue 1

Habitat Diversification for Pest Management in Vineyards—More Complicated Than It Seems

By: Houston Wilson | Asst. Cooperative Extension Specialist
Kearney Agricultural Research and Extension Center
Dept. Entomology, UC Riverside

Ammi majus blooming in a Sonoma County vineyard.
All photos courtesy of Houston Wilson.

Vineyard Habitat Diversification

Cover crops, hedgerows and other on-farm habitat plantings can potentially attract and support beneficial insects that can then potentially increase biological control of pests—the key word here being *potentially*. The diversity and abundance of beneficial insects that can be found on a wide variety of non-crop plants, many of them flowering, has been very well documented over the past several decades. These data have subsequently been used to advocate for the establishment of on-farm habitat plantings, with the assumption that adding in non-crop plants that attract beneficials will **(1)** lead to more beneficial insects on your farm, **(2)** those beneficials will go on to attack the key pests that you're concerned about and **(3)** they will do so in a manner that lowers pest populations below economic thresholds.

This logic is embodied in a number of public and private programs as well as publications that promote on-farm habitat diversification. While this logic is not entirely off-base, the development of specific on-farm habitat strategies that can reliably and economically control arthropod pests in agriculture has remained fairly limited. This is primarily because such practices are very ecologically specific and must be tailored to the target pest and its key natural enemies, as well as the agronomic and economic requirements of the cropping system itself. As such, habitat diversification practices that work for a specific pest in a specific crop are not typically transferable to other crop-pest systems. Moreover, practices that may work for a given crop-pest system may not be readily transferable to the same crop-pest combination in another region or climate. This is not to say that on-farm habitat plantings have no potential, but rather that the development of practices that can produce consistent and economically relevant outcomes require research and development on a pest-by-pest and crop-by-crop basis.

Leafhoppers and Anagrus Parasitoids in California Vineyards

Leafhopper pests in California vineyards include the Western grape leafhopper (*Erythroneura elegantula*), which is native to the state, along with two invasive species that arrived in the 1980s, the variegated leafhopper (*E. variabilis*) and Virginia creeper leafhopper (*E. ziczac*). These closely related leafhopper species all feed on grape leaves, which can reduce vine productivity, crop yield/quality, and the adults can be a nuisance at harvest. These leafhoppers are primarily controlled by a suite of parasitoids that attack their eggs, this includes *Anagrus erythroneurae*, A. *daanei* and A. *tretiakovae*. These *Anagrus* parasitoids are unique in that they seasonally move between vineyards and natural areas, such as riparian and oak woodland habitats. During the growing season, *Anagrus* parasitoids will regularly attack and reproduce on the eggs of *Erythroneura* leafhoppers in vineyards, but when vines senesce in the fall these leafhoppers enter a reproductive diapause and overwinter as adults in and around the vineyard, typically taking shelter in leaf litter or nearby vegetation. In the absence of *Erythroneura* eggs, the *Anagrus* parasitoids must seek out an alternate leafhopper species that continues to produce eggs over the winter, and these alternate hosts are typically located on plants outside of vineyards. When grape vines begin to develop again in the spring, the *Erythroneura* leafhoppers move onto the vines where they begin to feed and soon after start to lay eggs into the new leaf tissue. It is at this point that

Continued on Page 24

WE'VE GOT YOU COVERED.

Join the fight against disease.

ChampION++™ Fungicide/Bactericide has the smallest, most consistent copper particles of any water dispersible granule (WG) copper formulation. This leads to more thorough leaf coverage and plant absorption for excellent control. All this with less environmental load than high-dose copper products and OMRI listed for use in organic crop production.

Get the copper fungicide that won't back down. For more information, contact your Nufarm rep today or go to nufarm.com/us.

ChampION++™

OMRI LISTED For Organic Use

Nufarm
Grow a better tomorrow

Continued from Page 22

the *Anagrus* parasitoids will leave their alternate hosts and then move back into the vineyard and resume attacking the new *Erythroneura* leafhopper eggs on grape leaves.

Overwintering Habitat for Leafhopper Parasitoids

Previous University of California (UC) research demonstrated that blackberry (*Rubus* spp.) and French prunes (*Prunus domestica*) were the primary plants that harbored the alternate insect hosts that the *Anagrus* utilized during the winter (Doutt and Nakata 1965, Kido et al. 1984, Wilson et al. 1989). Follow-up studies demonstrated that *Anagrus* populations were higher and arrived earlier in vineyards that were closer to riparian areas where blackberry was abundant (Doutt et al. 1966, Doutt and Nakata 1973). Unfortunately, efforts to establish blackberry plantings in vineyards outside of riparian areas largely failed and any further desire to propagate this plant near vineyards was snuffed out when it was revealed that blackberry was a reservoir for *Xyllela fastidiosa*, the bacterium that causes Pierce's Disease as well as a host plant for glassy-wing sharpshooters (*Homalodisca vitripennis*), which can transmit this pathogen to grape vines. That leaves us with the French prunes, which of course aren't naturally occurring in the landscape like blackberry and thus provide a relatively limited overwintering resource for the *Anagrus* parasitoids. While some growers have attempted to establish French prunes in and around their vineyards, these overwintering refugia are dwarfed by the sheer quantity of vineyard acreage that needs to be colonized by these parasitoids.

More recently, surveys conducted in the North Coast region identified a number of previously unknown overwintering host plants utilized by the *Anagrus*—most notably coyote brush (*Baccharis pilularis*) (Wilson et al. 2016). Not only is this plant abundant in the landscape, it's drought tolerant, grows in very disturbed conditions, harbors *Anagrus* parasitoids year-round, and is a California native plant. Thus, in combination blackberry and coyote brush are likely responsible for supporting regional populations of these *Anagrus* parasitoids near vineyards.

Summer Cover Crops

Cover crops are incredibly useful for soil quality maintenance, as they can contribute to erosion control, improved water penetration, reduced compaction, and restoration of soil fertility—but can they also contribute to biological control of pests? In California, the use of cover crops to attract beneficial insects to increase biological control of vineyard leafhoppers was first explored in the 1990s by various UC researchers.

Anagrus daanei parasitizes a leafhopper egg

One series of trials evaluated fall-sown legume/grass cover crop blends that consisted of vetch (*Vicia* spp.), oats (*Avena* spp.) and/or barley (*Hordeum* sp.) in Central Valley vineyards (Daane and Costello 1998, Roltsch et al. 1998, Costello and Daane 2003, Hanna et al. 2003). Rather than mow and plow these down in the spring, as is typical when they are used for soil management, the cover crops were left in place until they dried out in the early summer. In some cases, leafhopper densities were indeed reduced in the presence of the cover crop but this effect was actually due to changes in vine vigor—competition from the cover crop led to reduced petiole nitrate levels which had a negative impact on leafhoppers. Additional studies have demonstrated that leafhoppers prefer more vigorous vines as well as vines with greater levels of irrigation (Daane and Williams 2003).

Another series of experiments explored the use of summer flowering cover crops in North Coast vineyards. One set of trials evaluated spring-sown species that required supplemental irrigation, this included buckwheat (*Fagopyrum esculentum*), sweet alyssum (*Lobularia maritima*), and sunflower (*Helianthus annus*) (Nicholls et al. 2000). Another set of trials used fall-sown species that relied on winter rains alone, these species were purple tansy (*Phacelia tanacetifolia*), bishop's flower (*Ammi majus*) and wild carrot (*Daucus carota*) (Wilson et al. 2017). In both of these studies, the flowering cover crops attracted a lot of beneficial insects but this never translated to increased biological control of leafhoppers in the vine canopy itself.

Finally, a study in the Lodi area assessed the influence of a perennial native grass cover crop that consisted of blue wildrye (*Elymus glaucus*), meadow barley (*Hordeum brachyantherum*) and California brome (*Bromus carinatus*) (Daane et al. 2018). Leafhopper populations were reduced in the presence of the cover crop but again the effect was due to changes in vine vigor—the cover crops reduced petiole nitrate levels which led to lower leafhopper densities. Furthermore, the deep-rooted perennial grasses also improved water infiltration which led to increased soil moisture and reduced vine water stress, which can also lead to lower leafhopper densities.

Taken as a whole, these studies demonstrate that the effect of cover crops on

Continued on Page 26

NORTH VALLEY Nut Conference

SAVE THE DATE!

Jan 30, 2019

NEW LOCATION! **GLENN COUNTY FAIRGROUNDS** 221 E Yolo St, Orland, CA 95963

AGENDA

DPR Approval Pending

DPR: 0.5 Laws & Regs and 3.5 Other
CCA: 4.5 hour

7:00am	Registration, Trade Show Open
8:00am	Laws and Regulations Update Marcie Skelton, Glenn County Agricultural Commissioner
8:30am	Mite Control in Almonds David Haviland, UCCE IPM Advisor, Kern County
9:00am	Walnut Husk Fly Management Dr. Bob VanSteenwyk, Entomology Specialist Emeritus, UC Berkeley
9:30am	Preventing and Managing Walnut Crown Gall Dr. Dan Kleupfel, Plant Pathologist, USDA ARS, Davis
10:00am	Break; Trade Show Open
10:45am	Butte-Yuba-Sutter Water Quality Coalition Update Rachel Castanon, Program Coordinator, Butte County Farm Bureau
11:00am	Navel Orangeworm Research Updates Dr. Emily Symmes, UCCE IPM Advisor, Sacramento Valley
11:30	Early Season Irrigation: Do We Know When to Start? Dr. Ken Shackel, Department of Plant Sciences, UC Davis
12:00pm	Lunch
1:00pm	Botryosphaeria and Band Canker update Dr. Themis Michailides, UCCE Plant Pathology Specialist, Kearney Agricultural Research and Education Center
1:30pm	Weed Management in Young Orchards Dr. Brad Hanson, UCCE Weed Specialist, UC Davis
2:00pm	Adjourn

Hosted By: **WEST COAST NUT**

In Conjunction with the UCCE Butte/Glenn/Tehama Counties Almond & Walnut Day

UCCE | University of California Agriculture and Natural Resources | Cooperative Extension

Continued from Page 24

leafhoppers is primarily due to changes in vine vigor rather than any increase in biological control. While cover crops are in some cases used to moderate vine vigor, in many situations this can be achieved much more economically by adjusting irrigation regimes, soil amendments and pruning practices.

Landscape Diversity

Given the importance of overwintering habitat to *Anagrus* parasitoids and the dismal performance of cover crops, researchers have more recently started to focus on the relationship between landscape diversity and biological control of vineyard leafhoppers. Landscape diversity can be defined in many nuanced ways, but generally refers to the quantity of natural habitat that falls within a larger radius surrounding the vineyard (for example, the total area of all riparian habitat within two miles of a vineyard).

Recent studies in the North Coast evaluated biological control of leafhoppers in multiple vineyards located in contrasting low and high diversity landscapes. Vineyards in high diversity landscapes, with lots of natural habitat within one third mile of the vineyard, tended to have more *Anagrus* parasitoids earlier in the season, which then led to increased leafhopper parasitism rates and lower late-season leafhopper densities (Wilson et al. 2015a, Wilson et al. 2017). While not all natural habitats necessarily harbor *Anagrus* overwintering habitat (i.e. coyotebrush and blackberry), these plants are more likely to be present in a high diversity landscape given that there is more natural habitat overall.

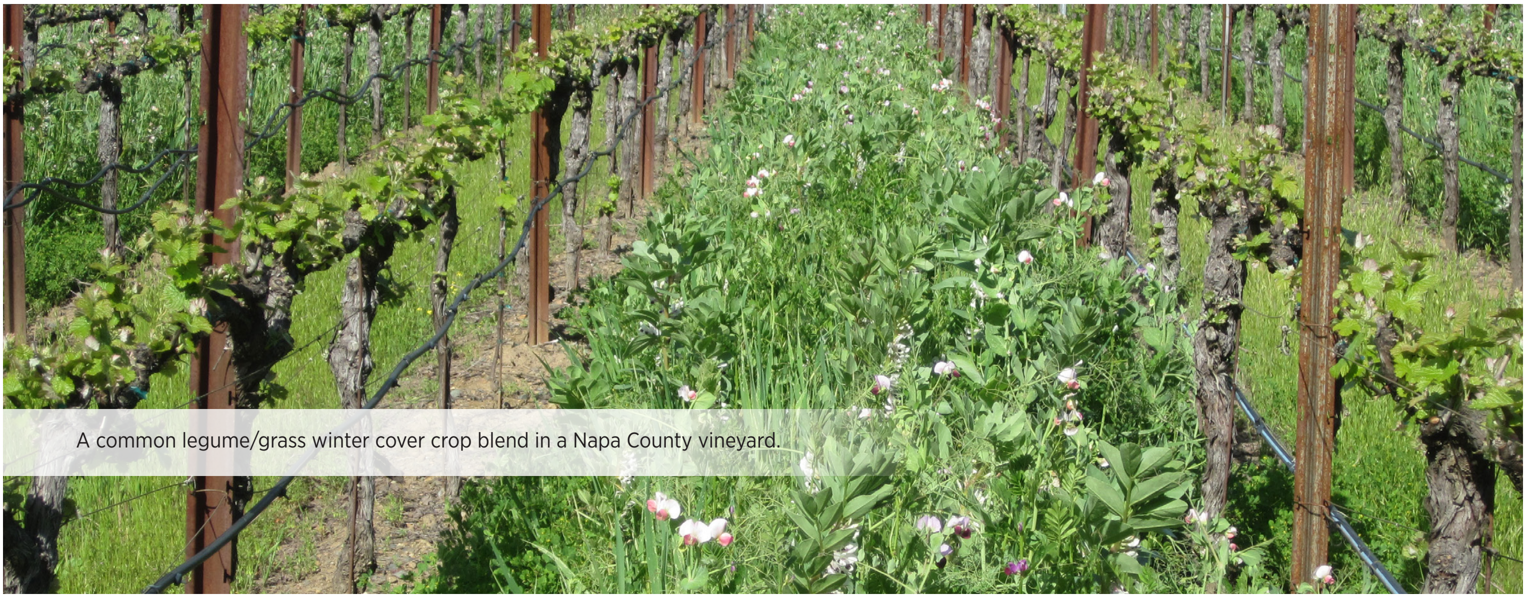
In a related study, biological control of leafhoppers was evaluated in vineyard blocks that were close to (30 feet) and far away from (500 feet) riparian habitats. Since these areas harbor a lot of blackberry, it could be that *Anagrus* populations and leafhopper parasitism is greater on vines closer to the riparian area. Leafhopper densities were indeed lower on vines closer to the riparian areas, but this was once again due to changes in vine status rather than increased parasitism (Wilson et al. 2015b). Similar to the cover crop studies, vines that were close to the riparian area tended to be less vigorous, most likely due to changes in microclimate and soil conditions associated with vine shading from the tall riparian vegetation and compacted dirt roads along the riparian border of vineyard blocks.

Conclusion

As you can see, almost all the vineyard habitat research to date has focused on leafhoppers, whereas growers are of course managing for a much wider range of pests, including mealybugs/ants, sharpshooters, mites and thrips. Impacts of habitat diversification on these other pest species has simply not taken place yet. Very early research on Willamette mites (*Eotetranychus willamettei*) did find that Johnson grass (*Sorghum halepense*) could harbor alternate prey that supported Western predatory mites (*Galendromus occidentalis*) and led to lower Willamette mite densities on vines—but no economic program was ever developed for this pest. Beyond that, not much else is known about how habitat diversification influences other key grape pests.

Research on habitat diversification to control vineyard leafhoppers has demonstrated the importance of overwintering habitat for *Anagrus* parasitoids and moderation of vine vigor. Alternately, cover crops do not appear to be a viable way of increasing biological control of leafhoppers. While their ability to reduce vine vigor can translate to some changes in leafhopper populations, there are other ways to moderate vigor that are more practical and cost-effective. Furthermore, vigor moderation in the absence of *Anagrus* overwintering habitat may still result in increased leafhopper densities, as it is a combination of early-season parasitism and moderate vine vigor that regulates leafhopper populations.

Phacelia tanacetifolia blooming in a Napa County vineyard.



A common legume/grass winter cover crop blend in a Napa County vineyard.

Even with all the emphasis on leafhoppers, habitat diversification strategies that can produce consistent results for this pest remain elusive, and many key questions remain. How much *Anagrus* overwintering habitat is adequate? How far can these parasitoids migrate into vineyards? Does overwintering habitat need to be directly adjacent to the vineyard? And so on…

In summary, specific habitat diversification practices that can produce consistent and economically relevant impacts on vineyards pests remain elusive. While in theory this is not entirely impossible to achieve, the reality is that a lot of additional research is certainly still needed at this point in time.

References

Costello, M. J., and K. M. Daane. 2003. Spider and leafhopper (*Erythroneura* spp.) response to vineyard ground cover. Environ. Entomol. 32: 1085-1098.

Daane, K. M., and M. J. Costello. 1998. Can cover crops reduce leafhopper abundance in vineyards? Calif. Agric. 52: 27-33.

Daane, K. M., and L. E. Williams. 2003. Manipulating vineyard irrigation amounts to reduce insect pest damage. Ecol. Appl. 13: 1650-1666.

Daane, K. M., B. N. Hogg, H. Wilson, and G. Y. Yokota. 2018. Native grass ground covers provide multiple ecosystem services in Californian vineyards. J. Appl. Ecol.

Doutt, R. L., and J. Nakata. 1965. Overwintering refuge of *Anagrus epos* (Hymenoptera: Mymaridae). J. Econ. Entomol. 58: 586-586.

Doutt, R. L., and J. Nakata. 1973. The *Rubus* leafhopper and its egg parasitoid: an endemic biotic system useful in grape pest management. Environ. Entomol. 2: 381-386.

Doutt, R. L., J. Nakata, and F. Skinner. 1966. Dispersal of grape leafhopper parasites from a blackberry refuge. Calif. Agric. 20: 14-15.

Hanna, R., F. G. Zalom, and W. J. Roltsch. 2003. Relative impact of spider predation and cover crop on population dynamics of *Erythroneura variabilis* in a raisin grape vineyard. Entomol. Exp. Appl. 107: 177-191.

Kido, H., D. Flaherty, D. Bosch, and K. Valero. 1984. French prune trees as overwintering sites for the grape leafhopper egg parasite. Am. J. Enol. Vit. 35: 156-160.

Nicholls, C. I., M. P. Parrella, and M. A. Altieri. 2000. Reducing the abundance of leafhoppers and thrips in a northern California organic vineyard through maintenance of full season floral diversity with summer cover crops. Agric. For. Entomol. 2: 107-113.

Roltsch, W., R. Hanna, H. Shorey, M. Mayse, and F. Zalom. 1998. Spiders and Vineyard Habitat Relationships in Central California, pp. 311-338. In C. H. Pickett and R. L. Bugg (eds.), Enhancing Biological Control: Habitat Management to Promote Natural Enemies of Agricultural Pests. University of California Press, Berkeley, California.

Wilson, H., A. F. Miles, K. M. Daane, and M. A. Altieri. 2015a. Landscape diversity and crop vigor influence biological control of the western grape leafhopper (*E. elegantula* Osborn) in vineyards. PLoS ONE 10: e0141752.

Wilson, H., A. F. Miles, K. M. Daane, and M. A. Altieri. 2015b. Vineyard proximity to riparian habitat influences western grape leafhopper (*Erythroneura elegantula* Osborn) populations. Agric., Ecosyst. Environ. 211: 43-50.

Wilson, H., A. F. Miles, K. M. Daane, and M. A. Altieri. 2016. Host plant associations of *Anagrus* spp. (Hymenoptera: Mymaridae) and *Erythroneura elegantula* (Hemiptera: Cicadellidae) in northern California. Environ. Entomol. 45: 602–615.

Wilson, H., A. F. Miles, K. M. Daane, and M. A. Altieri. 2017. Landscape diversity and crop vigor outweigh influence of local diversification on biological control of a vineyard pest. Ecosphere 8.

Wilson, L. T., C. H. Pickett, D. Flaherty, and T. Bates. 1989. French prune trees: refuge for grape leafhopper parasite. Calif. Agric. 43: 7-8.Laborupt

Comments about this article? We want to hear from you. Feel free to email us at article@jcsmarketinginc.com