**2015 WASHINGTON RED RASPBERRY COMMISSION**

**RESEARCH PROPOSAL**

**New Project Proposal Proposed Duration:** 2 years

**Project Title:** Impacts of Alleyway Cover Crops on Soil Quality and Plant Competition in Established Red Raspberry

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**Cooperators:** Undisclosed.

**Year Initiated 2015 Current Year 2015 Terminating Year 2016**

**Total Project Request: Year 1** $8,157 **Year 2** $8,297

**Other funding sources:**

**Agency Name:** Northwestern Agricultural Research Foundation (NARF)

**Amt. Requested/Awarded:** $7,032

**Notes:** We will be seeking a 50% match for this proposal from NARF. With the total cost for the first year amounting to $15,189, this equates to $8,157 requested each from WRRC and $7,032 from NARF.

**Description:**

Red raspberry (*Rubus idaeus*) alleyway management in northwestern Washington typically consists of repeated cultivation and herbicide applications in order to maintain bare soil between rows. These management practices can have deleterious effects on soil quality. Raspberry plants and fruit quality may also be negatively impacted by these management practices. Some of the effects include increased soil compaction and erosion, reduced soil microbial diversity, and reduced photosynthetic activity and increased spider mite activity from excessive dust. An alternative management approach is planting alleyway cover crops, such as annual cover crops or perennial groundcovers. Studies on alleyway cover crops in raspberry production systems are limited, especially in Washington. This project proposes to address this knowledge gap by measuring the effects of alleyway cover crops in established red raspberry on: 1) Soil quality, using select chemical, physical, and biological variables; 2) Soil microbial community structure, with specific focus on changes in pathogenic and pathogen-suppressing populations; and 3) Plant competition between alleyway cover crops and raspberry plants. Completion of this research will provide valuable information regarding the suitability of alleyway cover crops in raspberry production in northwest Washington.

**Justification and Background:**

Management of alleyways in raspberry fields in northwest Washington entails repeated cultivation and herbicide applications. While effective at minimizing weeds, this strategy has several disadvantages, including: 1) Reductions in soil quality, which can manifest into increased erosion, compaction, loss of physical structure, and reductions in nutrient- and water-holding capacity (Funt and Hall, 2013; PNW Extension, 2007); 2) Increased dust during the dry season, which can reduce plant productivity, as well as promote spider mite activity (PNW Extension, 2007); 3) Complicate operation of mechanical equipment because clean-cultivated fields tend to be difficult to operate in due to mud (Funt and Hall, 2013; PNW Extension, 2007); and 4) Increased expenditures due to associated mechanical, fuel, and labor costs of frequent alleyway management (PNW Extension, 2007).

One approach to reduce the negative impacts of current alleyway management strategies is through cover crops. Zebarth et al. (1993) observed that nitrogen cycling improved and nitrate leaching was reduced with cover crops in the alleyways of raspberries in Canada. Yet, a small reduction in berry yield was also observed. Bowen and Freyman (1995) observed no differences in yield with white clover (*Trifolium repens*) established in the alleyways compared to clean cultivation, but yield was significantly lower with perennial ryegrass (*Lolium perenne*) compared to clean cultivation. In another four-year study with alleyway cover crops in raspberry, plots that were annually seeded with oats (*Avena* spp.) produced the same yields as clean cultivated plots (Sanderson and Cutcliffe, 1988). Certain species of cover crops may also have the potential to suppress diseases and pests, which may be useful in fields starting to exhibit declines in plant health. Mustard crops are commonly used as green manures or biofumigants in Washington to control nematodes and other soilborne diseases (Clark, 2012). Specific wheat cultivars can induce soilborne disease suppression by enhancing antagonistic microbial populations (Mazzola and Gu, 2002). Cover crops can also suppress weeds, which negatively impact crop production and can serve as nematode hosts (Funt and Hall, 2013; Forge et al., 2000).

Previous research demonstrates that there are many potential benefits of cover crops in perennial fruit systems. The role of cover crops in promoting soil quality and suppressing diseases/pests have been minimally studied in raspberry, particularly in Washington. Ensuring the continued productivity of this industry through improved soil and plant management strategies, such as through the successful use of cover crops, will help ensure the economic vitality of this industry.

**Relationship to WRRC Research Priority(s):**

This project addresses the following objectives: 1) Understanding soil ecology and soil borne pathogens and their effects on plant health and crop yields and 2) Soil fumigation techniques and *alternatives* to control soil pathogens, nematodes, and weeds.

**Objectives:**

The primary objectives of this experiment are to measure the effects of alleyway cover crops in established red raspberry on: 1) Soil quality, using select chemical, physical, and biological variables; 2) Soil microbial community structure, with specific focus on changes in pathogenic and pathogen-suppressing populations; and 3) Plant competition between alleyway cover crops and raspberry plants. An additional goal is to evaluate the suitability of select annual and perennial grains and turfgrasses as alleyway cover crops in raspberry production in northwest Washington.

**Procedures:**

Cover crops were seeded in an established commercial field of ‘Meeker’ located in Lynden, WA, on October 1, 2014. The site was reportedly starting to decline due to soilborne pathogens/pests and the investigators identified the site as suitable for an observational cover crop study that could become a more comprehensive study with project support. Cover crop treatments were established as a completely randomized design with an experimental unit representing a 30 x 12 ft plot, replicated four times per treatment. Plots span the entire alleyway on both sides of the row and a minimum of 60 ft were maintained between plots as buffer. Treatment cover crops seeded in the alleyways include: 1) Hard, red winter wheat cv. Norwest 553 (*Triticum* *aestivum*); 2) Soft, white winter wheat cv. Rosalyn (*T.* *aestivum*); 3) Winter-hardy oats cv. TAM 606 (*Avena sativa*); 4) Winter-hardy oats cv. Nora (*A. sativa*); 5) Ryegrass (*Lolium* spp.) mix that included 51.25% intermediate ryegrass cv. Tetralite and 48.24% tetraploid perennial ryegrass cv. Kentaur ; 6) Perennial ryegrass (*L.* *perenne*) mix that included 43.93% ‘Esquire’, 31.44% ‘TopHat 2’, and 22.49% ‘Tetragreen’; 7) Triticale cv. Trical 103BB (*Triticosecale* sp.); 8) Triticale cv. TriMark 099 (*Triticosecale* sp.); and 9) a generic cereal rye (*Secale* *cereale*). All cover crops were seeded at recommended rates. Untreated bare soil controls were also maintained, which represents conventional management of raspberry alleyways.

Fall 2014 soil samples were collected within rows prior to seeding and will provide baseline soil biological (microbial), physical, and chemical information. Cover crop growth will be monitored every 2-4 weeks through fall and winter. In early spring of 2015, cover crops will be mowed down. When necessary, perennial cover crops will be mowed to a height of 4-6 in throughout the season. Bare soil areas will be clean-cultivated and managed per industry standard. Soil and plant growth variables will be collected according to **Table 1**.

**Table 1. Variables and timeline of sample collection for alley cover crop in red raspberry experiment.**

zSamples will be collected and analyzed separately in alleyways and rows; bulk density, aggregate stability, and infiltration will only be monitored in alleyways; all other soil variables will be analyzed both in row and alleyway samples.

ySoil microbial populations will be monitored using Terminal Restriction Fragment Length Polymorphisms (T-RFLP).

**Anticipated Benefits and Information Transfer:**

Compatibility of alleyway cover cropping in raspberry may translate into adoption and subsequent improvements in soil quality. Improvements in biological aspects of soil quality may help mitigate soilborne diseases/pests. Benefits may also translate into financial savings on behalf of growers by reducing costs associated with conventional management of alleyways (i.e., frequent cultivation and herbicides). Results of this project will be part of a doctoral thesis, published in a peer-reviewed journal, and presented in a WSU Extension Publication. Furthermore, final results will be presented at the Washington Small Fruit Conference in Lynden and shared online at the Small Fruits Website (<http://smallfruits.cahnrs.wsu.edu/>).

**References:**

Bowen, P. and S. Freyman. 1995. Ground covers affect raspberry yield, photosynthesis, and nitrogen nutrition of

primocanes. HortScience 30(2):238-241.

Clark, A. 2012. Managing cover crops profitably. 3rd ed. SARE, College Park, MD.

Forge, T.A., R.E Ingham, D. Kaufman, and J.N. Pinkerton. 2000. Population growth of *Pratylenchus penetrans* on

winter cover crops grown in the Pacific Northwest. J. Nematol. 32(1):42-51.

Funt, R.C. and H.K. Hall. 2013. Raspberries. CAB International, Oxfordshire, UK.

Mazzola, M. and Y. Gu. 2002. Wheat genotype-specific induction of soil microbial communities suppressive to

disease incited by Rhizoctonia solani Anastomosis Group (AG)-5 and AG-8. Phytopathology 92(12):1300-1307.

Pacific Northwest Extension. 2007. Commercial red raspberry production in the Pacific Northwest. PNW 598.

Sanderson, K.R. and J.A. Cutcliffe. 1988. Effect of inter-row soil management on growth and yield of red raspberry.

Can. J. Plant Sci. 68:283-285.

Washington Red Raspberry Commission (WRRC). 2013. 2013 Production Statistics. Accessed on 8 Oct. 2014 at:

<http://www.red-raspberry.org/statistics.asp>.

Zebarth, B.J., S. Freyman, and C.G. Kowalenko. 1993. Effect of ground covers and tillage between raspberry rows

on selected soil physical and chemical parameters and crop response. Can. J. Soil Sci. 73:481-488.

**Budget:** *Indirect or overhead costs are not allowed* unless specifically authorized by the Board

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|  | **2015** | **2016** |
| **Salaries1/** | $ | $ |
| **Time-Slip2/** | $3,200 | $3,328 |
| **Operations (goods & services)3/** | $4,150 | $4,150 |
| **Travel4/** | $493 | $493 |
| **Meetings** | $ | $ |
| **Other** | $ | $ |
| **Equipment5/** | $ | $ |
| **Benefits6/** | $314 | $326 |
| **Total** | **$8,157** | **$8,297** |

# **Budget Justification**

2/Time-slip for two months of graduate student summer work at $10/hr in 2015 & $10.40/hr in 2016.

3/Funds for soil quality evaluations, including chemical and biological analyses, which will cover cost of reagents, soil DNA isolation kits, primers, gels, sequencing, etc. (disposables).; figures based on 360 total samples (including running T-RFLP samples in triplicate) from fall 2014, spring 2015, fall 2015, and spring 2016 with an estimated $23 per sample for both chemical and biological analyses; amount also includes cost of cover crop seeds for treatments.

4/Travel funds for commuting from Mount Vernon, WA, to field site in Lynden, WA approximately ten times in 2015 and 2016 (88 mi/roundtrip at 0.56 cents/mi).

6/Benefits for a part-time student is 9.8%.