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USDA Agricultural Research Service scientists engaged in grape and grape products research prepared the surveys collected here in preparation for the ARS Grape Workshop held July 10-12, 2005 in St. Louis, Missouri. The surveys provide an introduction to the research being conducted by ARS scientists that addresses challenges and opportunities of the grape and grape products industry.

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GENETICS, BREEDING, AND GERMPLASM

Name(s) and location(s) of scientist(s) working on the project:
Ed Stover, Malli Aradhya, and Bernard Prins, National Clonal Germplasm Repository, Davis, California
Name, email address, and phone number of contact person:
Ed Stover, ewstover@ucdavis.edu, 530-752-7009
What is the problem you are addressing?
Plant genetic resources are recognized as being crucial for the welfare and quality of life for current and future generations. Availability and even survival of grape genetic resources are threatened by diverse forces.

What is the project that you are conducting to address the problem?
We are horticulturists and a geneticist working to acquire, maintain, characterize, and distribute grape genetic resources.

What is the approach you are taking?
New material is actively acquired to complement the existing collection. Plants are maintained in the field and screenhouses. Accessions are characterized for phenology, morphology, and genetic characteristics. Molecular fingerprinting is underway to provide assurance of identity. Propagation material is routinely distributed to plant breeders, researchers, and the nursery industry.

What has been accomplished?
The repository collection includes 2700 accessions of grapes and grape relatives, with a high proportion duplicated in the field and screenhouse. New grape acquisitions number 306 since 2000 and more are currently being negotiated. Phenological and morphological data have been collected numbering 109,907 individual data points. DNA microsatellite fingerprints have been developed for 714 grape accessions and AFLP fingerprints have been completed for 352 accessions. Many of these microsatellite data will soon be searchable on the Genetic Resource Information Network (GRIN) website (http://www.ars-grin.gov/npgs/searchgrin.html). Over the last five years we have distributed grape germplasm in response to 4,400 accession requests.

What impact do you expect from your project?
Ready access to a broad spectrum of grape genetic material assists plant breeders in responding to challenges and opportunities for commercial grape producers. In addition, availability of grape varieties not accessible through commercial channels provides a direct resource for identifying varieties with characteristics that may provide improved adaptation, distinctive grape-product features, or other niche advantages. Resources from our repository will contribute to improved grape varieties and rootstocks for the next decade and coming centuries.

Do you receive any additional support for this project? If so, from what source(s)?
We have submitted a grant proposal to accelerate characterization of the Iberian grapes in our collection. This proposal has been jointly submitted to the American Vineyard Foundation, the California Table Grape Commission, the California Competitive Grant Program for Research in Viticulture and Enology, and the Viticulture Consortium Program in 2005. With this additional financial support we will employ several part-time lab and field technicians.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?

There are hundreds of cooperators on this project. Among the most notable are:

Name	Affiliation	Interaction
Peter Cousins	USDA/ARS, PGRU, Geneva, NY	Provides new germplasm; utilizes the collection in his breeding program.
Deborah Golino	UC Davis, Davis, CA	Access to new germplasm
Jiang Lu	FL A&M U, Tallahassee, FL	Provides new germplasm; utilizes the collection in his breeding program.
Gary Moulton	WSU, Pullman, WA	Assessing 148 accessions in Washington
Chris Owens	USDA/ARS, PGRU, Geneva, NY	Utilizes the collection in his breeding program.
Penelope Perkins-Veazie	USDA/ARS, Stillwater, OK	Utilizes collection to assess nutriceutical properties
Davis Ramming	USDA/ARS, Fresno, CA	Provides new germplasm; utilizes the collection in his breeding program.
Bruce Reisch	Cornell U., Geneva, NY	Provides new germplasm; utilizes the collection in his breeding program.
Robert Sotomayer	Gila River Indian Community	Assessing 130 table grape accessions
Gayle Volk	USDA/ARS, Ft. Collins, CO	Cryopreservation studies, characterizing genetic diversity
Andy Walker	UC Davis, Davis, CA	Provides new germplasm; utilizes the collection in his breeding program.
Numerous nurseries and vineyards	Throughout U.S.	Utilizing grape resources for propagation or testing
Numerous individuals	California Rare Fruit Growers	Provide new germplasm; assess numerous accessions for niche use

Name(s) and location(s) of scientist(s) working on the project:
Philip L. Forsline, Plant Genetic Resources Unit (PGRU), Geneva, New York
Name, email address, and phone number of contact person:
Philip L. Forsline, PLF1@cornell.edu, 315-787-2390
What is the problem you are addressing?
Conservation, characterization, distribution and utilization of grape germplasm
What is the project that you are conducting to address the problem?
I am working under the strategic plan of the USDA-ARS National Program 301 "Conservation and Utilization of the Genetic Resources pf Apples, Grapes and Tart Cherries"
What is the approach you are taking?
The Plant Genetic Resources Unit scientists maintain, characterize, evaluate, document, and distribute the genetic resources of grape including wild species, wild and weedy relatives, landraces, obsolete and current cultivars. The collection is a resource for plant breeders, farmers, botanists, nutritionists, and others who study and use plant genetic diversity.
What has been accomplished?
Working in concert with the National Clonal Germplasm Repository (NCGRP) in Davis, CA, nearly 4000 accessions have been acquired and are being maintained by the two repositories. In Geneva, we have 1200 accessions and most of these are species and hybrids of North American origin. We have characterized with 17 descriptors the majority of the accessions, and the data is available on line: http://www.ars.usda.gov/Aboutus/docs.htm?docid=6245. We have also completed digital imaging of a large portion of the collection. In addition we have distributed over the last 12 years, 9000 accessions based on 600 orders to our user community.
What impact do you expect from your project?
I expect that we will have information on the diverse collection that we maintain that will be valuable to breeders, other scientists and growers. This gives them a full library of phenotypic, genetic and molecular traits that will be useful in creating new cultivars and expanding the environments in which grapes can be grown.
Do you receive any additional support for this project? If so, from what source(s)?
We receive support from the NE9 regional project that supports two of the technicians that work on this project. Support also comes in the form of evaluation grants to collaborators who evaluate the collection for disease resistance and adaptation to different environments.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
We cooperate closely with other scientists at PGRU: 1) Chuck Simon and Angela Baldo characterize the collection using molecular tools; 2) Peter Cousins who uses the collection in his grape rootstock breeding program; 3) Lance Davidson is a grape pathologist using genomics approaches to disease resistance; and 4) Chris Owens and Amanda Garris in breeding, genomics and physiological and nutritional aspects of the collection. We also work with scientists at the NCGRP in Davis on grape germplasm conservation and Cornell scientists: Bruce Reisch, Wayne Wilcox and Tom Burr in characterizing the collection for disease resistance.

Name(s) and location(s) of scientist(s) working on the project:
David W. Ramming, USDA-ARS, San Joaquin Valley Agricultural Sciences Center, Crop Diseases, Pests and Genetics Research Unit, Parlier, California

Name, email address, and phone number of contact person:
David W. Ramming, dramming@fresno.ars.usda.gov, 559-596-2823

What is the problem you are addressing?
1. Need for better seedless table grapes that are productive, store and ship well.
2. High cost of harvesting raisin grapes and fall rain damage.
3. Powdery mildew susceptibility of table and raisin grapes and the cost of control measures as well as protection of the environment from chemicals.
4. Susceptibility of table and raisin grapes to Pierce's disease and the increased problem of the disease as caused by the GWSS vector.
5. Susceptibility of rootstocks to phylloxera.

What is the project that you are conducting to address the problem?
1. Development of improved, larger fruited, seedless table grapes with good production, storage and shipping ability that ripen from early to late with white, red and black fruit.
2. Development of improved seedless raisin grapes that dry naturally on the vine without cutting canes.
3. Development of powdery mildew resistant table and raisin grape varieties.
4. Development of Pierce's disease resistant table and raisin grape varieties.
5. Development of genetic information about the inheritance of phylloxera resistance.

What is the approach you are taking?
1. Using a traditional breeding program with embryo rescue to hybridize seedless with seedless grapes. Selecting for very large berries with very small aborted seeds, firm fruit, good production. Advanced selections are put into 25 vine cultural trials to determine pruning, and other appropriate cultural practices.
2. Using a traditional breeding program with embryo rescue to hybridize seedless with seedless grapes. Identified parents that have natural dry on the vine characteristics without cutting canes. Hybridizing these parents with the best raisin types in our program. Select based on seedless fruit, ability to dry into raisins by October 1 without cutting canes.
3. Using a traditional breeding program with embryo rescue to hybridize seedless individuals. Resistant germplasm screened in the field is hybridized with the best seedless table and raisin grapes. Greenhouse screening of seedlings and advanced selections for quicker determination of resistance. Developing leaf disk laboratory screening procedure. The best resistant selections are backcrossed to the best table and raisin grape selections.
4. Using a traditional breeding program with embryo rescue to hybridize seedless individuals. Resistant germplasm determined to be resistant in the greenhouse screen is being hybridized with the best table and raisin grape selections. Greenhouse screening of seedlings is done to determine resistant individuals. Molecular markers are being developed and have been used to identify resistant individuals in certain populations. The best resistant selections are backcrossed to the best table and raisin grape selections.

5. A greenhouse screening method was developed to determine germplasm resistant to phylloxera nodisities. Populations were created by crossing resistant and susceptible germplasm and observing seedling reactions in the greenhouse. Segregating populations are being used to search for molecular markers to aid in selecting for phylloxera resistant individuals.

What has been accomplished?

1. Released a number of seedless table grape varieties for the fresh market.

Crimson Seedless 2003 production = highest TG in California with 17.6M boxes
Commercial production also in Chile and other grape producing regions.
Autumn Royal 2003 production = 5th in California with 2.5M boxes.
Princess Seedless 2003 production = 9th in California with 1.08M boxes.
Sweet Scarlet (released, patent pending), Scarlet Royal and Autumn King (patent applied for, September 2004).

2. Released two neutral flavored early ripening raisin grapes suitable for drying on the vine when canes are cut = DOVine and Selma Pete. Over 500 acres of Selma Pete now planted. Also released two Muscat flavored seedless raisin grapes, Diamond Muscat and Summer Muscat.

Progress – Natural DOV (dry on the vine) selections made that dry to 14% moisture by first of October. One in particular, with Thompson Seedless size fruit and small aborted seed looks outstanding in a 4 vine plot. It also has average production in the first 3 years of testing.

3. We are in the BC3 generation of backcrossing powdery mildew resistant grapes with quality table and raisin grapes. Over 200 selections at various stages of testing have been made. Greenhouse screening to determine resistant/susceptible seedlings and selections propagated by dormant cuttings has been implemented. Cooperating with Joe Smilanick to develop leaf disk laboratory inoculation methods and it shows high correlation to results obtained for old vines in the field.

4. In 2000, the first crosses between Pierce's disease resistant wild material and advanced seedless table and raisin grape selections were made and 4 families were developed. They were screened in the greenhouse and 20 resistant and 7 tolerant individuals were identified. The most resistant were backcrossed to seedless table and raisin grape selections and their seedlings screened in 2003/4 with molecular markers. Twenty resistant individuals were identified with molecular markers. Greenhouse screening of these individuals confirmed resistance. One selection has 8 gram berries compared to 2-3 g berries for the wild resistant material. The second backcross generation was made in 2004 and plants from these crosses are growing in the greenhouse and ready to be screened for resistance.

In 2001, three additional families were produced by crossing a different source of PD resistance to the best seedless table grape selections in the USDA breeding program. These were screened in the greenhouse and 25 resistant and 13 tolerant individuals identified.

5. Twenty families in a half dialelle cross have been screened in the greenhouse for resistance to phylloxera. Resistance was characterized as no nodosity formation. One rootstock was identified that produced >90 % resistant individuals even when crossed with susceptible vinifera material like Thompson Seedless. When other resistant rootstocks were hybridized, their families segregated for resistance/susceptibility.

What impact do you expect from your project?

1. New table grape varieties. They already apply to commercial grape industry and are being used.
2. New raisin grape varieties. They already apply to commercial raisin industry and are being used.
3. Mildew resistant table and raisin grape varieties that require no or reduced application of fungicides to control powdery mildew. They will apply directly to the industry when released.
4. Pierce's disease resistant table and raisin grape varieties. Even if and when vectors of Pierce's disease change they will remain resistant and epidemic spread of Pierce's disease will be reduced/eliminated. When released they will apply directly to the industry.
5. Will aid scientists in understanding the inheritance of resistance so better hybridization plans can be implemented in the development of phylloxera resistant rootstocks.

Do you receive any additional support for this project? If so, from what source(s)?

California Table Grape Commission
California Raisin Marketing Board
California Competitive Grants Program Viticulture and Enology

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?

1. Sayed Badr, California State University, Fresno – large scale trial of Sweet Scarlet, Princess and Autumn Royal. Carmen Gaspert, University of California Cooperative Extension Farm Advisor, Riverside County/Coachella Valley – Evaluation on advanced table grape selections in the desert.
2. Matthew Fidelibus, University of California, Department of Viticulture and Enology, Grape Extension Specialist, based at the University of California Kearney Agricultural Center – production trial of Zante type raisin selections.
3. Joe Smilanick, Plant Pathologist, USDA/ARS, Parlier, CA – development of laboratory leaf disk assay for resistance determination.
4. M. Andrew Walker, University of California, Davis, CA – determined resistant germplasm, developed greenhouse screening technique, developing markers for resistance.

Name(s) and location(s) of scientist(s) working on the project:
Peter Cousins, Plant Genetic Resources Unit, Geneva, New York
Name, email address, and phone number of contact person:
Peter Cousins, psc9@cornell.edu, 315-787-2340
What is the problem you are addressing?
Root-knot nematodes (*Meloidogyne* species) are a principal soil pest of vineyards. Root-knot nematodes feed on and damage the roots of susceptible grapevines. Virulent and aggressive nematode populations are emerging that damage the currently available nematode resistant rootstocks.
What is the project that you are conducting to address the problem?
I am breeding grape rootstocks that are resistant to the virulent nematode populations.
What is the approach you are taking?
I evaluate germplasm and identify desirable parents for breeding, then hybridize suitable parents and screen their seedlings for nematode resistance in the greenhouse. Nematode resistant selections are planted into the vineyard. Additional horticultural testing and grafted vineyard trials are conducted to identify superior candidate rootstocks.
What has been accomplished?
My program has screened over 12,000 seedlings for nematode resistance since 2001. More than 250 nematode resistant selections have been planted in the vineyard. Fifteen selections are being advanced to grafted vineyard trials in 2005. No commercial or industry benefit has yet been realized.
What impact do you expect from your project?
I expect that superior nematode resistant rootstocks will be released to the public for vineyard use. Additional vineyard evaluation of the rootstocks, conducted in cooperation with growers and Cooperative Extension advisors, will provide more information about the performance of the rootstocks, facilitating their adoption for commercial use.
Do you receive any additional support for this project? If so, from what source(s)?
I received additional support for this project from the American Vineyard Foundation and the California Table Grape Commission in 2003, 2004, and 2005. With their additional financial support I hired another technician who evaluates nematode resistance of seedlings.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
University of California, Davis, professor of Viticulture and Enology M. Andew Walker cooperates by providing access to the germplasm in the departmental rootstock collection. Stephen Vasquez, University of California Cooperative Extension viticulture advisor, cooperates in vineyard evaluation of nematode resistant selections. Philip Forsline, horticulturist and curator of the germplasm repository at Geneva (ARS Plant Genetic Resources Unit), Ed Stover, research leader and curator of the germplasm repository at Davis (ARS National Clonal Germplasm Repository), and Bernard Prins, horticulturist at NCGR, cooperate by providing access to the plant genetic resources in the two repositories. David Ramming, research horticulturist, Crop Diseases, Pests and Genetics Unit, ARS San Joaquin Valley Agricultural Sciences Center, cooperates by providing access to rootstocks and nematode resistant selections in his germplasm collection. Duarte Nursery, Hughson, California, cooperates by growing nematode resistant selections in its nursery mother blocks.

Name(s) and location(s) of scientist(s) working on the project:
Stephen Stringer, Small Fruit Research Station, Poplarville, Mississippi

Name, email address, and phone number of contact person:
Stephen Stringer, sjstringer@ars.usda.gov; (601) 795-8751

What is the problem you are addressing?
The market for fresh muscadine grapes is limited by characteristics including skin thickness, flesh texture, and large seeds. Muscadine grapes are rich sources of nutriceuticals including antioxidants, resveratrol, and phenolic compounds. The genetic variation present in existing cultivars and germplasm and the inheritance of these traits have not been elucidated

What is the project that you are conducting to address the problem?
I am breeding muscadine grape germplasm with improved fresh market quality and enhanced levels of antioxidants and other compounds identified as natural agents in reducing the potential for inflammation, heart disease and cancer.

What is the approach you are taking?
I evaluate germplasm and identify desirable parents for breeding, then hybridize suitable parents and screen their seedlings for fruit quality. Promising selections are evaluated in field plantings to evaluate their performance and potential suitability for release as new cultivars. Muscadine grape cultivars and germplasm are being screened for their nutriceutical properties and will be utilized in breeding for enhanced concentrations of health promoting compounds.

What has been accomplished?
A repository has been established containing over 70 cultivars and breeding lines. The performance and quality of these strains have been evaluated since 2001. One breeding line has been identified as having potential as a new fresh market muscadine grape cultivar. Several others have been identified as having very high levels of phenolic compounds (ie. antioxidants). These are being evaluated at sites in Mississippi and Florida and are being increased for evaluation at other locations. Seedlings resulting from hybridizations among several fresh market type parents have been established in field plantings.

What impact do you expect from your project?
I expect that superior fresh market muscadine grape cultivars will be released to the public for vineyard use. I also expect that muscadine grapes will be grown for their pharmaceutical properties and that cultivars possessing having higher concentrations of these value-added compounds will be developed for commercial use.

Do you receive any additional support for this project? If so, from what source(s)?
No

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Penny Perkins Veazie, USDA-ARS, Lane Oklahoma. Evaluation of Muscadine germplasm for antioxidant concentration.

Name(s) and location(s) of scientist(s) working on the project:
Lance Cadle-Davidson, Plant Genetic Resources Unit, Geneva, New York

Name, email address, and phone number of contact person:
Lance Cadle-Davidson, led8@cornell.edu, 315-787-2442

What is the problem you are addressing?
Many cultivated grape varieties are susceptible to fungal diseases. As a result, growers invest significantly in the management of powdery mildew, downy mildew, Botrytis bunch rot, and other fungal diseases.

What is the project that you are conducting to address the problem?
I am attempting to identify novel sources and mechanisms of resistance to economically important fungal pathogens.

What is the approach you are taking?
We screen the PGRU germplasm collection, mapping populations, and progeny derived from sports for reduced disease susceptibility as well as molecular markers of resistance. Additionally, we characterize the biochemistry of host tissue development and how development affects disease susceptibility through phenomena such as ontogenic resistance.

What has been accomplished?
In the past 2 years, we have become the major user of the Geneva germplasm collection, screening hundreds of accessions for resistance to *Phomopsis*, powdery mildew, and *Botrytis*. In addition to traditional, non-temporal disease resistance, we have identified novel variation in the timing of ontogenic resistance and have developed proteomic techniques to ascertain the biochemical basis. These approaches are at least 15 years from commercial impact.

What impact do you expect from your project?
Our approach will result in the identification of resistance genes to be transferred into cultivars and molecular markers to assist breeders in making disease resistant selections.

Do you receive any additional support for this project? If so, from what source(s)?
Currently my only financial support for this research is the USDA-ARS.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
We work alongside Drs. David Gadoury, Bob Seem, and Wayne Wilcox of Cornell University, who have expertise in the biology and epidemiology of our pathogens-of-interest. Our proteomic analyses are conducted in the laboratory of Dr. Ted Thannhauser (USDA-ARS, Ithaca). Additionally, we have powdery mildew resistance projects with Dr. Ian Dry of CSIRO in Australia. Ian is part of the group working to clone *Run1*, a powdery mildew resistance gene from *Muscadinia*, and he published the original attempts to identify the molecular basis of ontogenic resistance. We are working with the Fredonia Vineyard Laboratory (Cornell) to characterize disease resistance in 140 genotypes from the cold-hardy germplasm collection.

Name(s) and location(s) of scientist(s) working on the project:
Amanda Garris, Plant Genetic Resources Unit, Geneva, New York

Name, email address, and phone number of contact person:
Amanda Garris, ajl34@cornell.edu, 315-787-2463

What is the problem you are addressing?
Grapes in North America are often "maladapted" to the growing environment or market niches. The timing of budbreak, anthesis, fruit set, veraison, leaf fall, and dormancy have large effects on survival, fruit quality, and market value of grapes. The genetic basis for the timing of these events with environmental cues is poorly understood.

What is the project that you are conducting to address the problem?
I am using an array of molecular approaches to identify genes involved in these processes.

What is the approach you are taking?
My approach is to apply genomics to understand naturally occurring variation for these traits of interest. I identify sources of the trait and use molecular tools such as mapping, analysis of variation gene structure and gene expression to identify key genes that regulate the processes as a switch would.

What has been accomplished?
In the year I have been with the ARS, I have identified sources of traits in wild and cultivated grapes. I have also been developing molecular tools, including marker sets for efficient mapping and cloning of genes which are strong candidates for response to environmental cues based on information from other organisms. No commercial or industry benefit has yet been realized.

What impact do you expect from your project?
I expect that clarification of the genetic control of budbreak, anthesis, fruit set, veraison, leaf fall, dormancy, ripening, and other characteristics will facilitate 1) improvement of grape varieties for these traits and 2) development of novel management technique and diagnostic tools.

Do you receive any additional support for this project? If so, from what source(s)?
No additional support is being received for this project.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
The following individuals and institutions cooperate by providing access to genetic resources:
Philip Forsline, horticulturist and curator of the ARS Plant Genetic Resources Unit collection of grapes in Geneva, New York.
Ed Stover, research leader and curator of the National Clonal Germplasm Repository for Tree Fruit and Nut Crops in Davis, California.
Bernard Prins, horticulturist at the National Clonal Germplasm Repository for Tree Fruit and Nut Crops in Davis, California.
Bruce Reisch, grape breeder at Cornell University, Geneva, New York.
Andrew Walker, Professor of Viticulture and Enology, University of California, Davis.

Name(s) and location(s) of scientist(s) working on the project:
Chris Owens, Plant Genetic Resources Unit, Geneva, New York
Name, email address, and phone number of contact person:
Chris Owens, clo5@cornell.edu, 315-787-2437

What is the problem you are addressing?
Fruit ripening, composition, and flavor are regulated by a complex interaction of the grape variety, the environment, and management practices. Understanding this complex interaction so that fruit quality can be optimized in the vineyard is problematic.

What is the project that you are conducting to address the problem?
I am identifying genetic components of the grapevine that regulate fruit ripening and quality so that fruit quality can be maximized in new varieties and so we can better understand the process of fruit ripening in grapevines.

What is the approach you are taking?
I am identifying individual genes that regulate fruit ripening and fruit quality.

What has been accomplished?
We have identified a single gene that regulates fruit color, aroma, and tannin accumulation. We have been conducting experiments since 2003 to understand how this gene is regulating fruit color and have initiated experiments to elucidate how this gene is affecting other aspects of fruit quality. Additional genes that possess key regulatory roles in affecting fruit ripening and quality are being identified. No commercial or industry benefit has yet been realized.

What impact do you expect from your project?
The results of this research will be primarily utilized by publicly and privately funded grape breeders by maximizing selection efficiency or in the generation of transgenic grapevines with desirable characteristics (e.g. better color, earlier ripening).

Do you receive any additional support for this project? If so, from what source(s)?
Not presently.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Patrice This, INRA, Montpelier, France cooperates by providing access to germplasm and by conducting genetic analysis in his laboratory. Philip Forsline, horticulturist and curator of the germplasm repository at Geneva (ARS Plant Genetic Resources Unit), Ed Stover, research leader and curator of the germplasm repository at Davis (ARS National Clonal Germplasm Repository), and Bernard Prins, horticulturist at NCGR, cooperate by providing access to the plant genetic resources in the two repositories. John Clark, University of Arkansas cooperates by providing access to populations of grape seedlings and collecting phenotypic data from those populations.

Name(s) and location(s) of scientist(s) working on the project:
Angela M. Baldo Plant Genetic Resources Unit, Geneva, New York
Name, email address, and phone number of contact person:
Angela M. Baldo, amb82@cornell.edu, 315-787-2413
What is the problem you are addressing?
Leveraging computational tools to develop markers, characterize phylogenetic relationships, identifying differences among expressed genes, mine public data for candidate genes, etc.
What is the project that you are conducting to address the problem?
1) Large-scale phylogenetic characterization of genomic gene fragments in *Vitis*, identification of genes expressed uniquely in *V. riparia*. 2) Development and refinement of data mining and SNP prediction tools.
What is the approach you are taking?
Expressed gene fragments are retrieved from public databases, clustered, and analyzed. When polymorphic regions are desired, PCR primers are designed to bracket these regions. Fragments are re-annotated based on their similarity to known genes in grapes and other organisms.
What has been accomplished?
I have developed a set of PCR primers that have been demonstrated to amplify genomic DNA across 40-50 grape species. The regions amplified are also polymorphic within *V. vinifera.* These markers are different from the currently available microsatellite markers, and can contribute to germplasm collection management, high-throughput SNP marker development, and elucidating evolutionary relationships within *Vitis*. I have conducted preliminary phylogenetic analyses on the large dataset resulting from sequencing 13 of the above gene fragments (4900 bp total from 200+ accessions). A set of genes expressed in *V. riparia* has been identified that have not been found expressed in other grape species. These will be investigated by collaborators for dormancy and bud-specific expression.
What impact do you expect from your project?
My work generates software, methodologies, and molecular tools. The results are leveraged by other research scientists who work directly with *Vitis*.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Chuck Simon and Heidi Schwaninger (USDA-ARS Plant Genetic Resources Unit) are colleagues on the grape phylogeny project, providing insight into the accepted relationships among grapes and suggesting analysis techniques. Yizhen Wan (Northwest Sci-Tech University of Agriculture and Forestry, College of Horticulture), a colleague on the grape phylogeny project, collected DNA, tests PCR primers, sequences DNA, and analyzes DNA trace files. Dr. Wan has contributed many Asian *Vitis* samples that would not have been otherwise available. Anne Fennell (South Dakota State University, Dept. of Horticulture, Forestry, Landscape, and Parks), colleague on the *V. riparia* expression project, contributed a set of EST sequences. She also conducts laboratory analyses confirming gene expression.

Name(s) and location(s) of scientist(s) working on the project:
Chuck Simon, Plant Genetic Resources Unit, Geneva, New York
Name, email address, and phone number of contact person:
Chuck Simon, csimon@ars-grin.gov, 315-787-2454
What is the problem you are addressing?
The result of our effort will be a better understanding of the genetic interrelationships between, among, and within different species of the grape genus (*Vitis*).
What is the project that you are conducting to address the problem?
We are sequencing key expressed DNA sequences of grape genes that have been shown in the international sequence database to be polymorphic at a useable level for genetic relationship studies.
What is the approach you are taking?
DNA sequences are amplified in a wide range of over 300 accessions of grapes and grape relatives (*Vitis* sp.). The sequences are then determined by DNA sequence analysis, and are then compared using a variety of software packages designed for this sort of research. The software creates hierarchical trees that illustrate genetic relationships, and genetic affinities and contrasts are noted.
What has been accomplished?
While such research in plants is only now beginning, previous studies in yeast and animals have shown that approximately 20 targeted sequences are needed to adequately resolve genetic relationships with reasonable confidence. As plants are new to this, our goal is to analyze 30 sequences so that we know we have looked at a sufficient number. To date we have complete data for eleven genes on 218 accessions, and nearly complete data for another six genes on a total set of 308 accessions. With the amount of data we have now, we are already seeing a very coherent and sensible tree, with the only caution that we are at the edge of statistical significance with the data. This is not unexpected, and we anticipate this shortcoming will be corrected as we generate more data. We are quite pleased with the preliminary result so far, however.
What impact do you expect from your project?
We believe that our results will have utility at the genebanking level to better organize and offer for use the genetic diversity available for grape improvement. We also anticipate that this study will generate a freer exchange of germplasm between our collections and important collections in Asia, as this study is part of a collaborative effort with China (see below).
Do you receive any additional support for this project? If so, from what source(s)?
The Chinese government has donated the efforts of a visiting Chinese geneticist for one year, and has also given us, for this study, access to Chinese grape germplasm heretofore unavailable and unstudied. We anticipate this will offer inroads to access to this germplasm for future efforts in grape genetic improvement.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility? As mentioned above, we have a visiting Chinese scientist working in our lab for one year to devote his efforts to conducting this research. This is the first such known extended collaboration between Chinese and American researchers, and it will hopefully set the stage for future collaborative research. Angela Baldo and Heidi Schwaninger are others on the PGRU staff contributing to this project.

PEST AND DISEASE MANAGEMENT

Name(s) and location(s) of scientist(s) working on the project:
Hong Lin, USDA-ARS, San Joaquin Valley Agricultural Sciences Center, Crop Diseases, Pests and Genetics Research Unit, Parlier, California
Name, email address, and phone number of contact person:
Hong Lin, hlin@fresno.ars.usda.gov, 559-596-2933
What is the problem you are addressing?
Grape Pierce's disease (PD): to understand PD resistance and susceptibility mechanisms and to utilize grape PD resistant genetic resources to improve grape performance.

What is the project that you are conducting to address the problem?
1) Using PD resistant and susceptible genotypes to conduct comparative study of grape plants in responses to *Xylella fastidiosa* (Xf) infection at physiological, biochemical and molecular genetic levels.
2) *Xylella fastidiosa* detection and population genetic analysis.

What is the approach you are taking?
1) Screened PD resistant *Vitis* species and evaluated antimicrobial activity in resistant xylem sap.
2) Developed grape expression profiles in response to Xf challenge and will identify transcription pathways associated to PD resistant and susceptible responses.
3) Developed a high-throughput Xf pathogen detecting system using simple sequence repeat (SSR) DNA marker system for Xf genotyping and genetic structure and biodiversity studies.
What has been accomplished?
Using the *in vitro* bioassay method we developed, we evaluated and identified the effect of xylem saps colleted from PD resistant grape on Xf colony development and biofilm formation. Currently xylem saps from some PD resistant grapes are chemically fractionated and the chemical compositions will be further identified.

PD expression profiles associated Xf infection between PD resistant and PD susceptible genotypes have been sequenced and annotated. A set of candidate genes has been selected for microarray gene expression analysis.

The multi-locus SSR Xf marker system was developed and validated. Our research collaborators and I are using this marker system to conduct Xf genetic structure analyzes for grape-associated strains and almond-associated strains in California. Thousands of Xf strains had been collected in 2003 and 2004. These samples are currently analyzed by our high-thoughput pathogen detecting platform.

What impact do you expect from your project?
PD expression profiles and microarray gene expression analysis along with xylem sap chemical analysis will provide molecular details of genes and metabolic pathways involved PD resistance. The goal of the research is to identify PD resistant genes in grape and to enhance expression of resistant genes. The strategy here is to express resistant genes in grape rootstocks and transmit gene products to scion plants to suppress Xf. This research will have a great impact on solving PD problem because we are taking the approach to improve plant performance with no genetic modification involved. It is critical because it will be very difficult to produce economically competitive wine grape cultivars through classical breeding or genetic engineering due to the

conservative and international wine industry. If a rootstock that can confer PD resistance is produced the integrity of wine grape cultivars will be maintained.

Do you receive any additional support for this project? If so, from what source(s)?
Three PD research proposals had been funded from funding agencies since 2003. Two of them are from California Department of Food and Agriculture PD/GWSS Board. They are:
(1) Developing Transcriptional Profiles and Microarray Expression Analysis of Grape Plant Response to *Xylella fastidiosa* (2003-2006)
(2) Development of SSR markers for genotyping and genetic diversity assessment of *Xylella fastidiosa* in California (2004-2006)
Another was funded by University of California, PD Research Program:
Characterization and Identification PD resistance mechanisms: Analysis of xylem anatomic structures and of natural products in xylem sap among *Vitis* species (2003-2005).

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
I have a specific cooperative agreement with M. Andrew Walker, professor, Department of Viticulture and Enology, University of California, Davis on the project identifying grape PD resistant genes. Walker provides grape materials and expertise in greenhouse grape propagation and PD expression experiments. Walker is also collaborator for the project of Xf population genetic study. Feng Chen, assistant professor, Department of Plant Sciences, University of Tennessee, collaborated in identifications of xylem sap chemical compositions, analyzing metabolic pathways involved PD resistance.
Jiang Lu, Center for Viticulture and Small Fruit Research, Florida A&M University, collaborated in study PD expression profiles for identifying PD resistant genes in *V. arizonica and V. shuttleworthii* grapes.

Name(s) and location(s) of scientist(s) working on the project:
Jianchi Chen, USDA-ARS, San Joaquin Valley Agricultural Sciences Center, Crop Diseases, Pests and Genetics Research Unit, Parlier, California

Name, email address, and phone number of contact person:
Jianchi Chen, (559) 596-2924, jichen@fresno.ars.usda.gov

What is the problem you are addressing?
Diseases caused by *Xylella fastidiosa*

What is the project that you are conducting to address the problem?
Molecular biology of *Xylella fastidiosa* and xylellae diseases in grape (Pierce's disease), as well as in almond (almond leaf scorch disease) and other crops.

What is the approach you are taking?
Genomics, genetics as related to bacterial phenomics and host-pathogen interactions.

What has been accomplished?
- Identified and correlated new variations in genetic and phenomic traits of *X. fastidiosa*.
- Recognized mixed genotype infection in almond leaf scorch disease.

What impact do you expect from your project?
New information on how *X. fastidiosa* causes diseases for developing new disease management strategies.

Do you receive any additional support for this project?
Yes (University of California Pierce's Disease Research Program, California Almond Board)

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Yes. Depending on the projects, cooperators are from ARS, Universities and commercial growers. They provide epidemiology and ecology information related to *X. fastidiosa* strains.

Name(s) and location(s) of scientist(s) working on the project:
Russell L. Groves, USDA-ARS, San Joaquin Valley Agricultural Sciences Center, Crop Diseases, Pests and Genetics Research Unit, Parlier, California
Name, email address, and phone number of contact person:
Russell L .Groves, rgroves@fresno.ars.usda.gov, 559-596-2923
What is the problem you are addressing?
1. Epidemiology *Xylella fastidiosa* (*Xf*) diseases, including Pierce's disease of grape.
What is the project that you are conducting to address the problem?
1a. Identification of the seasonal sequence of perennial host plant species used by GWSS, overwintering biology, and landscape movement patterns.
1b. Characterizing current and future GWSS population distributions in California using temperature-dependent adult feeding assays on selected perennial tree and vine crop species.
What is the approach you are taking?
1a. Deploying trapping grids and protein markers within different perennial tree and vine crops including navel orange, Spanish lemon, olive, avocado, sweet cherry, plum, peach, pistachio, and grape to monitor seasonal host utilization patterns and population shifts of adult GWSS.
1b. Laboratory-based feeding bioassays were developed to determine the minimum temperature limits for adult GWSS feeding. Modified honeydew clocks in combination with electronic feeding monitoring apparatus accurately determined the temperature minimums below which GWSS discontinue ingestion.
What has been accomplished?
1a. Spatial patterns of GWSS capture were dissimilar among crop species examined. Clusters of mean capture varied among distances and transects within GWSS-reproductive citrus hosts compared to avocado and olive where aggregations were detected along crop margins and mean capture rates declined with distance into fields ($\leq$ 50m) away from citrus.
1b. Electronic feeding assays recorded reductions in the frequency and duration of insect feeding behavior below 10^{o} C, and were associated with reduced levels of excreta at decreasing temperatures.
What impact do you expect from your project?
1a. New information about GWSS feeding including, host-finding behavior, and plant-to-plant movement patterns on multiple scales will identify long-range seasonal and trivial movements that lead to the spread of *Xf* in grape.
1b. Understanding the spatial ecology of GWSS will identify specific regions where insect overwintering is greatest and a significant threat of reinfestation is posed, and spatially define where GWSS populations may be unable to overwinter.
Do you receive any additional support for this project? If so, from what source(s)?
University of California, Division of Agriculture and Natural Resources
California Department of Food and Agriculture.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
1. Marshall W. Johnson, University of California, Riverside, Department of Entomology – monitoring adult GWSS and associated natural enemy landscape-scale movement patterns.
2. Elaine Backus, USDA-ARS, Parlier, CA – electronic monitoring assays of adult GWSS feeding.
3. James Hagler, USDA-ARS, Phoenix, CA – development of monoclonal antibodies for mark / capture studies of GWSS population shifts.

Name(s) and location(s) of scientist(s) working on the project:
John A. Goolsby, Research Entomologist, Beneficial Insects Research Unit (BIRU), Weslaco, Texas
Name, email address, and phone number of contact person:
John A. Goolsby, jgoolsby@weslaco.ars.usda.gov, 956-969-4852
What is the problem you are addressing?
The glassy-winged sharpshooter (GWSS) (*Homalodisca coagulata*) is a serious economic pest because it vectors a strain of *Xylella fastidiosa*, a bacterium that causes Pierce's disease (PD) in grapevines. The wine and table grape industry is a 33 billion dollar industry in California. Within the last ten years the GWSS has invaded California where they pose a serious threat to this industry.
What is the project that you are conducting to address the problem?
I am conducting the foreign exploration program for GWSS natural enemies. This project has two parts: 1) surveys in the native range of GWSS (Texas) for egg and nymphal parasitoids and 2) Evaluation of parasitoids from South America collected con-generic sharpshooters.
What is the approach you are taking?
We are conducted monthly surveys in the native range. Parasitoids recovered from the surveys are reared and evaluated in Weslaco, Texas. Natural enemies from Argentina are imported into quarantine in Mission, Texas where a risk assessment regarding their release in North. America is conducted.
We are also planting three vineyards (three acres each) on USDA-ARS farmland to evaluate GWSS/PD in the native range. Three varieties of grapes are planted: Black Spanish (Convent), Blanc du Bois, and Chardonnay. Future collaboration with ARS-Parlier and Geneva is being planned.
What has been accomplished?
Several species of native *Gonatocerus* spp. (egg parasitoids of GWSS) have been collected in Texas and transferred to cooperators in California. Two species are now established. Candidate parasitoid species from Argentina are in quarantine and being evaluated for their potential non-target impacts on native N. American sharpshooters.
What impact do you expect from your project?
Long-term population suppression of GWSS in California. In particular, the biological control agents may reduce the numbers of GWSS in ornamental urban plantings that are the source for reinfestation of agricultural areas.
Do you receive any additional support for this project? If so, from what source(s)?
No.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
David J. W. Morgan of the California Department of Food and Agriculture (CDFA), receives the natural enemies from Texas for rearing and release. Guillermo Logarzo from USDA-ARS, South American Biological Control Laboratory conducts the foreign exploration and ecological studies in South America (Argentina). Serguei Triapitsyn from the University of California, Riverside, CA cooperates by identifying exotic and native egg parasitoids. Andy Scott of Rio Farms in Monte Alto, TX collaborates with our vineyard trials which evaluate the effect of cover/trap crops on GWSS

Name(s) and location(s) of scientist(s) working on the project:
Jesse H. de León, Beneficial Insects Research Unit (BIRU), Weslaco, Texas
Name, email address, and phone number of contact person:
Jesse H. de León, jhleon@weslaco.ars.usda.gov, 956-969-4856
What is the problem you are addressing?
The glassy-winged sharpshooter (GWSS) (*Homalodisca coagulata*) is a serious economic pest because it vectors a strain of *Xylella fastidiosa*, a bacterium that causes Pierce's disease in grapevines. The wine and table grape industry is a 33 billion dollar industry in California. Within the last 10 years the GWSS has established in southern California ,where they pose a serious threat to this industry.
What is the project that you are conducting to address the problem?
I am conducting several projects. I am genetically characterizing both the GWSS and its natural enemies (*Gonatocerus* species; egg parasitoids) in order to support and improve the classical biological control program. I am also trying to identify (in collaboration with James Hagler, ARS, Phoenix, AZ) key predators of the GWSS.
What is the approach you are taking?
I am incorporating molecular genetics techniques to perform population genetics studies (DNA fingerprinting) and molecular systematics (sequencing standard genes as well as other regions of the genome) to genetically characterize both the GWSS and its natural enemies.
What has been accomplished?
I have determined the origin (Texas) of the GWSS that invaded California. I discovered that one of the GWSS egg parasitoids (*G. morrilli*) exists in nature as a cryptic species complex. I determined that geographic populations of another GWSS egg parasitoid (*G. ashmeadi*) are highly differentiated. I have developed molecular diagnostic markers for the GWSS and a closely related sharpshooter, the smoke-tree sharpshooter (*H. liturata*) to aid in predation studies of these sharpshooters and also for diagnostic purposes. I have utilized DNA fingerprinting methods to distinguish ten species of GWSS egg parasitoids.
What impact do you expect from your project?
Determining the origin of the GWSS now guides biocontrol workers to a location (Texas) to collect natural enemies. Accurate identification of natural enemies is crucial to the success of biocontrol programs; by knowing that cryptic species of a certain natural enemy exists, the correct or a better agent can be imported to California. The development of diagnostic markers for the GWSS will now allow us to search and screen for key predators of the GWSS by analyzing predator gut contents without disrupting the natural microclimates of the predators.
Do you receive any additional support for this project? If so, from what source(s)?
I am a co-author on a CDFA grant with James Hagler (ARS, Phoenix, AZ) to develop molecular diagnostic markers for the GWSS.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
David J. W. Morgan of the California Department of Food and Agriculture (CDFA) cooperates by providing GWSS from various locations in California; He also provides several species of GWSS egg parasitoids. James R. Hagler, Valerie Fournier, and Kent M. Daane from ARS, Phoenix, AZ and University of California, Berkeley, CA cooperate by sending predators that feed on GWSS eggs or adults. Russell F. Mizell from the University of Florida, Quincy, FL cooperates by sending GWSS egg parasitoids from Florida. Eduardo Virla and Guillermo Logarzo from USDA, ARS, South American Biological Control Laboratory cooperate by

sending egg parasitoids from South America (Argentina). Serguei Triapitsyn from the University of California, Riverside, CA cooperates by identifying exotic and native egg parasitoids.

Name(s) and location(s) of scientist(s) working on the project:
Wayne Hunter, Lead Scientist, (0.9 FTE), David Hall, Research Leader (0.1 FTE) Subtropical Insects Research Unit, USDA-ARS, U.S. Horticultural Research Lab, Ft. Pierce, Florida
Name, email address, and phone number of contact person:
Wayne Hunter, Whunter@ushrl.ars.usda.gov, 772-462-5898
What is the problem you are addressing?
Glassy-winged sharpshooter (GWSS) and Pierce's Disease of grapes. *Homalodisca coagulata*, the glassy-winged sharpshooter, is the major vector of the plant pathogen *Xylella fastidiosa*, the causal agent of Pierce's Disease of grapes. Few pathogens are known for the GWSS and little is known of the genes regulating glassy-winged sharpshooter biology.
What is the project that you are conducting to address the problem?
I am elucidating the genetic basis of sharpshooter biology, feeding and development, as well as the identification of new viral pathogens of sharpshooters. I am also producing genetic markers in collaboration with a grape breeder for a marker-assisted selection breeding program at Florida A&M University to develop new grape cultivars with increased disease and insect resistance.
What is the approach you are taking?
Gene expression libraries have proven their usefulness in many other insect, veterbrate and plant systems. I produced expression cDNA libraries to different life stages and tissues of the GWSS (Adults, 5th instar, Salivary glands, and Midgut) and to other sharpshooter vectors (*O. nigricans*). By mining these genetic libraries I determine the sequences of GWSS genes and proteins, identify their functions in GWSS development, responses to biotic and abiotic stresses, such as immune response to viral infections, and/or responses to heat or cold. I have developed genetic primers for use in analyses of gene expression, phylogeny, and pathology studies. I also use molecular methods to discover and identify insect viruses. These viruses are also screened for pathogenicity in insect cell cultures, and in adult GWSS. I have produced large scale expressed sequence tags (ESTs) from Pierce's Disease resistant grape to create genetic markers for use in grape breeding programs.
What has been accomplished?
My program has produced over 20,000 ESTs, to genes of the GWSS. Over 15,000 GWSS ESTs have been deposited to the public database at NCBI and are available for research.
A unigene set of ~5,000 GWSS genes was produced and are being used to create GWSS arrays with 2,000 of these coming from GWSS salivary gland and midgut tissues (Agilent/Univ. Miami, FL). Nineteen full length proteins have been deposited in the public protein database at NCBI. The desaturase of sharpshooters, which aids lipid processing, has been characterized. The gene for GWSS vitellogenin has been completely sequenced. Other proteins we have characterized are the GWSS Cathepsins (from whole body), Laccases (from salivary glands) and Serine Proteases (from midguts). Eight heat shock proteins have been identified along with numerous other genes and proteins. A Hemipteran gene database was established (www.ibchome.org) to encourage collaborations and aid national research efforts.

Three new GWSS viruses have been discovered, the genome of the first virus called: HoCV-1, *Homalodisca Coagulata Virus-1*, has had its genome sequenced. HoCV-1 is being processed for patent submission.

My collaborative program produced 30,000 expressed sequence tags from PD resistant *Vitis shuttleworthii.* A unique set of about 247 sequences were submitted for inclusion on the Affymetrix Vitis Gene Chip, which is commercially available as the "GeneChip® Vitis vinifera Genome Array".

Approximately 800 putative genetic markers have been produced and are now being used and screened against grape selections at FAMU in their grape breeding program (collaboration with Dr. Jiang Lu).

What impact do you expect from your project?

The projects I have initiated will enable the development of genetic targets to reduce GWSS populations, as well as to identify new pathogens for use as biological control agents against GWSS. The projects on grape resistance genes will advance the search for the gene(s) which impart PD resistance, as well as identify other genes and pathways for resistance to other important grape diseases.

The genetic markers have accelerated the grape breeding program at FAMU, whose focus is to produce varieties with increased disease and pest resistance. The genetic products from the GWSS has increased research on sharpshooter biology and growth, and in the development of new management strategies against the GWSS, other leafhoppers (viral pathogens), which will have applications to other insect pests as well.

The new viral pathogens will enable the development of molecular tools to advance research on GWSS biology, and potentially will facilitate the development of new biological control agents or strategies that may be commercialized. The potential commercialization of newly discovered enzymes, and viruses is being investigated by my laboratory working with the advice of the Technology Transfer representatives.

Do you receive any additional support for this project? If so, from what source(s)?

I received additional support for the grape EST project as a collaborator, from FAMU, Science Research Grant in 2003 to complete sequencing of grape ESTs.

Are there cooperators on the projects? If so, who are the cooperators and what are their respective areas of responsibility?

* Dr. Jiang Lu, Florida A&M University, Tallahassee, FL. Grape breeder, responsible for screening genetic markers on his grape populations. Identify important proteins in grape linked to disease and insect resistance.
* Drs. Russell Mizell and Pete Andersen, University of Florida, Quincy, FL. Responsible for producing sharpshooters for genetic sequencing and evaluating gene expression of Xylella in specific media. Specific Cooperative Agreement: hired one technician to run real time PCR analysis, and annotate data.
* Dr. Elaine Backus, USDA, ARS, Parlier, CA. Responsible for collection of GWSS salivary gland and midgut tissues for isolation of genetic material.
* Dr. Tom Coudron, USDA, ARS, Colombia, MO. Responsible for screening genetic markers made for genes in GWSS linked to diet qualitative analysis.
* Dr. Gerald Reeck, Kansas State University, Biochemistry Dept., Responsible for characterization of identified GWSS proteins and their enzymatic activities.

Name(s) and location(s) of scientist(s) working on the project:
Roger A. Leopold, USDA Biosciences Research Laboratory, Fargo, North Dakota
Name, email address, and phone number of contact person:
Roger Leopold. leopoldr@fargo.ars.usda.gov, 701-239-1284
What is the problem you are addressing?
Egg parasitoids of the *Gonatocerus spp*. are mymarid wasps which account for 95% of the observed parasitism on the glassy-winged sharpshooter (GWSS) in California. Research is currently being conducted to develop methods for rearing these insects for release in areas where augmentation is needed or where other control measures cannot be used. Protocols designed for efficient mass-rearing generally include techniques that enable the production managers to hold or store insects for varying periods of time to synchronize various aspects of the rearing procedure and for distribution to the release sites. These storage techniques usually involve placing the host and/or the parasitoid at some subambient temperature that increases the shelf-life and utility of the insects.
What is the project that you are conducting to address the problem?
Our project facilitates the mass-rearing and inundative releases of mymarid parasitoids attacking the GWSS by determining tolerance to chilling and developing cold storage protocols that have minimal effects on quality of these biological control agents.
What is the approach you are taking?
We are determining the cold tolerance of GWWS eggs and of the egg parasitoids, *Gonatocerus ashmeadi* and *G. triguttatus,* within their hosts under specific environmental and developmental parameters. We also are assessing whether chilling has latent effects on the post-storage quality of the adult parasitoid.
What has been accomplished?
We have discovered a suitable plant host for cold storage of the GWWS eggs, determined the temperature and time limits for storage, and established the suitability of stored eggs for use by the parasitoids. We have determined the temperature and time limits for storage of *G. ashmeadi.* We have determined the laboratory responses of *G. ashmeadi* to their egg hosts in terms of density and handling and processing time which will allow us to test the post-storage quality of these insects.
What impact do you expect from your project?
We anticipate that our data will facilitate the mass-rearing and utility of the *Gonatocerus spp.* as biological control agents used IPM programs for control of GWSS. If rearing of these species were to be commercialized, the technology would also aid the process. We are also collaborating with efforts by Dr. Tom Coudron, an USDA-ARS scientist at Columbia, MO, in a project attempting to develop artificial media to be used for mass-rearing of GWSS parasitoids. We would be testing the quality of these insects before and after cold storage.
Do you receive any additional support for this project? If so, from what source(s)?
Initially, this project was funded by a USDA-APHIS grant. It is now supported by unit funds under the ARS CRIS project entitled "Development of Cold Storage Technology for Mass-reared and Laboratory-colonized Insects" and a subordinate CRIS entitled "Cold Storage of Parasitized and Unparasitized Eggs of the Glassy-winged Sharpshooter, *Homalodisca coagulata"*. At the end of November of this year, the funding expires and I am unsure of the fate of this project. I doubt that it will be totally finished in terms of determining the cold tolerance parameters for *G. trigutattus* and quality assessment for both species.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?

The cooperators on this project are two scientists located in the Entomology Department of North Dakota State University. Dr. Marion Harris is the lead cooperator who supervises a post-doctoral scientist, Dr. Wenlong Chen. His responsibility is to test the cold tolerance of the insects and determine quality assessment parameters for the GWWS as a host and for the parasitoids. He works in our laboratory and I direct the overall focus of the project and serve as team leader.

Name(s) and location(s) of scientist(s) working on the project:
James (Jim) Fisher, Research Entomologist, Horticultural Crops Research Laboratory, Corvallis, Oregon

Name, email address, and phone number of contact person:
James Fisher, fisherj@science.oregonstate.edu (541) 738-4032

What is the problem you are addressing?
My project covers the area of soil insects and their relationships with horticultural crops. With winegrapes the concern in this area is grape phylloxera. Over 70 vineyards in Oregon are affected by this root destroying pest and over 30,000 acres of Washington are on self-rooted vines; thus, candidates for infestation by this pest. Washington has been in wine grape production as long as Oregon without a phylloxera problem. Likewise although only of recent development, phylloxera is not a pest in Idaho. The major question is will grape phylloxera invade Washington or Idaho? Grafted resistant rootstock does not survive the Washington climate. The survival of rootstock in Idaho is unknown.

What is the project that you are conducting to address the problem?
We are looking at the effects of temperature, soil series and soil water on the life history of the pest.

What is the approach you are taking?
Much of the research is conducted in the greenhouse and in growth chambers as phylloxera is a quarantined pest in Washington. We are looking at the generations per season under simulated conditions from California, Oregon, and Washington. We have looked at the effect of 6 soil types on phylloxera. We will be looking at a broader range of soil and maintaining the soil water content at dry and wet conditions.

What has been accomplished?
One soil from Washington appeared to suppress phylloxera development and establishment. Under the simulated soil temperature conditions, there were eleven generations under California conditions, seven generations under Oregon conditions, and four generations under the Washington conditions. These findings with more information on the effects of soils on establishment and development may be used to look for grape growing situations that are naturally resistant to the insect.

What impact do you expect from your project?
We expect to answer the question concerning the establishment of phylloxera in Washington vineyards and find if properties of the soil enhance or retard the growth and development of these pests. This knowledge should give rootstock researchers and edge as to knowing what to develop and the conditions that the rootstock may be needed for.

Do you receive any additional support for this project? If so, from what source(s)?
I have but as of right now there is no additional support. Grape phylloxera appears to be of little concern to growers as they feel that Washington and Idaho are and will remain free of this pest. However, history has shown that this pest can bring the industry 'to its knees'.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility? University of California – Davis, Dr. Jeffery Granett, Professor of Entomology, provides CA phylloxera stock and is a general collaborator on this project. John Watson, Extension Horticulturalist, Washington State University, Cooperative Extension, Prosser, Washington, location of vineyards with phylloxera and cooperators in Washington. Anne Connelly, Extension Viticulturalist, Oregon State University, Corvallis, Oregon, location of phylloxera vineyards and other problem vineyards in Oregon.

Name(s) and location(s) of scientist(s) working on the project:
John Pinkerton, Horticultural Crops Research Unit, Corvallis, Oregon
Name, email address, and phone number of contact person:
John Pinkerton, pinkertj@science.oregonstate.edu, 541-738-4076
What is the problem you are addressing?
Plant-parasitic nematodes are major pests in vineyards worldwide. However, limited data have been available on the distribution of plant-parasitic nematodes and damage that they cause in Pacific Northwest vineyards. Nematode management strategies need to be developed for vineyards in this region.
What is the project that you are conducting to address the problem?
I am evaluating chemical and biological-based nematicides and screening rootstocks for nematode resistance and/or tolerance.
What is the approach you are taking?
To determine the impact of plant-parasitic nematodes on grapevines, I conducted vineyard surveys in Oregon and Washington. Impact of nematode species is estimated from nematode population densities, plant growth and yield data provided by growers, and data on vineyard and edaphic characteristics.
Nematicide trials are conducted in an established vineyard in the Yakima Valley of Washington state. Nematode population densities, fruit yields, and pruning data have been collect for two years to determine efficacy of nematicides.
Rootstocks are evaluated in glasshouse pot studies and in field plots infested with plant-parasitic nematodes. Effects of nematode parasitism on vine growth and function are evaluated further with rootstocks planted in field microplots.
What has been accomplished?
My research identified the ring nematode, *Mesocriconema xenoplax*, as the most common plant-parasitic nematode in Oregon vineyards. I demonstrated that low population densities of *M. xenoplax* significantly reduce the establishment and growth of vines. I identified two rootstocks that are highly resistant to *M. xenoplax*.
What impact do you expect from your project?
I expect that guidelines will be developed for economic damaging densities of plant-parasitic nematodes in Pacific Northwest vineyards and management options will be developed to manage problematic nematode species.
Do you receive any additional support for this project?
I have received additional funding from the Northwest Center for Small Fruit Research and Oregon Wine Advisory Board which has been used to pay land use charges, purchase supplies, and hire a part-time technician.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
USDA-ARS HCRL, Corvallis, research plant physiologists Drs. Paul Schreiner and David Bryla collaborate by evaluating the physiological responses of rootstock to the ring nematode.
Oregon State University, Corvallis, associate professor of Horticulture Dr. Carmo Vasconcelos cooperates by maintaining a rootstock trial in which ring nematode resistance is evaluated.
Washington State University, IAREC, associate nematologist, Dr. Ekaterina Riga by collaborating on nematicide trials and vineyard surveys.

Name(s) and location(s) of scientist(s) working on the project:
Sally Schneider, Thomas Trout, and Suduan Gao, San Joaquin Valley Agricultural Sciences Center, Parlier, California

Name, email address, and phone number of contact person:
Sally Schneider, sschneider@fresno.ars.usda.gov, 559-596-2890

What is the problem you are addressing?
Methyl bromide has commonly been used a soil fumigant prior to replanting vineyards and to insure that propagative material grown in open field nurseries is free of economically important soilborne pathogens. Use of methyl bromide is now phased out, except for Quarantine/Preshipment situation and growers who have approved Critical Use Exemptions. Growers need alternatives to methyl bromide for both the production of clean planting material in nurseries and for replanting of vineyards.

What is the project that you are conducting to address the problem?
We are evaluating potential alternatives to methyl bromide for soil fumigation prior to planting of grape field nurseries and prior to planting of production vineyards.

What is the approach you are taking?
Management strategies for control of soilborne pathogens and weeds are being evaluated in greenhouse, microplot, research station field plots, and on-farm trials. Management strategies include cultural activities such as fallowing and cover crops, biological approaches such as resistant rootstocks, and chemical controls including fumigant and non-fumigant materials. Drip application protocols, as an alternative to the conventional shank-injection of fumigants, is a key component of this research project.

What has been accomplished?
Efficacy of nematode control with shank and drip-applied 1,3-dichloropropene and iodomethane, each alone and in combination with chloropicrin, and propargyl bromide has been shown to be comparable to methyl bromide at the time of planting to a depth of five feet in grapevine nurseries and in vineyard replant situations for up to six years after treatment. Yield in the 6th growing season after treatment in plots treated with iodomethane or 1,3-dichloropropene was comparable to yield in plots treated with methyl bromide. Fallow of up to three years was more effective at reducing populations of rootknot nematodes (*Meloidogyne* spp.) than populations of citrus nematode (*Tylenchulus semipenetrans*). Rootstocks resistant to rootknot nematodes are not necessarily resistant to citrus nematode. Combinations of strategies provide more robust alternatives to methyl bromide than single strategies for controlling replant disorder. To date, only chemical alternatives have provided the level of nematode control required for field-grown nurseries.

What impact do you expect from your project?
Alternatives to methyl bromide will be identified and implemented that allow growers to maintain competitiveness in a global economy while allowing the U.S. to comply with the terms of the Montreal Protocol.

Do you receive any additional support for this project? If so, from what source(s)?
Financial support has been received from the California Fruit Tree, Nut Tree, and Grapevine Improvement Advisory Board. Planting material has been received from Sunridge Nursery and L.E. Cooke Nursery. Donations of land, labor, and equipment have also been received from L.E. Cooke Nursery. In-kind donations of chemicals and fumigation services have been received from Tri-Cal, Arvesta, Dow AgroSciences, Niklor, Aberco, AmVac, and others.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility? H. Ajwa, former USDA ARS soil scientist, provided expertise on soil chemistry and fumigant distribution. A. Shrestha, UC weed ecologist, provides expertise on weed management. G. Browne, USDA ARS Davis plant pathologist, provides expertise on soil-borne fungal pathogens. L.E. Cooke Nursery hosted an on-farm field trial at their nursery.

Name(s) and location(s) of scientist(s) working on the project:
Daniel Kluepfel, Crops Pathology and Genetics Research Unit, Davis, California
Kerri Steenwerth, Crops Pathology and Genetics Research Unit, Davis, California

Name, email address, and phone number of contact person:
Daniel Kluepfel, dakluepfel@ucdavis.edu, 530-752-1137

What is the problem you are addressing?
Characterization of the microbial community present in the rhizosphere of grapevines. Knowledge of the effects and diversity of the microbial community growing in soil surrounding, and influenced by, the roots of grapevines is limited. The majority of the characterization of the soil-borne microbial community revolves around examination of a few important pathogens and symbionts, e.g. *Agrobacterium tumefaciens*, the cause of crown gall disease, *Armillaria* spp. the cause of Armillaria root disease and various mycorrhizae species. Since grapevines are perennial and routinely remain productive for decades, the microbial communities that develop in association with plant root tissue may have long lasting and significant implications for the health and productivity of the vines. Currently we know virtually nothing about the grape rhizosphere community and what effect, if any, it may be having on the life of the grape vine. By understanding how bacterial communities affect grapevines, grape production and ultimately, wine quality, grape producers may be better equipped to manage the soil for improved long-term health and productivity of the vine.

What is the project that you are conducting to address the problem?
We are characterizing both the culturable and non-culturable microbial community present in the rhizosphere of grape vines under vineyard conditions. One of the by-products of this project is the assembly of a large collection of grape rhizosphere microbial isolates that will be evaluated for their ability to control ring nematode reproduction in the grapevine rhizosphere.
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What is the approach you are taking?
In a vineyard in the Carneros region (southern Napa County) of California, ten 2 meter-deep soil pits were dug adjacent to the grapevine revealing both the grapevine root architecture and the soil profile. Both bulk and rhizosphere soil from each of the identified horizons were sampled and processed so as to characterize the microbial community present. The following techniques are being used:
For culturable isolates, methods include; sequence analysis of the 16S ribosomal DNA gene and fatty acid analysis of the colony purified isolates collection from each of the horizons in each of the pits. To date we have collected approximately 1,000 bacterial isolates that we feel are representative of the culturable component of the bacterial community. Total aerobic culturable bacterial populations are being enumerated using standard dilution plating onto several media types. The entire bacterial community (i.e. culturable and non-culturable) is being characterized using the following three techniques; 1.) Denaturing gradient gel electrophoresis (DGGE) of 16s rDNA amplified from DNA that was extracted directly from soil, 2.) sequence analysis of cloned 16s rDNA that was originally amplified from soil DNA and 3) analysis of the phospholipid fatty acids extracted directly from soil. Differences in the community are documented by using various forms of discriminate analysis. Functional microbial groups in the community are identified by detecting diagnostic/unique fatty acids and/or specific 16s rDNA sequences.

What has been accomplished?
In collaboration with Kerri Steenwerth and a graduate student (Shane Parker) in my lab we have characterized the phospholipid fatty acids extracted from each of the horizons (three to five horizons / pit, bulk and rhizosphere) in each of the ten soil pits dug in the vineyard. In addition we have completed enumeration of culturable bacterial populations in each of the horizons in each of the soil pits. Finally, we have completed identification (down to species) of all of the culturable bacterial isolates collected from each of the horizons (both bulk and rhizosphere) in one of the soil pits. This includes both 16srDNA sequence and fatty acid analysis.

What impact do you expect from your project?
Since we are just in the initial stages of this project it is a bit difficult to predict impacts but it is already becoming evident that the rhizosphere microbial community in grape appears to be significantly different from that observed in many well studied annual crops and a few woody crop species. By understanding what constitutes a healthy microbial community in grape we may be able to design a variety of management and/or soil amendment strategies that will dramatically enhance such phenotypes as drought tolerance, disease resistance and the use of biological control agents in the rhizosphere. In addition, knowledgeable manipulation of the rhizosphere microbial community also may facilitate more efficient utilization of nutrients by the vine.

Do you receive any additional support for this project?
We do not currently receive extramural support for this project.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Dr. Kerri Steenwerth, USDA-ARS CPGRU, Davis, CA, research plant physiologists/weed scientist, Dr. Steenwerth is examining the microbial community via the analysis of phospholipid fatty acids extracted directly from soil.

Dr. David Smart: U.C. Davis, Viticulture and Enology Department. Dr. Smart is involved in the physical characterization of the soil as revealed in the 6-meter pits in the vineyard. More generally, Dr. Smart is conducting an extensive soil mapping effort of this vineyard in order to relate soil type with a wide variety of grape and grapevine phenotypes.

Shane Parker, Ph.D. candidate, USDA-ARS CPGRU, Davis, CA. Mr. Parker is involved in the fatty acid and 16s rDNA sequence analysis of pure culture isolates collected from this field trial.

Name(s) and location(s) of scientist(s) working on the project:
Jerry Uyemoto, Crops Pathology and Genetics Research Unit, Davis, California
Name, email address, and phone number of contact person:
Jerry K. Uyemoto, jkuyemoto@ucdavis.edu, 530-752-0309

What is the problem you are addressing?
Graft transmitted diseases of grapevines are a significant and growing problem in vineyards, resulting in reduced fruit yield and quality and even vine decline and death.

What is the project that you are conducting to address the problem?
I am investigating and developing applied and basic concepts in etiology, epidemiology, and control of virus, phytoplasmas and graft-transmissible agents and abiotic disorders of grapevines.

What is the approach you are taking?
I research diseases of grapevines observed in vineyards to determine the cause and to identify management strategies for prevention, treatment, and control. I use vineyard, greenhouse, and laboratory approaches to characterize grapevine responses to graft- transmissible diseases and to describe the molecular aspects of the viruses and other agents associated with the diseases.

What has been accomplished?
My research identified and characterized a new closterovirus in the table grape variety Redglobe that causes decline of grafted plants. Furthermore, we have identified new varieties for woody indexing of plant materials that expands the range of graft transmissible disease detection.

What impact do you expect from your project?
I expect that the identification and characterization of graft transmissible diseases and abiotic disorders will facilitate their control, management, and reduction, resulting in healthier vines with longer productive lives.

Do you receive any additional support for this project?
Yes; from the California Competitive Grant Program for Research in Viticulture & Enology and The California Tree Fruit/Nut and Grapevine Improvement Advisory Board.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Adib Rowhani, Department of Plant Pathology, University of California, Davis, cooperate on the molecular characterization of virus isolates. Also, we have formed a collaboration between ARS, University of California, Davis and Giovanni Martelli's group at the University of Bari, Bari, Italy. University of California Cooperative Extension farm advisors and grape growers and cooperate through identification of diseased vineyards and in epidemiology and control studies. Kerri Steenwerth, USDA, ARS Davis, is lead PI on the Syrah decline project.

Name(s) and location(s) of scientist(s) working on the project:
Walter Mahaffee, Horticulture Crops Research Laboratory Corvallis, Oregon

Name, email address, and phone number of contact person:
Walt Mahaffee, mahaffew@science.oregonstate.edu, 541-738-4036

What is the problem you are addressing?
Powdery mildew and botrytis bunch rot result in significant economic losses through reductions in yield, quality, or cost of control that will become more important as market competition increases. Our current understanding of disease epidemiology is limiting the further refinement of disease forecasting models and alternatives to traditional pesticides are needed. An increased understanding the disease epidemiology and the development of more effective disease managements tools to further reduce the economic impacts of these diseases are needed.

What are the projects that you are conducting to address the problem?
We are conducting several projects.

1) Increase understanding of inoculum availability for grape powdery mildew and Botrytis bunch rot.
2) Increase understanding of how short exposure of powdery mildew spores or colonies to non-conducive temperatures impact in infection and spore dispersal.
3) Understand how periods of leaf wetness impact establishment and sporulation of grape powdery colonies.
4) Develop more economical methods for delivery of infection risk models and weather data.
5) Improve efficacy or biological control agents against botrytis bunch rot.
6) Increase understanding of how *Botrytis cinerea* infects grape clusters.

What is the approach you are taking?

1) We are developing molecular techniques and equipment for the detection and quantification of aerial borne spores and relating spore numbers to disease levels and weather parameters.
2) Controlled environment studies are being conducted to determine temperature regimes that reduce infection and sporulation of *Erysiphe necator* (grape powdery mildew).
3) At specific times during the infection and colony development plants are subjected to periods of leaf wetness under specific temperature regimes to determine impact on infection frequency, colony development, and sporulation.
4) We are forming a consortium of researchers that brings together expertise in climatology, weather forecasting, GIS, pest forecasting, information technology, and extension to development methods for creating virtual weather stations derived from public weather data
5) Various commercial and novel tank adjuvants are being investigated for enhance efficacy of biological controls agents.
6) We have engineered a *Botrytis cinerea* strain to express the green fluorescent protein (GFP), which allows us to monitor the same spore throughout colonization and infection processes.

What has been accomplished?

1) We have developed specific primers for *E. necator* and a cost effective solar-powered spore trap that are able to detect >100 spores/air sample. Detection using the spore trap is well in advance of visional detection of disease symptoms in the field. We have used this information to time the initiation of fungicide program and reduced the number of fungicides applied.
2) We have determined that exposure of 3 day old or younger colonies to >95 for 2 or more hours results in greater than 60% reduction in colonies that survive to sporulate under optimal humidity conditions. We expect that this reduction will be even greater under low humidity.
3) With other powdery mildews we have shown that brief periods of leaf wetness result in reduced infection, we are beginning experiments to determine if this is true for *E. necator*.
4) We organized a group of researchers from California, Oregon, and Washington. Two meetings of the group have been held and priorities have been established for the research to create virtual weather stations.
5) Several adjuvants have been found that enhance biological control agents in other cropping systems but none have proven to be advantageous for commercial agents registered for use on grapes.
6) Using the GFP marked *B. cinerea* strain we have found that the fungus grows epiphytically on plant surfaces under a wide range of conditions.

What impact do you expect from your project?

1) The spore detection research will impact all aspects of disease management programs. First, we will be able to add an "inoculum availability component" in powdery mildew risk assessment models to indicate when control programs should begin. Second we will be able to develop algorithms for incorporation to mildew infection risk forecasters that account for spore availability when assessing infection risk post initial detection of inoculum presence.
2) The information gained on impacts of supra-conducive temperatures will enable us to refine infection forecasters to be less conservative (i.e. result in fewer fungicide applications).
3) Information of how leaf wetness impacts powdery mildew epidemics will result in model algorithms that are better at estimating infection risk in climates with frequent rainfall or long dew periods.
4) The formation of a research team to develop improved systems for distribution of weather and pest models will lead to greatly improved methods for growers to economically access this information and facilitate implementation of pest models.
5) Improved delivery methods that enhance efficacy of biological control agents should enhance their efficacy and therefore their acceptance and utility in management systems.
6) Increase understanding of how *B. cinerea* establishes a presence in fruit clusters and leads to bunch could help identify improved methods of management.

Do you receive any additional support for this project? If so, from what source(s)?

I have or in conjunction with collaborators received support from American Vineyard foundation, Washington and Oregon Wine Advisory Boards, Viticulture Consortium, and Northwest Center for Small Fruit Research.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?

Dr. Gary Grove, Washington State University cooperates through co-development of research direction, data collection, sample processing, and analysis. Dr. Doug Gubler, UC Davis collaborates through discussion of ideas and access to historical data. Carla Thomas, Fieldwise Inc., collaborates through co-development of model algorithms, access to weather and disease data. Drs. Len Coop, Chris Daily, Paul Jepson, Oregon State University; Dr. William Pfender, USDA-ARS, Dr. Doug Gubler, Carl Thomas, Joyce Strand, UC Davis; Drs. Gary Grove and Fran Pierce, Washington State University; Alan Fox, Fox Weather, LLC are members of the group attempting to develop an approach for generating virtual weather stations.

Name(s) and location(s) of scientist(s) working on the project:
Joseph L. Smilanick, USDA ARS San Joaquin Valley Agricultural Sciences Center, Parlier, CA
Name, email address, and phone number of contact person:
Joseph Smilanick, jsmilanick@fresno.ars.usda.gov, 559-596-2810
What are the problems you are addressing?
Most postharvest losses of fresh table grapes after harvest are due to gray mold, caused by *Botrytis cinerea.* We investigate two aspects of management of this disease: 1) postharvest treatments with biological, chemical, or physical treatments; and 2) identification and quantification of gray mold resistance in grapevine germplasm in collaboration with a cultivar development program at this location. A second problem we are addressing, also in collaboration with a cultivar development program at this location, is the identification and quantification of resistance to powdery mildew, caused by *Uncinula necator,* in grapevine germplasm.
What are the projects that you are conducting to address the problems?
Develop and evaluate conceivably practical approaches to control postharvest gray mold by near-harvest and postharvest treatments with chemical, physical, or biological agents. Identify and quantify gray mold and powdery mildew resistance in grapevine in service of a cultivar development program at this location.
What is the approach you are taking?
We are developing and evaluating a number of conceivably practical approaches to control postharvest gray mold by near-harvest and postharvest treatments with "reduced-risk" or "GRAS" chemical, physical, or biological agents. We have developed and employed a variety of inoculation techniques to assess gray mold and powdery mildew resistance in service of a cultivar development program at this location.
What has been accomplished?
A reduced-rate, postharvest sulfur dioxide fumigation protocol, termed "total utilization", was developed with many collaborators and has become the standard industry practice in California to control gray mold. Numerous other approaches have been evaluated and published, such as ozone fumigation, but their use is limited.
What impact do you expect from your project?
This work is directed at practical commercial application of methods to manage gray mold and its objective to introduce practices superior to those now in use. For example, we plan to assess near-harvest vineyard practices, such as canopy management and "reduced-risk" fungicide applications, on postharvest quality long after harvest. If successful, results from this work could enter commercial practice in a short time.
Do you receive any additional support for this project? If so, from what source(s)?
The California Table Grape Commission has supported this work since 1986. Other support was obtained from grants from the California Energy Commission and BARD.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Collaborators in the development of postharvest treatments of table grapes include University of California personnel (Prof. Carlos Crisosto, UC Davis; UC extension Farm Advisor Jennifer Hashim), Grower John France, Israeli collaborators Amnon Lichter and Susan Lurie of Volcani Institute, and Visiting Scientists Franka Mlikota Gabler from the Adriatic Crops Research Institute and others. The assistance to cultivar development is provided to David Ramming of this location.

PHYSIOLOGY, CULTURAL PRACTICES, AND SUSTAINABILITY

Name(s) and location(s) of scientist(s) working on the project:
Julie Tarara, Horticultural Crops Research Unit, Prosser, Washington
Name, email address, and phone number of contact person:
Julie Tarara, jtarara@wsu.edu, 509-786-9392
What is the problem you are addressing?
My program addresses grape production from the perspective of understanding the vineyard microclimate, its effects on vine biology, and the potential to increase the efficiency of vineyard management vis-à-vis the physical environment.
What is the project that you are conducting to address the problem?
I am engaged in a range of efforts including: automated yield estimation, vine water use, sunscald in red-fruited varieties, the effects of field temperatures on growth and fruiting.
What is the approach you are taking?
I leverage my program's ability to measure and often manipulate the vine microclimate (temperature, radiation, humidity, wind) with the plant physiology, food science, precision agriculture expertise, and extension delivery systems of my colleagues at Washington State University's Irrigated Agriculture Research and Extension Center (WSU-IAREC), where I am located.
What has been accomplished?
Many growers already have applied what we learned about sunscald in red-fruited varieties to simple, low-cost adjustments in their management of vine canopies and fruit ripening, namely selective fruit thinning and not raising the "wind wire" on the west side of a sprawl trellis system. Direct measurements of water use in well-watered and deficit-irrigated vines have demonstrated wetting/dry-down dynamics, in addition to season-long estimates for semi-arid climates. Commercial application to improve irrigation efficiency may have to await revision of western water law. A U.S. patent (no. 6,854,337) was issued for my work on automating yield estimation in vineyards.
What impact do you expect from your project?
I expect better understanding of the interactions between vine and microclimate to provide a sound scientific basis for accepting or refuting viticulture industry dogma. I also expect that this understanding will be translated into more efficient vineyard practices and/or higher fruit quality at relatively low marginal cost to the grower. Cooperation from Extension professionals is essential.
Do you receive any additional support for this project? If so, from what source(s)?
Between 2003 and 2005, I received USDA-ARS headquarters funding for a post-doctoral Research Associate to advance development of an automated system for estimating yield.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
The HCRL/Corvallis viticulture group includes myself in Prosser plus Krista Shellie, Research Horticulturist, and Jungmin Lee, Research Food Technologist, in Parma, Idaho. We share common themes across our projects. I collaborate extensively with faculty at Washington State University's Irrigated Agriculture Research and Extension Center (WSU-IAREC), Prosser. Markus Keller, Associate Viticulturist, provides access to experimental vineyards at WSU-IAREC and cooperates as physiologist in our mutual experiments. Mercy Olmstead, Extension Viticulturist, provides access to the viticulture website for the posting of notable developments of interest to the grape industry. Sara Spayd, Food Scientist, has provided biochemical analysis of many fruit samples. Francis Pierce, Director of the Center for Precision Agricultural Systems at

WSU-IAREC, provides access to the AgWeatherNet telemetry backbone for transmission of yield estimation data from commercial vineyards to IAREC.

Name(s) and location(s) of scientist(s) working on the project:
Krista Shellie, Horticulture Crops Research Unit, Parma, Idaho
Name, email address, and phone number of contact person:
Krista Shellie, kshellie@uidaho.edu, 208-722-6701
What is the problem you are addressing?
Vine water stress and cultivar suitability impact many grape components that influence wine quality. Viticultural production has recently expanded into semi-arid growing regions with an historical risk of cold injury, yet many of the viticultural practices adopted in these new production regions are optimized for less arid, more temperate climates.
What is the project that you are conducting to address the problem?
I am researching how the severity and phenological timing of vine water stress impacts vine physiology and grape quality components. I am also researching cultivar adaptation and response to vine water stress and cold injury.
What is the approach you are taking?
In field trials with various wine grape cultivars, I impose differing severities of vine water stress at particular berry growth stages by manipulating duration of irrigation. I measure various physiological responses of the leaf and vine to the imposed treatments and analyze grape berry composition. A minivinification facility is used to assess impact of cultural practices on wine quality. Cultivar adaptation is assessed by annual collection of phenological and cold injury data for multiple wine grape cultivars grown under similar cultural practices.
What has been accomplished?
This project was initiated in 2001 and is situated on land leased by ARS at the University of Idaho Parma Research and Extension Center. The worksite consists of two 1500 ft^2 modular buildings used for offices and analytical laboratories, and a minivinification facility. Three years of data have been collected from an irrigation trial installed in 2002, and from 30 cultivars grown in an experimental vineyard. Commercial/Industry benefits of this project include presentations of research results at state and national meetings and regional and national integration of wine grape research efforts.
What impact do you expect from your project?
I expect to identify optimum irrigation regimes and optimum wine grape cultivars suitable for sustainable production in semi-arid regions with an historic record of cold injury.
Do you receive any additional support for this project? If so, from what source(s)?
The Northwest Center for Small Fruits Research in 2002, 2003, and 2004 provided monies to install and manage an irrigation field trial in Idaho. A Specific Cooperative Agreement between ARS and the University of Idaho is/was used to establish some facilities (minivinification facility, some analytical instrumentation, some field equipment) and to support maintenance and management of experimental wine grape vineyards at the University of Idaho Parma Research and Extension Center.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
The University of Idaho cooperates administratively by sharing facilities, services, and infrastructure and employs a vineyard manager. A lease established between Winemakers LLC and ARS on 2.5 acres of commercial Idaho vineyard is used for field trials where Winemakers LLC manages all viticultural practices except treatment variables. The Parma worksite (two scientists) is on the same CRIS project as Prosser (Julie Tarara) and is administered by HCRL in Corvallis, Oregon.

Name(s) and location(s) of scientist(s) working on the project:
Kendra Baumgartner, Crops Pathology and Genetics Research Unit, Davis, California
Name, email address, and phone number of contact person:
Kendra Baumgartner, kbaumgartner@ucdavis.edu, 530-754-7461
What is the problem you are addressing?
Sustainable control of grapevine diseases is the main emphasis of my research, with a current focus on developing cultural and biological practices that either compliment or replace chemical practices. Challenges to my research include incomplete knowledge of disease epidemiology and the need for methods to assess efficacy of control practices. Thorough knowledge of disease epidemiology is crucial for developing control practices that target the weakest point in the pathogen's life cycle and/or to prevent dispersal of infectious propagules. Once I have thorough knowledge of the epidemiology, I need methods to evaluate control practices. Additionally, it is difficult to adapt practices that were originally developed for other crops, as the popular use of deficit management to intentionally reduce grapevine vigor and yield (e.g. vineyard establishment on marginal soils and deficit irrigation) is atypical of most perennial cropping systems.
What is the project that you are conducting to address the problem?
My research on Armillaria root disease focuses on developing control practices that improve the tolerance of diseased vines, given the proven futility of eradicating the pathogen, *Armillaria mellea*, from infested vineyards. My research on Pierce's disease focuses on examining the contributions of riparian hosts that serve as reservoirs of the pathogen, *Xylella fastidiosa*, and the insect vector, *Graphocephala atropunctata* (the blue-green sharpshooter), to the spread of the disease in Northern California vineyards.
What is the approach you are taking?
For research on Armillaria root disease, I quantified the effects of the disease on yield, growth, nutrition, and juice quality parameters from symptomatic grapevines and determined which parameters are significantly decreased by the disease. With these measurements, I was able to test various control practices on infected grapevines, using significant improvements in these parameters are evidence of efficacy. For research on Pierce's disease, I examined pathogen populations in systemic riparian hosts (California blackberry, California grapevine, elderberry, Himalayan blackberry, periwinkle) in Northern California, using traditional culture-based methods and molecular techniques.
What has been accomplished?
I developed a method for evaluating the efficacy of control treatments for Armillaria root disease of grapevine and, then, developed a new cultural treatment known as 'root collar excavation' to control the disease. Root collar excavation significantly improves yields of symptomatic grapevines and increases grape cluster weights to sizes comparable to those of healthy grapevines. I modified a cultural control practice for Pierce's disease of grapevine in the North Coast of California known as 'riparian revegetation management', a technique that involves replacement of hosts of both the pathogen, *Xylella fastidiosa,* and the vector, *Graphocephala atropunctata* (blue-green sharpshooter) with non-hosts. I found that two invasive weeds, *Vinca major* (periwinkle) and *Rubus discolor* (Himalayan blackberry), are important reservoirs of *X. fastidiosa*. In contrast, the native riparian plants in our study, *Rubus ursinus* (California blackberry) and *Sambucus mexicana* (blue elderberry), were not found to be important reservoirs of *X. fastidiosa*. As California blackberry and elderberry may not be important reservoirs of *X.*

fastidiosa, efforts expended in removing these species may not be repaid with a reduction in disease incidence.

What impact do you expect from your project?

Results of my research on root collar excavation have scientific significance and economic significance. The methodology I developed to evaluate control practices for Armillaria root disease gives scientists a tool to test other control practices. Root collar excavation is currently the only postinfection control practice (chemical or non-chemical) for Armillaria root disease, which attacks approximately 500 species of woody plants, worldwide. Root collar excavation improves yields of infected grapevines, which, in turn, results in higher profit, as grapes are sold by weight. Results of my research on Pierce's disease have economic and environmental significance. Grape-growers that manage riparian vegetation to control Pierce's disease can focus on clearing fewer plant species, thereby cutting labor costs associated with plant removal. By removing fewer plants in riparian areas adjacent to vineyards, there is less disruption of wildlife habitat. Removing invasive weeds may help restore riparian areas to a more natural condition.

Do you receive any additional support for this project? If so, from what source(s)?

I received additional support from the American Vineyard Foundation (2001-2002), the California Competitive Grants Program for Research in Viticulture and Enology (2001-2002), the Viticulture Consortium (2001-2003), the California Department of Food and Agriculture (2002-2005), and the Western Sustainable Agriculture Research and Education Program (2002-2005). With their financial support I hired two post-docs and two technicians.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?

Collaborations with Dr. David M. Rizzo, Department of Plant Pathology, University of California, Davis, contributed to research on identity and distribution of *Armillaria* species in California. Collaborations with Larry Bettiga and Richard Smith, both with University of California Cooperative Extension, Salinas, contributed to research on the effects of vineyard floor management practices on beneficial root fungi.

Name(s) and location(s) of scientist(s) working on the project:
Kerri Steenwerth and Jerry Uyemoto, Crops Pathology and Genetics Research Unit, Davis, California
Name, email address, and phone number of contact person:
Kerri Steenwerth, ksteenwerth@ucdavis.edu, 530-752-7535
What is the problem you are addressing?
Syrah disorder has been a noted problem in California vineyards. Suspect causes of decline include pathogenic, physiological stress and cultural factors.
What is the project that you are conducting to address the problem?
We are investigating potential herbicide sensitivity in Syrah. Preliminary evidence gathered from growers' vineyards suggest that this may be one component of the early decline observed in Syrah.
What is the approach you are taking?
1) A three-year trial composed of three Syrah clones on a single rootstock will be initiated in May 2005. A single cabernet clone on the same rootstock as the Syrah clones will be planted for comparison. Suspect herbicides will be sprayed on grapevines of different ages (one-three years old). Subsequently, in the fall, grapevines will be destructively harvested and inspected for damage. While we do not suspect that graft transmissible agents (GTA) are causing the observed necrosis in Syrah, we will create a panel of the same Syrah and Cabernet Sauvignon clones so that we can test for GTAs as a source of the necrosis.
2) We are also conducting a small on recent Syrah replants in a grower's vineyard to determine if the same necrotic symptoms can be induced by repeating the practices used previously when he applied herbicides. Other winegrape varieties, such as Cabernet Sauvignon, have been sprayed with the suspect herbicides to determine if the necrosis can be induced in varieties other than Syrah.

What has been accomplished?
This project has not produced results yet. We expect preliminary results from the survey in the grower's vineyard in Fall 2005. Initial results from the field trial will be available in Fall 2006.

What impact do you expect from your project?
Expected results: This trial will provide information on whether the observed decline in these particular clones of Syrah is due to herbicide sensitivity or GTAs. It may also provide preliminary information that herbicide sensitivity in Syrah is specific to certain clones. This project may provide information to growers about how herbicide application should be modified to avoid damage to Syrah grapevines.

Do you receive any additional support for this project? If so, from what source(s)?
No.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?

Sunridge Nursery donated the grapevines for the trial.

The Department of Viticulture and Enology at the University of California at Davis (UCD) is providing the vineyard facilities and a portion of the management required to run the project.

Dr. Tom Lanini, a weed scientist in the Department of Vegetable Crops at UCD, provides consultation as well as the support of his technician, who has helped us with herbicide application.

We are also working closely with several U.C. Cooperative Extension advisors to identify vineyards exhibiting these symptoms (Rhonda Smith, Mark Battany and Ken Churches).

Dr. Deborah Golino, the director of Foundation Plant Services at UCD, has provided services to verify the identity of grapevines we observe in the field.

Name(s) and location(s) of scientist(s) working on the project:
Kendra Baumgartner and Kerri Steenwerth, Crops Pathology and Genetics Research Unit, Davis, California
Name, email address, and phone number of contact person:
Kendra Baumgartner, kbaumgartner@ucdavis.edu, 530-754-7461
What is the problem you are addressing?
It has been demonstrated in annual agricultural systems that cultural practices can shift weed communities, intense and repeated soil disturbance by tillage can negatively impact soil health, and cover crops can be used to improve soil quality. However, vineyards are unique because they are perennial cropping systems and are spatially heterogeneous compared to annual systems. Currently, little is known about the impacts of vineyard floor management on weed communities and soil health.

What is the project that you are conducting to address the problem?
For three years, various vineyard floor management approaches using different cover crops and tillage regimes were employed to study impacts on weed communities and grapevines in Napa County, California.

What is the approach you are taking?
This project is a smaller component of the trial initiated by Kendra Baumgartner. I am documenting the change in weed communities in the 'row middles' between the vines and on the berms underneath the vines, just adjacent to the 'row middles'. In addition, microbial activity (e.g., potential net N mineralization, microbial respiration) and particulate soil organic matter will be compared among the different treatments to determine the effects of management intensity and cover crop selection on parameters indicative of soil quality.

What has been accomplished?
Weed community surveys are being completed and analyzed, but the results of this project are not yet finished.

What impact do you expect from your project?
We expect to understand how different cover crops and weed management practices affect weed community dynamics and soil microbial activity. It may also provide information on which specific cover crop was most effective in shifting populations of weeds and the associated seedbank.

Do you receive any additional support for this project? If so, from what source(s)?
No.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Robert Mondavi Vineyard provides the vineyard for the study and manages the cultural practices and cover crop planting.

Name(s) and location(s) of scientist(s) working on the project:
Kerri Steenwerth, Crops Pathology and Genetics Research Unit, Davis, California
Name, email address, and phone number of contact person:
Kerri Steenwerth, ksteenwerth@ucdavis.edu, 530-752-7535
What is the problem you are addressing?
It has been demonstrated in annual agricultural systems that cultural practices can shift microbial communities, but less is known about how cultural practices in perennial vineyard systems influence soil microbial communities and soil health. Vineyard floor management practices create high spatial heterogeneity, and it is not known how this spatial heterogeneity may influence soil nutrient availability. Furthermore, it is not understood if changes in microbial communities are linked to shifts in nutrient supplies, and how this may impact grapevine health.

What is the project that you are conducting to address the problem?
I am investigating the effects of the vineyard floor management regimes on microbial community composition, microbial activity, soil nutrient availability, and other parameters related to soil quality. These data will be collected in parallel with information on shifts in weed community composition, grapevine water status, and grape quality. Measurements that describe the weed community and grapevines will be conducted by other researchers.

What is the approach you are taking?
This project is a small component of a trial initiated by Richard Smith and Larry Bettiga, two UCCE advisors in Monterey County, California. For five years, various vineyard floor management approaches using different cover crops and tillage regimes were employed to study impacts on weed communities and grapevines.

What has been accomplished?
Soil collection and analysis has been initiated. Please contact Larry Bettiga or Richard Smith for information about the other components of this trial.

What impact do you expect from your project?
I expect to gain understanding of different weed control practices on soil nitrogen and carbon dynamics and soil microbial communities. This will provide information to growers that may assist them in choosing weed control practices that provide the level of control that they desire and that sustain long-term soil quality.

Do you receive any additional support for this project? If so, from what source(s)?
No. However, Larry Bettiga and Richard Smith receive funding from the American Viticulture Foundation to support the management of the various treatments.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Kendra Baumgartner – assessment of mycorrhizal colonization in the vineyard system
Michael Cahn – effects of weed control practices and cover crops on soil erosion
Richard Smith – effects of various treatments on weed community dynamics
Larry Bettiga – responsible for viticultural aspects of the project

Name(s) and location(s) of scientist(s) working on the project:
Kerri Steenwerth, Crops Pathology and Genetics Research Unit, Davis, California
Name, email address, and phone number of contact person:
Kerri Steenwerth, ksteenwerth@ucdavis.edu, 530-752-7535
What is the problem you are addressing?
Impacts that cover crops and vineyard floor management can have on soil carbon storage as a means to mitigate greenhouse gas emissions and global warming.
What is the project that you are conducting to address the problem?
We are investigating the effect of cover crop management practices and climate on soil organic matter dynamics in a vineyard at the Oakville Research Station in Oakville, Napa County, CA.
What is the approach you are taking?
Barley UC603 was planted in the vineyard in November 2003 (repeated in 2004) to establish three treatments: barley that would be mowed, barley that would be mowed and then tilled, and resident vegetation that would be mowed and tilled (no barley). In January, soil moisture, plant biomass and soil respiration were monitored every two weeks. Grapevine water status, grape quality, and pruning weights were also measured in each treatment. Economic analyses of these practices will be performed.
A more-detailed study addressed the effects of mowing or tilling on soil organic matter dynamics. The cover crop was labeled with the stable isotope $^{13}CO_2$, which served as a tracer to follow the organic matter derived from the cover crop after it was either mowed or tilled into the soil. Simulated rainfall was applied to the labeled treatments to determine the effect of wet-dry cycles, a dominant cycle in Mediterranean climates, on the availability of cover crop derived organic matter in mowed or tilled soils.
What has been accomplished?
We have completed two years of vineyard experiments on this project, assessing grapevine and vineyard soil parameters. Additional data collection is needed for project completion.
What impact do you expect from your project?
We expect to estimate the relative net increment of soil C derived from the cover crop that is retained from mowing or tillage. Furthermore, we expect to gain an understanding of the economic cost of these vineyard practices in comparison to the increment of C stored in the soil environment. Our study will also identify potential impacts that cover crops may have on grape quality and grapevine water stress.
Do you receive any additional support for this project? If so, from what source(s)?
Kearney Soil Science Foundation
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Dr. David Smart, at the University of California at Davis, Department of Viticulture and Enology, manages the grant that pays for sample analysis and provides salary for the graduate student with whom I am working on the project.

Name(s) and location(s) of scientist(s) working on the project:
Kerri Steenwerth, Crops Pathology and Genetics Research Unit, Davis, California
Name, email address, and phone number of contact person:
Kerri Steenwerth, ksteenwerth@ucdavis.edu, 530-752-7535
What is the problem you are addressing?
Reduction of the use of pre-emergent herbicide chemicals is important to reduce both potential impacts in the environment and management costs incurred by growers. Initial reduction of weed seedbanks may also be crucial when establishing new vineyards.

What is the project that you are conducting to address the problem?
We are investigating the reactivity of alternative chemicals like essential oils and acetic acid on seeds of aggressive weeds found in vineyard systems. We are also investigating various chemical delivery methods to the soil environment.

What is the approach you are taking?
We are assaying chemical reactivity through direct application to seeds in Petri dishes and in soil in the greenhouse. Seed viability is assessed relative to a control of untreated seed.

What has been accomplished?
Currently, we are determining the reactivity of the chemicals on seed germination, but will later identify any negative effects on the soil environment that may have subsequent implications for grapevine growth.

What impact do you expect from your project?
We expect that this research may result in alternative controls of weed seed germination and reduce the use of pre-emergent herbicide, depending on the effectiveness of the chemical delivery system and neutral effects on the soil environment.

Do you receive any additional support for this project? If so, from what source(s)?
No.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Dr. Anil Shrestha, UC IPM, Kearney Agricultural Center – He provides advice and support for seed viability assays.

Name(s) and location(s) of scientist(s) working on the project:
Kerri Steenwerth, Crops Pathology and Genetics Research Unit, Davis, California
Name, email address, and phone number of contact person:
Kerri Steenwerth, ksteenwerth@ucdavis.edu, 530-752-7535
What is the problem you are addressing?
Vineyard systems utilize drip systems to irrigate grapevines, and fertilizer is often delivered through the irrigation system (i.e., fertigation). Long-term use of drip fertigation may cause changes in soil chemical properties in the drip zone, thereby affecting biological properties and nutrient retention in the vineyard. Also, fertigation is often applied when soils are warm and dry, which may cause significant nitrogen trace gas loss from vineyards. Nitrogen trace gas emissions derived from fertilizer are problematic because they contribute to greenhouse gases in the atmosphere.
What is the project that you are conducting to address the problem?
We are investigating changes in soil chemical and biological characteristics underneath vines that have undergone either long-term fertigation or irrigation (i.e., no fertilizer).
What is the approach you are taking?
To understand the changes in soil characteristics in fertigated or irrigated grapevines, soil was collected along two transects that extended either along the berm within and outside of the dripzone or from the dripzone into the 'middles' between the grapevine rows. A total of 25 points were measured along these transects at each vine. Soil was collected from two depths (0-20 cm and 20-50 cm) and assessed for microbial activity, microbial community composition, and chemical characteristics. Specific chemical characteristics included exchangeable cations, pH, and total combustible carbon and nitrogen. To identify potential contributions of trace gas N emissions derived from fertigation, grapevines were fertigated or irrigated in spring, and subsequent efflux of nitrous oxide was measured along the transects (i.e., along the berm and into the 'middles').
What has been accomplished?
We have completed all sample processing, except for microbial community composition analyses.
What impact do you expect from your project?
We expect to understand how fertigation impacts soil chemical and biological characteristics and determine implications for long-term grapevine health and soil quality.
Do you receive any additional support for this project? If so, from what source(s)?
Yes. Funds provided by D.R. Smart for soil chemical analyses.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Dr. David Smart, at the University of California at Davis, Department of Viticulture and Enology, provided assistance with field soil collections and analyses for soil chemical characteristics.

Name(s) and location(s) of scientist(s) working on the project:
R. Paul Schreiner, Horticultural Crops Research Lab (HCRL), Corvallis, Oregon
Name, email address, and phone number of contact person:
R. Paul Schreiner, schreinr@science.oregonstate.edu, 541-738-4084
What is the problem you are addressing?
Understanding the influence of soil factors and management practices on root and mycorrhiza function, and the resulting impacts on vine growth, mineral nutrition, water relations, and fruit quality. Identifying optimal plant nutrient levels based on fruit quality.
What is the project that you are conducting to address the problem?
I am investigating the role that arbuscular mycorrhizal fungi (AMF) perform in promoting growth and nutrient uptake in various soil types, and the impact of various management practices (including fertilizer inputs, irrigation, and cover crops) on roots, mycorrhizas, and vine physiology.
What is the approach you are taking?
I am primarily using a whole-plant approach, manipulating specific variables where appropriate under field and/or glasshouse conditions. I rely on grower-cooperators for some field studies. I am increasingly using pot in pot vineyards to allow for greater control of soil conditions and more accurate root assessments.
What has been accomplished?
1. Surveys of commercial vineyards in Oregon and Washington states have identified factors important in determining the activity of mycorrhizal fungi in grape roots (pH in Oregon, nitrogen use in Washington, and water inputs in both states). 2. Screened rootstocks for mycorrhizal colonization potential in the field and found only a small genotype (or parental background) influence on colonization potential. 3. Comparisons of different soils types have shown that AMF are essential for grapevine establishment in redhill soils (Ultisols) common to Oregon viticulture, but not so for the more fertile, valley soils (Mollisols) that are sometimes used for grape growing. 4. A two year study of whole plant nutrient uptake and allocation conducted in an Oregon dryland vineyard showed that the rate of nutrient uptake for N and P peaked at bloom and then declined through the rest of the summer, while K uptake peaked at veraison. N uptake also occurred in one year only between harvest and pruning 5. A three year study in an irrigated Columbia Basin vineyard (Washington) showed that vines were more reliant on AMF when stressed beyond typical regulated deficit irrigation practices. 6. Field and glasshouse studies have shown that ring nematodes (*Mesocriconema xenoplax*) specifically reduce arbuscules (specialized structures where nutrients are exchanged in arbuscular mycorrhizas) in grapevine fine roots by apparently utilizing carbohydrates that would otherwise go to AMF. 7. Found that nine "putative" species of AMF on average colonize vine roots within typical Oregon vineyards, but four *Glomus* species are very common. 9. Showed that inoculation with AMF is rarely needed in to ensure that young vines are well colonized by AMF under Oregon conditions. It is hard to gauge how much industry has been affected by these findings, but some growers have altered management practices as a consequence of this research.
What impact do you expect from your project?
The impact from this project will be in the adoption of management practices that increase the efficiency of nutrient and water use in vineyards by enhancing root and mycorrhiza health while still achieving fruit quality goals. The optimal nutrient research (when completed) will give growers better guidelines for leaf and petiole nutrient tests and will likely be adopted very quickly.

Do you receive any additional support for this project? If so, from what source(s)?
I have received support from the Oregon Wine Board (4 years, 1999-2002) and from the Northwest Center for Small Fruits Research (2 years 2004-2005). This has supported nutrient analysis, time-slip labor, and a graduate student.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Jack Pinkerton USDA-ARS-HCRL nematology, Carolyn Scagel USDA-ARS-HCRL root physiology and plant nutrition, David Bryla USDA-ARS-HCRL water relations and plant nutrition, Julie Tarara USDA-ARS-HCRL viticulture & climate, Krista Shellie USDA-ARS-HCRL viticulture, Jungmin Lee USDA-ARS-HCRL fruit quality & enology, John Baham Oregon State Univ. soil chemistry, Joey Spatafora Oregon State Univ. fungal genetics & phyologeny, Jim Kennedy Oregon State Univ. fruit quality-phenolics, Micheal Qian fruit quality-flavors, Markus Keller Washington State Univ. viticulture-physiology, Joan Davenport Washington State Univ. viticulture-nutrition. Andy Gallagher Red Hill Soils soil mapping & interpretation.

QUALITY AND HEALTH

Name(s) and location(s) of scientist(s) working on the project:
Jungmin Lee, Horticultural Crops Research Laboratory Worksite, Parma, Idaho
Name, email address, and phone number of contact person:
Jungmin Lee, jlee@uidaho.edu, 208-722-6701 ext.282.
What is the problem you are addressing?
Idaho's wine industry is fairly new and growing. My program began October 2004, and initial efforts are concentrated on establishing a working food chemistry laboratory, and understanding what problems affect Idaho wine grapes and wine, and what unique qualities they may have as well. I am interested in all components of wine grapes and wine from a food chemist's standpoint.
What is the project that you are conducting to address the problem?
Initially, I am analyzing commercially available Idaho wines. I also plan to analyze grapes, must, and wine from vineyards and wineries within Idaho's proposed Snake River appellation, and then compare those results with samples obtained from established wine growing regions with similar geographic and climatic conditions (such as eastern Washington and parts of Australia, Spain, and South Africa.)
What is the approach you are taking?
My program will examine the biochemical components in wine grapes, must, and wine that are indicators of fruit, and fruit product, quality from a food chemistry standpoint. I will also establish a functional laboratory for routine analysis of anthocyanins, phenolics, amino acids, antioxidants, and color measurement. I collaborate with viticulturists and horticulturists to extend their projects to understand how fruit and wine qualities are influenced by the various field treatments.

What has been accomplished?
The USDA wine chemistry program in Parma, Idaho is brand new. I am currently getting my new laboratory established, have hired a permanent technician, and have talked to local wine makers to ascertain wine quality issues Idaho does not suffer from.

What impact do you expect from your project?
I expect to obtain a baseline of where the industry is currently at and eventually apply different wine making processes to enhance the final product. I also expect to determine economical, quick, and simple analysis methods that small wineries could implement.
Do you receive any additional support for this project? If so, from what source(s)?
Not at this time.
Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
The ARS Horticultural Crops Research Laboratory (Corvallis, Oregon) 'grape program' CRIS includes, myself, Julie Tarara (Research Horticulturist, Prosser, Washington), and Krista Shellie (Research Horticulturist, Parma, Idaho). Krista Shellie will be providing grapes from her irrigation and kaolin trials, which will be monitored for quality from the grape to end product, from a food chemistry standpoint. Jim Kennedy (Assistant Professor of Food Science and Technology) at Oregon State University cooperates by lending his expertise on wine chemistry and tannin analysis. Idaho Grape Growers and Wine Producers will be providing grape, must, and wine samples, and their expertise in wine grape production and wine making. Paul Schreiner (USDA-HCRL, Corvallis, OR) will provide wine grape samples from his plant nutrient experiments. Luis Rodriguez (Assistant Professor of Food Science) at Ohio State University will be providing FT-NIR and IR analysis.

Name(s) and location(s) of scientist(s) working on the project:
Penelope Perkins-Veazie, USDA-ARS, South Central Agricultural Research Laboratory, Lane, Oklahoma; Stephen Stringer, USDA-ARS, Poplarville, Mississippi; Bernard Prins, USDA-ARS, Davis, California
Name, email address, and phone number of contact person:
Penelope Perkins-Veazie, Pperkins-usda@lane-ag.org, 580-889-7395

What is the problem you are addressing?
Our ultimate goal is to be able to select muscadines with high levels of antioxidants, and with specific antioxidants, for the development of functional foods.

What is the project that you are conducting to address the problem?
Determination of antioxidants (total phenolics, total anthocyanin) in muscadine germplasm.

What is the approach you are taking?
Fruit is harvested in Mississippi and California, sent to Lane, Oklahoma and analyzed for antioxidants.

What has been accomplished?
In the first year of the study, sixteen varieties were evaluated for antioxidant content. Of these, two were found to be unusually high in total phenolics. The total anthocyanins (pigments) were found primarily in purple skinned varieties rather than the bronze skinned varieties.

What impact do you expect from your project?
At this point, the information is being used first as a means to screen germplasm for high antioxidant containing lines. However, new projects can be evolved from this work to determine specific compounds of interest, and to determine how genetics and environment affect them. Ultimately, there is interest in tailoring muscadine grapes to produce antioxidant-rich foods and pomace (for skin care products).

Do you receive any additional support for this project? If so, from what source(s)?
Yes. The Crop Germplasm Committee on Grapes has provided funds for this research.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?
Stephen Stringer, USDA-ARS, Poplarville, Mississippi; Bernard Prins, USDA-ARS, Davis, California. Stephen Stringer is a breeder and will use the information to pursue crosses for increased antioxidants. Both Stephen and Bernard have been providing fruit of known repository selections grown in very different environments to utilize the information about environmental effects on antioxidant content.

Name(s) and location(s) of scientist(s) working on the project:

Susan J. Zunino, Ph.D., Western Human Nutrition Research Center, Davis, California
Charles B. Stephensen, Ph.D., Western Human Nutrition Research Center, Davis, California

Name, email address, and phone number of contact person:

Susan J. Zunino, szunino@whnrc.usda.gov, (530) 752-5156

What is the problem you are addressing?

Grapes contain multiple antioxidants that have anti-inflammatory activities. Juvenile type I diabetes is an autoimmune inflammatory disease that affects approximately 0.5 % of the population in developed countries. Onset of type I diabetes usually occurs in children and young adults and is characterized by the specific destruction of insulin-producing cells in the pancreas by auto-reactive immune cells. Without exogenous insulin, patients with this disease succumb to severe metabolic disturbances resulting in coma and death. These patients also have an increased risk of cardiovascular diseases that can lead to stroke, heart attack, and limb amputations.

What is the project that you are conducting to address the problem?

The overall goal of this research is to determine whether the constituents of grapes can inhibit the inflammatory responses that lead to onset and pathogenesis of autoimmune type I diabetes. Using a well-characterized mouse model for autoimmune diabetes, we are feeding these animals diets containing defined levels of freeze-dried grape powder (provided by the California Table Grape Commission) and comparing them to animals receiving a normal diet.

What is the approach you are taking?

The non-obese diabetic (NOD) mouse model is being used in the feeding study. In these experiments, control mice are fed normal diet supplemented with 0.45% fructose and 0.45% glucose to control for the additional sugars found in grapes (values for fructose and glucose were provided by the California Table Grape Commission). Mice are fed either control diet or diet containing 1% grape powder. Blood glucoses are monitored using a glucose meter once per week. Animals are euthanized for tissue removal when they become diabetic and at the end of the experimental period (when mice reach 30 weeks of age). The pancreas is taken for histological analysis for the presence of immune cells and extent of destruction of the insulin-producing cells. The spleen contains immune cells and this organ is also removed. Spleen cells are analyzed to determine whether the grape powder is inhibiting the general immune response in these animals and results are compared to control mice.

What has been accomplished?

At the age of approximately 28 weeks, 71% of control mice have progressed to diabetes versus 33% in the mice receiving 1% grape powder diet. The histological examination of the pancreas is in progress. No commercial or industry benefit has yet been realized.

What impact do you expect from your project?

Although not yet completed, this ongoing study strongly suggests that grape powder in the diet has a protective effect against autoimmune inflammatory attack of the insulin-producing cells of the pancreas and subsequently inhibits the onset of type I diabetes in NOD mice by at least 50%. By analyzing the histology of the pancreatic tissues of animals, we expect to find significantly reduced inflammation in the mice that received grape powder in their diet. Further experiments with increased amounts of grape powder in the diet have been proposed to the California Table Grape Commission for the 2005-2006 funding period to analyze the anti-inflammatory effects of grape constituents. To determine the antioxidants in grapes that may be responsible for the protective effect against type I diabetes, further experiments by us are planned to supplement

diets with individual antioxidants. Once the protective antioxidants are defined, this will allow the identification of grape varieties that have the most beneficial levels of these compounds and also lead to the development of new varieties that have a higher antioxidant yield.

Do you receive any additional support for this project? If so, from what source(s)?

The current experiments are supported by ARS. An application has been submitted to the California Table Grape Commission for funds in 2005-2006 to expand on this research to understand the role grape constituents play in the inhibition of type I diabetes.

Are there cooperators on the project? If so, who are the cooperators and what are their respective areas of responsibility?

Dr. Charles Stephensen at the Western Human Nutrition Research Center is analyzing immune cell function using the spleen cells removed from the mice. Discussions have been initiated with Bernard Prins, horticulturist, at the ARS National Clonal Germplasm Repository, Davis, CA regarding the testing of multiple varieties of grapes for antioxidant activity. Discussions for collaboration have also been initiated with Dr. Andrew Waterhouse, Vice-Chair, Department of Viticulture and Enology, University of California, Davis for this research.

Name(s) and location(s) of scientist(s) working on the project:
Tara McHugh, Research Leader, Processed Foods Research Unit, USDA, ARS, Western Regional Research Center, Albany, California; Wally Yokoyama, Processed Foods Research Unit

Name, email address, and phone number of contact person:
Tara McHugh, thm@pw.usda.gov, 510-559-5864

What is the problem you are addressing?
Our overall mission as a unit is to increase utilization and consumption of agricultural commodities such as grapes through processing and biotechnology. We are working on development of products and technologies that can improve the quality of the American diet to combat obesity and improve overall healthfulness.

What is the project that you are conducting to address the problem?
We investigate effects of processing on the health promoting compounds in foods and develop technologies to help the farmers utilize more of the products they grow and improve their overall economic returns.

What is the approach you are taking?
The Western Regional Research Center has state of the art laboratory facilities, a pilot plant processing facility, and a small animal research facility. Our current research includes:
1) Grape pomace. Grape pomace is a co-product of the wine and juice processing industries that contains high levels of polyphenolics, fibers and other phytochemicals that could be beneficial to human health. One of the researchers in our unit, Wally Yokoyama, performed a preliminary study feeding on grape pomace to animals.
2) Raisins and raisin products: We are developing new raisin products and processes and techniques for utilizing raisins in novel foods.

What has been accomplished?
1) Grape pomace: Wally Yokoyama discovered that the grape pomace has cholesterol lowering action. The grape pomace also had a favorable effect on the overall lipoprotein profile in the animals that were tested. We would like to do additional studies on this to better understand the relative effects and potential synergies of the fibers, polyphenolics and other phytochemicals on health promotion. We also would like to look at the potential of grape pomace to ameliorate insulin resistance, a precursor to diabetes. In addition we hope to develop food products and processes to utilize the pomace.
2) Wine flavored raisins. We developed a value-added raisin product for adults that is a dehydrated grape infused with wine. These raisins are nonalcoholic and very tasty. They can be made in varieties such as Pinot Noir, Cabernet, Chardonnay, etc. The technology has not been commercialized yet, although we have several commercial partners considering it. Safeway just introduced a line of infused, flavored raisins for kids; this product could expand upon that market sector.
3) Shade dried raisins. We are discussing a potential collaboration with USAID and Roots for Peace on improving the quality and safety of shade dried raisins that are grown in Afghanistan. This shade drying process is unique in that it produces light colored, sweet raisins that are sold for a premium over traditional sun dried raisins in India and other nearby countries. These light colored raisins do not contain any sulfur dioxide. We are interested in not only improving the quality and safety of the Afghanistan raisins to stimulate their agricultural production, but also in exploring this technology for potential application in the U.S. for production of a novel, light colored raisin that is not treated with sulfur dioxide.

4) Extruded raisin sticks and bars. We have developed forming and extrusion processing technologies that can be used to produce other types of novel value-added raisin products such as raisin sticks and bars.

What impact do you expect from your project?

We expect that the processes and products that we are developing will enhance nutrition through increased consumption of foods rich in health promoting compounds and will improve returns to growers by enabling them to utilize more of the products they grow (for example, pomace).

On the cover: Autumn Royal seedless table grapes. This variety was developed by David W. Ramming and Ronald E. Tarailo, who are with ARS at the San Joaquin Valley Agricultural Sciences Center in Parlier, California. Released to grape growers in 1996, Autumn Royal currently is the fifth highest table grape variety in production in California.