DISEASE SYMPTOMS AND EFFECT ON YIELD OF POTATO FOLIAGE INFECTED WITH COLLETOTRICHUM COCCODES

by
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Black dot, caused by the fungus Colletotrichum coccodes, has increased in prevalence in Washington State during the last eight years. C. coccodes was isolated as early as six weeks after crop emergence and was associated with a high percentage of potato stems by 6 July in 1990 throughout the potato growing areas in Washington. The fungus was also associated with lesions on potato foliage in the field in 1990 and was reported to cause infection on potato foliage in Idaho. The purpose of this work was to determine the conditions necessary for infection of potato foliage by C. coccodes and to determine the effect of infection on yield.

Materials and Methods

Small whole tubers of certified potato seed (cultivar Russet Burbank) were planted in 16 cm diameter pots in the greenhouse. Soil was a silt loam from virgin sagebrush land, supplemented with 0.17 oz. of Osmocoat fertilizer per pot prior to planting. Two shoots per pot were grown and mean height of shoots was about 23 in. when inoculated.

Plants were wounded before inoculation by making a single vertical pass 20 in. from each shoot with a hand-held sandblaster using 16-grit autoclaved silica sand. Wind velocity was about 10 miles/hr at the plant surface. Each pass took about 0.7 sec. to complete. Plants were also left unwounded.

Spores of the fungus were sprayed on test plants with a mini spray gun. After inoculation, plants were placed in a plastic mist chamber for a predetermined time, removed, and dried as quickly as possible with forced air from a fan, and then placed in the greenhouse. Experiments were set up as randomized complete block designs. Data were analyzed by regression and analysis of variance.

Age of wounding. To determine the effect of age of wound on susceptibility to infection, plants were inoculated 0, 1, 2, 3, 6, 8, or 10 days after wounding. Check plants were either wounded but not inoculated or inoculated but not wounded. Concentration of inoculum was 11×10^6 conidia/ml. Three replicates were used with two shoots per replicate, and the experiment was repeated.

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Length of wet period. To determine the effect of length of wet period on infection by C. coccodes, plants were wounded, inoculated with a conidial suspension of 11.6 x 10^6 conidia per ml, and removed from the mist chamber 3, 4, 6, 9, 12, and 24 hr after inoculation in one experiment. In a second experiment they were wounded, inoculated with 13 x 10^6 conidia per ml of inoculum, and removed from the mist chamber 2, 3, 6, 9, 12, 24, and 48 hr after inoculation. The elapsed time from washing conidia from agar to inoculation and placing plants in the mist chamber was about 1 hr. Checks were wounded but not inoculated and were left in the mist chamber for 24 and 48 hr, respectively, for the two experiments. Three replicates of each treatment with two shoots per replicate were used.

Infection of below ground stems and roots. Below ground stems and roots of 4 non-inoculated check plants and 20 plants whose foliage had been inoculated were gently removed from the soil and washed. Stems and roots from each pot were placed in individual plastic bags and sealed for 1 week. Plant material was then examined for sclerotia of C. coccodes.

The following treatments were applied in the greenhouse to potted plants with 2 to 4 stems per pot and replicated twice: (1) 31 ml of inoculum (12 x 10^6 conidia/ml) was drenched on the soil surface; (2) Foliage was wounded and inoculated as previously described; (3) Soil was not drenched and foliage was not inoculated (check). One month after inoculation, lower stems and roots were collected and placed in a sealed plastic bag for 1 week. They were then examined for sclerotia of C. coccodes.

Inoculation in the field. Certified seed pieces of potato (cv. Russet Burbank) were planted by hand to a silt loam soil at the Irrigated Agriculture Research and Extension Center near Prosser, Wa. on 19 April, 1991. Two weeks before planting the soil was treated with methyl bromide 448.5 Kg/ha) under polyethylene tarps. Plots were single rows 20 ft long (27 seed pieces/plot) with two buffer rows between plots. Plants emerged on 17 May. Plants in plots were wounded with 16 grit autoclaved silica sand on either 19 June or 10 July, 1991. Individual plants were blasted with sand in a vertical pass for approximately 0.5 seconds. The wounded plants in plots were inoculated with a conidial suspension of C. coccodes the evening they were wounded and then sprinkle irrigated for 13 hr on 19-20 June and 16 hr on 10-11 July using 7/64 in. nozzles. For comparison, both wounded and non-wounded plots were not inoculated. Plants in an individual plot were wounded and inoculated only once. Concentration of inoculum was 7 x 10^6 conidia/ml on 19 June and 4 x 10^6 conidia/ml on 10 July.

Results

Disease symptoms developed on the foliage of plants wounded and then inoculated with conidia in the greenhouse and both inoculations in the field. Lesions initially had a water soaked appearance and then turned dark brown to black and they were usually associated with wounds. Lesions on leaflets were generally similar to those caused by Alternaria solani but did not contain concentric rings.

Size of lesions was 0.3 to greater than 7 mm in diameter on leaflets and 0.5 to 5 mm on petioles and stems. Lower and middle leaves of inoculated plants frequently became chlorotic and sometimes blighted. Significantly more ($P < 0.01$) lesions developed on plant foliage that was wounded by sand blasting before inoculation than on nonwounded foliage (Fig. 1). Plants that were wounded but not inoculated did not develop lesions or severe chlorosis. Symptoms on wounded and inoculated plants in the greenhouse and the field were similar. C. coccodes was reisolated from lesions and blighted leaves of all inoculated treatments in the greenhouse and the field.

Susceptibility of wounds decreased significantly ($P < 0.001$) from the day of inoculation to two days before inoculation (Fig. 1). Foliage wounded three or more days before inoculation was no more susceptible to infection than non-wounded foliage ($P = 0.05$).

Lesions developed on plants held in the mist chamber for as little as 2 or 3 hours after wounding and inoculation. Number of lesions increased significantly ($P < 0.001$) on stems and petioles as the length of wet period increased from 3 to 24 hr in the first test (Fig. 2) and from 2 to 48 hr in the second test (Fig. 3).

Sclerotia of C. coccodes formed on below-ground stems and roots of all plants where the foliage was wounded and inoculated. Sclerotia were measured a distance of 7 cm below the soil surface on many of the buried stems. Sclerotia did not form on below ground stems and roots of plants where the foliage was wounded but not inoculated. Sclerotia developed on all below-ground stems (7 stems) and roots where the soil was drenched with a conidial suspension. Sclerotia only formed on one of seven stems and root systems where the soil was not drenched with conidia.

Total weight, weight of No. 1's, and number of No. 1's/plant were significantly reduced ($P = 0.05$) when foliage was sand blasted and then inoculated in the field (Table 1). Sand blasting by itself did not affect yield ($P=0.05$). Specific gravity was not affected.

Discussion

Black dot has historically been known as a root, stolon, and below-ground stem disease of potato (2). Foliar symptoms of yellowing and wilting have been ascribed to the infection and rot of below-ground stems and roots. Infection of below ground tissues by C. coccodes has been discounted by some researchers as playing a significant role in potato early dying disease (3,5). However, a significant reduction in yield of the cultivar Superior was measured in the greenhouse when sclerotia of C. coccodes were added to soil (6). Yield reductions from foliar infections have been recently reported from field studies in Idaho (1,4) as well as in this study.

We isolated C. coccodes from below and above-ground plant tissues of Russet Burbank potato in Washington beginning six weeks after crop emergence in the spring.

C. coccodes was also isolated from lesions on stem, petioles, and leaflets of potato foliage collected in grower's fields that were similar to those lesions found on potato foliage after artificially wounding and inoculating C. coccodes in this study. Davis and co-workers have also recently reported infection of potato foliage in Idaho after wounding and inoculating with C. coccodes (1,4). Foliar wounds caused by the blowing sand and soil that commonly occur during the growing season in the Columbia Basin of Washington seem likely points of infection for C. coccodes in grower's fields.

Wounding increased symptom development on foliage. Non-intentional wounds may have been the infection sites when a few lesions developed on foliage that was not sand blasted before inoculation. Long wet periods of 24 and 48 hr were most conducive for infection. Lesions were initiated on plants by spraying with conidia that had been in a water solution for 1 hr followed by a two hour wet period.

Roots and below-ground stems became infected from conidia that were washed from the plant and soil surfaces through the soil. Infection of below-ground tissues may have contributed to some of the chlorosis observed of lower and middle leaves of inoculated plants. In the field, conidia from infected foliage and on the soil surface may play an important role in supplying inoculum for infection of below-ground plant tissues.

Literature Cited

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Table 1. Number of colonies of Colletotrichum coccodes and yield of Russet Burbank potatoes either wounded or not wounded and inoculated or non-inoculated with C. coccodes.

	Wounded		Not Wounded
	Non-inoculated[a]	Inoculated[a]	Non-inoculated
Colonies of Colletotrichum per cem stem	1.6	9.9**	2.2
Weight (CWT)			
Total	698.4	642.4*	687.3
No. 1	529.8	468.0*	528.7
No. 2	168.7	174.4	162.5
Number of tubers/plant			
Total	6.7	6.5	6.7
No. 1	4.5	4.1*	4.6
No. 2	2.2	2.3	3.0
Mean tuber weight (oz)			
Total	8.1	7.7	7.9
No. 1	9.1	8.8	9.0
No. 2	5.8	5.8	5.6
Specific gravity	1.0750	1.0781	1.0775

[a] * and ** significantly different from the non-inoculated at P = 0.05 and P = 0.01, respectively, using single degree of freedom controls.

Figure 1. Lesions per linear centimeter of potato stems not wounded (check) and wounded with air-driven sand and inoculated with Colletotrichum coccodes 0, 1, 2, 3, 6, 8, and 10 days after wounding.

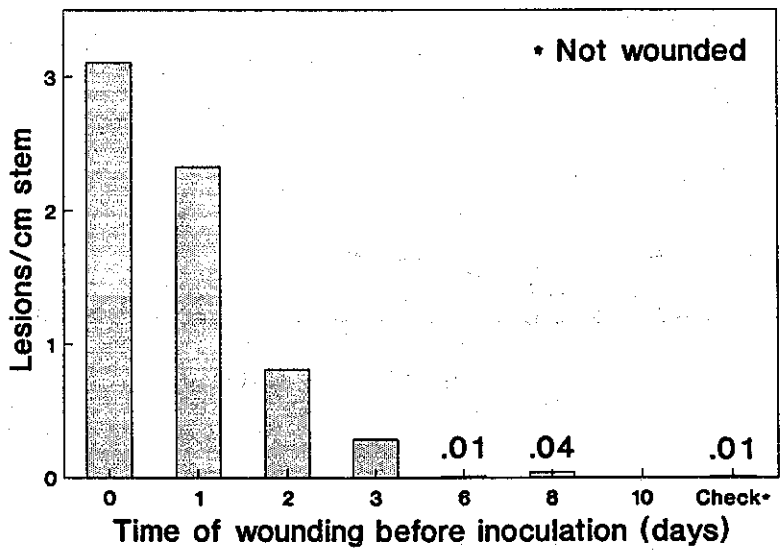

Figure 2. Lesions per petiole and per linear centimeter of potato stem wounded with air-driven sand, inoculated with Colletotrichum coccodes, and placed in a mist chamber for 3-24 hr.

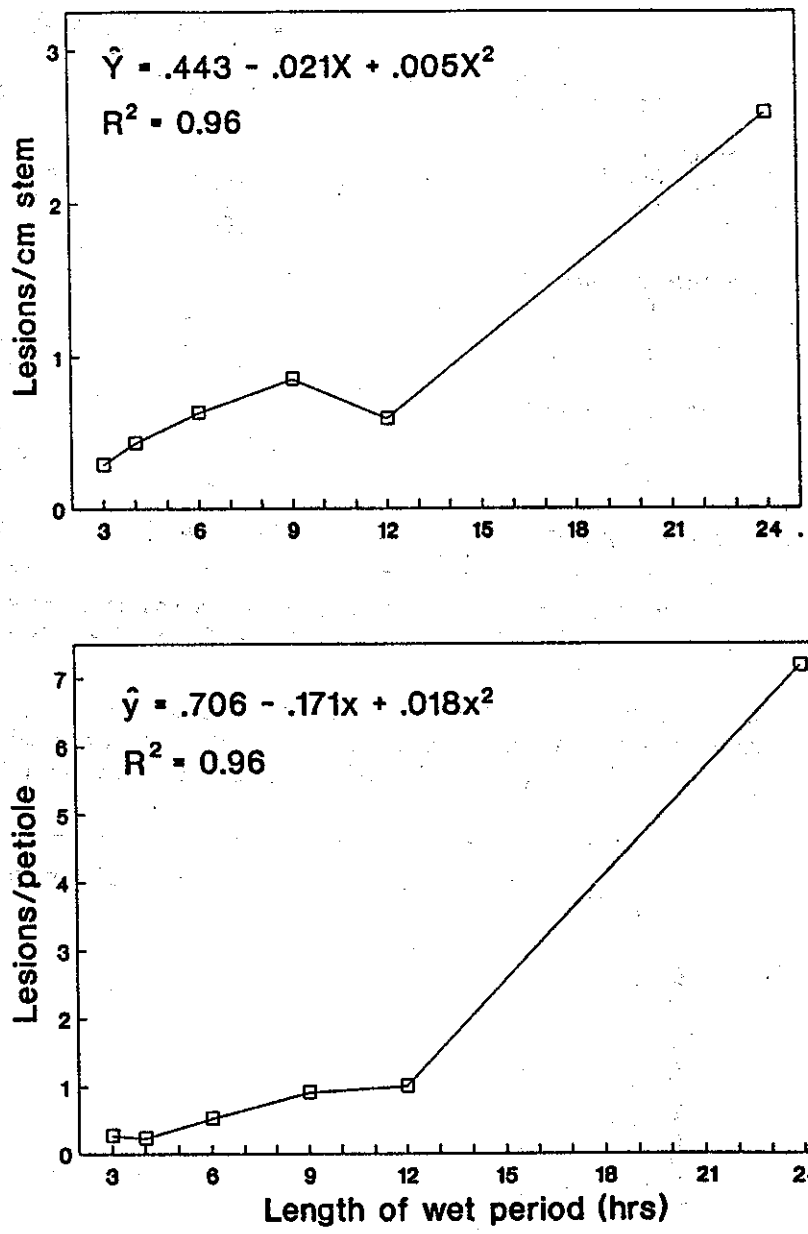

Figure 3. Lesions per petiole and per linear centimeter of potato stem wounded with air-driven sand, inoculated with Colletotrichum coccodes, and placed in a mist chamber for 2-48 hr.