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Soil Incorporated Sulfur for Rhizoctonia Root Rot Control in Sugarbeet^{*}

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INTRODUCTION

Sugarbeet (*Beta vulgaris* L.) losses from root rot caused by *Rhizoctonia solani* Kuehn are increasing in Texas and elsewhere (2). Cultural and management practices can affect root rot incidence (1, 3, 4, 6, 7, 12, 13); however, manipulation of these factors does not always provide adequate control. Fungicides are not used commercially on this disease although some give partial control (5, 9, 10, 11). Sulfur was tested as a crown spray in field plots and was found ineffective (10).

In a greenhouse experiment, flowable sulfur provided some control of seedling damping-off of sugarbeet caused by *Rhizoctonia solani* (8). However, since this control was noted only in unautoclaved soil, the authors speculated that the effect of sulfur may have been indirect through some other biotic system. In related field tests, flowable sulfur; applied preplant broadcast and incorporated 10-cm deep; reduced root rot intensity one year but had no effect another year.

The objective of this study was to test the effectiveness of flowable sulfur under field conditions as a preplant, soil-incorporated control of root rot caused by *Rhizoctonia solani*.

MATERIALS AND METHODS

All studies were conducted at the USDA Conservation and Production Research Laboratory, Bushland, Texas, on Pullman clay loam soil. This soil has a pH of 7.5, 1.2% organic matter, and consists of equal portions of sand,

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silt, and clay in the 25-cm plow layer. All infections were due to natural infestation.

Three sugarbeet cultivars were used in one or more studies. Holly Sugar Corporation HH32 has some resistance to *Rhizoctonia*. Great Western Mono-Hy D2 and Mono-Hy TX9, locally adapted cultivars, are susceptible to *Rhizoctonia*. Irrigation was surface-applied by flood in level basins or graded furrows.

In 1981 and 1982, flowable sulfur (sulfur A, 0.72 kg sulfur/liter) was broadcast on previously listed 76-cm beds prior to planting and incorporated 8-to 10-cm deep with a rolling cultivator. In 1983, flowable sulfur B (a combination of sulfur and copper, 0.69 and 0.06 kg/L respectively) was used in addition to sulfur A. Application and incorporation of these two materials in 1983 was the same as in prior years. Sulfur plots were four rows wide by 15m long in 1981, and 7.5 to 9.1m long thereafter, with 8 to 12 replications in a randomized complete block design.

The sugarbeets were planted in April and harvested in November. All plots were hand-thinned to a stand of six plants per meter of row. Stand counts were taken and alley-ways were cut after thinning. No further plants were removed or trimmed from the plots before harvest. The plots were harvested with a modified commercial harvester. All harvested roots were counted and the roots from each plot were given a composite disease rating according to the following index: 0 = no disease, 1 = slight, mostly healed scars; 2 = moderate, some rotted tissue; 3 = severe, much rotted tissue. Harvest weights were recorded and a representative subsample was collected for sugar analysis.

Results will be reported from five studies during 1981 to 1983. There were three studies in 1982. One of these was on the same plot area as the 1981 and 1983 studies, and will be referred to as the 1982 continuous-beets area. This area was in continuous sugarbeets beginning in 1980 and had severe rhizoctonia root rot in 1980. Another area

in 1982 previously had been cropped to sugarbeets in 1973 and 1977 and will be referred to as the 1982 rotation area. The third area used in 1982 had never been planted to sugarbeets, having been in dryland wheat and sorghum for at least 30 years. This area will be referred to as the 1982 virgin area.

RESULTS AND DISCUSSION

A significant root yield and sucrose yield response to soil-incorporated sulfur was noted across cultivars in 1981 (Table 1). Sucrose yield was increased 34, 36, and

Table 1. Yield response and disease rating of three sugarbeet cultivars with and without preplant, soil-incorporated sulfur on the continuous sugarbeet area in 1981 at Bushland, Texas.

Sulfur <u>w/</u>	Cultivar	Root yield	Sucrose	Sucrose yield	Harvested roots <u>x/</u>	Root rot rating <u>y/</u>
L/ha		t/ha	%	kg/ha	%	0 to 3
0	D2	35.2	13.75	4840	44	1.16
	TX9	24.4	14.16	3460	30	1.37
	HH32	45.9	14.05	6450	48	0.87
	Mean	35.2	13.99	4920	41	1.13
46	D2	45.2	14.38	6510	53	1.05
	TX9	32.7	14.36	4690	39	1.22
	HH32	51.3	14.11	7240	53	0.72
	Mean	43.0	14.28	6140	48	1.00
LSD .05		7.6	NS	1150	5	0.10
for sulfur means <u>z/</u>						

w/ Sulfur A, 0.72 kg sulfur/L.

x/ Harvested roots as a percentage of stand counts taken after thinning.

y/ 0 = no rot to 3 = severe rot.

z/ Since there were no significant interactions of cultivars with sulfur, means for the two sulfur rates averaged over the three cultivars are compared using LSD.

12% with Mono-Hy D2, Mono-Hy TX9, and HH32, respectively. Interestingly, root yield of Mono-Hy D2 with sulfur was about the same as HH32 without sulfur. This would indicate that the value of sulfur was about the same as the value of the genetic resistance to rhizoctonia in HH32. There was a definite visual response to the sulfur application. With sulfur the stand was improved and there was an increased percentage of harvested roots. The rating of

disease severity on harvested roots was reduced slightly by sulfur. There were no interactions of cultivars with sulfur application for any parameter in 1981.

In 1982, the virgin area had no incidence of root rot; whereas the rotation area and the continuous beets areas were severely infected. Sucrose yield and roots harvested as a percentage of early season stand were much greater on the virgin area than on the continuous-beets area. The rotation area was intermediate in sucrose yield and disease incidence (Table 2).

Table 2. Yield and disease rating with Mono-HY TX9 at several rates of preplant, soil-incorporated sulfur in 1982 at Bushland, Texas. w/

Area	Sulfur <u>x/</u> L/ha	Root		Sucrose	Harvested	Root rot
		yield t/ha	Sucrose %	yield kg/ha	roots <u>y/</u> %	rating <u>z/</u> 0 to 3
Virgin	0	65.9	16.57	10,910	93	0.0
	23	67.0	16.54	11,080	93	0.0
	46	68.8	16.53	11,370	94	0.0
Rotation	0	47.9	13.98	6,700	72	1.0
	23	48.2	14.08	6,780	70	1.2
	46	47.5	14.01	6,650	71	1.1
Continuous	0	28.7	13.43	3,850	57	1.3
	23	28.2	13.51	3,810	59	1.4
	46	28.4	13.61	3,870	55	1.5
	92	32.0	13.60	4,360	51	1.3

w/ There were no significant differences due to rate of sulfur for any parameter in any area.

x/ Sulfur A, 0.72 kg sulfur/L.

y/ Harvested roots as a percentage of stand counts taken after thinning.

z/ 0 = no rot to 3 = severe rot.

In contrast to the large effect of previous cropping history noted above, there was no yield response to sulfur on any area in 1982. There was also no noticeable effect of sulfur on the percentage of harvested roots or root rot rating indicating that sulfur had no effect on disease incidence in 1982. The lack of response to sulfur in 1982 seems to indicate that any sulfur response in the other years was not a fertilizer effect. There are no known sulfur deficiencies on sugarbeets or any other crops on

Pullman clay loam soil.

In 1983, sulfur A increased yield and suppressed root rot while sulfur B had no effect on sugarbeet yield or disease incidence (Table 3). Sucrose yield was increased

Table 3. Yield and disease rating with Mono-Hy TX9 sugarbeets at several rates of two flowable sulfurs applied preplant, soil-incorporated on the continuous sugarbeet area in 1983 at Bushland, Texas.

Material	\bar{x} / Rate	Root Yield	Sucrose %	Sucrose Yield kg/ha	Harvested roots \bar{y} / %	Root rot rating \bar{z} / 0 to 3
Sulfur A	0	17.9	15.43	2790	57	1.4
	23	17.7	15.34	2710	62	1.4
	46	23.3	15.25	3570	64	1.3
	92	25.1	15.07	3810	75	1.1
	r ²		0.31*	NS	0.29*	0.92**
intercept		17.4		2710	56.8	1.44
slope		0.089		12.67	0.191	-0.0035
Sulfur B	0	17.9	15.76	2840	61	1.3
	23	17.5	15.24	2690	61	1.3
	46	18.6	15.93	2970	62	1.5
	92	20.6	15.08	3110	64	1.2
	r ²		NS	NS	NS	NS

\bar{x} / Sulfur A, 0.72 kg sulfur/L. Sulfur B, 0.69 and 0.06 kg/L of sulfur and copper, respectively.

\bar{y} / Harvested roots as a percentage of stand counts taken after thinning.

\bar{z} / 0 = no rot to 3 = severe rot.

* Significant F-test at 5% level.

** Significant F-test at 1% level.

by 37% by 92 L/ha of flowable sulfur A compared to the untreated control. Neither flowable sulfur had any effect on the percentage of sucrose.

The benefit to cost ratio of using sulfur A was favorable in 1981 and 1983. Sulfur at \$1.32/L, plus \$12.00/ha for application, costs \$66 and \$126/ha for the 46 and 92 L/ha rates, respectively. The value of the yield increase due to sulfur A use, minus extra harvest cost, was about \$270/ha in both 1981 and 1983. Thus, benefit/cost ratios were 4.1 and 2.1 in 1981 and 1983, respectively.

Despite the favorable benefit/cost ratios outlined above, the economic feasibility of sulfur use does not

look good. In 1982, there was no response to sulfur in any of three environments studied even though root rot was severe in two environments. A similar erratic response to sulfur was noted in Colorado (8). Even where sulfur won the battle, it lost the war because yield levels in 1981 and 1983, even with sulfur use, were not high enough to provide an overall profit. If a severe root rot problem is anticipated, planting an alternative crop would probably be more profitable.

SUMMARY

Sulfur was broadcast and incorporated 8-to 10-cm deep before planting for control of rhizoctonia root rot of sugarbeets. In 2 of 3 years, sulfur gave some control of root rot and increased sucrose yield of susceptible cultivars 34 to 37%. In the other year, sulfur did not control root rot and did not increase yield in the absence or presence of the disease. The yield responses noted are not believed to be a fertilizer response.

The erratic response to sulfur and the unprofitable yield level in those cases where sulfur reduced disease incidence, probably indicates that sulfur is not an economically viable treatment for control of rhizoctonia root rot.

REFERENCES

1. Afanasiev, M. M. and D. E. Baldrige. 1968. Selection for resistance and chemical control of rhizoctonia root rot disease of sugarbeets. *J. Am. Soc. Sugar Beet Technol.* 15:151-158.
2. Hecker, R. J. and E. G. Ruppel. 1977. Rhizoctonia root-rot resistance in sugarbeet: breeding and related research. *J. Am. Soc. Sugar Beet Technol.* 19:246-256.
3. Hecker, R. J. and E. G. Ruppel. 1978. Effect of pesticides and nitrogen fertility on rhizoctonia root rot of sugarbeet. *J. Am. Soc. Sugar Beet Technol.* 20:6-10.

4. Hecker, R. J. and E. G. Ruppel. 1980. Rhizoctonia root rot of sugarbeet as affected by rate and nitrogen fertilizer carrier. J. Am. Soc. Sugar Beet Technol. 20:571-577.
5. Potter, H. S. and C. L. Schneider. 1981. Control of cercospora leaf spot and rhizoctonia crown rot diseases of sugarbeet with fungicides applied by sprinkler irrigation. J. Am. Soc. Sugar Beet Technol. 21:50-55.
6. Ruppel, E. G. and R. J. Hecker. 1982. Increased severity of rhizoctonia root rot in sugarbeet treated with systemic insecticides. Crop Prot. 1:75-81.
7. Ruppel, E. G., R. J. Hecker, and E. E. Schweizer. 1982. Rhizoctonia root rot of sugarbeet unaffected by herbicides. J. Am. Soc. Sugar Beet Technol. 21:203-209.
8. Ruppel, E. G. and R. J. Hecker. 1983. Efficacy of sulfur for controlling rhizoctonia root rot in sugar beet. Plant Dis. 67:156-158.
9. Schneider, C. L. and H. S. Potter. 1974. Tests with soil treatments and crown sprays to control rhizoctonia crown and root rot of sugarbeet. J. Am. Soc. Sugar Beet Technol. 18:45-52.
10. Schneider, C. L. and H. S. Potter. 1983. Efficacy of some fungicides in controlling rhizoctonia crown rot of sugarbeet. J. Am. Soc. Sugar Beet Technol. 22:54-59.
11. Schneider, C. L., H. S. Potter, and D. L. Reichard. 1976. Tests with fungicides to control rhizoctonia crown rot of sugarbeet. J. Am. Soc. Sugar Beet Technol. 19:150-156.
12. Schneider, C. L., E. G. Ruppel, R. J. Hecker, and G. J. Hogaboam. 1982. Effect of soil deposition in crowns on development of rhizoctonia root rot in sugarbeet. Plant Dis. 66:408-410.
13. Schuster, M. L. and L. Harris. 1960. Incidence of rhizoctonia crown rot of sugarbeets in irrigated crop rotation. J. Am. Soc. Sugar Beet Technol. 11:128-136.