

Western Regional IPM Grants
Annual Progress Report Guidelines
Due October 15, 2008

INSTRUCTIONS: PLEASE PROVIDE ONLY THE ESSENTIAL COMPONENTS OF ACCOMPLISHMENT WHICH ARE:

1. A CLEAR IDENTIFICATION OF THE PROBLEM/ISSUE ADDRESSED BY THE RESEARCH/EXTENSION.
2. A CONCISE EXPLANATION OF HOW THE RESEARCH/EXTENSION ACHIEVEMENT CONTRIBUTED TO THE SOLUTION OF THE PROBLEM/ISSUE BEING RESEARCHED.
3. THE IDENTIFICATION OF OTHER BENEFITS RESULTING FROM THE RESEARCH/EXTENSION, EVEN IF UNPLANNED.
4. PLEASE ATTACH A SUMMARY OF THE PAST YEARS PROGRESS, ONE PAGE MINIMUM.

PROJECT NUMBER: 2007-34103-18579

PROJECT TITLE: Integrated Management of Mite Pests and Powdery Mildew Diseases on Perennial Hosts

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**THE PROBLEM, ISSUE, OR REASON FOR PURSUING THIS RESEARCH/
EXTENSION PROJECT.**

Integration of powdery mildew control on hops and grapevine with biocontrol of spider mite pests (*Tetranychus urticae* and *Eotetranychus willamettei*) on these crops is difficult because sulfur fungicides are toxic to certain predatory mites and may enhance dispersal of spider mites. Developing IPM strategies for these pests is further complicated by the recent discovery of two new eriophyid mites species in the Pacific Northwest, the grape leaf rust mite (*Calepitrimerus vitis*) and the grape bud mite (*Colomerus vitis*), that require carefully timed sulfur applications for successful control. This Research and Extension project seeks to improve IPM of spider mites, eriophyid mites and powdery mildew diseases on perennial crops by enhancing our understanding of how sulfur applications for powdery mildew control influence suppression and disruption of conservation biological control of mites, and developing IPM strategies that maximize biological control of mites and powdery mildew control.

**THE SINGLE MOST IMPORTANT ACCOMPLISHMENT OR BENEFIT RESULTING
FROM THIS RESEARCH/EXTENSION PROJECT.**

The phenology and population dynamics of arthropod pests and natural enemies were identified and quantified in hop yards and vineyards in relation to the timing of sulfur applications. In Year 1 and 2 of the regional project, fungicide programs that exacerbate and suppress spider mite and eriophyid pests were identified. Indirect effects of sulfur on spider mite dispersal and fecundity were identified and quantified, and suggest strategies to integrate control of mite pests, powdery mildew, and maintain natural enemies to optimize conservation biological control.

BRIEFLY DESCRIBE ADDITIONAL BENEFITS, SUCH AS:

SOCIAL BENEFITS -

N/A

ECONOMIC BENEFITS -

Identification of fungicide programs that maximize biological control and suppression of mites will lead to greater non-chemical management of these pests, and enhance grower efficiency and profitability due to less intensive miticide use.

ENVIRONMENTAL BENEFITS -

Greater reliance on conservation biological control of mite pests should lead to less intensive pesticide use in hops, grapevine, and other perennial crops.

OTHER –

N/A

**PLEASE SUBMIT A HIGH RESOLUTION DIGITAL IMAGE REPRESENTATIVE OF
YOUR RESEARCH/EXTENSION PROJECT THAT WE CAN USE IN WESTERN IPM
CENTER PUBLICATIONS WHICH MENTION YOUR PROJECT.**

When you have completed this form, return to

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THIS FORM WAS COMPLETED BY:

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Summary of Past Years Progress

Objective I. Identify predatory mites associated with mite pests on grapevines and hops.

Vineyard Surveys.

A vineyard survey was conducted to determine the incidence of pest mites and 'Short Shoot Syndrome' (SSS) in Oregon wine grapes since little information is available on the incidence of mite-associated SSS. Approximately ten percent of the total wine-grape acreage in Oregon was selected for investigation of 'Short Shoot Syndrome' (ca. 1800 acres) symptoms. Within this acreage we began to survey approximately ten percent of vineyard sites. During the two seasons canes were collected from 100 farms (4,000 canes total). A total of 180-200 acres were therefore assessed. Crop loss assessments were conducted in vineyards that showed Eriophyid mite incidence and mite-related SSS during ripening (September 2006, 2007 and planned for late October 2008). A ranking system was used to determine percentage crop loss using a central-systematic sampling system in order to survey entire blocks. The three biggest wine producing counties; Yamhill, Polk and Washington Counties showed SSS and Eriophyid mite incidence on 40-50% of the sampled materials. Counties where no mite presence and symptoms were yet found include Jackson, Lane, Clackamas and Wasco.

Symptoms and crop losses were found in all vineyards where mites were present. No symptoms and crop losses were found in vineyards where mites were absent. Records of crop losses were found in all counties where mites and SSS were present in the sampling years of 2006 and 2007. Crop losses ranged between 3-80% in affected vineyards. Data suggest that SSS is widespread through the wine industry in Oregon as a whole with impact on vine architecture and crop loss, in all major grape-producing areas. Reports of damage were also made from vineyards in Napa, Sonoma and Monterey counties in California.

In 2007 and 2008, small developing shoots were visually inspected for arthropod presence early in the season by examining 16 shoots per plot x 3 replications. As plants grew, 48 developing leaves were visually examined biweekly per treatment in the field for arthropods beginning with a pre-treatment assessment in early April and continuing until grape harvest in September and October, respectively. As shoots grew taller (>10-20 cm), motile natural enemies were enumerated from canopy shake samples at 14 day intervals. Canopy shake samples were collected by placing a 1 meter² white cloth under a grape cane and vigorously shaking the cane. Dislodged arthropods were identified and counted on the cloth and collected into vials for preservation purposes. Two samples were collected from each replicate plot on each sampling day.

Our research over the two seasons has demonstrated the value of identification and numbers of the beneficial organisms contributing to mite pest reduction. In addition, it has highlighted the need to understand the contributions of individual predator taxa to biological control to better conserve the 'diversity' in vineyard systems and benefit from this ecosystem service. Some of the highest numbers sampled of beneficial organisms found over the 2 seasons included: Coccinellid spp. (e.g., *Coccinella septempunctata*, *Cycloneda* spp., *Harmonia axyridis* (Pallas), *Coleomegilla maculata*), *Orius* spp. (*O. tricolor* and *insidiosus*), *Chrysopa* spp., six-spotted thrips (Thysanoptera: *Scolothrips*

sexmaculatus), four spider families (Araneae: Salticidae, Linyphiidae, Thomisidae, Clubionidae). Identification of natural enemies is being confirmed and data is being compiled and analyzed. The most predominant predatory mite was *Typhlodromus pyri* (Phytoseiidae family) is currently considered the most effective mite predator in Willamette Valley Oregon vineyards and was used in bioassay studies.

Hop yard studies.

In hops, the phytoseiid mite fauna in semi-arid regions of production (i.e., central Washington) have been characterized previously (James et al., 2001 and 2003), but there is limited information available on phytoseiid fauna important for suppression of *T. urticae* on hops in the mild maritime of western Oregon. To obtain information on seasonality, abundance, and diversity of phytoseiid mites in Oregon, four or six commercial hop yards were monitored in 2007 and 2008, respectively. Leaf samples, sticky traps, and canopy shake samples were collected at regular intervals (every 14 to 21 days) in yards from June 1 to harvest (2007) or April 15 to harvest (2008). Experiments plots in Oregon and Washington also were sampled regularly (every 7 to 14 days) and predatory mite species associated with hop plants were collected and identified. Statistical analyses are underway.

Preliminary results from commercial hop yards indicate that spiders and predatory thrips were the most abundant predators encountered, followed by mite-eating ladybeetles (*Stethorus*). Minute pirate bugs (*Orius*) and other ladybeetles were also common. Predatory mites appear less common than predatory insects, with populations of predatory mites not exceeding 1 per leaf in any of the commercial yards survey. Preliminary identifications indicate that the dominate phytoseiid species in Oregon hop yards are *Neoseiulus fallacis* and *Galendroms occidentalis*.

Objective II. Quantify the effects of direct and indirect exposure to sulfur residues on mortality, fecundity and longevity of phytoseiid mites that regulate eriophyid and spider mite pests on grapevine and hops.

Laboratory Bioassay Studies. Bioassays have been conducted with a precision Potter Spray tower to test the toxicity and effects on fecundity of multiple pesticides, including sulfur, synthetics, oils, and whey powder, an alternative 'soft' fungicide, on *T. pyri* under laboratory conditions. The Spray Tower was purchased, set-up, and calibrated to assimilate treatment rates used in the vineyard system in 2007. The predominant predatory mite is reared and cultured on 12 x 7 cm plastic arenas lined with wet paper towel and a glue barrier along the edges.

Experimental units have consisted of 15 juveniles (0-4d old) or mated adult female mites contained in a ventilated covered glass Petri dish with one bean leaf petiole inserted into moist aqua-foam and a glue barrier to prevent escape. Treatments consist of high, medium and low concentrations of all test fungicides based on field recommendations and replicated three times each, with water as control. The first trials were done using the medium field concentration in all cases. Each test unit received a direct over-spray to leaf run-off (~2 mls) using the Spray Tower to achieve the desired coverage of 2 ± 0.2 mg/cm². Mortality was assessed for the juveniles at 24h, 3d and 7d post-application to determine direct and residual toxicity. Treatment mortality and fecundity have been determined for adult females at 24h, 3d and 7d. Percent mortality

and the LC is determined using Abbots formula. A probit regression analysis was used to obtain rate-response relationships. Fecundity, oviposition rate, and longevity have been determined for protonymph and adult females at 6d, 10d, 14d and 4d, 10d, 14d.

Preliminary results of lab bioassays.

Initial laboratory trials with adult predatory mites showed no impact of sulfur sprays on adult mortality and fecundity. In all cases, mean adult mortality remained below 2.22% for all compounds tested. Mean reproduction was not affected over time by any of the compounds tested on adults.

Sprays applied to juvenile test individuals resulted in a slightly higher mortality compared to the water control. The same trend was found when looking at mean reproductive rates. We may deduce from this data that younger stages are more vulnerable to repeated sulfur-only sprays. Taken into account that these stages very often comprise the bulk of the total population, the impact on predatory mite populations may be more severe than suggested by trials done on adult populations only. Initial data from both field trials and laboratory bioassays suggests that multiple sulfur-only applications may negatively influence important beneficial mite populations in vineyards. Further statistical analysis and trials are needed in order to confirm these trends (Table 1 & 2).

Table 1. *Typhlodromus pyri* fungicide assays on adult gravid females.

Treatment	Fungicide Rate	DAT	Mean Mortality	% Mortality (lethal effect) ¹	Mean Reproduction ²
Sulfur	6lbs/A	1	0.6	0.6	5.10
		7	1.8	1.21	
Whey powder	10lbs/A	1	0.6	0.6	4.25
		7	2.8	2.21	
Water	1mL	1	0.2	0.2	5.36
		7	1.6	1.00	
No spray control		1	0	-	4.69
		7	0.6	-	

¹Correction for control calculated according to Abbot. The 'No spray control' treatment

was applied for correction factor.

²Reproduction calculated using #eggs/day/surviving females over the 7 day trial.

Table 2. *Typhlodromus pyri* fungicide assays on juvenile motlies (0-4d old).

Treatment	Fungicide Rate	DAT	Mean Mortality	% Mortality (lethal effect) ¹	Mean Reproduction ²
Sulfur	6lbs/A	1	2.75	1.52	2.11
		7	5.25	2.07	
		14			
Whey powder	10lbs/A	1	1.75	0.51	3.34
		7	3.5	0.26	
		14			
Water	1mL	1	1.75	0.51	0.81
		7	3	-0.26	
		14			
No spray control		1	1.25	–	3.39
		7	3.25	–	
		14			

¹Correction for control (No Spray treatment) calculated according to Abbot's formula. Juvenile mortality assessed from day 1 to day 7.

²Reproduction calculated using #eggs/day/surviving females from day 7 to day 14.

Objective III. Identify the phenology of predatory and pest mite population dynamics in vineyards and hop yards in relation to the number and timing of sulfur applications; and

Experiments were established in small plots and commercial vineyards and hop yards in Oregon and Washington to quantify the effects of sulfur applications on phenology and density of predatory and pest mite populations.

For grapevine studies in Washington, population monitoring of eriophyid mite populations commenced at four Washington vineyards in the Walla Walla and Yakima Valleys providing information on abundance, seasonality and associated populations of predatory mites. Difficulties were experienced in getting viticulturists not to use recommended management strategies for rust mite management, thus blocks not treated with sulfur were hard to obtain. The recommended spring spray program using sulfur was adopted widely and appeared to be overwhelmingly successful with no serious damage to grape shoots and berry formation reported from any appellation in eastern Washington in 2007. Population monitoring showed very low populations of eriophyids in all sampled vineyards from April to September, with very little summer bronzing of leaves reported, compared to previous seasons. Phytoseiid and stigmaeid mites were common at some sites in spring and in some instances appeared to have a strong suppressive effect on eriophyid populations.

Sampling of mite populations on canes and buds during late winter and spring revealed large numbers of predatory mites in many cases. At some sites, dissection of grape buds in late winter showed predatory mites overwintering in buds alongside bud and rust mites. In a few instances we documented a decline in rust/bud mite numbers over a few weeks, which appeared to be mediated by predatory mites. Our observations indicate that significant

biological control of overwintering eriophyid mites on grapevines is a distinct possibility and may have contributed to the small populations of mites emerging from overwintering. Definitive identification of the predatory mites associated with eriophyids on Washington grapevines is ongoing. The two major families appear to be Phytoseiidae and Stigmaeidae. The major stigmaeid species found appears to be *Zetzellia mali*, a well known predator of rust mites in apple orchards that has not been recorded on previously on grapes.

Two spray trials for rust mites and bud mites were established and conducted at commercial vineyards in the Walla Walla and Yakima Valleys. These sites, based on mite population data from 2006 were expected to provide significant eriophyid mite challenges to the treatments. However, this did not occur, mite populations were very small and data obtained from the trials were not convincing concerning pesticide efficacy against *C. vitis* and/or *Ca. vitis* in the month following application. Some information was also obtained on the effect of various treatments on predatory mites in the immediate post-trial period. Phytoseiid predatory mite numbers were highest in the Stylet oil treatment during the four weeks after application (0.6 mites/bud) and lowest in the Fujimite treatment (0.1 mite/bud). Intermediate numbers occurred in the untreated plots and the Envidor, Silmatrix and sulfur treatments (0.24-0.30 mites/bud). The stigmaeid predatory mite, *Zetzellia mali*, was most abundant in the Stylet oil treatment (1.3 mites/bud) followed by the Envidor, Silmatrix and untreated plots (0.4-0.6 mites/bud). Lowest numbers (0.1-0.2 mites/bud) occurred in the sulfur and Fujimite treatments.

In Oregon, field trials during 2007 were conducted in two grape vineyards near Dallas, Oregon (cv. Riesling) and the other near Dundee, Oregon (Pinot Noir). During 2008, the Dallas vineyard was replaced by a vineyard near Salem, Oregon (cv. Pinot Noir). Powdery mildew is managed largely with sulfur fungicides in both conventional and organic production, so the treatments investigated reflected production practices for this region. The treatments in 2007 and 2008 included:

1. Non-sulfur control (synthetics only)—a rotation of synthetic fungicides only were applied which included pyraclostrobin + boscalid, myclobutanil, and quinoxyfen beginning at 10 to 20 cm shoot length – (no sulfur).
2. Organic grower standard (sulfur only) treatment—Nine applications of sulfur beginning at the woolly bud stage.
3. Conventional sulfur/synthetics grower standard (b) —Sulfur applied at bud swell and 7 to 10 days after bud burst; then a rotation of synthetic fungicides as described above – (early sulfur).
4. Conventional grower standard (c) – Two stylet oil applications at bud swell spaced 7 to 10 days apart. Two organic 'Bordeaux' treatments were applied; remainder of applications included a rotation of synthetic fungicides– (oil early).
5. Sulfur early to fruit set and synthetics late – Sulfur applied at bud swell and 7 to 10 days after bud burst; followed by sulfur limited to the period prior to fruit set, and synthetic fungicides thereafter – (sulfur to fruit set).
6. Sulfur-synthetic rotation – sulfur applied at bud swell and 7 to 10 days after bud burst, followed by a rotation of sulfur and synthetic fungicides – (rotated sulfur).
7. Organic compound – an organic compound (Vineyard Magic) starting at bud break to harvest at 7 to 10 day intervals.– (organic). Note: Dundee 07 only.
8. Synthetics only- starting at bud break
9. Rotation of Whey and Sulfur- starting at woolly bud (2008 vineyards)
10. Sulfur late with synthetics early starting at bud break. 2008 vineyards.

Pest mites (including rust, bud, and spider mite populations) and predatory mite numbers were sampled at 14 day intervals throughout the seasons by collecting 16 leaves from four vines in the center of each plot (proximal shoots (top and bottom leaf) and distal shoots (top and bottom leaf)). Leaves were taken to the laboratory and 15mm diameter leaf disks were removed and examined for pest and predatory mite incidence using a stereo-microscopes. Sampling continued to the end of the summer season until leaf senescence. Incidence of powdery mildew on leaves and clusters were assessed bi-weekly. Crop loss and fruit yields were assessed at harvest including cluster quality, weight, and numbers per vine; shoot scarring and short shoot symptoms; and incidence of powdery mildew. Data has been entered and statistical analyses are underway. Preliminary results are presented below.

During 2007, pest mite numbers and predator mite numbers were generally higher in plots that only received synthetic fungicides in both locations. In the Dundee vineyard, mean seasonal pest mite numbers per leaf was 0.25 in plots that only received synthetic fungicides compared to 0.08 in plots that received a mix of synthetic fungicides and sulfur. The mean number of predatory mites was similar in each of the treatments at 0.07 predatory mites per leaf. In the Dallas vineyard, mean seasonal pest mite numbers per leaf was 0.08 in plots that only received synthetic fungicides compared to 0.05 in plots that received a mix of synthetic fungicides and sulfur. Mean seasonal predatory mites per leaf in synthetic fungicide plots were 0.22 mites per leaf compared to 0.26 mites per leaf in plots that received both synthetic fungicides and sulfur.

During 2008, the same trend of higher pest mite numbers were seen in plots that only received synthetic fungicides in both locations. In the Dundee vineyard, mean seasonal pest mite numbers per leaf was 1.07 in plots that only received synthetic fungicides compared to 0.2 in plots that received a mix of synthetic fungicides and sulfur. The mean number of predatory mites was slightly higher than during the previous season at 0.18 and 0.15 mites per leaf similar in each of the treatments at 0.07 predatory mites per leaf. In the Salem vineyard, mean seasonal pest mite numbers per leaf was 8.1 in plots that only received synthetic fungicides compared to 3.44 in plots that received a mix of synthetic fungicides and sulfur. Mean seasonal predatory mites per leaf in synthetic fungicide plots were 0.48 mites per leaf compared to 0.21 mites per leaf in plots that received both synthetic fungicides and sulfur.

Overall, vineyard plots with multiple sulfur applications resulted in the lowering of both pest and predatory mite populations as seen from preliminary data taken over two seasons, 2007 and 2008. In cases where synthetic fungicides were the only compounds used for fungus control, both pest and predatory mite populations were higher than in plots where sulfur was used. In many cases, it however appeared as if pest populations were not contained by predatory mite numbers. In plots where sulfur was applied in combination with synthetic fungicides, there were lowering of pest mite numbers, and beneficial mite numbers were not affected in the same negative degree as in plots where sulfur were used as the only fungicide. Further statistical analysis and an additional field season are needed in order to confirm these findings. In order to show trends only treatments (i), (ii), and (vi) are shown in the graphs during the past two seasons (Fig. 1 & 2, 3 & 4).

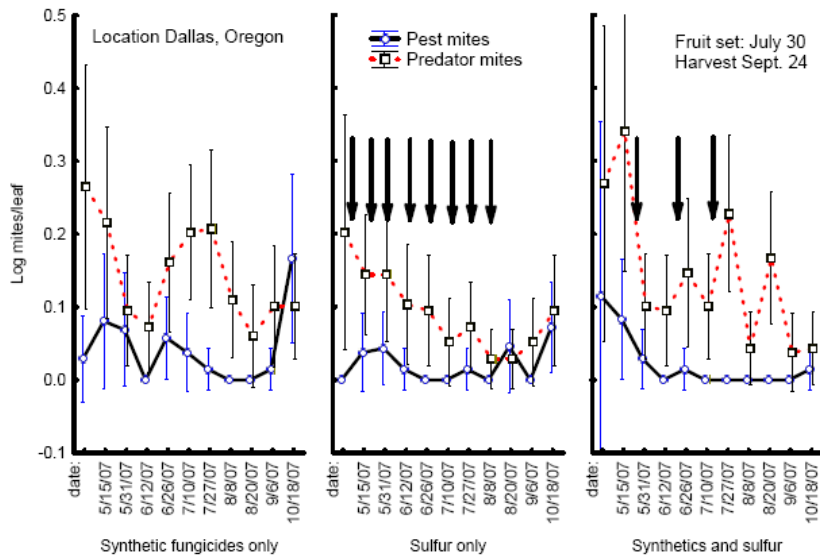


Fig. 1. Log mites per leaf in Dallas, Oregon during 2007 using three fungicide treatment regimes: Synthetic fungicides only, Sulfur applications as only fungicide treatment (sulfur applications indicated by arrows) and Synthetic fungicides interspersed by sulfur applications.

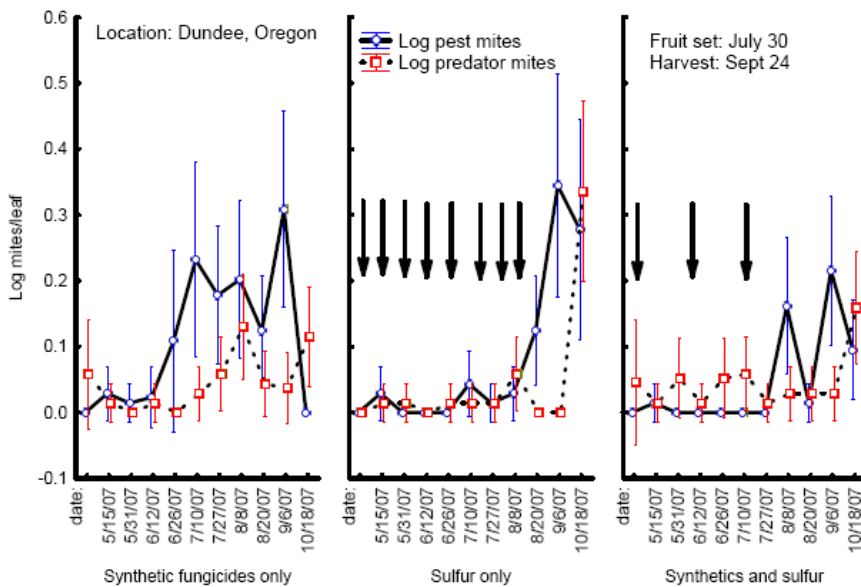


Fig. 2. Log mites per leaf in Dundee, Oregon during 2007 using three fungicide treatment regimes: Synthetic fungicides only, Sulfur applications as only fungicide treatment (sulfur applications indicated by arrows) and Synthetic fungicides interspersed by sulfur applications.

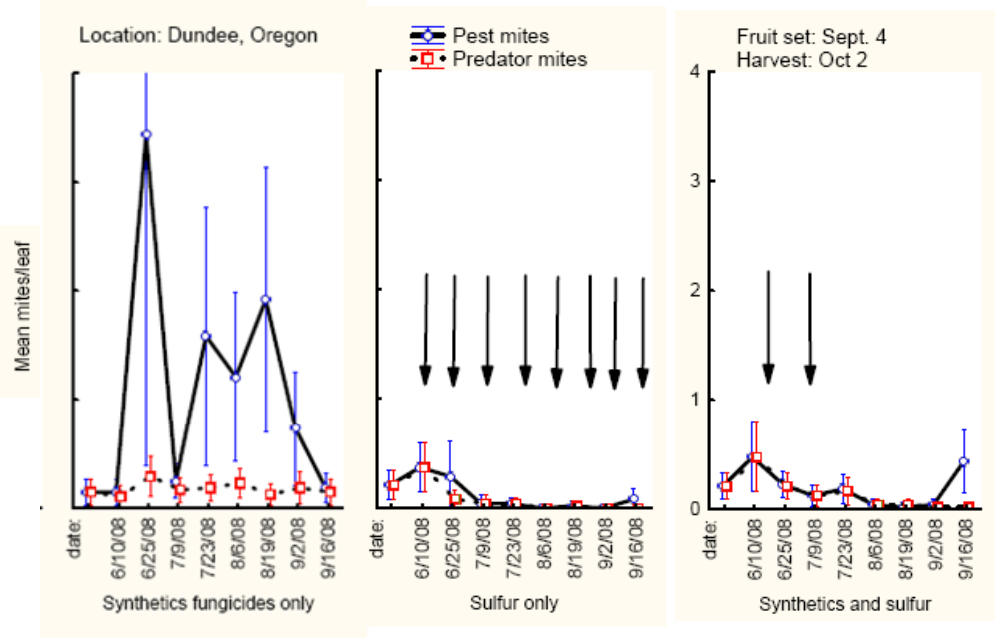


Fig. 3. Mean mites per leaf in Dundee, Oregon during 2008 using three fungicide treatment regimes: Synthetic fungicides only, Sulfur applications as only fungicide treatment (sulfur applications indicated by arrows) and Synthetic fungicides interspersed by sulfur applications.

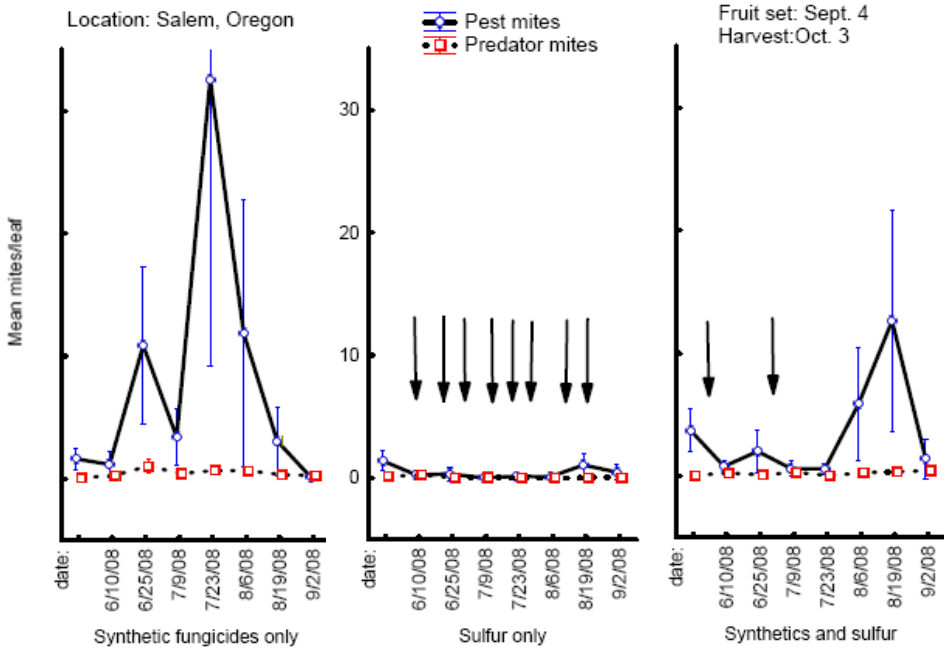


Fig. 4. Mean mites per leaf in Salem, Oregon during 2008 using three fungicide treatment regimes: Synthetic fungicides only, Sulfur applications as only fungicide treatment (sulfur applications indicated by arrows) and Synthetic fungicides interspersed by sulfur applications.

Hop yard studies.

In experiments with hops, small plot experiments were established in 2007 and 2008 at two sites near Corvallis, Oregon and Prosser, Washington to quantify the effects of sulfur applications on phenology and density of predatory and pest mite populations. Regular sampling of leaves indicated overwintering spider mites were present in all plots beginning at the first emergence of shoots in early spring. Spider mites and phytoseiid mites were observed during the first quantitative assessments in early spring, and populations increased in the lower and upper canopy beginning in early May to early July. In both Washington and Oregon, plots treated with sulfur early-season tended to have the lowest populations of spider mites, and while applications beginning in mid-June had the highest mite populations. In Oregon in 2007, late sulfur applications required the application of multiple miticides to contain the outbreak, whereas mite outbreaks were contained with a single miticide application in the other treatments.

Populations of other predatory insects, individually or combined, did not vary among treatments. However, predatory mite populations were very low in the experimental yard in Corvallis in 2007 and 2008. The reason for the increase in spider mite populations in response to treatment with sulfur at the Corvallis location does not appear to be related to toxicity to natural enemies, and appears related to increased dispersal (repulsion) of mites. During the first two years of this study in Corvallis and Prosser, sulfur exacerbated spider mite outbreaks in all four trials. Preliminary analysis of data sets collected in Oregon law did not indicate large differences in patterns of motile spider mites over the time course of the entire season when outliers were removed. Significant differences in aggregation of eggs were detected, as indicated by the greater slope of the regression line for non-treated plots (Fig. 6). Spatial analysis of 2008 data was limited to a time period of three weeks after the final sulfur applications were made, and indicated significant dispersion of spider mites soon after the termination of application. Spatial patterns of adult and juvenile mites and eggs were similar among non-treated and sulfur-treated plots three weeks after the final sulfur application, indicating dispersion of mites in response to sulfur on hop occurs during or immediately following cessation of applications. This study will continue in 2009 to validate the results obtained in 2007 and 2008 and develop sound recommendations on the appropriate timing of sulfur applications to maximize biological control of spider mites.

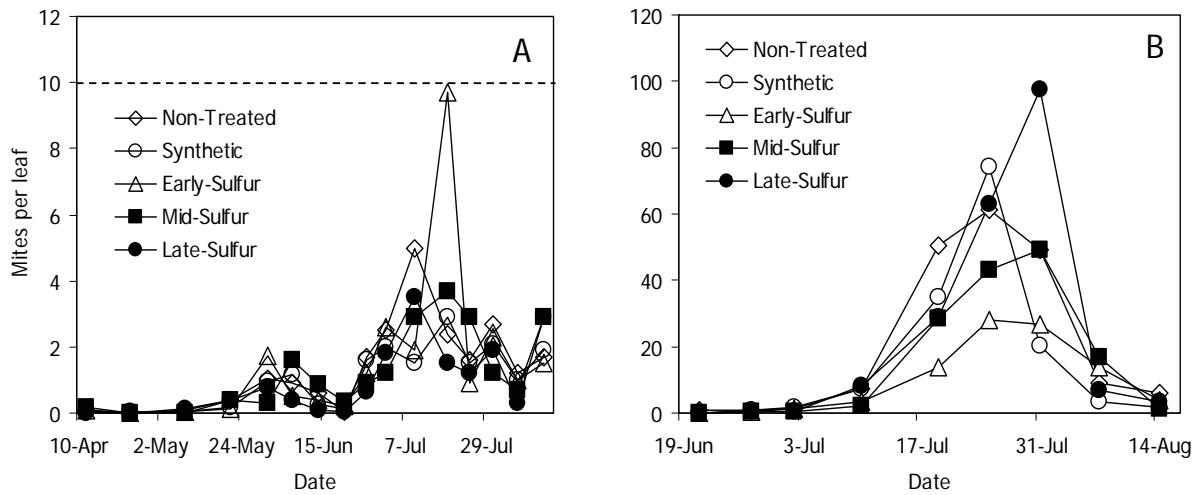


Figure 5. Spider mite (*Tetranychus urticae*) populations in the lower canopy (≤ 1 meter) (A), and upper canopy (2 to 3 m) (B) in cultivar Willamette in response to different powdery mildew management programs. Populations are for non-miticide treated plots. Error bars are not presented to increase legibility of the figures.

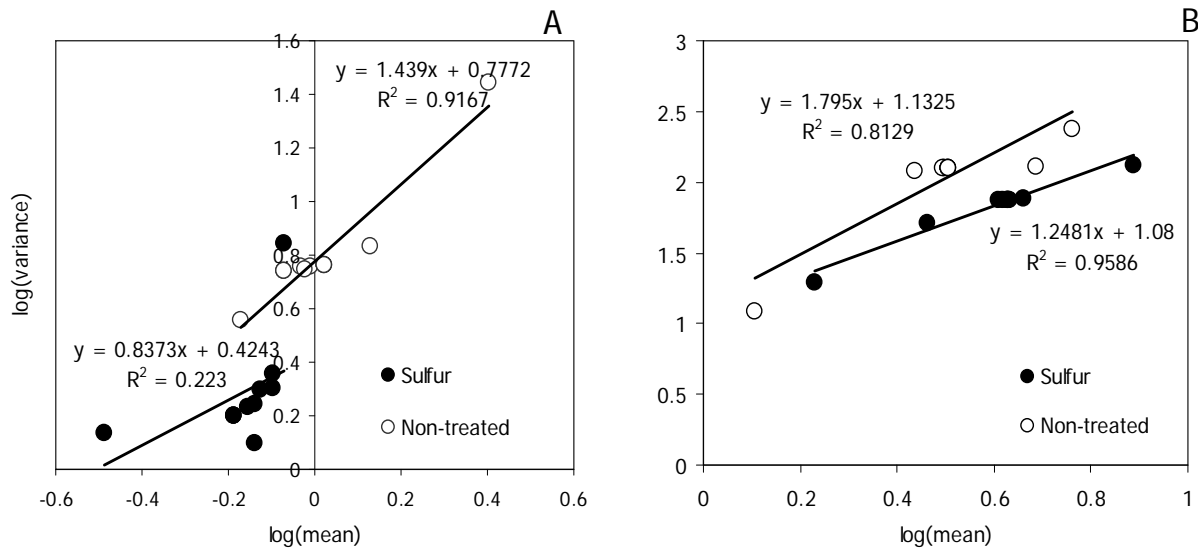


Figure 6. Spider mite dispersion (A) and egg dispersion (B) on leaves averaged over two samplings heights in the canopy.

Objective IV. Transfer knowledge and IPM systems developed in this project to stakeholders through established public-private partnerships by extension bulletins, electronic formats, trade publications, and annual meetings.

Extensive extension activities were conducted during 2007 and 2008 to transfer knowledge and IPM recommendations to stakeholders. Publications, presentations, reports, and other outreach activities are detailed below.

Surveys were also conducted to document the impacts of this project. In order to

implement a survey at Oregon State University, a test, application, informed consent with purpose and procedures must be submitted. All documents have been submitted to Institutional Review Board, Office of Sponsored Programs and Research Compliance. An online survey was sent out to participants of the Southern Oregon and Columbia Gorge Vineyard Field Day Tour held July 31st and August 5, 2008, respectively. An additional survey has been prepared and will be sent out winter 2009 to document changes in grower awareness and implementation of IPM practices, and to make decisions concerning future project and research activities.

Peer Reviewed Publications

1. Gent, D. H., James, D. G., Wright, L. C., Barbour, J. D., Dreves, A. J., Fisher, G. C., and Walton, V. M. 2008. Effects of powdery mildew fungicide programs on two spotted spider mite (Acari: Tetranychidae), hop aphid (Homoptera: Aphididae), and their natural enemies in hop yards. *J. Econ. Entomol.* *In press.*
2. Walton, V. M., 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* (Nalepa), bud mites *Colomerus vitis* (Pagenstecher) (Acari: Eriophyidae) and short shoot syndrome in Oregon vineyards. *Internat. J. Acarol.* 33:307-318.
3. OSU Grape Pest Management Guide for Wine Grapes in Oregon. EM8143-E. Revised Mar 2008.

Posters, Presentations, Workers, Field Days

1. Dreves, A.J., Walton V., Gadino, A., Skinkis, P., and Fisher, G. Dec. 9-12, 2007. Relationship between rust mites, *Calepitrimerus vitis* (Acari: Eriophyidae), bud mites *Colomeris vitis* (Acari: Eriophyidae) and short shoot syndrome in Oregon vineyards. Ten-minute paper was presented at 55th Annual Meeting of the Entomological Society of America.
2. Dreves, A.J., V. Walton, A. Gadino, U. Chambers. Dec. 9-12, 2007. Beneficial organisms associated with pesticide spray regimes in northwest Oregon vineyards. Poster presented at 55th Annual Meeting of the Entomological Society of America.
3. Dreves, A.J., A. Gadino, V. Walton, G. Fisher, and D. Gent. March 2008. The impact of pesticides on beneficial organisms in Northwest Oregon Vineyards. Poster presented at: Pacific Branch Entomological Society meeting.
4. Gent, D. H. 2007. Biology, Epidemiology, and Management of Hop Disease. Presented research update to U.S. hop industry at Winter Meeting of the Hop Research Council. January 24, 2007, Yakima, Washington.
5. Gent, D. H. 2007. Biology, Epidemiology, and Management of Hop Disease. Presented research update to U.S. hop industry at Winter Meeting of the Hop Research Council. August 7, 2007, Salem, Oregon.
6. Gent, D. H. 2008. Biology, Epidemiology, and Management of Hop Disease. Presented research update to U.S. hop industry at Winter Meeting of the Hop Research Council. January 23, 2008, Portland, Oregon.
7. Gent, D. H. 2008. Biology, Epidemiology, and Management of Hop Disease. Presented research update to U.S. hop industry at Winter Meeting of the Hop Research Council. August 1, 2008 Yakima, Washington.
8. James, D. G. 2007. Development of Hop Integrated Pest Management Strategies. Presented research update to U.S. hop industry at Winter Meeting of the Hop Research Council. January 24, 2007, Yakima, Washington.
9. James, D. G. 2007. Development of Hop Integrated Pest Management Strategies.

Presented research update to U.S. hop industry at Winter Meeting of the Hop Research Council. August 7, 2007, Salem, Oregon.

10. James, D. G. 2008. Development of Hop Integrated Pest Management Strategies. Presented research update to U.S. hop industry at Winter Meeting of the Hop Research Council. January 23, 2008, Portland, Oregon.
11. James, D. G. 2008. Development of Hop Integrated Pest Management Strategies. Presented research update to U.S. hop industry at Summer Meeting of the Hop Research Council. August 1, 2008 Yakima, Washington.
12. Technical Research Meeting with Growers. Presented on-farm tour of SSS symptoms in vineyard. Sept. 15, 2007. Dundee, OR.
13. Technical Research Meeting with Growers. Sept. 11, 2008. Dayton, OR. Presented on-farm demonstration of SSS symptoms in vineyard.
14. V. Walton, A.J. Dreves, D. Gent, D. James, R.R. Martin, U. Chambers, and P. Skinkis. March 2008. 20-minute talk was presented on Biology and IPM of Eriophyid mites in Oregon Vineyards at Pacific Branch Entomological Society Meeting.

On-Farm Tours and Field Days discussing research plans and mites:

1. Sept 2007 Technical Research Tour with Growers in Willamette Valley
2. May 7, 2008 Vineyard Growers Field Day in Willamette Valley
3. June 12, 2008 Grape Day in the Umpqua: 1 day of seminars (mites and SSS)
4. July 31, 2008 Southern Oregon Annual Vineyard Tour
5. Aug. 5, 2008 Columbia Gorge Vineyard Field Day
6. Sept 11, 2008 Technical Research Tour with Growers in Willamette Valley

Alerts and Newsletters

1. May 18, 2007 Vineyard Notes: Short Shoot Syndrome Update
2. Sept 7, 2007 Viticulture Notes - Mites and Short Shoot Syndrome
3. Feb 22, 2008 OSU Winter Newsletter: Act now: Manage mites and short shoot syndrome and how to take shoot samples. about vineyard arthropods
4. Oct 2007 and April 10, 2008 OSU Vineyard Newsletter: Who's who in the Vineyard?
5. James, D. G. 2007. Development of Hop Integrated Pest Management Strategies.
6. Apr 20, 2008 OSU Spring Wine and Grape Research and Extension Newsletter: Observations in the Vineyard: keeping an eye on short shoot syndrome
7. June 15, 2008 OSU Summer Newsletter. Take a Closer Look: Mite-associated short shoot syndrome and other factors expressing SSS
8. Aug 8, 2008 OSU Fall Wine and Grape Research and Extension Newsletter (<http://wine.oregonstate.edu>): Survey of the incidence of rust mites and short shoot syndrome in Oregon
9. Oct 9, 2008 Alert Newsletter: Lab Test Reveals Mealybug found in Oregon Vineyards is not harmful vine mealybug.
10. Gent, D. H. 2007. Biology, Epidemiology, and Management of Hop Disease. Technical Report submitted to Hop Research Council.
11. Gent, D. H. 2008. Biology, Epidemiology, and Management of Hop Disease. Technical Report submitted to Hop Research Council.
12. James, D. G. 2007. Development of Hop Integrated Pest Management Strategies. Technical Report submitted to Hop Research Council.
13. James, D. G. 2008. Development of Hop Integrated Pest Management Strategies. Technical Report submitted to Hop Research Council.