MANAGEMENT OF NEMATODES ON POTATO IN THE SAN LUIS VALLEY, COLORADO 2008 PROGRESS REPORT

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Symptom expression of corky ringspot in potato varieties grown in the SLV

Introduction

Corky ringspot disease (CRS) is caused by Tobacco Rattle Virus (TRV) which is vectored to potato by stubby-root nematodes (*Paratrichodorus allius* in the SLV). Symptoms occasionally include poor and/or delayed emergence and stunted stems with mottled leaves. More commonly, however, tubers display necrotic arcs, rings or diffuse brown spots of varying size and severity (Figures 1 and 2). In some cases, infected tubers may be grossly misshapen.

Different varieties of potato may express symptoms differently when infected with TRV. Symptoms may also vary with different strains of TRV. For example, Russet Norkotah has expressed extensive symptoms of CRS when grown in areas of the Columbia Basin, but was symptom-free when grown in areas of the Klamath Basin. Yukon Gold grown adjacent to the Norkotah in the Klamath Basin had extensive symptoms of CRS which confirmed the presence of TRV. If some varieties suitable to the SLV can be determined to express symptoms less than others it would represent a management option for growers that have fields that are known or suspected to be infested with TRV. This would also provide growers information on particular cultivars to avoid in TRV-infested fields.

Methods

Study design: The potato varieties listed in Tables 1-3 were planted May 13, 2008 in a field with a history of CRS in a randomized block design with 6 replications. Plots were covered with a tarp when Vydate was applied to the field by the grower. Plots were harvested September 16 and 25 tubers were collected at random from each plot for root-knot and CRS evaluation.

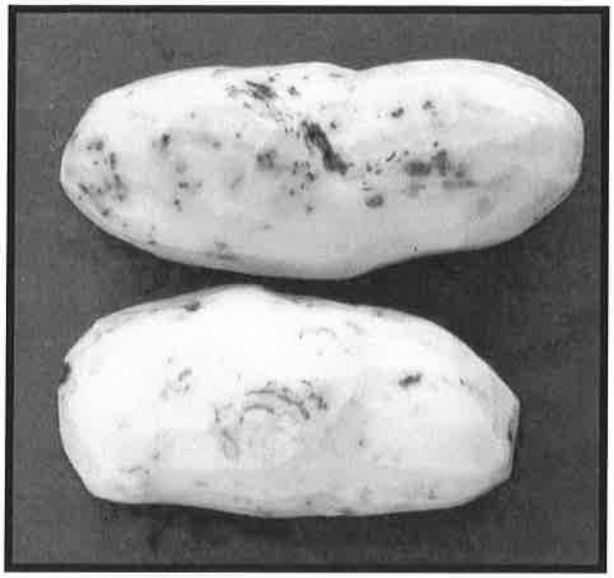

Figure 1. Diffuse brown spots and concentric arcs on the surface of peeled Canela tuber.

Figure 2. Arcs and diffuse brown spots inside a Canela tuber.

Nematode sampling: Soil samples for nematode population assessments were collected on May 13 and September 16 by taking 10 one-in-diameter cores to a depth of 12 in. from each plot Soil was mixed and nematodes were extracted from 250 g subsamples by wet sieving - density centrifugation and counted.

Tuber evaluations: Tubers were examined closely for damage from external galling due to Columbia root-knot nematode (*Meloidogyne chitwoodi*, CRKN) and then peeled by hand and the number of root-knot nematode infection sites were counted under a magnifying lamp. Infection parameters presented include percent external damage (tubers with any external symptoms), percent internal infection (any internal spots/tuber), and percent internal culls (6 or more spots/tuber). An infection index (0 = 0, 1 = 1-3, 2 = 4-5, 3 = 6-9, 4 = 10-49, 5 = 50-99, 6 = 100 or more infection sites) was used to measure infection intensity. Percentage of external culls (tubers with 10% or more of external surface blemished) was also evaluated but few tubers met these criteria and data are not presented in this report. CRS was evaluated by slicing each tuber into ½ in. transverse sections and examining the exposed internal surface for symptoms. Tubers were graded as acceptable (<5%) damage (0-1, 1/8 in. diameter or larger "spot" per 1/2 in. (2 oz) of tuber length), serious (5-10%) damage (1-2, 1/8 in. diameter or larger "spot" per 1/2 in. (2 oz) of tuber length), and culls (>10% damage) (>2, 1/8 in. diameter or larger "spot" per 1/2 in. (2 oz) of tuber length).

Statistical analysis: All percent damage data were transformed to arcsin square root (x) and evaluated by analysis of variance (ANOVA). Nematode densities were adjusted for soil moisture to convert to density/250-g dry soil and transformed to $\log_{10}(x+1)$ before analysis (ANOVA). Means of transformed values were back transformed before reporting and Duncan was used to separate means only when ANOVA was significant at $P \leq 0.05$. All differences reported are at $P \leq 0.05$ unless otherwise stated.

Results and Discussion

Nematode evaluations: At planting, populations of root-lesion (*Pratylenchus neglectus*), root-knot (*Meloidogyne chitwoodi*), and stubby-root (*Paratrichodorus allius*) nematodes across all plots averaged 150, 12 and 18/250 g dry soil, respectively (Table 1). By chance, starting populations of stubby-root nematodes were significantly higher in Yukon Gold plots than in Russet Nugget, Centennial and Canela. By harvest, root-lesion nematodes had declined to an average of 77/250 g soil and there was no difference between the varieties. Similarly, stubby-root nematodes declined to an average of 2.5/250 g soil. However, root-knot nematodes increased substantially through the season and by harvest averaged 1,300/250 g soil across all plots. Populations in Centennial plots were significantly less than in Russet Nugget and Rio Grande plots.

Table 1. Nematode populations (number/250 g dry soil) in different potato varieties tested for expression of corky-ringspot symptoms. San Luis Valley, CO – 2008.

	Root-lesion		Root-knot		Stubby-root	
Variety	At Plant[1]	Harvest[2]	At Plant	Harvest	At Plant	Harvest
Russet Norkotah	149[3]	59	9	1,175 abc	19 ab	1
Russet Nugget	161	44	23	2,480 a	16 b	4
Centennial	122	105	15	560 c	13 b	1
Rio Grande	69	67	9	1,820 ab	17 ab	3
Canela	177	72	8	935 bc	11 b	3
Yukon Gold	221	113	10	845 bc	32 a	3

[1]May 13, 2008
[2]September 16, 2008
[3]Means within the same column that are followed by the same letter are not significantly different ($P \leq 0.05$). Columns with no letters had no significant differences between means. Data were transformed before analysis and back-transformed means are presented.

CRS evaluations: Based on incidence and severity of CRS, the tested varieties could be placed into two groups with three varieties each (Table 2). Canela, Rio Grande, and Yukon Gold had high levels of CRS (30% of tubers were seriously damaged or culled) that were significantly higher than in Centennial, Russet Norkotah and Russet Nugget which had relatively low levels of CRS (<1% serious damage or culls). There was no significant differences between varieties within either group, but Rio Grande tended to have slightly less symptoms than Canela or Yukon Gold.

Table 2. Expression (% of tubers examined) of tuber symptoms of Corky Ringspot Disease in potato varieties grown in 2008. San Luis Valley, CO.

Variety	Acceptable Damage[1]	Serious Damage[2]	Culls[3]	Any CRS[4]
Russet Norkotah	97 a[5]	<1 b	<1 b	7 b
Russet Nugget	95 a	1 b	<1 b	10 b
Centennial	100 a	0 b	0 b	1 b
Rio Grande	74 b	9 a	11 a	36 a
Canela	57 b	21 a	18 a	63 a
Yukon Gold	57 b	15 a	17 a	59 a

[1]≤ 1 1/8 in. diameter or larger "spot" per 1/2 in. (2 oz) of tuber length.
[2]1-2 ≤ 1 1/8 in. diameter or larger "spots" per 1/2 in. (2 oz) of tuber length.
[3]>2 1/8 in. diameter or larger "spots" per 1/2 in. (2 oz) of tuber length.
[4]1 or more 1/8 in. diameter or larger "spots" per tuber.
[5]Means within the same column that are followed by the same letter are not significantly different ($P \leq 0.05$). Columns with no letters had no significant differences between means. Data were transformed before analysis and back-transformed means are presented.

Root-knot evaluations: External damage from root-knot nematode was relatively low and highly variable among all varieties. As a consequence 20% incidence in Russet Norkotah was not different from 0% in Canela (Table 3). Incidence of internal symptoms of root-knot infection was high in all varieties, averaging 93%. However, intensity of infection was less in Centennial which had 41% culls as opposed to Russet Norkotah, Russet Nugget and Rio Grande which had 89-90% culled tubers from root-knot nematode. Canela and Yukon Gold were intermediate. The infection index was also significantly less in Centennial than in Russet Norkotah, Russet Nugget and Rio Grande. This correlates well with root-knot population densities at harvest which were lowest in Centennial and highest in Russet Norkotah, Russet Nugget and Rio Grande.

Conclusions

It has long been known than Yukon Gold is particularly susceptible to CRS and it was used in this trial as a control to ensure TRV was present. In recent years acreage planted to Rio Grande and Canela has increased and growers have reported problems with CRS. **This research clearly showed that both Rio Grande and Canela are highly susceptible to TRV and express extensive symptoms of CRS. These varieties should be avoided in fields suspected of having TRV unless a strong management plan for stubby-root nematode is implemented.** It is currently unknown if the other three varieties in trial are resistant to TRV or just did not express symptoms. The latter would be a concern because seed could potentially carry the virus without being detected and potentially infest new fields with TRV. This should be of particular concern to growers who plant back their own seed or purchase seed that is not certified free of TRV.

The apparent indication of some resistance to Columbia root-knot nematode observed in Centennial is interesting. Although the level of infection was still unacceptable**, the fact that the percent culls from CRKN was less than half that in Norkotah suggests that root-knot nematode may be managed more easily in Centennial** which may be an appropriate choice in fields where root-knot nematodes are managed less intensively. This study needs to me repeated to confirm these results, however.

Table 3. Expression (% of tubers examined) of tuber symptoms of Columbia root-knot nematode in potato varieties grown in 2008. San Luis Valley, CO.

Variety	External Damage[1]	Internal Infection[2]	Culls[3]	Infection Index[4]
Russet Norkotah	20[5]	99	89 a	3.97 ab
Russet Nugget	14	98	90 a	3.70 abc
Centennial	<1	85	41 b	2.10 d
Rio Grande	<1	98	89 a	4.21 a
Canela	0	88	66 ab	2.85 cd
Yukon Gold	5	92	70 ab	2.95 bcd

[1]Percentage of tubers with any external symptoms of CRKN.
[2]Percentage of tubers with one or more visible internal CRKN infection sites.
[3]Percentage of tubers with six or more visible internal CRKN infection sites.
[4]A measure of infection intensity (0 = 0, 1 = 1-3, 2 = 4-5, 3 = 6-9, 4 = 10-49, 5 = 50-99, 6 = 100+ infection sites).
[5]Means within the same column that are followed by the same letter are not significantly different ($P \leq 0.05$). Columns with no letters had no significant differences between means. Data were transformed before analysis and back-transformed means are presented.

Effect of Sudan Varieties on Columbia Root-knot Nematode

Introduction
Trials have documented that sorghum-sudan cv Sordan 79 is effective at suppressing populations of Columbia root-knot nematode (*Meloidogyne chitwoodi*, CRKN) in the SLV. Honey Sweet, another sorghum-sudan hybrid available in the SLV, has not been as effective at suppressing CRKN populations. However, symptoms of CRKN in tubers grown after both cultivars were acceptable for domestic markets when tubers were evaluated at harvest. When tubers were incubated to reveal late season infection, damage was higher in tubers grown in Honey Sweet plots than after Sordan 79. Variation in the suppressiveness of different cultivars of sudan and sorghum-sudan hybrids has also been observed in the Pacific Northwest. It is important to know the reaction of CRKN to different sudan or sorghum-sudan cultivars to determine if a variety exists that is more suppressive than Sordan 79 or if there are cultivars that may actually increase CRKN and thus should be avoided in potato rotations. Furthermore, cultivars that are equal or superior to Sordan 79 need to be identified should Sordan 79 be discontinued. Very little screening of sudan cultivars for nematode suppression has been completed, however.

Procedures
Plots of four sorghum-sudangrass hybrid varieties (Sordan 79, SX17, Honey Sweet II, Honey Sweet BMR), one sudangrass hybrid (Piper), and a wet fallow control were established on June 20, 2007 in a field known to have CRKN that had been in potato in 2006. Each treatment was replicated five times in randomized block design. The rest of the field around the trial was planted to sudangrass as well. Green biomass was chopped on August 29 and incorporated into the soil with a rototiller on August 30.

Soil for nematode analyses was sampled from each plot before planting (May 8, 2007), after incorporation (September 19, 2007) of sudangrass, and after potatoes were planted (May 12, 2008) the following year. Samples consisted of ten one-inch-dia. cores to a depth of 12 in. in a zig-zag pattern down the middle of each plot. Soil was mixed and nematodes were extracted from 250 g subsamples by wet sieving and density centrifugation and counted. Nematode densities were adjusted for soil moisture to convert to density/250-g dry soil and transformed to $\log_{10}(x+1)$ before analysis (ANOVA). Means of transformed values were back transformed before reporting and Duncan was used to separate means only when ANOVA was significant at $P \leq 0.05$. R values for as a measure of reproduction were calculated for CRKN by dividing the population on September 19, 2008 by that on May 8, 2008. R values were evaluated with a Mann-Whitney test. All differences reported are at $P \leq 0.05$ unless otherwise stated.

Results and Discussion
Before planting, CRKN averaged 60/250 g soil across the trial area and starting densities for all varieties was very similar (Table 4). After incorporation, the highest densities were in the wet fallow treatment. This was surprising since wet fallow treatments have typically had low population levels of CRKN in previous studies. CRKN on the September sample date and R values were not different between varieties. However, September populations and R values for SX17, Honey Sweet II and Honey Sweet BMR were statistically lower than in wet fallow plots while Piper and Sordan 79 were not different from wet fallow. Populations in all plots declined

over the winter and were only detected in four plots in the May 12, 1008 sample. Funds were not received to sample at potato harvest or to evaluate tuber damage.

Root-lesion nematodes were at relatively low levels, averaging 43, 90 and 34/250 g soil across all treatments before planting sudangrass, after incorporation, and after planting potato, respectively (Table 5). There was no difference between treatments on any sample date. Stubby-root nematodes (SRN) were barely detectable before planting and averaged 8/250 g soil after incorporation (Table 5). This may be further indication that sudangrass may increase densities of SRN. However, SRN increased in the wet fallow treatment as well. Populations declined over the winter to an average of less than 3/250 g soil. No difference was noted between treatments but populations may have been too low for treatment differences to be measureable.

Conclusions

A complete test of CRKN suppression will require growing potatoes after these sudangrass varieties and assessing tuber damage, preferably with higher starting populations than in this trial. However, **the data from this study suggest that SX17, Honey Sweet II and Honey Sweet BMR could potentially be alternatives for Sordan 79.** This is somewhat surprising since the standard Honey Sweet variety that was used in earlier tests did not suppress CRKN as well as Sordan 79. However, there may be some differences between the different Honey Sweet varieties that may make one variety more suppressive than another.

Table 4. Columbia root-knot nematode (No./250 g soil) before and after different varieties of sudan or sorghum-sudan. San Luis Valley, CO.

Variety	May 8, 2007	Sept. 19, 2007	R value[1]	May 12, 2008
Wet Fallow	52	88 a[2]	1.16 a	1
Piper	71	37 ab	1.17 ab	0
Sordan 79	54	21 ab	0.46 ab	1
Honey Sweet BMR	66	10 b	0.25 b	0
Honey Sweet II	63	5 b	0.17 b	0
SX17	53	8 b	0.16 b	0

[1]R value = Sept. 2008 population/May, 2008 population.

[2]Means within the same column that are followed by the same letter are not significantly different ($P \leq 0.05$). Columns with no letters had no significant differences between means. Data were log transformed before analysis and back-transformed means are presented.

Table 5. Root-lesion and stubby-root nematodes (No./250 g soil) before and after different varieties of sudan or sorghum-sudan.

Variety	Root-lesion nematodes			Stubby-root-nematodes		
	May 8	Sept. 19	May 12	May 8	Sept. 19	May 12
Wet Fallow	45	89	42	0	9	5
Piper	37	122	29	<1	9	1
Sordan 79	40	120	63	<1	13	6
Honey Sweet BMR	57	77	24	<1	9	1
Honey Sweet II	49	90	17	<1	4	1
SX17	31	90	26	0	5	2

[1]Means within the same column that are followed by the same letter are not significantly different ($P \leq 0.05$). Columns with no letters had no significant differences between means. Data were log transformed before analysis and back-transformed means are presented.

Evaluate green manure cover crops for suppression of stubby-root-nematodes, corky ringspot disease and root-knot nematode.

Justification: Sudangrass green manure crops have been successful at suppressing population densities of CRKN in the San Luis Valley and are being grown extensively. Recently, however, it has been documented that sudangrass can increase stubby-root nematodes and potentially increase the severity of CRS if TRV is present in that field. Use of green manure crops is highly desirable for improving soil health, however, and should not be abandoned for suppression of CRKN. What is needed are cultivars or cultivar mixtures that may suppress CRKN and SRN, or at least not increase SRN, for use in fields with both CRKN and CRS. Studies in other areas suggest that radish may be better at suppressing SRN.

Procedures: In 2008, the following green manure crops were planted in a SLV field with CRKN, SRN and a history of CRS. This trial was in cooperation with Merlin Dillon, who was planting another green manure trial in the same field, to conserve resources.

1. Sudangrass cv Sordan 79
2. Radish cv Adios
3. Radish cv Dublet
4. Radish cv Terranova
5. Mustard cv Caliente 61
6. Sudangrass cv Sordan 79 plus Radish cv Dublet
7. Wheat

Plots were sampled the first week of April and averaged 3/250 g soil root lesion, 310/250 g soil root-knot, and 5/250 g soil stubby-root nematodes over all the plots in these treatments. This study will be completed in 2009 and a full report will be given next year's report.