RESEARCH UPDATE ON ROOT-KNOT NEMATODES OF POTATO IN THE SAN LUIS VALLEY

Russ Ingham, Professor
Nick David, Graduate Student
Department of Botany and Plant Pathology
Oregon State University
Corvallis, OR

Richard Zink
Extension Potato Specialist
San Luis Valley Research Center
Colorado State University
Center, CO

Introduction

Columbia root-knot nematode (CRKN) represents a significant threat to the profitability of potato production. These nematodes infect and develop in tubers, causing quality defects such as galling (bumps) on the surface and brown spots in the vascular tissue. These defects are unacceptable for fresh market or processing and tubers with even a low level of infection must be culled. If even a small percentage of tubers are damaged, the entire crop may be substantially devalued or rejected. Seed growers must be especially diligent so that the infestation does not spread to new areas in infected seed. While primarily considered a pest in the Pacific Northwest (Idaho, Oregon, Washington), CRKN has also been reported from California, Colorado, Nevada, New Mexico, Texas and Utah.

CRKN can be controlled by soil fumigation, particularly with Telone, which is expensive ($185+/acre), but is probably the most effective strategy for seed growers, fields with high nematode populations and/or areas with long, warm growing seasons. Vydate (oxamyl) is a nonfumigant nematicide that can be effective in suppressing CRKN damage at low densities, particularly in cooler growing areas. Vydate is cheaper than soil fumigants (less than $25/a per application), but because it breaks down rapidly in soil, repeated applications during the season are necessary. The optimum timing of applications is being refined with ongoing research, but is believed to be related to the development of the nematode population as determined from heat units, which can be predicted by tracking accumulated soil degree-days (average daily temperature – minimum temperature for nematode development, 5C or 41F) after the crop is planted. In 2001, the Colorado Potato Administrative Committee (CPAC) funded a research project to determine the population dynamics cycle of CRKN in the SLV and develop a management program for CRKN using Vydate applications based on degree-day accumulations. Dupont provided additional assistance. Results from 2001 were reported in Pomme de terre Vol. 8 No 4 June 2002. This report briefly describes results from research completed during 2002. A complete report will be printed in the proceedings for the 2004 Potato Grain Conference.

Site Selection and Experimental Design

This study was conducted in a Russet Nugget field near Blanca, CO. Initial density across the study area averaged 281 CRKN/250 g soil. Different schedules of Vydate application times (See table 1) were evaluated. Untreated plots and three treatments representing various application schedules were sampled weekly for most of the season to determine effects of Vydate C-LV on population dynamics. Samples of 25 tubers/plot were evaluated for any external or internal symptoms of nematode damage following incubation at ambient temperature for 900 DD_{5C} after harvest (January 9, 2003) and after storage in the grower's cellar (May 6, 2003). Additional sets of tuber samples were collected from treatments where population dynamics were monitored (PD Row) and evaluated at harvest and after incubation.

Nematode Population Dynamics

Densities of CRKN in soil increased slowly until June 14, presumably due to spring hatching of eggs, and then declined rapidly as nematodes in the soil invaded roots or died (figure 1). CRKN densities began to increase slowly again between July 12 (888 DD_{5C}) and July 19 (984 DD_{5C}) and then increased rapidly. This represents the hatching of the 2nd generation and the time period of initial tuber invasion by CRKN. Numbers continued to rise until September 6 (1,558 DD_{5C}), after which, populations increased at a much faster rate, suggesting the hatching of the 3rd generation. Peak densities on September 13 (1,632 DD_{5C}) were nearly 23-fold higher than populations at planting. After vine-kill, populations declined rapidly, reaching 30% of peak densities by harvest. **This suggests that the optimum time to sample**

for CRKN that may be present in a current season potato crop would be immediately after vine-kill.

Effect of Vydate C-LV Treatments on Population Dynamics

In furrow applications of Vydate C-LV delayed hatch of the 2nd generation and populations increased less than in the same treatment without an in furrow application. Banded application at hilling had no lasting impact on populations. Chemigation applications at 888 DD_{5C}, two weeks later and four weeks later did not delay initiation of the hatch of the second generation, but substantially suppressed the number hatching after mid-August. In addition, there was little increase in these treatments at the time of the 3rd generation hatch in untreated plots. At the time of peak density in untreated plots, populations in all treated plots averaged 84% less. **However, while Vydate suppressed nematode population growth, it did not <u>reduce</u> nematode populations, as densities at harvest were much higher than at planting.**

Effect of Vydate C-LV Treatments on Suppression of Nematode Tuber Damage

For **fresh market production**, external damage from stored samples is probably the most appropriate evaluation to assess treatment performance. However, while 38% of tubers from untreated plots had external damage, all but one Vydate treatment had little to no external damage. Therefore, internal infection after incubation was used to determine the relative performance of the different application times. None of the treatments that had applications at hilling were better than comparable treatments without this application. Similarly, comparable treatments with and without applications at hooking demonstrated no or marginal improvement with the application at hooking. This suggests that the applications at hilling or hooking may be ineffective for suppression of damage from CRKN. These treatments may have been ineffective because the CRKN is less susceptible to Vydate at this stage in its life cycle, or because these applications were sprayed on the surface and then incorporated by irrigation later. Delivery of Vydate through chemigation on these dates may have been more effective. In contrast, all treatments with in furrow applications had markedly less infection than comparable treatments without an in furrow treatment. **Therefore, these data suggest that, for control of CRKN, it would be better to spend the money on an in furrow application than on applications at hilling or hooking**. Applications at these times may be necessary to control corky ringspot, however. Treatments with an in furrow application plus one, two, or three additional chemigation applications starting at 900 DD_{5C} had 56%, 21% and 7% infection, respectively, after incubation, demonstrating the value of chemigation applications at these times. Overall, the best strategy may be to apply Vydate C-LV in furrow and at 900 DD_{5C} with additional later applications depending on initial densities and/or the warmth of the growing season.

For **seed production**, presence of any internal infection sites after incubation is the most critical evaluation to determine if treatments are keeping nematodes out of tubers. In this case, only one of the treatments with five applications of Vydate C-LV had less than 1% of infected tubers. However, even 0.6% infected seed tubers would result in a large number of potential infestation sites when planted.

Effect of Cold Storage and Warm Incubation on Tuber Symptoms

It took 35 days for the cellar to reach a temperature (5C, 41F) below which CRKN can no longer develop. During this period, nematodes in tubers collected an additional 135 degree-days. However, during transport and evaluation, "harvest" sample tubers collected an additional 115 degree-days, so there was little difference in total degree-day accumulation between harvest (1,905 DD_{5C}) and storage (1,925 DD_{5C}) samples. Nevertheless, untreated plots appeared to have a slightly higher percentage of tubers with external and internal symptoms of nematode damage in stored samples than in samples evaluated after harvest. **In any case, there was no increase in symptom severity during storage for any of the three**

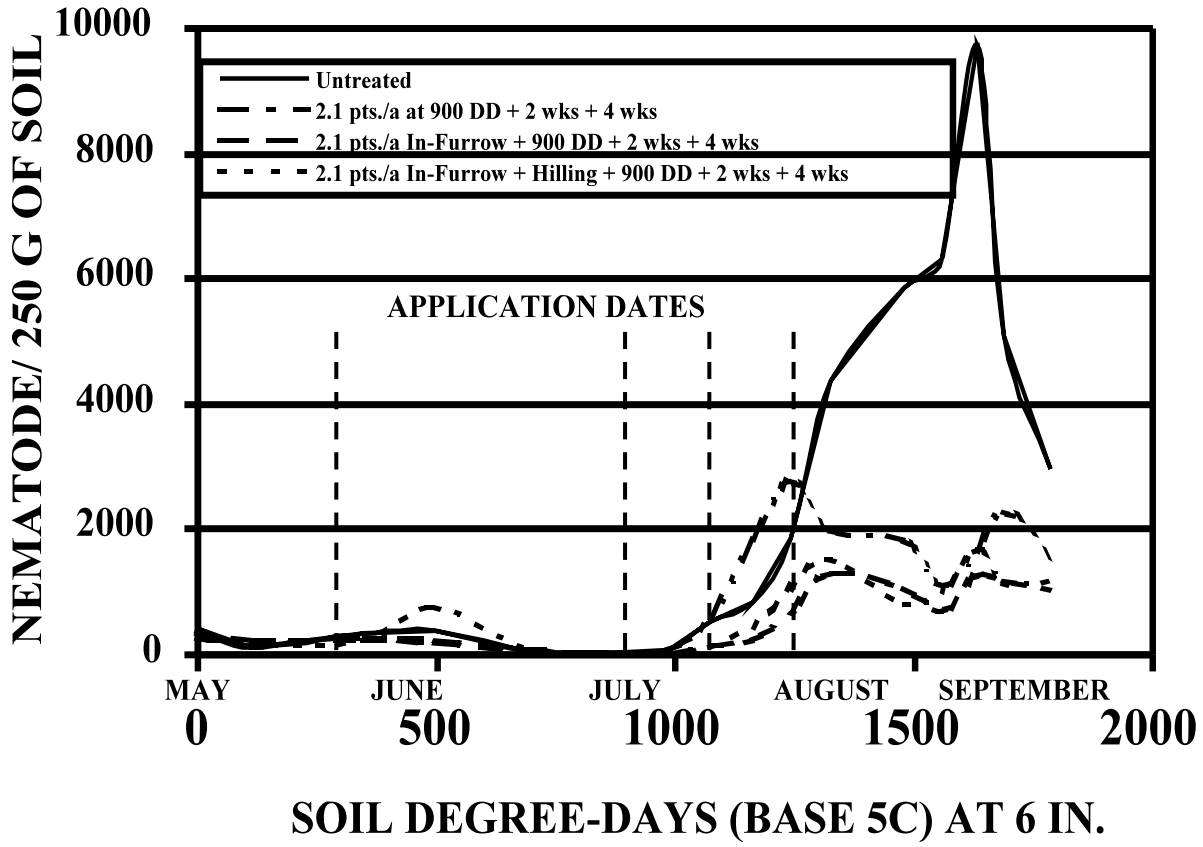

Figure 1. Population dynamics of Columbia root-knot nematode on Russet Nugget in the San Luis Valley, 2003

Vydate treatments evaluated, suggesting that the suppression of damage observed at harvest persisted through storage.

Percentage of tubers with external symptoms was similar between stored samples and those incubated for an additional 900 DD_{5C} (2,680 DD_{5C} total) after harvest, but internal infection was higher in most treatments after incubation. **Thus, incubation at room temperature appears to be an adequate procedure to estimate the amount of external damage to expect in fresh market tubers coming out of storage, as well as a useful assay for seed tubers which may harbor nematodes that are undetectable at harvest. In addition, since many tubers without external symptoms had nematodes inside, external evaluation of seed is not an effective method to determine if tubers are infected.**

At Planting Nematode Thresholds With and Without Vydate Treatment

During 2001, comparisons of CRKN densities at planting with tuber damage at harvest in a Russet Norkotah field indicated only minimal external symptoms in untreated plots with up to 230 CRKN/250 g soil at planting. Analysis of internal infection estimated that 5%, 10% and 15% of tubers would be culled if densities of 23, 55 and 110 CRKN/250 g soil were not treated. In plots treated with Vydate C-LV on July 16 and August 9, external and internal damage were minimal in all plots, so no relationship between initial density and nematode damage could be determined. This suggests that all population levels up to 231 CRKN/250 g soil were controlled by these two applications. No untreated plots could be examined in the Russet Nugget field in 2002. In plots treated with Vydate C-LV sprayed on the surface and watered in at hooking and chemigated in ½ in water on July 12th, July 29th, and August 12th, CRKN at planting ranged from 0-1,380 and averaged 187/250 g of soil. Averaged over all plots, external and internal symptoms were observed in 2.5% and 24% of incubated tubers, respectively. Even in the five plots with the highest initial CRKN populations (ave. = 745/250 g soil), only 3.1 % of tubers expressed external symptoms.

Again, there was no mathematical relationship between initial density and subsequent tuber damage. Therefore, **these four applications of Vydate C-LV suppressed damage by CRKN to commercially acceptable levels at relatively high populations of CRKN.** Furthermore, since the hooking application may have been ineffective, **the three later applications may have been sufficient**.

Table 1. Performance of different application schedules of Vydate C-LV for suppression of tuber damage caused by Columbia root-knot nematode (*Meloidogyne chitwoodi*). Russet Nugget, Planted May 1, Harvested October 1, 2003 (1,790 DD_{5C}) San Luis Valley, CO.

		Number of Applications of C-LV at 2.1 pts/a								
Applications	Date	0	3	3	4	4	4	5	5	5
In furrow at planting	May 1	--	X		X	X		X		X
Banded spray at hilling	June 6	--	X		X			X	X	
Broadcast spray at hooking	June 20	--					X		X	X
Chemigation at 900 DD_{5C}	July 12	--	X	X	X	X	X	X	X	X
Chem. 2 wks. After 900 DD_{5C}	July 29	--		X	X	X	X	X	X	X
Chem. 4 wks. After 900 DD_{5C}	Aug 12	--		X		X	X	X	X	X
PD Row – Harvest (1,905 DD_{5C}) Evaluations		% Tubers Affected								
Any external symptoms		23		0		0		0		
1 or more internal infection sites		73		9		9		7		
PD Row – Incubation (2,680 DD_{5C}) Evaluations		% Tubers Affected								
Any external symptoms		40		0		1		0		
1 or more internal infection sites		91		17		9		2		
Storage (1,925 DD_{5C}) Evaluations		% Tubers Affected								
Any external symptoms		**38**	**13**	**0**	**1**	**0**	**<1**	**<1**	**<1**	**0**
1 or more internal infection sites		81	35	7	5	<1	23	2	12	<1
Incubation (2,680 DD_{5C}) Evaluations		% Tubers Affected								
Any external symptoms		29	7	<1	<1	<1	<1	2	<1	0
1 or more internal infection sites		**92**	**56**	**22**	**21**	**7**	**15**	**9**	**19**	**<1**

Effect of Telone fumigation on control of Columbia root-knot nematode

A barley field with high nematode densities was grid sampled before (October 3, 2002) fumigation with Telone at 20 gpa (October 7, 2002) and before planting potatoes (May 8, 2003) the following spring. Before fumigation, root-lesion nematode densities ranged from 108-4,102 and averaged 1,021/250 g soil. Root-knot nematode densities ranged from 2-6,922 and averaged 1,905/250 g soil. After fumigation, spring densities of root-lesion nematodes ranged from 0-30 and averaged 13/250 g soil while total CRKN ranged from 0-192 and averaged 23/250 g soil. **However, out of 15 grid samples examined, only 6 (avg. = 0.4/250 g soil) of all the CRKN examined were found to be alive at planting.**

Summary

CRKN increased 23-fold in untreated plots of Russet Nugget in the SLV. Vydate C-LV, particularly treatments including in furrow applications, suppressed population growth substantially. Three or more applications of Vydate C-LV adequately controlled damage to fresh market tubers at CRKN densities commonly found in the SLV. In furrow and chemigation applications at and after 900 DD_{5C} were more effective than applications sprayed on the surface and watered in at hilling or hooking. However, while Vydate may be sufficient for fresh market production, many tubers were infected with a low number of nematodes that probably would not be detected at harvest and high populations were present in the soil at harvest. Therefore, Telone, which nearly eliminated all CRKN from soil, would be preferable to Vydate C-LV for seed production.