PROJECT NO: New

TITLE: Fungal and Oomycete Soil-Borne Diseases of Cereals in Idaho: Causal Agents, Relative Importance and Disease Management Tools

PERSONNEL: James Woodhall, Kurtis Schroeder and Juliet Marshall

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JUSTIFICATION: Throughout the PNW, rotations are limited and concentrated in cereal production, especially under dryland and rainfed production conditions. Several soil-borne diseases constrain yield including various strains of *Rhizoctonia, Pythium* species, the eyespot species: *Oculimacula yallundae* and *O. acuformis* and the take-all pathogen: *Gaeumannomyces graminis* var. *tritici.* Presently there is little to no resistance germplasm available for *Rhizoctonia* and *Pythium* species and we have no knowledge of relative incidence of the major pathogen groups present in Idaho. Therefore, knowledge of the relative importance of the individual pathogen species will be invaluable in developing effective disease management strategies.

This project will aim to determine the main disease causing agents in cereal production throughout Idaho. Since cropping practices and climate can radically differ over the state, this approach will enable us to gain a unique understanding of the various factors influencing the relative incidence and impact of the pathogen species present. The project will consider all potential soil-borne diseases of wheat and barley initially, and later developing targeted disease management strategies including both chemical and various cultural approaches. Molecular tools will be used throughout the project, in particular TaqMan PCR, for determining the DNA levels of the various pathogens in bulk soil samples. This will be used to study the epidemiology and population dynamics of the various pathogens. However, if effective data on inoculum thresholds and disease development is generated in this project, we will develop predictive diagnostic assays for testing soil and determining disease risk pre-planting. In Australia, this is routinely done in cereal production for take-all, cereal cyst nematode and *Rhizoctonia solani* through the service called PredictaB (Ophel-Keller et al., 2008).

HYPOTHESIS & OBJECTIVES: The hypothesis is that soil-borne diseases are causing a yield constraint on cereal production in Idaho. The project will investigate the casual agents, population dynamics in soil, disease development *in planta* and develop predictive diagnostic methods for determining risk prior to planting. Disease management methods will be prescribed from crop rotation, cultural control methods and chemical control options.

PROCEDURES:

1. Determine the prevalence of the individual types of soil borne diseases in cereal cropping systems in Idaho. At least 30 commercial cereal fields each year over three years will be surveyed for the presence of *Rhizoctonia* and *Pythium* and where relevant, other soil borne diseases (eyespot and take-all). In addition, research fields at four University of Idaho R&E Centers will be surveyed. From each field a soil sample will be taken pre-planting as well as plant samples in spring. Soil will be tested for the presence of pathogens using qPCR from bulk soils samples (250 g). Spring plant samples will be analyzed using isolation and qPCR techniques. Isolates will be identified using both real-time PCR and DNA sequencing where appropriate.
2. Determine relative importance and inoculum thresholds for individual pathogens. From the predominant groups identified in objective 1, controlled environment and field trials will be

undertaken to determine the relative importance of each pathogen to cereal production in Idaho. These trials will determine relative yield and quality losses and investigate the inoculum threshold required for disease to occur. The effect of variety, temperature and moisture will also be investigated.

3. Providing disease management and risk prediction tools for growers. A range of cultural and chemical control methods, and the effectiveness of qPCR assays for testing soils pre-planting as a predictor of risk will be investigated in the project. From the soil surveys and qPCR results in objective 1, data on the effectiveness of various crop rotations can be analyzed.

DURATION: 4 years.

COOPERATION: The project leader (James Woodhall) and a student will be primarily based at Parma where the qPCR testing and DNA sequencing will take place. Kurtis Schroeder and Juliet Marshall will also be on the student's committee. It is expected that the student will spend time in Moscow and Aberdeen to undertake the relevant survey work for those areas of Idaho. The project team ensures all parts of Idaho can be considered in this project.

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER: The project is expected to inform us of the key soil-borne pathogens in Idaho cereal production systems. Knowledge of the key pathogens present will enable adequate disease management measures to be developed targeting these pathogens in the latter half of the project. These disease management strategies will include chemical (and biopesticide) for the key pathogens and crop rotation strategies. In addition, qPCR assays and a decision support system for managing soil-borne diseases will be developed.

LITERATURE REVIEW: Soil-borne diseases are capable of causing significant losses. Previous research in eastern Idaho documented the occurrence of several soil-borne pathogens, including Fusarium dryland foot rot (Strausbaugh and Windes, 2004), Cereal Cyst nematodes (Smiley, 2009), and Bipolaris crown rot (*B. sorokiniana*) (Strausbaugh and Koehn, 2004). While *Pythium* and *Rhizoctonia* occur, their distribution and frequency of occurrence is not well documented in southern Idaho, but have been more thoroughly investigated by Schroeder and others in the Palouse region (Paulitz et al, 2010; Schroeder et al., 2013; Mohd Jaaffar et al., 2016).

For take-all, total crop loss is possible, with losses of 20% even with few visible symptoms. Severe eyespot infection can reduce yields by up to 15% (Ray et al., 2006). In the UK over five seasons, *Rhizoctonia* infection resulted in losses of up to 26% with severe infections (Clarkson and Cook, 1983), and 14% yield losses were observed in New Zealand (Cromey et al., 2002). In China, sharp eyespot is regarded as serious threat to wheat production with losses estimated at over one billion Yuan from 2005 to 2008 (Chen et al., 2008). In Australia, yield losses of 25% or more have been observed (MacNish and Neate, 1996). In Australia, *R. solani* AG-8 is one of the main soil-borne diseases in wheat. This pathogen, as well as take-all and cereal cyst nematode is tested routinely in Australian cereal fields as part of a pre-planting soil testing service based on PCR detection called Predicta B (Ophel-Keller et al., 2008).

The complexity of *Rhizoctonia* presents an additional problem, since it is broken down into multiple strains called Anastomosis Groups (AGs), many of which can have vastly different impacts on the plant. Essentially, Rhizoctonia strains are divided into binucleate *Rhizoctonia* (BNR) designated AG-A to AG-U and the multinucleate *Rhizoctonia solani* designated AG1 to AG13. Multiple subgroups can exist within the AGs and typically a subgroup is associated with a particular crop. For cereals, numerous AGs of *Rhizoctonia* have been implicated in disease; the binucleate *Rhizoctonia cerealis* (AG-D) which causes the sharp eyespot symptom on stem bases is arguably one of the most important *Rhizoctonia* species affecting stems, although strains such as AG-5 (Woodhall et al., 2012) and AG-4 have also been found. Interestingly in 2017, a *Rhizoctonia solani* AG-4 isolate was recovered from wheat showing eyespot symptoms in southwest Idaho which resulted in considerable yield losses from early maturity and whiteheads (Parma Diagnostic Lab, 2017). Some *Rhizoctonia* strains such as AG-8 and AG-2-1 can cause root rots. However, there is little data for *Rhizoctonia* in southern Idaho. A previous survey only considered northern Idaho (Ogoshi et al., 1990) where they found AG-8 was predominant with AG-4 also present. More recent work has also shown the importance of *Rhizoctonia oryzae* (Okubara et al., 2014) in the Pacific Northwest. We also have no data on the relative incidence of *Pythium* species present in Idaho cereal crops. In 2016, a mefenoxam resistant isolate of *Pythium ultimum* was found causing disease in barley in southern Idaho (Dangi et al., 2016). This species is widely found in potatoes and this crop in rotation could increase the inoculum pressure in subsequent cereal crops, as well as the presence of fungicide resistant isolates.

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IDAHO WHEAT COMMISSION - BUDGET FORM

Principal Investigator: James Woodhall

Allocated by	Idaho Wheat Commission	during FY 2017	$
Allocated by	Idaho Wheat Commission	during FY 2018	$

REQUESTED FY2019 SUPPORT:

	Salary (*staff, post-docs, etc.*)	Temporary Help	Fringe	Travel	OE	Graduate Tuition/Fees	TOTALS
Idaho Wheat Commission	$ 4,500	$ 4,500	$ 1,584	$ 2,400	$ 2,800	$ 2,216	$ 18,000

TOTAL BUDGET REQUEST FOR FY 2019: $ 18,000

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

	James Woodhall	*Juliet Marshall*	*Kurt Schroeder*	*(Insert CO-PI Name)*
Salary	$ 4,500	$ -	$ -	$ -
Temporary Help	$ 3,000	$ 750	$ 750	$ -
Fringe Benefits	$ 1,092	$ 246	$ 246	$ -
Travel	$ 800	$ 800	$ 800	$ -
Operating Expenses	$ 2,800	$ -	$ -	$ -
Graduate Student Tuition/Fees	$ 2,216	$ -	$ -	$ -
TOTALS	$ 14,408	$ 1,796	$ 1,796	$ -

Total Sub-budgets $ 18,000

Explanatory Comments: (see FY2019 RFP for definition)

Fall 2017 Version