Evaluation of Three Systemic Fungicides for Control of Powdery Mildew

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INTRODUCTION

Powdery mildew in sugarbeets has been an economically damaging disease in the United States since 1974. The disease is caused by a fungus *Erysiphe polygoni D.C.* (*E. betea* in Europe) which appears to be specific to sugarbeets and related crops such as Swiss chard and table beets.

Powdery mildew normally appears in California's sugarbeet fields when the crop is growing vigorously and the foliage nearly covers the area between the rows. The first signs of the disease are small, white or grayish powdery areas which appear on the underside of mature leaves. The mycelium spreads rapidly and may soon cover both leaf surfaces. Haustoria penetrate the cells of leaf tissue and the fungus produces abundant spores (conidia) that are readily disseminated by wind. The disease is favored by warm, dry climate, with temperatures ranging from 68° to 84°F. It usually attacks the older leaves spreading to newer leaves as they mature. The disease has been fairly well controlled with timely applications of sulfur, preferably dusting sulfur at rates of 30 to 40 pounds per acre applied at first signs of the disease and repeated as necessary. Restrictions may be imposed on applications of dusting sulfur because the dust formulation can be explosive, an irritant to people, and can cause injury to crops growing in nearby fields.

Systemic fungicides, including Bayleton®(triadimefon), have been tested by University of California researchers

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at Davis since 1974 (Frate (1) 1977) Frate (2) Leach and Hills 1979. In the Imperial Valley, Kontaxis conducted a field trial in 1978 (Kontaxis (5) Abstr 1978), and also found Bayleton to be effective in providing long lasting control of the disease.

The purpose of this report is to compare the effectiveness of three systemic fungicides, CGA-644250, EL-2281, and Bayleton WP, with sulfur in order to measure their relative effectiveness in controlling powdery mildew and to determine their influence on sugarbeet yields and quality.

METHODS AND MATERIALS

Eight experiments were conducted in the San Joaquin Valley of California between 1980 and 1982. Six were harvested, but two were abandoned because of low disease incidence. Treatments in each experiment were replicated 4 to 5 times in a randomized block design. The fungicides were applied in 1980 and 1981 with a CO_2 constant pressure sprayer, except for granular formulations at the Westside Field Station trial where a Clampco granular applicator was used. The broadcast formulated treatments were applied with 11006 nozzle tips. When crown applications were made, 2506 nozzle tips were used and the materials were directed to the lower petiole and crown portions of the plants. An experimental tractor drawn sprayer with six separate tanks and booms was used for the 1982 trials. Thirty pounds pressure was used and applications were made in sufficient water to wet foliage thoroughly. Evaluations were made throughout the disease season at two-week intervals by examining 25 recently matured leaves in the center two rows of each four-row plot. The degree of infestation was estimated according to the method described by Hills, et al (3,4).

Yield data were obtained by harvesting each plot with a modified 1-row commercial sugarbeet harvester equipped with a weighing scale. Two and sometimes three subsamples were randomly collected on the harvester for each plot

[1]Recently named nuarimol (Trimidal).

in each replication and submitted for tare, sugar concentration, and special quality determinations at the Spreckels regional tare laboratory at Mendota.

RESULTS

Two of the three 1980 trials were severely infested with powdery mildew and excellent data were obtained (Figures 1,2). The treatments were initiated on June 3rd and repeated in designated treatments as the season progressed. The experiments were harvested in early fall, and data are reported in Tables 1 and 2.

The disease progressed considerably slower at the Westside Field Station than at Firebaugh. Although the treatments were established on June 10th at the Westside Field Station, powdery mildew did not appear until early July. Thus, the sulfur applied on June 10th was largely ineffective and the three sulfur applications probably represent what could be expected from two well timed applications. Once started, however, the disease developed rapidly and remained at a high level until harvest (Figure 1).

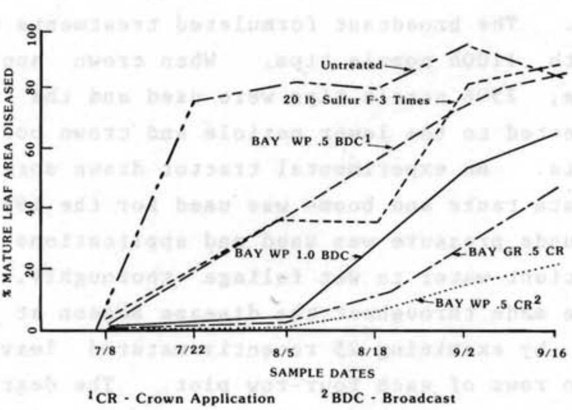

Figure 1. Sugar beet mildew control with bayleton & sulfur Univ. of Cal. Westside Field Station - 1980.

The data from Figure 1 support earlier work by Frate et al (2) in that the granular formulation of Bayleton applied in the crown area produced longer lasting disease control than when the material was applied as a broadcast

Table 1. Sugar beet yields as influenced by Bayleton® and sulfur treatment for control of powdery mildew.

Trial Location: Westside Field Station
Established: 6/10/80
Variety: USH9
Harvested: September 23, 1980
Harvest Area: 2 Rows (30") x 50'

FUNGICIDES	RATE Lb ai/A	METHOD	DATES OF TREATMENT	SUGAR T/A	BEETS T/A	SUCROSE PERCENT	NITRATE PPM	% MLAD[1] AVG.
Bayleton 5 GR.	0.5	Crown	6/10	4.04	32.1	12.6	56.5	3
Bayleton 50 WP	1.0	Crown	6/10	4.00	30.3	13.2	85.5	2
Bayleton 5 Gr.	1.0	Crown	6/10	3.86	30.4	12.7	106.0	1
Bayleton WP	1.0	Bdcst	6/10	3.80	29.9	12.7	72.7	11
Bayleton WP	0.5	Crown	6/10	3.75	31.0	12.1	84.2	5
Sulfur Flo	20.0	Bdcst	6/10,7/8,8/5	3.56	30.2	11.8	137.2	27
Sulfur Flo	20.0	Bdcst	6/10,7/8	3.49	29.1	12.0	91.2	34
Bayleton 50 WP	0.5	Bdcst	6/10	3.42	28.3	12.1	79.5	28
Untreated	---	---	---	3.02	26.0	11.6	131.5	58
Statistical Notation) LSD @ P = .05				0.99	3.1	.47	45.0	
) LSD @ P = .01				1.20	4.2	.64	60.8	

[1]Seasonal average - percent mature leaf area diseased.
Remarks: Harvested area was 250 Ft^2, values represent average calculated yields per acre.

Table 2. Sugar beet yields as influenced by treatment for powdery mildew.

Trial Location: Firebaugh, CA — Harvested: October 1, 1980
Established: June 3, 1980 — Irrigation: Furrow
Variety: USH9

FUNGICIDES	lb ai/A	METHOD	DATES OF TREATMENT					SUGAR T/A	BEETS T/A	SUCROSE %	% MLAD[1] AVE.
Bayleton [a]	1.0	Crown	6/3	----	----	----	----	3.57	30.5	11.7	1
Bayleton [a]	.5 + .5	Crown	6/3	7/15	----	----	----	3.28	29.3	11.2	2
Bayleton [a]	0.5	Bdcst	6/3	7/15	8/18	----	----	3.19	30.4	10.5	17
Bayleton [a]	.5 + .5	Bdcst	6/3	7/15	----	----	----	3.04	29.0	10.5	5
Bayleton [a]	1.0	Bdcst	6/3	----	----	----	----	3.02	28.2	10.7	10
Bayleton [a]	0.5	Crown	6/3	----	----	----	----	2.89	28.3	10.2	1
Sulfur WP[a]	10.0	Bdcst	6/3	7/2	8/4	8/12	9/9	2.53	24.1	10.5	39
Sulfur WP[a]	15.0	Bdcst	6/3	7/2	8/4	8/12	9/9	2.41	24.1	10.0	34
Sulfur Flo[b]	5.0	Bdcst	6/3	7/2	8/4	8/12	9/9	2.40	23.5	10.2	35
Sulfur WP[a]	5.0	Bdcst	6/3	7/2	7/15	----	9/9	2.35	23.5	10.0	46
Sulfur Flo[b]	2.5	Bdcst	6/3	7/12	7/15	----	9/9	2.28	24.0	9.5	51
Untreated			----	----	----	----	----	2.28	24.8	9.2	56
Statistical Notation) LSD @ P = .05								.62	3.4	NS	
) LSD @ P = .01								.84	4.6	NS	

a) X-77 added at ½% of spray volume
b) THAT 6 lb/gal wettable sulfur
1 Seasonal average - percent mature leaf area diseased
Remarks: Harvested area was 200 ft^2, values represent average calculated per acre.

spray. The yield data, however, indicated very little difference in sucrose production between the two formulations (Table 1).

Powdery mildew appeared approximately 80 days earlier at the Firebaugh site with untreated plots showing 25% leaf infection by June 24th (Figure 2). The incidence remained high until harvest in October. Sulfur in two formulations and Bayleton WP were used in this trial. Sulfur rates were lower than at the Westside Field Station, but were chosen to represent recommended commercial rates. It is obvious from the data in Figure 2 and Table 2, that the chosen rates for sulfur were inadequate.

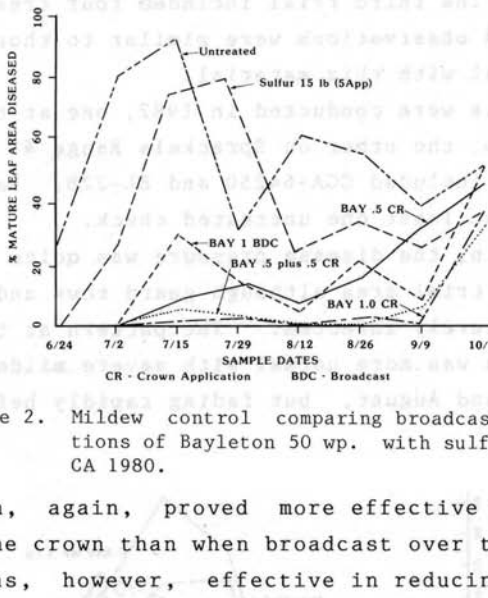

Figure 2. Mildew control comparing broadcast and applications of Bayleton 50 wp. with sulfur, Firebaugh, CA 1980.

Bayleton, again, proved more effective when concentrated in the crown than when broadcast over the foliage. Bayleton was, however, effective in reducing a powdery mildew infection when broadcast aerial applications of 0.5 or 1 lb ai/A rates were applied in a severely infected area adjacent to the replicated experiment.

A third replicated trial was established east of, and adjacent to, the Westside Field Station experiment to compare the effectiveness of several rates of CGA-64250 with sulfur. Very little powdery mildew developed in this trial, even in the untreated areas, in spite of the relatively severe incidence in the adjacent trial located up-wind from this experiment. Yield and sucrose data indicated that no statistical benefit was obtained from either CGA-64250 or sulfur over the untreated plots which averaged nearly 29 tons per acre.

The obvious visual differences between the two adjacent trials were surprising and resulted in speculation that the concentration of CGA-64250 treated plots around the untreated or sulfur plots could have change the local environment enough to alter the disease pressure.

Three replicated trials were established in 1981 comparing CGA-64250, EL-228, and Bayleton. Powdery mildew pressure was erratic, and two of the three tests were abandoned. The third trial included four treatments with CGA-64250 and observations were similar to those noted in the 1980 trial with this material.

Two trials were conducted in 1982, one at the Westside Field Station, the other on Spreckels Range 41 at Mendota. Each trial included CGA-64250 and EL-228, Bayleton WP, sulfur, and at least one untreated check.

Once again, the disease pressure was quite low at Mendota in the trial area although guard rows and the headland were severely infected. The pattern at the Westside Field Station was more normal with severe mildew appearing during July and August, but fading rapidly before harvest (Figure 3).

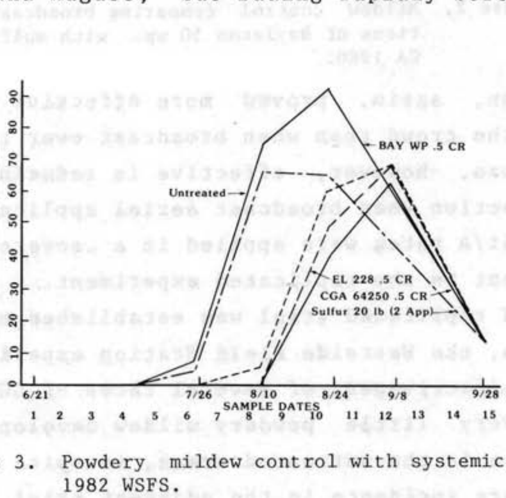

Figure 3. Powdery mildew control with systemic fungicides, 1982 WSFS.

Data from selected treatments from the two experiments are summarized in Table 3.

Table 3. Sugarbeet yields as influenced by treatment for powdery mildew (Average of two 1982 replicated trials)

TREATMENT	RATE Lb ai/A	METHOD	SUGAR T/A	ROOT YIELD T/A	SUCROSE %	NITRATE PPM	MILDEW[2] % MLAD
Bayleton W.	0.5	Crown	4.83	33.8	14.4	29	13
Sulfur	40[1]	Bdcst.	4.60	33.1	14.0	27	23
EL-228	0.5	Crown	4.53	33.4	13.7	35	12
CGA-64250	0.5	Crown	4.49	32.7	13.8	31	11
Untreated	---	---	4.36	31.4	14.0	26	33
LSD @ P = 0.5			0.41	1.5	NS	NS	
LSD @ P = .01			NS	2.0	NS	NS	

[1]Two applications
[2]Seasonal average - mature leaf area diseased

The disease pattern illustrated in Figure 3 demonstrates that all three systemic fungicides are superior to 20 pound rates of wettable sulfur applied as preventative treatments. The pattern for similar applications of each fungicide is much the same and all three provided more effective control at 0.5 lb ai/A rate than 20 lbs/A of wettable sulfur. Some evidence of leaf burn was evident with CGA-64250 and EL-228 when the 0.5 pound rates were concentrated into the crown area.

Although the disease pressure was severe for only a relatively short period of time in the 1982 trials, it was evident that rates of 0.25 lb ai/A were not as effective as the 0.5 lb ai/A rate. Averages for the three fungicides totalling seven treatments and including both crown and broadcast applications are compared at 0.25 and 0.5 lb ai/A rates in Figure 4. The graphs clearly indicate that the low rate does not provide effective control for as long a period of time as the 0.5 lb ai/A rate.

Yield data, as expected, indicated that the untreated plots resulted in less yield reduction in the 1982 trials when powdery mildew pressure was less severe (Table 3). There was a significant improvement in gross sugar and root yield in the treated areas, but a separation of

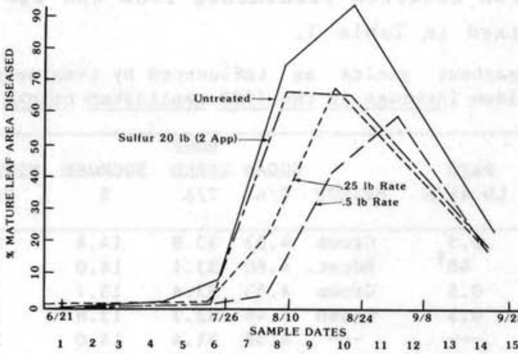

Figure 4. Powdery mildew control with three systemic fungicides, and sulfur. Compairson of .25 and .5 lb rates.

treatment effectiveness was not possible under 1982 conditions.

Powdery Mildew and Sugarbeet Quality:

Selected treatments from each of four trials conducted over the three year period were designated for special analysis for the following additional sugarbeet quality factors: (1) Diffusion juice purity, (2) Percent invert sugar on sucrose in the tare sample, (3) Color (percent transmittance of the extracted sugar sample solution compared with distilled water at 420 nm.).

Three treatments were selected for the special analysis in each of the four trials. The pooled data represents values from 16 comparisons (4 trials x 4 replications), and are summarized in Table 4.

It is evident that uncontrolled powdery mildew significantly reduces sugarbeet yield and quality in several ways: (1) Sucrose percent, (2) Diffusion juice purity, (3) Root yield and (4) Gross sugar yield.

Invert percent increased significantly as mildew percentage increased and there was a trend toward increasing the root nitrate content and the juice color although neither nitrate nor juice color were statistically significant under the conditions tested.

The data presented from four trials conducted over the

Table 4. Powdery mildew and beet quality, four test averages 1980-1982.

	BAYLETON	SULFUR	UNTREATED	LSD P = .05
Mildew % 1	6	13	51	12
Sucrose %	12.7	12.1	11.6	0.6
Purity %	81.2	80.2	78.7	1.4
Nitrate ppm	61	84	92	NS
Invert %	0.51	0.63	1.01	.40
Color	17	18	21	NS
Yield T/A	34.4	32.3	31.1	1.8
Sugar T/A	4.39	4.02	3.70	0.32

[1]Percent mature leaf area diseased (seasonal average).

past two years showed a reduction in mildew incidence in the checks when CGA-64250 and or EL-228 were included in the experiments. The evidence is largely circumstantial, but consistent when the replicated trial observations are compared with behavior in headlands and in guard rows. The results from 1980, 1981, and 1982 indicate the possibility that one or perhaps both of these fungicides may be volatile enough to influence adjacent untreated check plots, or plots treated with inadequate levels of fungicides. The data suggest that these findings need to be confirmed by altering test designs to minimize the risk to adjacent plots.

The data reported are in agreement with the earlier findings of Frate, Leach, Hills and Kontaxis in that powdery mildew when uncontrolled results in a significant yield loss. The data also confirm that systemic fungicides offer longer lasting control than that obtained from sulfur and that crown applications of Bayleton provide longer lasting control than broadcast applications.

CONCLUSIONS

1. Sugarbeet yields and quality are significantly reduced when powdery mildew remains uncontrolled for an extended period of time.
2. Three systemic fungicides, Bayleton WP, CGA-64250, and EL-228, controlled powdery mildew effectively for long period of time and improved sugarbeet

yield and quality.

3. The experiments indicated 0.5 lb ai/A would be required from all three compounds to provide adequate mildew control under most Central conditions. Follow-up treatment with additional systemic fungicide or sulfur could be required under severe disease pressure.
4. Altough Bayleton granules applied in the crown were superior to the WP formulation, the WP formulation was very effective. Broadcast applications of Bayleton WP were consistently inferior to crown applications.
5. The data suggest, but do not positively demonstrate, that broadcast applications of CGA-6425 and EL-228 were as effective as crown applications. (Some evidence of phytotoxicity was noted when these materials were applied to the crown area at the 0.5 lb ai/A rate).
6. All three systemic fungicides provided excellent control of powdery mildew at 0.5 lb ai/A and they were more effective than sulfur in the wettable or flowable formulation.

SUMMARY

Three systemic fungicides, Bayleton WP, CGA-64250, and EL-228, provided more effective control of powdery mildew on sugarbeets than sulfur. All three systemic fungicides provided season long control at 0.5 lb ai/A when applied at layby. Bayleton WP sprayed into the crown of the beets provided better mildew control than broadcast applications.

Significantly improved root and sugar yields were obtained with the systemic fungicide when compared with yields from sulfur or untreated areas. (early observations suggest that CGA-64250 may be more volatile than Bayleton.)

ACKNOWLEDGMENTS

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