Field and Laboratory Studies for Control of Phymatotrichum Root Rot

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Summary

Effect of sodium chloride on control of *Phymatotrichum* root rot. - Ten replicated field plots were established in Arizona during 1977, 1978 and 1979 to determine the effect of pre-plant applications of sodium chloride on control of *Phymatotrichum* root rot.

The tests were established in Graham Co. (South-Eastern Arizona), Pinal Co. (Central Arizona) and Pima Co. (South-Central Arizona). The tests were similar in nature and consisted of applying 1800 to 2000 kg/ha of granulated sodium chloride with various types of fertilizer spreaders in strips (usually 8 to 16 beds in width), through old cotton soils heavily infested with *Phymatotrichum* root rot. Alternating non-treated strips constituted check treatments. All plots were replicated at least 4 times. After application the sodium chloride was disked or plowed into the soil and the beds shaped. These field operations were followed by irrigation, bed mulching, and subsequent planting. Varieties in these trials consisted of commonly planted Pima varieties (*Gossypium barbadense*) and upland varieties (*G. hirsutum*) both of which are equally susceptible to the disease. Stand counts were made after emergence and disease evaluation determined by use of aerial infra-red photography, visual observations and yield data. The middle 4 rows of each plot was harvested with a 2 bed harvester. No reduction in incidence of *Phymatotrichum* root rot was seen in any of the sodium chloride tests established during 1977, 1978, and 1979. Also, no carry-over effects have been noted in any of the tests. The results of a typical field test during 1979 at Marana, Arizona is shown in Table 1.

Table 1. Effect of pre-plant application of sodium chloride on *Phymatotrichum* root rot of cotton a

Treatment		Plants/ha x1000	Lint kg/ha
Salt	2000 kg/ha	145 y[c]	879 y
check		136 y	693 y

a Each value is a mean of four replications.
b Two-thousand kg/ha of sodium chloride was spread and plowed down prior to bed shaping. The field was planted on May 16 and harvested on November 7, 1979.
c Plant counts were made 1 month after seeding. Numbers followed by the same letters are not significantly different by Duncans multiple range test (P=0.05).

We do not plan any further studies with sodium chloride. This material has been erratically successful for disease control in dry-land cotton in central Texas but has not been successfully used in irrigated cotton in the Rio Grande Valley.

The effect of soil cations on the distribution of *Phymatotrichum* root rot. - The cotton root rot fungus, *Phymatotrichum omnivorum*, is unusual among soil-borne plant pathogens in that it often has a peculiar localized distribution pattern. The fungus is not spread by cultivation and irrigation, and essentially appears in the same areas year after year. The occurrence of the fungus in these well-defined areas led to the suggestion that the distribution might be influenced by some local soil condition.

If a soil factor responsible for localizing the fungus could be identified, it might be possible to manipulate this factor and thereby control the disease.

To determine whether there is a relationship between soil cation content and distribution of *Phymatotrichum*, an extensive sampling of soil from root rot areas and adjacent noninfested areas was undertaken. Levels of four cations (calcium, magnesium, potassium, and sodium) were determined and compared.

Soil cores were taken in infested areas and in adjacent noninfested areas using a hydraulic soil coring machine mounted in the bed of a truck. The 90 x 2.5 cm cores were divided into 30cm increments. Each sample consisted of a composite of three core increments from a given depth. Two sets of such composites were obtained from infested areas and two from the immediately adjacent noninfested areas. Series of samples were obtained from 12 sites in Arizona.

For cation analysis, a 5.00 g subsample of the soil sample was placed in a 50 ml plastic centrifuge tube and 25 ml of 1 N ammonium acetate solution (ph 7.0) was added. The tube was stoppered and shaken horizontally on a slide action shaker at moderate speed for 15 min. The stopper and sides of the tube were rinsed into the contents of the tube using NH4OAc, and the tube was centrifuged at 10,000 rpm for 10 min. The supernatant was decanted into a 100 ml volumetric flask. The pellet was resuspended in 25 ml NH4OAc and shaken, centrifuged, and decanted as described above. The contents of the flask were brought to volume with NH4OAc and 20 ml aliquots were stored at 10 c in screwtop plastic vials. After addition of cesium chloride to a final concentration of 100 ppm, the extract was analyzed for calcium, magnesium, potassium, and sodium content by flame atomic absorption spectrometry.

The amounts of soil sodium, potassium, calcium, and magnesium and the sum of these four cations were the five parameters used in comparing cation levels of infested areas with adjacent noninfested areas. The values for each site were compared using a one-way analysis of variance at the 95% confidence level. The results are listed in Table 2.

Table 2. Comparison of cation content of 12 Phymatotrichum-infested soils with adjacent noninfested soils (F Test, 95% level)

Milliequivalents	No Difference	Infested area	Noninfested area
Sodium	7	2[1]	3
Potassium	10	0	2
Calcium	10	1	1
Magnesium	11	0	1
Total	10	1	1

1/ Cation level significantly higher (P=0.05) in at least one of the three depth zones.

This study may have located three sites where sodium could be the factor limiting distribution of the fungus. In ten other sites, however, this was clearly not the case. At some sites there were indications that one of the other cations might be involved. Perhaps the differences in cation levels are simply a reflection of some other difference in soil chemistry or composition, such as a difference in cation exchange capacity due to differences in clay content or organic content.

These studies indicate that total extractable cations cannot explain the unique distribution pattern of Phymatotrichum root rot. Further studies are underway to determine if water-soluble cations differ in infested versus adjacent noninfested areas.

Soil distribution of strands of P. omnivorum. - Soil cores, to a depth of 90 cm, were taken in cotton fields infested with Phymatotrichum omnivorum near Marana, Arizona from June, 1979 through April, 1980. Viable strand lengths (VSL) of P. omnivorum (per 50 g soil) of 0.1 and 0.2 cm were recovered at 15-30 and 30-60 cm depths respectively, in June, 1979, whereas no VSL were recovered at 0-15 or 60-90 depths. Viable strand lengths increased during July and peaked during August and September when maximum VSL of 0.1, 0.4, 1.0, and 0.6 cm were recorded for 0-15, 15-30, 30-60, and 60-90 cm depths, respectively. Viable strand lengths declined after November. In April, 1980, VSL at 0-15, 15-30, 30-60, and 60-90 cm depths were 0.05, 0.2, 0.3, and 0.05 cm respectively. All infected tap roots contained viable strands at depths between 0-15, 15-30, and 30-45 cm during field collections made in July and August, 1978 and 1979. These percentages fell to 35-50 (0-15 cm root depth), 53-77 (15-30 cm root depth) and 76-96 (30-45 cm root depth) in later collections made from November to February (prior to plow down).

Phymatotrichum omnivorum was isolated from internal noncortical tissue of all infected cotton roots collected from the field in August. Percentage of recovery declined in September and no positive recoveries were made after October.

These studies indicate that the fungus is more common and survives for longer periods of time at increased soil depths. The reason for this survival characteristic is not known at this time.

Double cropping studies. - During the last two years it was noted that cotton planted late (about June 1) in land infested with root rot had less disease than normally expected. For that reason a field plot was initiated in heavily infested land at David Prechel's farm in Coolidge. One-half of the field was planted on April 28 (early plant) and the other half 4 weeks later (late plant). The results of this test are given in Tables 3 and 4. Root rot incidence was less than expected from previous observations. Yields were higher in the early plant test, even though disease incidence was higher. The field was out of cotton for one year prior to this test, which probably explains the lower incidence of disease.

Table 3. Short Staple Variety Demonstration, Early Plant

David Prechel - Coolidge   Agent-in-charge: Sam Stedman

Variety	Turnout[1/] %	Lint lbs./A.	Plants/A. x 1000
DPL-7120	39.5	1397[a] [2/]	36.8[a] [2/]
DPL-61	34.7	1338[a]	42.5[a]
DPL-70	35.6	1329[a]	42.8[a]
DPL-41	35.1	1281[ab]	33.3[a]
ST-825	34.0	1216[ab]	38.8[a]
ST-213	34.1	1146[ab]	38.8[a]
ST-506	30.9	1045[b]	35.3[a]

1/ Turnouts are based on laboratory gin results.
2/ Values followed by the same letter are not significantly different at the .05 level by the Student-Newman-Kuel's Test.

C.V.: Stand = 20.6%; Yield = 10.04%.

Table 4. Short Staple Variety Demonstration, Late Plant

David Prechel - Coolidge   Agent-in-charge: Sam Stedman

Variety	Turnout[1/] %	Lint lbs./A.	Plants/A. x 1000
DPL-41	34.1	1073[a] [2/]	26.0[a]
DPL-61	32.8	1025[ab]	26.8[a]
DPL-70	33.3	984[ab]	34.0[a]
ST-825	30.5	965[ab]	26.3[a]
ST-213	31.5	933[b]	34.5[a]
ST-506	29.7	918[b]	33.0[a]

1/ Turnouts are based on laboratory gin results.
2/ Values followed by the same letter are not significantly different at the .05 level by the Student-Newman-Keul's Test.

C.V.: Stand = 16.2%; Yield = 5.74%

Another test was conducted on field E-3 of the Marana Experimental Farm and was designed to compare the yield of seed cotton obtained from a cotton crop planted in April to the yield of a crop planted in late May or early June following a winter barley crop. The test was conducted at the same location for three consecutive seasons. Aerial infra-red photographs and ground observations in September, 1979 showed less Phymatotrichum root rot of cotton in the barley-cotton plots than in the standard cotton cropping plots.

Core samples were taken from these plots in December, 1979 for determination of the number of Phymatotrichum strands, ammonium nitrogen levels, and percent organic matter. Each soil sample represents a composite of five cores (divided into one foot increments), taken in the bed, and spaced about two feet apart. Two sets of five cores were taken in each plot. All samples were taken in areas with diseased plants or (in the barley-cotton plots) in areas where the fungus would be expected to occur based on infestation patterns of nearby areas.

Table 5. Effect of double cropping (barley-cotton) on soil organic matter, soil ammonium nitrogen and propagules of *Phymatotrichum omnivorum*

Soil Depth (in inches)	Organic Matter %		Ammonium Nitrogen (PPm)		Strands[3]	
	a[1]	b[2]	a	b	a	b
0-12	0.67	0.58	1.95	2.47	0	18
13-24	0.44	0.32	0.87	1.72	0	22
25-36	0.29	0.24	1.65	1.75	0	18

[1]Samples taken from the barley-cotton plots.

[2]Samples taken from early plant cotton plots.

[3]Number of strands of *P. omnivorum* recovered from a 100 g. soil sample.

Yields in this test were slightly less in the cotton planted late following barley which we believe is due primarily to a nitrogen deficiency caused by the barley crop.

We are encouraged with these results because: (1) the inoculum density of *Phymatotrichum* is reduced (we found no strands in the double-cropped plots); (2) the yields are reasonable, and (3) we have the advantage of the economics of a barley crop.

In summary, double cropping (barley-cotton) appears to be a method of "living" with root rot if we are talking about repeated planting of cotton in heavily infested land and if the price of barley is sufficiently high to off-set the reduced cotton yields.