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INVESTIGATOR: Pappu, HA, .; Amiri, AC, .; Beers, EL, .; Chastagner, GA, .; Felsot, AL, .; Gerdeman, BE, .; Grove, GA, .; Inglis, DE, .; James, DA, .; Johnson, DE, .; Jones, VI, .; Moyer, MI, .; Murray, TI, .; Rayapati, NA, .; Walsh, DO, .; Hulbert, SC, .; Harper, SC, .

PERFORMING INSTITUTION:
WASHINGTON STATE UNIVERSITY
240 FRENCH ADMINISTRATION BLDG
PULLMAN, WASHINGTON 99164-0001

REDUCING THE IMPACT OF PESTS AND DISEASES AFFECTING WASHINGTON AGRICULTURE

NON-TECHNICAL SUMMARY: Washington's variable climate and diverse cropping systems are highly conducive to pest and disease outbreaks. Almost all major and minor crops grown in Washington are affected by pests and diseases resulting in loss of yield and quality. Managing pests and diseases to reduce their impacts is a recurring cost that adds to the total cost of production and reduces profitability and sustainability of farm operations. Rapid detection and diagnosis, sustainable and eco-friendly management tactics, and decision aid systems are needed for enhancing the farming enterprise's sustainability by maintaining yields and reducing costs. Specific goals include, (a) Characterization and control of diseases in diverse cropping systems; (b) Developing management strategies for destructive pests of crops in Washington State; (c) Development and implementation of sustainable biologically-based pest management systems for high value specialty crops in central Washington; and (d) Develop agricultural technologies that estimate and mitigate adverse human and environmental impacts.

OBJECTIVES: Objective 1. Develop sustainable management programs for plant diseases in diverse cropping systems.1a. Characterization and control of viral diseases of horticultural crops1b. Develop IPM-based strategies to mitigate postharvest diseases of apple and pear1c. Improve chemical and cultural strategies that address management of plant parasitic nematodes, trunk diseases, and fungicide resistance in vineyard systems.1d. Investigate alternative approaches for controlling diseases of specialty vegetable crops in western Washington1e. Sustainable control of wheat diseases through development of improved varieties and effective chemical control1f. Develop chemical and cultural strategies for managing wheat diseases.1g. Develop disease warning and forecasting systems for potato1h. Develop chemical and cultural strategies that address management of powdery mildews of cherry and hop.1i. Characterize genetic and pathogenic variation within pathogen populations and the potential interaction with disease resistance genes.1j. Improved management of diseases of flower bulb, Christmas tree and ornamental nursery crops.Objective 2. Reduce the impact of economically important insect pests affecting Washington crops2a. Develop and implement sustainable management of pests affecting

Washington crops. and biologically-based pest management ssystems for high value specialty crops in central Washington.2b. Develop IPM-based strategies to control arthropods damaging seed crops and small fruit in Western Washington.2c. Reduce the impact of industry-critical arthropod problems in hops through thedevelopment of preventive and predictive strategies.Objective 3. Investigate and reduce the impact of non-target organisms and insect pests to mitigate adverse human and environmental impacts. 3a. Conduct studies of pest and non-target organisms exposure to crop protection agents. 3b. Estimate risk of adverse effects to non-target organisms, including natural enemies of pests and pollinators, from use of modern crop protection agents.

APPROACH: Chemical/Cultural Strategies for Managing Powdery Mildews of Cherry and Hop. Effects of temperature, relative humidity, and dew point on sporulation under controlled-environment will assist in developing forecasting models for improved disease management, made available on AgWeatherNet and DAS. Most effective fungicide classes for critical epidemiological periods will be determined and economic analyses of disease management programs will be conducted.Chemical/Cultural Strategies for Managing Plant Parasitic Nematodes, Trunk Diseases, and Fungicide Resistance in Vineyards. Partnering with the Washington wine grape industry, ~10 year on-farm trials will compare rootstock, fumigation and economic performance to control northern root knot nematode, Meloidogyne hapla, from vineyard establishment through long-term vineyard development. This will assist growers in developing an economically viable approach.IPM-based Strategies to Mitigate Postharvest Diseases of Apple and Pear. Fungi from decayed apple and pear with their corresponding spray records will be collected from packinghouses, maintained and tested against pre and postharvest fungicides. Development of a molecular detection assay will follow.Alternative Approaches for Controlling Vegetable Crop Diseases in Western Washington. Disease forecasting models for late blight, will include cultivar susceptibility and fungicide residues on foliage as model factors. Quantitative PCR will detect and quantify aggressive strains of Coletotrichum coccodes and Verticillium dahliae in pre-plant field soil. Field sampling designs will be validated by comparing quantitative PCR and bio-plant assays. Dual RNA-Sequencing technology of potato inoculated with aggressive and non-aggressive strains of V. dahliae will be used to distinguish among strains.Sustainable Control of Wheat Diseases Through Crop Improvement. Identify and transfer new sources of disease resistance into wheat varieties. Evaluate control options for eyespot and Cephalosporium stripe. Investigate genetic variation in Washington wheat pathogens and disease management potential. Research biochar and other by-products in reducing wheat diseases in acidic soils. Identify the gene/s conferring resistance to stripe rust in the cultivar Louise. Examine potential of the wheat rhizosphere microbiome to manage diseases through suppression.Characterization and Control of Viral Diseases of Horticultural Crops. Genetic diversity, molecular biology and host-virus interactions in grapes will be studied using contemporary methods. Virus impacts on vine health, fruit quality and transmission via plant materials and vectors will be investigated. Viruses impacting horticultural crops in "Feed the Future" countries will be documented and strategies to reduce crop losses in subsistence agriculture will be developed.Biological/Molecular Studies of Economically Important Viruses of Horticultural CropsTuber necrosis-causing viruses of potato: Potato mop top virus, Potato virus Y and Tobacco rattle virus will be characterized and US genetic diversity determined. Virus-potato interactions following infection, host defense and effects of host transcriptome and metabolome on endemic and emerging tospovirus-host interactions will be studied. Rapid virus detection methods will be developed particularly for dahlias.Disease Warning and Forecasting Systems for Potato. Field, greenhouse and lab research will assist in developing a disease warning and forecasting system for late blight, black dot and Verticillium wilt of potato. Natural and induced infections and outbreaks of the diseases will be used to develop these forecasting models. Susceptibility of potato cultivars and fungicides residues on potato foliage will serve as model factors.Improved Disease Management on Flower Bulb, Christmas Tree and Ornamental Nursery Crops. Characterize

Botrytis pathogen diversity of peonies and conifer nursery crops. Determine the level of fungicide resistance within these Botrytis pathogen populations. Assess importance of preharvest Botrytis peony flower bud infections vs. postharvest infections and effectiveness of pre and postharvest control measures on disease development during storage. Survey noble fir bough and Christmas tree plantations to determine the most common needle cast diseases affecting marketability. Evaluate effectiveness of new reduced risk and biopesticides in controlling disease development on these crops. Evaluate effects of soil type and moisture status on steaming to eradicate Phytophthoras. Evaluate effects of harvest date and production site elevation on postharvest moisture and needle retention of noble fir boughs.Develop Agricultural Technologies that Estimate and Mitigate Adverse Human and Environmental Impacts. Databases based on published studies and new experiments will establish potential risk of crop protection technologies on target and non-target organisms and rank them according to riskiness using a probabilistic risk analysis. Exposure studies will include biocontrol organisms, pollinators, and agricultural workers. New crop technology technologies can be assessed for likelihood of adverse effects under PNW regional conditions.Develop and Implement Sustainable Biologically-Based Pest Management for High Value Specialty Crops in Central Washington. Investigate the biology/ecology of arthropod pests and their natural enemies in laboratory and field studies. Establish laboratory cultures and evaluate insecticides and miticides in lab and field trials on targeted pests, emphasizing novel, narrow-spectrum chemistries.Develop/Validate New WSU-Tree Fruit Decision Aid System Models. Field studies will assist to develop and validate additional pest (mites, aphids, pear psylla, multiple natural enemies) and horticultural models (honeybee foraging, fruit set, fruit growth). Pesticide effects models are completed and validated for 5 insects including codling moth, leafrollers and 2 lacewing beneficials with more under construction. Canadian collaboration will add potential future pests creating a larger user base and more DAS flexibility.Develop IPM Methods to Control Pests of Seed Crops and Small Fruit in Western Washington.Evaluate treatments to protect direct-seeded crops from soil pests including germination assays to detect phytotoxicity. Research methods to decrease impact of root maggot flies on transplanted seed crops including timing and insecticide rotational sequences. Investigate potential effects of systemic insecticides on insect pollinated biennial seed crops. Continued research in managing spotted wing drosophila, in small fruits focusing on reducing insecticide residues. Monitor brown marmorated stink bug in Skagit and Whatcom Counties and release the parasitoid, Trissolcus japonicus if warranted.Develop and Implement Biorational Tree Fruit Pest Management in Eastern Washington. Research 8 management strategies for oblique-banded leaf roller in conventional and organic orchards with minimum impact on natural enemies. Evaluate causes of recent outbreaks of western tentiform leafminer using historical records and develop phenology models including its key natural enemy to identify best application windows. Determine appropriate timing and materials for pear psylla and spider mites and investigate nontarget effects to prevent pear IPM collapse. Explore non-insecticidal methods including acoustic disruption and tree washing.Reduce Impact of Industry-Critical Arthropod Problems in Hops Through Development of Preventive and Predictive Strategies. Multiple mutations were discovered in 2016 spider mite samples from hops which may contribute resistance. This prompted the need to develop a sensitive, rapid and cost-effective method to predict multiple acaricide resistance on a portable platform (allowing field use) using CRISPR for commonly used acaricides in hops.

KEYWORDS: Integrated pest management, tree fruits, hops, vegetables, grapes, forage crops, disease resistance