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Evaluation of Advanced Clones for Reaction to Ringrot Infection

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Summary:

Sixteen numbered clones and three named cultivars were tested in the field in the San Luis Valley for their reaction to inoculation with ringrot bacteria. The type and timing of symptom expression in the foliage and tubers was evaluated.

All clones and cultivars were susceptible to infection as evidenced by expression of symptoms in foliage and tubers and the presence of vascular exudate in the stems. Minimum time for recognizable symptoms to appear ranged from 56 to 100 days from planting. Percentages of inoculated plants which showed recognizable symptoms by late August 100 days after planting ranged from 4.8 to 95.2 percent. Tubers from all clones showed symptoms by mid September but symptomatic tubers were few and difficult to find in at least five clones.

Methods and Materials:

Sixteen advanced clones from the Colorado breeding and selection program and three standard cultivars (Table 1) were tested for susceptibility to ringrot infection and symptom expression in field tests in the San Luis Valley. Tubers

from each clone and cultivar were obtained from the San Luis Valley Research Center in April 1989. The tubers were cut into seedpieces which weighed approximately 1.5 to 2.0 oz. each. Half of the cut seedpieces were inoculated with the ringrot organism, Clavibacter (corynebacterium) sepedonicum, by dipping them into a slurry prepared by macerating infected tubers from the 1987 test plot in water using a food blender. The other half of the seedpieces were not inoculated and served as uninfected controls for comparison. The control (uninoculated) seedpieces for each clone and cultivar were prepared first and kept separate from the inoculated ones to avoid cross contamination with the ringrot bacterium. The inoculated and uninoculated seedpieces were placed in individual paper bags, stored at about 5•C overnight then transported to the San Luis Valley and planted in the field the following day. The seedpieces were planted on May 18, 1988in randomized plots replicated three times. Each replicate plot consisted of 7 seedpieces planted about 12 inches apart in the row. A 24 inch blank space was left between plots within the row and blank rows were left between planted rows across the plot to separate treatments and facilitate easy viewing of plants for symptom expression.

Uninoculated (control) seedpieces for all clones and cultivars were planted before the inoculated ones, again to avoid contamination of the controls.

Seedpieces were hand planted and mechanically covered.

Plots were watered by a combination of furrow and overhead sprinkler irrigation and weeds were controlled by application of pre-plant herbicides and by hand pulling and hoeing as needed. Early blight and insects were controlled by fungicide and insecticide applications as necessary.

Plant emergence was recorded and plants were closely examined for ringrot symptoms at weekly intervals from emergence until readings were no longer

possible due to maturity or other factors. Date of first symptom expression, number of plants in each plot which showed symptoms on each reading date, and types of symptoms expressed were recorded. At harvest, tubers were dug and examined to determine the symptoms present. The relative amount of tuber infection was determined by recording the ease with which infected tubers could be found by recording the number of replicates (1, 2 or 3) in which all tubers had to be examined visually and by cutting in order to find symptomatic tubers.

Results:

Data in Table 1 show that stands of 85-100% were achieved with inoculated seedpieces of all clones and cultivars except CO 8118-2 and CO 8136-6 which produced stands of 47.6 and 81.0% respectively.

Earliest ringrot symptoms were detected 56 days after planting in clone AC 81592-2. Symptoms were found in the susceptible cultivars, Russet Burbank and Sangre, 61 and 68 days, respectively, after planting. Seven clones showed first detectable symptoms at about the same time as Russet Burbank and Sangre. These included clones AC 7869-17, AC 81198-11, AC 81592-2, BC 0224-3, CO 8118-2, CO 8182-1 and CO 82124-4. Six additional clones, AC 75430-1, AC 77101-1, AC 82263-1, CO 8011-5, BC 0038-1, and CO 8195-4 expressed symptoms 14 days later than Russet Burbank, and 7 days later than Sangre. Two clones, CO 7918-11, and CO 8138-6 did not produce visible symptoms until 100 and 90 days, respectively, after planting. This was 29-39 days later than the Russet Burbank standard and 8-18 days later than the latest expressing standards, Centennial Russet and WNC 230-14 included in the study.

The percentage of inoculated plants in the cultivars and clones as standards for comparing the advancec breeding material which produced recognizable symptoms by late August (100 days after planting) ranged from 57.1%

to 89.7% in the susceptible cultivars, Russet Burbank and Sangre to 9.5 to 15.0% in the "tolerant" standards, Centennial Russet and WNC 230-14.

Percentages of symptomatic plants could be separated into three arbitrary groups, those which showed symptoms in percentages of inoculated plants equal to or greater than the susceptible cultivars, those which expressed symptoms in percentages of inoculated plants intermediate between the susceptible and the "tolerant" standards, and those which showed symptoms in much lower percentages of plants than the susceptible standards, Russet Burbank and Sangre.

Ten of the 15 test clones expressed symptoms in percentages of inoculated plants equal to or greater than the susceptible standards. Among this group which included clones AC 7869-17, AC 81592-2, AC 81198-11, BC 0224-3, CO 8182-1, AC 75430-1, AC 82263-1, CO 8011-5, AC 77101-1, and CO 8195-4, percentages of symptomatic plants ranged from 61.1 to 95.2%. In four clones, CO 8118-2, CO 81214-4, BC 0038-1, and CO 8138-6, symptoms were expressed in considerably fewer inoculated plants than in Russet Burbank or Sangre but the percentage expression which ranged from 28.1% in clone BC 0038-1 to 40.8% in clone CO 8118-2 was considerably higher than expressed by the "tolerant" standards Centennial Russet (15.1%) and WNC 230-14 (9.5%).

One clone, CO 7918-11. expressed symptoms very poorly with only 4.8% of the inoculated plants showing symptoms 100 days after inoculation. This percentage of expression was only half as much as the poorest expression among the standards (WNC 230-14 9.5%).

All clones and cultivars in the study developed at least some symptoms which were typical of bacterial ringrot by the end of the season. In all except clone CO 7918-11, multiple symptoms were expressed. These included wilting, early dwarfing (rosetting), interveinal chlorosis and necrosis, marginal necrosis

of leaves and bacterial exudate from the vascular bundles in the basal stems. In clone CO 7918-11, however, only mild interveinal chlorosis was found 100 days after planting along with bacterial exudate from the basal stem. considerably more early dwarfing (rosetting) symptom was observed in 1989 than in most seasons in the San Luis Valley. Nine of the 15 advanced clones showed the early dwarfing symptom in this test.

Tubers from all cultivars and clones had symptoms of bacterial ringrot at harvest time (September 15). In all, except one case (clone CO 8195-4), both internal and external tuber symptoms were present although in a few instances all tubers in two or three replications had to be examined to find the full range of symptoms.

In the case of clone CO 8195-4 all tubers produced by the clones were examined and only internal vascular discoloration and bacterial exudate from the discolored tissue was found. No external symptoms were present.

Discussion:

Five of the 15 advanced clones tested in 1989 expressed ringrot symptoms as early or earlier than Russet Burbank and Sangre and produced typical easily recognizable symptoms in both foliage and tubers. This group, consisting of clones AC 7869-17, AC 81592-1, AC 81198-11, BC 0224-3, and CO 8182-1 showed symptoms in a high proportion of inoculated plants. There are few concerns about the ability of inspectors to detect ringrot infection in these clones in the field. Five additional clones expressed good ringrot symptoms in high percentages of inoculated plants but expressed first symptoms up to 14 days later than the susceptible cultivars included as standards in the test. These clones, including AC 75430-1, AC 82263-1, CO 8011-5, AC 77101-1, and CO 8195-4, should present no particular problems in terms of ringrot detection in most years but

may prove to be troublesome in years when early frost occurs. Similarly a third group consisting of clones CO 8118-2, CO 82124-4, and BC 0038-1 by virtue of the fact that they exhibit symptoms in lower percentages of inoculated plants than the susceptible standards with which they were prepared or exhibited symptoms later and in considerably lower percentages of plants than the standards would probably not be problems for certification under normal circumstances. They may create some problems in short seasons (i.e., early frost) or in cases where the level of infection in a seed lot is very low.

Two clones expressed symptoms much later than Russet Burbank and Sangre and in lower percentages of inoculated plants than the controls. Clone CO 8138-6 expressed symptoms 29 days later than Russet Burbank and in only 35.7% of the inoculated plants. Clone CO 7918-11 did not express even mild symptoms until 39 days later than Russet Burbank and only 4.8% of the inoculated plants showed symptoms at the end of the season. This percentage of infection was only about half that of the most tolerant clone (WNC 230-14) included in the test. This suggests that these two clones, especially clone CO 7918-11, represent potential ringrot detection problems for certification by virtue of their late symptom expression and/or low percentages of expression in inoculated plants.

The 1989 results are especially significant since 1989 was a very good year for ringrot symptom expression in the San Luis Valley yet some clones still expressed ringrot symptoms poorly. Some clones such as CO 7918-11 expressed low amounts of infection in 1988 (6.3%) and 1989 (4.8%). Others such as CO 8138-6 which expressed very low levels of infections in both 1988 (5.6%) but expressed much better in the warmer 1989 season (35.7%) although expression in 1989 was still considerably below that expressed by the susceptible cultivars. The fact that clone CO 7918-11 expressed symptoms poorly in both 1988 and in the more

favorable 1989 season indicates that it will probably consistently present potential detection problems for the certification service.

The data also indicate that some clones will be "season sensitive" regarding expression of adequate symptoms to insure reasonable detection in seasons favorable for ringrot expression but perhaps not in seasons less favorable for disease expression. Clone CO 8138-6 is a good example of this phenomenon and underscores the need to test clones over several seasons in order to accurately determine their reaction to ringrot infection.

Table 1. Response of 19 clones and cultivars to inoculation with clavibacter (corynebacterium) syedonicum in the San Luis Valley - 1989.

Clones or Cultivars	% Plants Emerged	Number of Days from Planting to First Symptom	Plants with Ringrot Symptoms 100 days after planting.	Symptoms Observed[1]
Russet Burbank	100.0	61	57.1	ED,W,IVC,IVN,MN,SQ
Centennial Russet	95.3	82	15.1	W,IVC,IVN,MN,SQ
Sangre	95.3	68	89.7	W,IVC,IVN,MN,SQ
WNC230-14	100.0	82	9.5	W,IVC,IVN,MN,SQ
AC75430-1	95.3	75	95.2	W,IVC,IVN,MN,SQ
AC77101-1	100.0	75	85.7	ED,W,IVC,IVN,MN,SQ
AC7869-17	95.3	61	84.9	ED,W,IVC,IVN,MN,SQ
AC81198-11	100.0	68	61.9	W,IVC,IVN,MN,SQ
AC81592-2	100.0	56	95.2	W,IVC,IVN,MN,SQ
AC82263-1	95.3	75	64.3	ED,W,IVC,IVN,MN,SQ
BC0038-1	85.7	75	28.1	ED,W,IVC,IVN,MN,SQ
BC0224-3	100.0	68	66.7	ED,IVC,IVN,MN,SQ
CO7918-11	85.7	100	4.8	IVC,SQ
CO8011-5	95.3	75	61.1	W,IVC,IVN,MN,SQ
CO8118-2	47.6	61	40.8	ED,IVC,IVN,MN,SQ
CO8138-6	81.0	90	35.7	ED,IVC,IVN,MN,SQ
CO8182-1	100.0	61	71.4	ED,IVC,IVN,MN,SQ
CO8195-4	100.0	75	66.7	ED,W,IVC,IVN,MN,SQ
CO82124-4	95.3	68	39.7	ED,W,IVC,IVN,MN,SQ

Table 2. Tuber symptoms at harvest time resulting in 19 clones and cultivars inoculated with Clavibacter (corynebacterium) syedonicum in the San Luis Valley, 1989

Clone or Cultivars	Tuber Symptoms Observed[1]	Number of Replications Examined Before Symptoms Were Detected
Russet Burbank	SC,VD,VS	1
Centennial Russet	SC,VD,VS	3
Sangre	SC,VD,VS	3
WNC230-14	SC,VD,VS	1
AC75430-1	SC,VD,VS	1
AC77101-1	SC,VD,VS	2
AC7869-17	SC,VD,VS	1
AC81198-11	SC,VD,VS	1
AC81592-2	SC,VD,VS	1
AC82263-1	SC,VD,VS	1
BC0038-1	SC,VD,VS	1
BC0224-3	SC,VD,VS	3
CO7918-11	SC,VD,VS	2
CO8011-5	SC,VD,VS	1
CO8118-2	SC,VD,VS	2
CO8138-6	SC,VD,VS	2
CO8182-1	SC,VD,VS	3
CO8195-4	VD,VS	3
CO82124-4	SC,VD,VS	1

[1]SC = surface cracking, VD = vascular discoloration, VS = vascular exudate when squeezed.