Powdery mildew of sugar beet—here to stay?

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Powdery mildew disease of sugar beet has been known for many years in Europe and the Middle East, but it was seldom seen in California before 1974. The sudden and widespread occurrence of the disease in 1974 throughout the western United States is difficult to explain but probably was due to the introduction or development of a virulent race of the pathogen in or near the Imperial Valley, from where it rapidly spread by windblown spores to other areas. The continued presence of the disease in all areas in 1975 and 1976 indicates that a pathogenic race of this fungus disease is here to stay.

The disease is seldom seen in the field until 8 to 12 weeks after seedling emergence when small, white, powdery spots appear on older leaves. The fungus body (mycelium) rapidly grows over both surfaces of the leaf blade and obtains nourishment by sending numerous infection pegs into the first layer of leaf cells (epidermal cells) where absorbing organs (haustoria) develop. Asexual spores (conidia) are produced profusely by the surface mycelium, causing the powdery appearance of the leaf (fig. 1). Conidia are airborne and can be carried considerable distances to start new infections. Once started in the field, the disease increases rapidly, until, within a month, the leaf area can be nearly covered by the fungus.

There are powdery mildew diseases of many crops, but even though the fungus bodies and spore structures may look alike on different host species, the spores from one host species usually cannot cause the disease on another. The fungus race causing the disease on sugar beet appears to be restricted to the genus *Beta* and thus will cause powdery mildew only on sugar beet, swiss chard, table beet, and wild *Beta* species.

In 1974 and 1975, seven field tests at Salinas, Five Points, and Davis indicated that the disease reduced sugar yield 20 to 30 percent. (Control plants were kept healthy with sulfur.) These sugar losses result from the effect of the fungus in reducing root growth and root sugar concentration.

Some sugar beet varieties differ in their reaction to powdery mildew. Those showing some resistance to the fungus appear to suffer less yield loss. For a variety to be useful in California, it should also have resistance to the curly

TABLE 1. VARIETY DIFFERENCES IN SUSCEPTIBILITY TO POWDERY MILDEW ON SUGAR BEETS AT U.C., DAVIS

Variety origin	Reaction to powdery mildew	Root yield		
		Healthy	Diseased	Loss
		tons/acre		
Holland	Moderately resistant	33.7	31.4	2.3
California	Susceptible	35.3	29.3	6.0

TABLE 2. EFFECTS OF SULFUR FORMULATION, VOLUME OF SPRAY, AND APPLICATION DATES ON POWDERY MILDEW DEVELOPMENT AND SUGAR YIELD IN TWO LOCATIONS (1975)

Material	Amount/acre		Date applied	Area of mature leaves diseased		Sugar yield
	lb	*gal*		*percent*		*hundred lb/acre*
Davis				Sept. 1	Sept. 29	Oct. 3
None	–	–		86	94	76.2
Wettable sulfur	10	80	7/17, 8/13, 9/11	3	2	98.6
	10	80	7/17	47	83	89.0
	10	40	7/17	27	79	88.9
	10	20	7/17	54	85	90.5
	10	10	7/17	37	79	93.2
Dusting sulfur	40	–	7/17	11	56	98.4
LSD, 5%, one tailed				13	11	9.3
two tailed				16	14	7.1
Five Points					Sept. 2	Sept. 3
None	–	–			77	77.7
Dusting sulfur	40	–	6/26, 7/22		<1	87.3
Wettable sulfur	10	40	6/26, 7/22		22	90.6
	10	20	6/26, 7/22		12	91.1
	10	10	6/26, 7/22		24	90.3
LSD, 5%, one tailed					14	8.3
two tailed					16	10.0

TABLE 3. SUGAR YIELDS AS AFFECTED BY FUNGICIDES FOR POWDERY MILDEW – U.C., DAVIS, 1975

Treatment*		Sugar yield	
Fungicide	Rate/acre†	1974	1975
		hundred lb/acre	
Not treated	None	55.9	72.3
Benlate 50%	1.0 lb	78.2	–
Benlate 50% plus oil	1.0 lb plus 1 qt	–	90.6
Milstem 50%	1.0 lb	66.3	–
Morestan 25%	0.5 lb	64.8	–
Du-Ter 45.7%	0.5 lb	63.0	–
Sulfur, wettable, 98%	10 lb	81.1	102.4
Mertect 340F, 42.2%	10 fl oz	–	79.3
Kocide 404S‡	2 qt	–	84.7
BAY MEB 6447, 25%	0.125 lb	–	93.5
Elanco 222, 1 lb/gal	0.09 lb	–	97.8
LSD 5%, one tailed		4.6	6.4
two tailed		5.6	7.7

* Applied in 50 gal water/acre three times, except Benlate in 1974 applied four times.

† Rate used was as formulated.

‡ Kocide 404S contains 27.5 percent cupric hydroxide and 15.5 percent sulfur per gallon.

TABLE 4. SUGAR YIELD DUE TO POWDERY MILDEW CONTROL BY BAY MEB 6447 APPLIED TO SOIL COMPARED TO TOPICALLY APPLIED WETTABLE SULFUR, U.C., DAVIS 1975

Application method and material	Rate (active ingredient)	Date applied	Sugar yield*
	lb/acre		*hundred lb/acre*
Test 1, BAY MEB applied under seed:			
None	–	–	77.6 a
Wettable sulfur	10	7/23	93.0 b
BAY MEB 6447	1	at planting	96.6 b
Wettable sulfur	10	7/23, 8/13, 9/3	100.6 bc
BAY MEB 6447 plus	1	at planting	
wettable sulfur	10	7/23	103.9 c
Test 2, BAY MEB sidedressed:			
None	–	–	74.8 a
BAY MEB 6447	1	6/24	90.8 b
Wettable sulfur	10	7/23	95.4 bc
BAY MEB 6447 plus	1	6/24	
wettable sulfur	10	7/23	98.2 c

* Values followed by a common letter are not significant statistically at the 5 percent level (LSD test).

Fig. I. Sugar beet leaf with powdery mildew. The profuse production of spores (conidia) gives the leaf the powdery appearance characteristic of the disease.

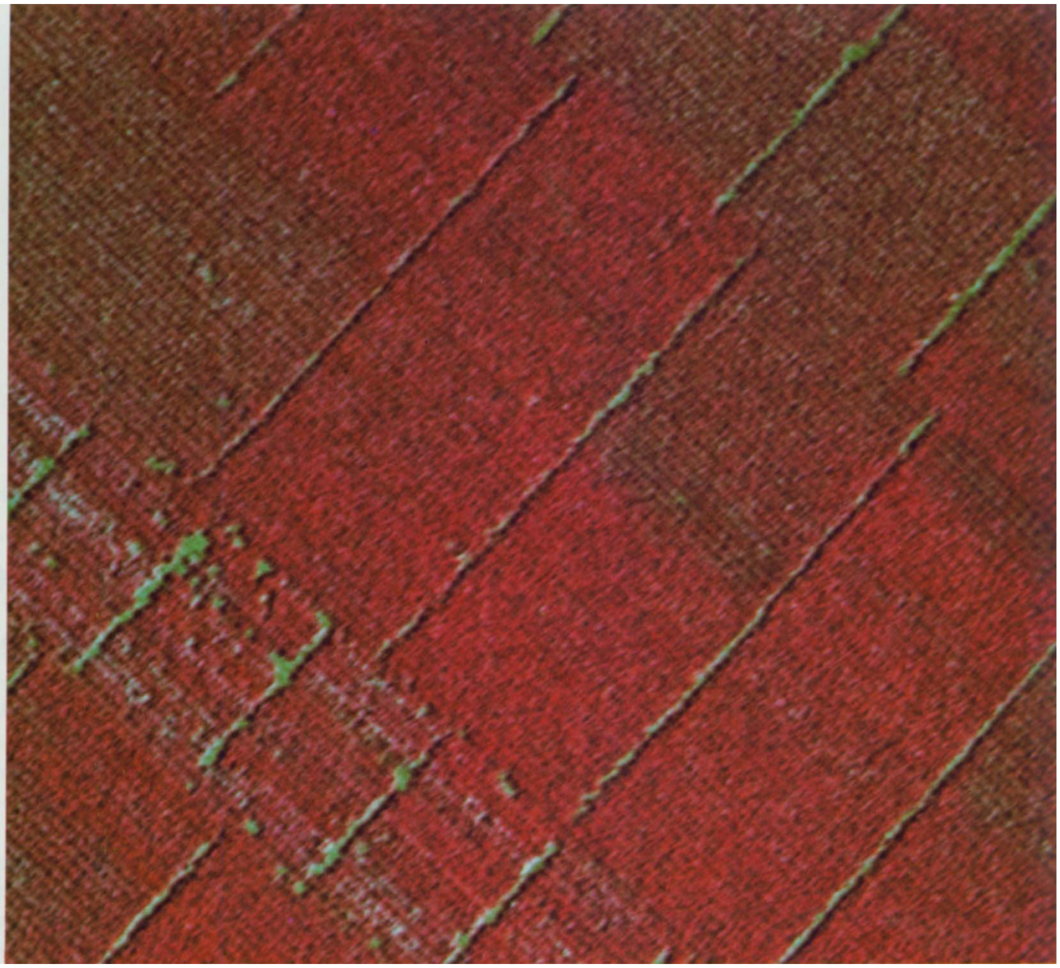

Fig. 2. Research on powdery mildew at U.C., Davis. In this infrared aerial photo, the pale areas are where the disease was not controlled. Controlling the disease results in dark-green foliage, which appears as deep red on infrared film.

top virus, the beet yellowing viruses, and bolting. The European mildew-resistant varieties tested so far do not have the combination of characteristics essential for California, and, even though they show less mildew infection, they suffer losses that are great enough to warrant fungicide treatment (table 1).

It appears possible to develop varieties adapted to California that are resistant to powdery mildew, but it will take time. Meanwhile, other effective and economical control measures are available.

Control with sulfur

Powdery mildew on sugar beets is easy to control with sulfur dust or wettable sulfur spray. Tests at Davis, Five Points, and Salinas indicate that control should be started when the disease can first be seen as small spots on a few older leaves. At this time, an application of 20 to 40 pounds of sulfur dust per acre or 10 pounds of wettable sulfur in at least 10 gallons of water per acre should protect against serious crop loss. Following this treatment, if disease increases again, a second application four weeks later appears to give adequate protection until harvest (table 2).

Early application is important. At Davis, in 1974, two weeks delay in the application of sulfur reduced sugar yield 17 percent. On the other hand, complete protection in late season does not appear to be necessary. In the 1975 Davis test (table 2), plants that received a single application of wettable sulfur at the first sign of disease averaged 91 percent of the yield of plants kept nearly disease-free all season, yet 41 percent of the mature leaf area of these plants showed mildew signs one month before harvest, and the disease area increased to 82 percent at harvest. A single application of sulfur dust resulted in 11 percent mature leaf area diseased a month before harvest and 56 percent at harvest, but these plants gave maximum sugar yield.

From these observations it appeared that 25 to 30 percent of the mature leaf area could be diseased five weeks before harvest with little or no reduction in sugar yield. Studies are under way to develop a procedure for predicting yield losses corresponding to certain disease-severity levels and stages of crop development.

Other fungicides

Various fungicides were compared with sulfur during 1974 and 1975 for control of powdery mildew. Except for Benlate, three applications were made, all at a single rate, beginning when mildew first appeared. Benlate was applied four times in 1974; the first application was made before mildew appeared.

All of the compounds tested improved sugar production over that of the untreated control (table 3). Only Elanco 222 gave control equivalent to wettable sulfur. BAY MEB 6447 also gave good control, but the rate used probably was too low for best results, because the degree of control improved with each additional application. Mildew control with Kocide 404S also improved with additional applications, probably reflecting an increase in the amount of sulfur with each application.

Systemic fungicides

Another possible method of controlling powdery mildew on sugar beets would be the application of a systemic fungicide to seed, soil, or foliage.

In tests at Davis, treatment of seed with three systemic fungicides at optimum dosages controlled mildew for up to two months in the greenhouse, but in the field, seed treatment had no effect on the level of disease or yield. Apparently, by the time the mildew appeared (60 to 75 days after seeding) the sugar beets were too large for the amount of chemical applied to the seed to provide internal protection.

Table 4 shows that the most effective systemic fungicide tested, BAY MEB 6447 (triadimefon), applied in granular form at 1 pound active ingredient per acre 3 inches below the seed at planting time or sidedressed eight weeks later, protected against mildew during most of the season. BAY MEB 6447-treated plots yielded about the same as plots treated with one sulfur spray (10 pounds per acre). Plots that received the fungicide below the seed and were later sprayed once with sulfur yielded as well as plots sprayed three times with sulfur.

At the present time, most of the fungicides we have tested are not registered for the control of sugar beet powdery mildew. Sulfur is registered and is recommended. Questions concerning the use of sulfur in a particular area should be directed to the local Cooperative Extension office.

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Powdery mildew on wheat cultivar Cocorit 71–on leaf blade (left) and on awns and glumes of a wheat head (right).

Wheat varieties susceptible to powdery mildew

Demetrios G. Kontaxis

During the last few years emphasis has been placed on wheat production in the Imperial Valley. In 1975-76 about 115,000 acres were planted to durum and another 35,000 acres to "bread" wheat.

REACTION OF WHEAT CULTIVARS TO POWDERY MILDEW IN IMPERIAL VALLEY, CALIFORNIA–1976

Type and cultivar	Disease index*
Bread:	
Anza	1.0 c
Cajeme 71	1.2 c
INIA 66R	1.2 c
Yecora Rojo	1.5 c
Durum:	
Mexicali 75	1.5 c
Cocorit 71†	6.0 b
Produra	7.7 a
Crane "s"	9.5 a
Modoc	9.5 a

* Disease index (average of four replications): 1 = 10 percent of foliage covered with fungal growth; 10 = 100 percent of foliage covered with fungal growth. Means with different letters are significantly different at the 5 percent level on Duncan's multiple range test. Means with the same letter are not significantly different.

† Numerous cleistothecia were observed on infected leaves of Cocorit 71 cultivar in a local field.

Powdery mildew caused by *Erysiphe graminis* DC was present in 1976 in several wheat fields. The disease also appeared in a variety trial at the University of California Imperial Valley Field Station near El Centro to the extent that evaluations of relative susceptibility of the cultivars could be made. The plots were seeded January 15, 1976, at the equivalent of 90 pounds per acre in a randomized complete block design and were replicated four times. Disease status was evaluated visually on May 18, 1976 (see table).

The incidence of severe powdery mildew on wheat is erratic in the Valley. This test was designed to study the performance of the cultivars in the desert environment rather than their reaction to powdery mildew. The experiment design did not provide extra plots for possible chemical control of the disease and the study of its effect upon yield. Yield data in this context, therefore, were not taken.

Cultivars Anza, INIA 66R, Cajeme 71, Mexicali 75, and Yecora Rojo were resistant to powdery mildew. The remainder of the cultivars exhibited varying degrees of susceptibility to the disease.

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