AGRICULTURAL EXPERIMENT STATION
SAN LUIS VALLEY RESEARCH CENTER
2005 PROPOSAL TO CPAC FOR POTATO RESEARCH

Title: ***Bio-fumigation Cover Crops to Enhance Potato Production***

Investigators: Merlin Dillon, Area Extension Agronomist
With technical support and advice from Russ Ingham, Nematologist, Oregon State University, Corvallis, OR

Nature and Objectives:

Over the past several years, Columbia Root-knot nematode (CRKN) began to cause serious damage to potatoes in Colorado's San Luis Valley. Warm seasons may have exacerbated the problem by allowing more generations. Some growers have lost sales from an entire circle of potatoes. Their investment in this crop might be $175,000 per center pivot with no return income. CRKN has caused severe and unsustainable losses to SLV potato growers.

CRKN may be controlled fairly well by either of two methods, neither of which growers seem to like. Fumigation with Telone is very expensive ($180/acre) and may have some deleterious side effects. Telone kills almost every living thing in the soil. So, it does provide some weed control. Since Telone kills good and bad soil microbes, damaging microbes such as CRKN or pink rot or some other disease-causing organism may come back more quickly than the beneficial microbes that help with their control.

Growers severely dislike handling Vydate. This pesticide is applied through chemigation and stops nematodes from feeding. Therefore, nematode levels are not reduced after using Vydate, but the crop can be grown without nematode damage.

Early dying disease is a disease complex between *Verticillium* and lesion nematodes. Early dying has been a persistent problem for potato growers for a long time. Neither pest is very damaging by itself, but when both are present, they do cause damage known as early dying. Early dying complex reduces yields because the potatoes stop growing prematurely and this disease complex causes some loss in almost every SLV potato crop. Though not the focus of this research, it is important to find if cover crops grown to reduce CRKN would also reduce *Verticillium* and lesion nematodes.

A persistent drought has combined with other factors to reduce irrigation well output. Growers must find ways to reduce irrigation water use. Bio-fumigation cover crops may be grown with about half as much water as barley or potatoes. Combining the need to reduce water use and the need to find a better way to address CRKN, bio-fumigation cover crops may address both needs.

Methods, Procedures and Facilities:

Methods: This project will be conducted on a farmer cooperator field known to have high levels of CRKN. First, one-half of a center pivot circle (60 acres) will be sampled on a 2 – 2.5 acre grid to determine the field area with highest nematode level. Small plots will be established and sampled to determine initial nematode levels. Plots will be assigned based on initial nematode analysis and assignment will try to level the initial nematode levels. The various cover crop treatments will be planted in plots 12' x 40'. Because of the high field variability of nematodes, five replications will be used.

Procedures: Nematodes (CRKN), lesion nematodes and *verticillium* will be monitored before and after the cover crop is grown to find the effect of growing cover crops and residue incorporation. Ending samples will be at 2006 potato planting.

2005 Treatments:

1. **Wet Fallow**
2. **Mustard (Caliente 119)**
3. **Hot Mustard (Pacific Gold)**
4. **Canola**
5. **Sorghum-sudan (split into incorporated vs. non-incorporated(6))**
7. **Sorghum-sudan hay (split into stubble incorporated vs. no-till(8))**
9. **Pine bark**

Facilities: No equipment purchases are necessary to carry out this project. This project will require a small tractor and plot planter available at SLV Research Center (small grains project). A swather from the alfalfa project will be used to remove sorghum-sudan hay. A pickup mounted soil probe from USDA-NRCS in San Luis will be used for soil sampling.

Relationship of Proposed Research to Overall Problem:

Controlling nematodes by fumigation or averting damage by in-season application of Vydate are not very satisfactory options for potato growers. Fumigation is very expensive and Vydate is caustic to the applicator. Another more environmentally friendly practice is desparately needed. Potato growers could grow a cover crop and at the same time reduce irrigation water use compared to other rotation crops. Finding the best choice bio-fumigation cover crop would reduce the need to use these expensive chemical pesticides.

A hotter, more peppery mustard will be an added treatment this year. A hotter mustard may produce more isothiocyanates in the soil and correspondingly more pest control. Splitting the sorghum-sudan plots will give different amounts of crop residue in the soil. Sorghum-sudan incorporated will put the most residue into the soil. Compare this with the same crop residue on the surface (non-incorporated). This treatment provides the most protection from wind erosion. Similarly, the sorghum-sudan plots with hay removed provide only 3-4 inches of stubble plus root material incorporated. This no-till sudan hay treatment will provide income plus provide some stubble for wind erosion control. Finding a cover crop treatment that a)reduces potato pests, b) reduces irrigation, c) provides some crop income, and d) protects soil from wind erosion would be a real benefit.

Potential for Leveraging Outside Funding:

A proposal was submitted to USDA CSREES (Plant Health) for a 2-year, $62,000 project. Although this project was not funded this year, it will be revamped and resubmitted next year. If successful, this would bring $9 for each dollar invested by CPAC. The project will also be submitted to USDA SARE since it seems to fit nicely with their objectives to reduce pesticide use and produce crops in a more sustainable manner. USDA-SARE projects require local matching funds such as these.

Ag Research Service, Ft. Collins, will conduct additional research on these very same plots. Soil microbes will be analyzed by DNA analysis (Daniel Manter, USDA-ARS, Ft. Collins). This will begin to show the effect of bio-fumigation cover crops on beneficial and destructive soil microbes. And, Jorge Delgado will conduct research to find the effect of cover crops on nutrient cycling. Cover crops might improve phosphorus or micronutrient uptake and, therefore, provide additional benefits to growers using these bio-fumigation cover crops.

Time Line for Proposed Research:

- This project is ongoing. Final nematode samples for the 2004 project will be at potato planting time, 2005. In another project, Russ Ingham proposes to monitor nematodes in the 2005 potato crop to find which cover crop effect would provide protection beyond planting. Continued breakdown of crop residue likely will provide soil chemicals that would protect the potatoes from CRKN nematodes, verticillium, and/or lesion nematodes.

- Cover crops will be established in June and soil incorporated in August, 2005.

- Soil samples will be taken prior to June planting, in October, and again at potato planting time in 2006.

Progress in 2004:

- Final 2003 samples (2004 potato planting) showed very good benefits for sorghum-sudan and wet fallow. Some nematode levels were not as low as the previous August (sampled dry soil). The final sample was found to be a better indicator.
- Evaluated six cover crops for bio-fumigation effects as of late October.
- Intermediate results (late October samples) indicate sorghum-sudan, sorghum-sudan for hay, and canola greatly reduced CRKN. Wet fallow, of only scientific interest, provided similar CRKN reduction.
- Canola grown and incorporated provided better immediate CRKN reduction than mustard or oil-seed radish.
- Even though intermediate results indicated much less CRKN reduction for mustard and oil-seed radish, cover crop residue breakdown may not be complete. The final sampling at potato planting may allow more residue breakdown and provide more reduction in CRKN.

Expected Accomplishments for 2005.

- Confirm benefits of sorghum-sudan cover crop and canola on CRKN, lesion nematode and *Verticillium*.
- Confirm whether sorghum-sudan hay provides as pest control benefits as good as sorghum-sudan cover crop.
- Determine whether pine bark provides CRKN, lesion nematode or *verticillium* pest control.
- Begin to determine the effect of cover crops on beneficial and pest soil microbes through DNA analysis.
- Determine the effect of different amounts of incorporated sorghum-sudan on the bio-fumigation benefits and wind erosion protection.

Funding History:

2002: $7,000
2003: $7,000
2004: $7,000

Budget for 2005:

Labor:	**$1,700**
Supplies:	**$ 300**
Shipping	**$ 400**
Soil Analysis-nematodes	**$6,500**
Soil Analysis-verticillium	**$1,000**
Total:	**$9,900**

(Reduced funding will mean reduced treatment number. Labor and nematode analyses must be funded in order to conduct the trial with all treatments).

Using Bio-fumigation Cover Crops To Reduce Potato Pests

Merlin A. Dillon, Area Extension Agent, Agronomy

Nematodes, especially Columbia Root Knot nematodes (CRKN), have become an important pest of potato in Colorado's San Luis Valley. Fumigants used preplant or application of Vydate in-season can control these pests. These chemicals, however, are very expensive and caustic. Growers are asking for alternative, less expensive pest management practices. More sustainable practices must be developed, proven and adopted which will safeguard the environment and improve the growers' quality of life.

Green manure cover crops such as mustard, oilseed radish, sorghum-sudangrass and rapeseed are used successfully in other states to reduce these pest problems. The primary objective of this CPAC Area II sponsored research has been to reduce the use of these harsh, expensive pesticides by introducing bio-fumigation cover crops. Cover crops can be grown with about half the irrigation needed for a cash crop. And, crop residues provide soil protection compared to fallow.

Methods and Results: Cover crops were grown in small plot, randomized and replicated field trials planted in 2003 and 2004. CRKN, lesion nematodes and *verticillium* levels were determined before planting and after cover crop incorporation. Final samples for 2003 were analyzed prior to potato planting in 2004. Final samples for 2004 will be analyzed prior to potato planting in 2005. Intermediate samples from October '04 are reported here.

All cover crops except barley reduced CRKN levels in 2003 (Figure 1). Barley as grown did not reduce CRKN. The barley, however, was thin, stunted, had few tillers and many weeds. Oilseed radish, mustard, and sorghum-sudan (variety Sordan 79) dramatically reduced CRKN compared to the starting levels. Counter insecticide/nematicide (Sudan +) did not reduce nematode levels more than sorghum-sudan alone.

Fig.1. Effect of Cover Crops on CRKN, 2003.

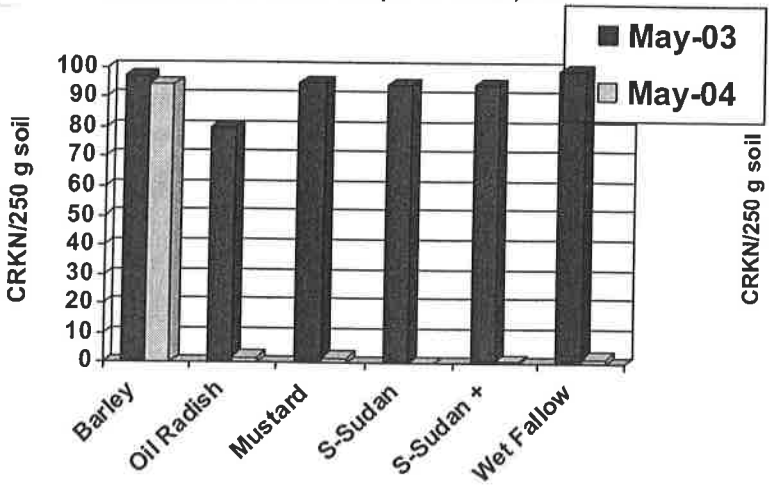
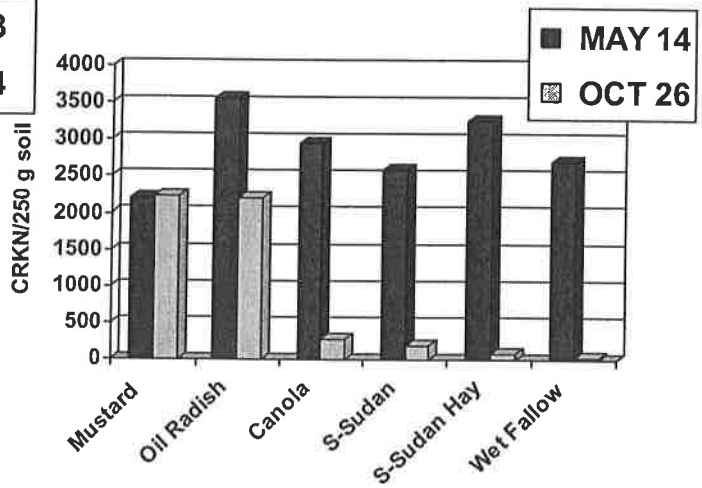


Fig. 2. Effect of Cover Crops on CRKN, 2004.



Beginning CRKN levels were much higher in 2004. Certain cover crops again reduced CRKN (Figure 2). Sorghum-sudan and wet fallow were very effective. Sorghum-sudan harvested for hay before incorporation also was effective. This treatment, if further trials concur, would provide both crop income and nematode reduction. Canola was also included in 2004 and significantly reduced CRKN nematodes. Mustard (Caliente 119) and oilseed radish were not effective; however, these cover crops depend on residue decomposition and that residue decomposition probably is not complete. Mustard and oilseed radish may show better results when the final soil samples are taken, just prior to potato planting this year.

Summary: Sorghum-sudan was a very effective bio-fumigation cover crop both years. CRKN were drastically reduced after sorghum-sudan incorporation. Canola reduced nematode levels impressively in only one year of testing. The jury is still out for mustard and oilseed radish. Final

samples at potato planting next spring will determine their effectiveness. Sampling during potato growth next season may reveal even more about the lasting benefits of these cover crops.