

**2012 PROPOSAL FOR COLORADO POTATO ADMINISTRATIVE COMMITTEE,
AREA II**

TITLE: Rotational Crop Options for Columbia Root-Knot Nematode and for Powdery Scab Management in San Luis Valley Potato Cropping Systems

FUNDING SOURCE: CPAC

INVESTIGATORS:

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NATURE, SCOPE AND OBJECTIVES OF PROPOSED RESEARCH:

Planting of multi-species cover, green manure, hay and forage crops for use in potato rotations have increased greatly among farmers in the San Luis Valley. Primary concerns in moving to multi-species crop mixes include improved pest management, potential water savings over traditional rotational crops, and improvement of soil health. Columbia Root-Knot Nematode (*Meloidogyne chitwoodi*, CRKN) and Powdery Scab (*Spongospora subterranean*) are established pests for many farmers in the San Luis Valley. The potential for economic damage to potato crops from either CRKN infection or from Powdery Scab infection is substantial where pest populations are not kept in check, with consequences ranging from exclusion from premium markets with zero-tolerance standards for infection, to the near total loss of marketable crops from physical tuber damage. Selection and management of rotational crops have proven effective for reducing CRKN in preparation for potato plantings. Trials on biofumigant crops preceding potatoes have also indicated the potential for specific crop types to reduce Powdery Scab inoculum. Greater than 50 different crop types, and many more cultivars of each, are on offer by seed suppliers to the San Luis Valley, for use by potato growers as rotational options. Little data concerning CRKN and Powdery Scab host status for these crop types and cultivars exists. Determining the host status and biofumigant potential of crop types and cultivars included in rotations with potatoes is critical for the continued suppression of CRKN, as multi-species seedings of crops become more common in the San Luis Valley. Research is sparse on

the CRKN host status of commonly grown cultivars of rotational cash crops and of novel grain, cover, green manure, hay and forage crops and cultivars, creating opportunity for study in this area. Investigation of Powdery Scab management through crop rotation is also in its initial phases. This research program proposes to begin establishing the CRKN host status, and the biofumigant potential of currently available rotational crops and cultivars for suppression of CRKN and of Powdery Scab. Future planting and management decisions for improved soil health, potato crop growth, and potato quality will be informed by the results of this research. The study will track crop growth and biomass accumulation through the season relative to plant population, water use, soil fertility and weather conditions, to establish baseline data for the studied crops and cultivars. This project will be a cooperative effort between Oregon State University Nematology Lab and Agro Engineering, Inc. Oregon State University will be responsible for all nematology lab work and greenhouse trials, and Agro Engineering, Inc. will perform the field trialing and coordinate all other analyses through established lab cooperators.

OBJECTIVES:

1. Evaluate rotational crops and cultivars available to San Luis Valley potato farmers for CRKN host status. Evaluate rotational crop growth effects on Powdery Scab inoculum levels.
2. Measure crop biomass relative to plant population, water use, soil fertility and weather conditions through the growing season on different rotational crops and cultivars available to San Luis Valley potato farmers. Measure in-season effects of rotational crop and cultivar choice on soil health.
3. Evaluate crops and cultivars available to San Luis Valley potato farmers for biofumigation potential against CRKN and Powdery Scab.
4. Inform San Luis Valley potato farmers of the utilization of specific crops and cultivars for use in managing CRKN and Powdery scab populations through rotational crops and mixes, and the resources required to produce the same.

JUSTIFICATION, METHODS, PROCEDURES AND FACILITIES (BY OBJECTIVE)

Objective 1: Evaluate rotational crops and cultivars available to San Luis Valley potato farmers for CRKN host status. Evaluate rotational crop growth effects on Powdery Scab inoculum levels.

Justification: Trials have documented distinct CRKN host status between crops and between cultivars within crop types, ranging from non-host status (allowing for decreased CRKN populations) to exceptional host status (causing CRKN populations to boom in the presence of the host). Establishing CRKN host status through use of pot trials and field trials will provide growers with a relative host ranking of commonly used rotation crops and cultivars, and of novel ones which may be planted alone or in multi-species mixes as cash, cover, or green manure crops. This will permit growers to make an informed choice when selecting cultivars as to the relative effect a cultivar may have on CRKN densities. Literature on rotational crops has also indicated the potential for specific crop types to reduce Powdery Scab inoculum present in soil.

As Powdery Scab is very challenging to culture for pot trial studies, only field trials will be used to rate relative host status of the different crop types and cultivars.

Procedures: Crops to Be Evaluated

Crop - Cultivar	Common Crop in SLV	Short-Water Potential	High Biofum/Non-Host Potential
1. Barley – Moravian AC-69	x		
2. Barley – Scarlet	x		
3. Wheat – IdaMax HWS	x		
4. Wheat - Centennial SWS	x		
5. Winter Cereal Rye – vns	x	x	
6. Triticale – Spring Variety	x		
7. Forage Oats - Monida	x	x	
8. Pearl Millet - Hybrid Pearl		x	
9. Oilseed Radish – Defender			x
10. Daikon Radish – Nitro		x	
11. Ethiopian Cabbage - PGG cv.		x	x
12. Forage Turnip – Purple Top type	x	x	
13. Turnip Hybrid - Winfred		x	
14. Chickling Vetch – AC Greenfix		x	x
15. Spring Forage Pea – ‘4010’	x	x	
16. Field Pea - Austrian	x		
17. Yellow Sweet Clover - vns	x	x	
18. Polyculture Mix with Terra Nova	x	x	x
19. Polyculture Mix with Sordan 79	x	x	x
20. Wheat – Stevens SWW	well-studied, included for comparison purposes		

Pot Trials – Seeds of plants to be tested will be planted into seedling trays and allowed to germinate and grow. When seedlings are three-weeks-old they will be transplanted into pots containing 2,000 g sandy-loam greenhouse potting mix and inoculated with 5,000 eggs of CRKN. Cultivars evaluated will be placed on a greenhouse bench in a randomized block design with five replications. At 55 days after inoculation, plants will be harvested and the roots gently washed free of soil. Roots will be cut into 2- to 4-cm pieces and shaken for three minutes in 0.5% sodium hypochlorite (bleach). The bleach solution will be poured through a fine mesh screen to collect the eggs which will be rinsed into a counting dish and counted under a stereomicroscope. The Reproductive Factor (R_f) will be calculated for each plant by dividing the number of eggs recovered at harvest (P_f) by the number of eggs in the inoculum ($P_i = 5,000$). The Reproductive Factor from different cultivars will be analyzed by Kruskal-Wallis (SAS 9.2).

Field Trials – The cooperating farmer will make available a portion of a field in rotation with potatoes, with a known history of CRKN, to be divided into plots of 18' x 20', and sampled for CRKN and Powdery Scab prior to planting. For all field trial sampling, 30 cores of 0-12" depth will be taken from the central 10' x 10' portion of each plot, with samples mixed and then split for CRKN, Powdery Scab and fertility analysis. The majority of plots will contain monoculture crop and/or cultivar plantings, along with a limited number of polyculture blends to be evaluated during this initial year of the project. Plots will be arranged in a randomized block design with five replications. Planting will be done using a broadcast seeder, with incorporation directly following. High seed rates for each crop and cultivar will be used to limit effects of weed competition. At the end of the crop cycle for the treatments soil samples will be taken to determine CRKN and Powdery Scab levels, in response to the growth of the crop.

Objective 2: Measure crop biomass relative to plant population, water use, soil fertility and weather conditions through the growing season on different rotational crops and cultivars available to San Luis Valley potato farmers. Measure in-season effects of rotational crop and cultivar choice on soil health.

Justification: Many of the crops and cultivars to be evaluated are new to San Luis Valley potato rotations, leaving in question the productivity and resource demands of each. Tracking incremental crop development relative to seeding rate, plant population, water use, soil fertility and temperature is necessary to evaluate the resource requirement for these crops. Previous trials have documented significant changes in soil tilth following one season of cover cropping. Changes in water infiltration rates, aggregate stability, and earthworm activity will be used as measures of soil health status in response to rotational crop type and cultivar grown.

Procedures: Using the field trial area described in Objective 1, measurement and record of soil health indicators to include earthworm activity, water infiltration rate, aggregate stability, soil fertility and soil moisture will be made pre-plant, and again prior to crop incorporation. Measures of seeding rate, established plant density, and temperatures during planting and establishment period will be made. Aboveground biomass measurements will be taken from plots incrementally throughout the growing season, to track biomass relative to water, soil fertility, seed rate and degree day accumulation. Relative feed value of aboveground biomass will be analyzed prior to incorporation of treatments.

Objective 3: Evaluate crops and cultivars available to San Luis Valley potato farmers for biofumigation potential against CRKN and Powdery Scab.

Justification: Trials have documented varied responses of CRKN populations to incorporation of aboveground biomass based on crop and cultivar. Using the field trials described in Objective 1, aboveground biomass will be mowed and incorporated, with CRKN and Powdery Scab populations to be evaluated following incorporation. Testing following incorporation will help distinguish potential biofumigant effects on established populations, differentiating host status from biofumigant effects. This is significant for farms considering haying/ensiling of rotational crop, windrow grazing of cover crops, or reducing tillage of crop residues between potato plantings.

Procedures: Field Trials – same location as described in Objective 1 - with incorporation to be done using flail mowing and discing immediately following. Sampling will occur two to four weeks following incorporation of aboveground biomass to determine effect on CRKN and on Powdery Scab levels in soils. The soil health indicators measured in Objective 2 will be repeated following crop biomass incorporation, to distinguish tillage effects on these factors. Those crops and cultivars which appear to have biofumigation potential will be evaluated in more detail using pot trials in years to come.

Objective 4: Inform San Luis Valley potato farmers of the utilization of specific crops and cultivars for use in managing CRKN and Powdery scab populations through rotational crops and mixes, and the resources required to produce the same.

Justification: Relating the findings of this study to potato farmers of the San Luis Valley will allow for improved decision making regarding rotational crop selection and use. This information will be made available to CPAC during the winter following the study period in time to inform farm plans for the following planting season.

Procedures: Data collected from pot trials and field trials in Objectives 1 – 3 will be analyzed statistically and findings from the study summarized into reports and presented to CPAC and San Luis Valley farmers.

ENHANCEMENT OF COMPETITIVENESS OF COLORADO POTATO GROWERS

Development of low cost and reduced pesticide-intensive measures for nematode and powdery scab control are required to maintain Colorado's competitive advantage relative to other potato growing regions. Research in pest management, to avoid buildup of CRKN and of Powdery Scab, while allowing maximum economic return to farms through crop rotation options, is critical for the long-term viability of the state's potato producers. Information currently available from research on alternate crops for their CRKN host and biofumigant status is very limited. This lack of information also limits the options Colorado potato farmers have for making informed decisions to minimize risk, maximize economic returns, and build soil health.

EXTENSION-OUTREACH PLAN

The cooperating investigators will work together to form recommendations for the most effective and economical use of alternative crops and cultivars, relative to CRKN and Powdery Scab control, and the resource investment required. Findings from this study will be communicated to potato growers at the 2013 Southern Rocky Mountain Agricultural Conference. These results and recommendations will be made available to CPAC for communication to its membership electronically, as well.

POTENTIAL OF PROPOSED RESEARCH TO OBTAIN FURTHER FUNDING

Demand for more diverse rotational crop options for the San Luis Valley has given additional incentive for seed suppliers to provide crops and cultivars best suited to local potato rotations. The number of crop types and cultivars proposed for evaluation through this study is not exhaustive, but is a starting point for this line of inquiry. Additional crop types and cultivars beyond those already listed in this proposal will be included in this trial, provided seed suppliers fund the cost of these additions. Rio Grande Commodities, Colorado Seed, Wilbur Ellis, Farm Service Center, Monte Vista COOP, Green Cover Seeds and other prospective suppliers of alternative crop seeds will be contacted for additional entries and funding, following review of this proposal by the Research Advisory Committee.

TIMELINE AND OUTCOMES

All fieldwork associated with these trials will be completed by fall of 2012. Funding for additional measurements of changes in soil health into the following crop season, resulting from 2012 field trial treatments, will be addressed in our 2013 proposal. Continued screening of cultivars and crop types for CRKN and Powdery Scab host status will also be addressed in our future proposals. The immediate (1-year) outcome of this study will be to better inform crop rotation decisions for the 2013 planting season. Longer-term (3-5 year) outcomes from the research completed in 2012 will include reduced dependence on costly and hazardous chemical controls of CRKN and Powdery Scab, increased potato market value due to exceptional quality, reduced water use from alternative rotational crop planting, increased crop diversity, and greater rotation opportunities for potato farmers.

BUDGET AND JUSTIFICATION

Objective	Description	Rate Per Entry (=5 replicates)	Flat Rate	Expense Category			Expense Amounts		
				Lab Fees	Labor	Equipment	Lab Fees	Labor	Equipment
Objective 1	Pot Trials	\$545		100%			\$10,900		
	Field Trials								
	Field Prep & Incorporation		\$100			100%			\$100
	Seeder		\$50			100%			\$50
	Plot Layout		\$100		100%			\$100	
	Planting		\$400		100%			\$400	
	Pre-Plant Nema/P. Scab Tests	\$375		93%	7%		\$6,975	\$525	
	End-Of-Crop Nema/P. Scab Tests	\$375		93%	7%		\$6,975	\$525	
	objective totals:	\$1,295	\$650						
Objective 2									
	Field Trials								
	Preplant Soil Health Tests	\$188		50%	50%		\$1,875	\$1,875	
	Biomass	\$125			100%			\$2,500	
	End-Of-Crop Soil Health Tests	\$300		71%	29%		\$4,260	\$1,740	
	objective totals:	\$613							
Objective 3									
	Field Trials								
	Post-Incorp Soil Health	\$175		50%	50%		\$1,750	\$1,750	
	Post-Incorp Nema/P. Scab Tests	\$375		71%	29%		\$5,325	\$2,175	
	Flailing & Tillage		\$150			100%			\$150
	objective totals:	\$550	\$150						
Objective 4									
	Data Analysis Stats., Communicate Findings		\$3,000		100%			\$3,000	
	objective totals:		\$3,000						
				Category Totals:			\$38,060	\$14,590	\$300
				Percent of Budget:			72%	28%	1%
				Expense Category:			Lab Fees	Labor	Equipment
To Complete All Objectives									
	Number of Entries	20							
	Flat Fees	\$3,800							
	Per Entry Fees	\$2,458							
	Total Cost Per Entry	\$2,648							
	Total Cost	\$52,950							
Note: Total Cost Estimate Based on 20 crop & cultivar entries, but can be adjusted based on funding available									