EFFECT OF POTATO VARIETY AND NITROGEN ON EXPRESSION OF RING ROT IN A SEED GROWING AREA [1]

by
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ABSTRACT

Ring rot caused by Corynebacterium michiganense pv. sepedonicum is a threat to both seed and commercial potatoes. In 1985 and 1986 near Mt. Vernon, Washington, a seed growing area, freshly-cut seed pieces of several varieties were dipped into a slurry prepared from ring rot infected tubers and then hand planted into fields. Foliage symptoms first appeared on Norgold Russet, LC-1 (1986 only), Norchip (1986 only,) Red Pontiac, White Rose, Nooksack, and Russet Burbank 75 (67), (81), (81), 90 (81), 105 (81), 105 (111), 105 (111) days after planting, respectively (1986 in parentheses). High nitrogen, 300 lb N/a compared to 50 lb N/a, had no effect on symptoms. Results indicate that ring rot inspections of fields for seed certification should be timed according to variety. Although only 2-5% of the plants from infested seed pieces of Nooksack and Russet Burbank showed ring rot symptoms, yields of both varieties were reduced significantly more in inoculated plots than plots not inoculated with ring rot bacteria.

INTRODUCTION

Ring rot caused by Corynebacterium michiganense pv. sepedonicum (Spieckernann and Kotthoff, Dye and Dempt) (Cms), was introduced into North America in the early 1930's (12). Starting in 1939, Bonde et al. of Maine began testing varieties and potato seedlings for immunity to ring rot (2). They reported Dutch varieties President and Frisco and progenies of crosses involving President were resistant to infection, but not immune. In 1946, a highly-resistant seedling derived from these crosses was named Teton (9). Later, resistant Saranac and Merrimack were introduced (1,10). Presently, breeding varieties for ring rot resistance is taboo since resistant varieties are considered latent carriers compared to more susceptible varieties (7). A recent release, Belrus, has lost some of its popularity because of its resistance to ring rot (6). However, Bonde and Covell considered resistant Teton to be a less likely carrier of Cms than the very susceptible Katahdin (3).

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In general, the United States seed industry has a zero tolerance for ring rot, so any variety that contains latent Cms is highly undesirable. In Canada, cultivars that do not readily express ring rot symptoms can not legally be propagated as seed (7).

Other factors may also delay ring rot symptoms, and therefore ring rot detection. Under controlled conditions, symptoms were more severe at 77°F and milder at 61°F and 93°F soil temperatures (5). However, percentages of tubers infected were about the same at all three temperatures. Perhaps this explains in a cold climate why Cms can be spread without being detected in the field.

Previous research on soil fertility as it effects ring rot symptoms is inconclusive (7). Evidently, due to diversity of soils throughout the world, the effects on disease development are not the same in all areas.

Reported herein is a two year study on the effect of potato variety and nitrogen level on expression of ring rot in a seed growing environment. Norgold Russet and Red Pontiac were selected because they readily expressed symptoms. Russet Burbank and Nooksack were selected because they develop late symptoms except occasionally when they show early green dwarf (4). The purpose of this study was to aid field inspectors in identifying ring rot in infected seed lots proposed for certification.

MATERIALS AND METHODS

The site selected was near Mt. Vernon, Wa. on a Rifle silt loam soil near a potato seed growing area.

Ammonium sulfate at the rates of 50 and 300 lb N/A were broadcast on the soil surface of plots 9-ft wide by 10-ft long prior to plowing 12 inches deep. Unfertilized and unplanted 5-ft alleys were left at the ends of each plot to facilitate plant reading and harvest.

In 1985, Norgold Russet, Nooksack, Red Pontiac, Russet Burbank, and White Rose were tested. In 1986, LC-1 and Norchip were also tested. Freshly-cut 2 to 3 oz seed pieces of each variety in wire baskets were dipped into a watery slurry of Cms prepared from ring rot-infected tubers. The slurry was prepared by grinding four to six tubers in a food blender with water and then adding additional water to make a total of about six gal (3). A tuber slurry rather than pure cultures of Cms were used because pure cultures are thought to lose their pathogenicity (2). First, all non-ring rot treated seed pieces were hand planted. Then the ring rot treated seed pieces of each variety were planted, using new disposable plastic gloves. Seedpieces were planted 12 inches apart into open furrows and covered with disks. A factorial design of variety, N fertilizer, and Cms treatments was established in three-row plots (9 ft by 10 ft long) arranged in a randomized complete block design with five replications.

Plants per plot showing ring rot symptoms such as paling of leaflet margins, leaflet necrosis, and plant wilt were counted every two weeks. In October, tubers in the center row of each plot were machine harvested. Total yield per plot was recorded and tubers with external dark brown necrotic areas typical for ring rot symptoms were weighed. All potatoes judged as U.S. No. 1 tubers were weighed whether expressing ring rot or not. Analysis of variance was calculated and mean separation was determined by Duncan's Multiple Range Test ($P = .05$).

RESULTS

In these two years, foliage symptoms first appeared on Norgold Russet, LC-1 (1986 only), Norchip (1986 only), Red Pontiac, White Rose, Nooksack, and Russet Burbank 75 (67), (81), (81), 90 (81), 105 (81), 105 (111), and 105 (111) days after planting, respectively (1986 in parentheses). In general, the early bulking varieties Norgold Russet, Red Pontiac, and White Rose had more plants with ring rot in 1985, but not in 1986 (Table 1). The late bulking Russet Burbank and Nooksack varieties consistently had fewer plants with ring rot than other varieties. In 1985, plots with Russet Burbank had fewer tubers with ring rot than any other variety. In both years, N rates had no consistent effect on ring rot or % U.S. No. 1 tubers, but 300 lb N/a produced significantly higher yields than 50 lb N/A. Data on rates of N were included in "Main Effect" at the bottom of Table 1, but not in the body of Table 1, since N had no effect on ring rot and had a nonsignificant interaction with ring rot infection. Varieties interacted with Cms inoculation to affect the % of ring rot plants and tubers and yield but not % U.S. No. 1 tubers.

DISCUSSION

The best control of Cms might be to develop highly resistant or immune varieties. However, with resistant varieties such as Teton, a few plants do show symptoms and symptomless plants are thought to be potential latent carriers. It should be recognized that symptomless plants of all varieties have varying potentials as latent carriers. Evidently, Nooksack and Russet Burbank have some resistance to infection by Cms and probably have more potential as latent carriers than early bulking and senescing varieties such as Norgold Russet, Red Pontiac, and White Rose.

Part of the difficulty in discovering ring rot in later-bulking varieties, as this study has shown, is the long, 105- to 110-day period of incubation from infection to symptoms. Because of this long period, ring rot in short season seed growing areas may not be seen in infected lots before vines must be killed for harvest. Low numbers of Cms bacteria entering the host might also produce potential latent hosts. It has been shown that about 300 CFU are needed to produce symptoms in susceptible Red Pontiac (8).

Environment may also effect symptom expression. However, the percentages of plants from infected seed pieces of six varieties planted near Fort Ellis, Montana were not significantly different from those in the same six varieties when grown near Prosser, Washington where average temperature was 10°F higher (11). In this study, nitrogen fertilization had no effect on symptoms.

Results of the study reported herein indicate that certification inspectors must know the period of Cms incubation and characteristic symptoms for each variety grown in their area. Many certification agencies prohibit ring rot gardens or trials in the vicinity of seed grower's farms. Such a practice severely limits training of inspectors in identification and eradication of ring rot.

LITERATURE CITED

1. Akeley, R.V., Stevenson, F. S. , Blood, P. T., Schultz, E. S., Bonde, R., and Neilson, K. F. 1955. Merrimack: A new variety of potato resistant to late blight and ring rot and adapted to New Hampshire. Am. Potato J. 32:93-99.

2. Bonde, R., Stevenson, F. J., and Akeley, R. V. 1947. Breeding potatoes for resistance to ring rot. Phytopathology 37:539-555.

3. Bonde, R. and Covell, M. 1950. Effect of host variety and other factors on pathogenicity of potato ring-rot bacteria. Phytopathology 50: 161-172.

4. Guthrie, J. W. 1959. The early, dwarf symptom of bacterial ring rot of potato in Idaho. Phytopathology 49:453-454.

5. Lodgson, C. E. 1967. Effect of soil temperature on potato ring rot. Am. Potato J. 44:281-286.

6. Manzer, F. 1983. Reaction of the Belrus variety to bacterial ring rot infection - an update. Maine Agr. Exp. Station. Misc. Report No. 283. 4 pp.

7. Manzer, F. E., Gudmestad, N. C. and Nelson, G. A. 1987. Factors affecting infection, disease development,and symptom expression of bacterial ring rot. In Press. Am. Potato J. 64:

8. Nelson, G. A. 1982. Corynebacterium sepedonicum in potato: Effect of inoculum concentration on ring rot symptoms and latent infection. Canadian J. Plant Pathol. 4:129-133.

9. Riedl, W. A., Stevenson, F. J., and R. Bonde. 1946. The Teton potato: A new variety resistant to ring rot. Am. Potato J. 23:379-389.

10. Stevenson, F. J., and Livermore, J. R. 1949. The Saranac potato: A new variety promising in Australia. Am. Potato J. 26:45-46.

11. Sun, M. K. C. and Easton, G. D. 1983. Symptom expression of Corynebacterium sepedonicum-infected Russet Burbank potato plants in Montana. Am. Potato J. News and Reviews 882.

12. Walker, J. C. 1952. Ring rot. 325-328. In Diseases of vegetable crops. McGraw-Hill Book Co. 529 pp.

Table 1. Effect of variety, nitrogen rates and Cms inoculation on ring rot disease and potato production.

Variety	Cms inoculation	% Ring Rot Plants per 3 rows 1985	1986	% Ring Rot Tubers 1985	1986	% U.S. No. 1 tubers 1985	1986	Yield (cwt/A) 1985	1986
LC-1 (LC)	yes	-[x]	20A c[y]	-	6A b	-	85B	-	408B d
	no	-	0B	-	0B	-	85B	-	452A d
Norchip (NC)	yes	-	25A bc	-	6A b	-	80BC	-	360B d
	no	-	0B	-	0B	-	83BC	-	478A d
Norgold Russet (NR)	yes	73A a	34A ab	14A ab	8A ab	78B b	79C	228B d	327B d
	no	0B	0B	0B	0B	85A b	82C	466A d	482A d
Nooksack (NO)	yes	25A c	2A d	11A bc	4A b	91A a	93A	517B c	457B c
	no	0B	0B	0B	0B	92A a	96A	641A c	518A c
Red Pontiac (RP)	yes	45A b	42A a	18A a	12A a	80B b	88A	438B bc	425B ab
	no	0B	0B	0B	0B	87A b	96A	781A bc	774A ab
Russet Burbank (RB)	yes	4A d	5A d	2A d	6A b	62B d	74D	588B b	526B b
	no	0B	0B	0B	0B	75A d	77D	700A b	630A b
White Rose (WR)	yes	66A a	16A c	5A cd	6A b	72B c	82B	634B a	568B a
	no	0B	0B	0B	0B	81A c	86B	802A a	729A a
Main Effect on:									
Variety (V)									
LC		-	10C	-	3B	-	84B	-	431D
NC		-	13BC	-	3B	-	81BC	-	419D
NR		36A	17AB	7AB	4AB	81B	80C	347D	404D
NO		12C	1D	5BC	2B	91A	95A	579C	488C
RP		22B	21A	9A	6A	83B	92A	609BC	602AB
RB		2D	3D	1D	3B	68D	75D	643B	579B
WR		33A	8C	3CD	3B	76C	84B	718A	648A

Table 1 (continued)

Variety	% Ring Rot Plants per 3 rows		% Ring Rot Tubers		% U.S. No. 1 tubers		Yield (cwt/A)	
	1985	1986	1985	1986	1985	1986	1985	1986
Nitrogen (N)								
50 lb/A	21A	10A	4A	4A	79A	85A	561B	451B
300 lb/A	21A	11A	6A	3A	81A	84A	598A	569A
Cms inoculation (I)								
Ring rot	42A	21A	10A	7A	76B	83A	481B	439B
No ring rot	0B	0B	0B	0B	83A	86A	678A	581A
Interactions								
V x I	*[z]	*	*	*	ns	ns	*	*
N x I	ns	ns	ns	ns	ns	ns	ns	ns
V x N x I	ns	ns	ns	ns	ns	ns	ns	ns

[x]Data not recorded
[y]Vertical means with the same letter are not significantly different according to Duncan's Multiple Range Test (P = .05). Upper case letters represent infection with ring rot. Lower case letters represent effect of variety.
[z]* = significant at (P = .05).