Chemical control of seed-borne diseases of wheat and barley

Dennis H. Hall ■ Beth L. Teviotdale ■ Albert O. Paulus

When alkyl mercury compounds were prohibited as treatment for seed-borne diseases of cereals, tests were begun to find effective controls that do not contain mercury.

Barley, wheat, and oats are susceptible to several seed-borne fungus diseases which, if not controlled, may cause considerable loss in yield. Included among these diseases are Helminthosporium stripe of barley and the covered and loose smuts of wheat, barley, and oats. Each smut disease is caused by a different fungus that is specific in its ability to infect a particular cereal host.

Seed-borne diseases fall into two general categories based on the manner of transmission. Most of the smut fungi are carried as spores on the seed surface and are relatively easy to control with seed dressings. Barley stripe disease and nuda loose smut of wheat and barley exist as mycelium deep within the seed, and therefore are more difficult to control.

Most seed-borne diseases were controlled by treating seed with alkyl mercury compounds until 1972 when all use of mercury-containing compounds in agriculture was prohibited. It then became essential to find suitable alternative chemicals to protect some of our most important food and feed crops from severe losses. A project, funded in part by the Bureau of Reclamation, Department of the Interior, was conducted from 1971 through 1976 to screen fungicides for use as seed dressings. Some of the results of these studies are reported here.

Stinking smut (bunt) of wheat, caused by two similar pathogens *Tilletia caries* and *T. foetida*, was chosen as one of the test diseases. Most wheat cultivars that have been or are being used in California are susceptible to one or both of the two species of the bunt fungus. This was illustrated in a non-replicated trial conducted at Davis in 1972 (table 1). Generally, *T. foetida* caused a higher percentage of smutted heads in most cultivars than did *T. caries*. Wheat for use in the trials was infested by dusting spores of the bunt fungus on the seed before treatment. Both *T. caries* and *T. foetida* were used as test pathogens in different trials. Trials with common bunt disease were conducted on the campuses of the University at Riverside and Davis and at the South Coast Field Station. The amount of wheat smut was based on head counts made at maturity, and disease incidence was expressed as a percentage of smutted heads. Plots for each treatment were usually single-row, 8 feet long, and replicated four to six times.

Barley stripe disease caused by the fungus *Helminthosporium graminium* was a second test disease used in these studies. Trials on stripe were conducted at the

TABLE 1. Susceptibility of Some Wheat Cultivars to Two Species of the Bunt Fungus, *Tilletia caries* and *T. foetida*—Davis, 1972.

	Percent smutted heads	
Cultivar	*T. caries**	*T. foetida†*
Sentry	5.2	<1
Leeds	<1	<1
Pacific Bluestem 37	0	22.0
Bluebird 4	40.4	34.8
Sonora 64‡	11.9	36.5
Sonora‡	44.8	36.1
Sonora 37	0	41.2
Poso	0	13.2
Poso 48	<1	21.2
Azteca 67	17.6	20.2
Pitic 62	9.7	35.0
White Federation	13.2	19.9
White Federation 54	0	80.6
Big Club 60	0	37.4
Ramona	17.1	24.1
Ramona 50	<1	24.8
Nainari 60	13.3	20.8
Nuri 70	15.0	58.2
Onas	3.8	52.5
Onas 53	0	61.4
Anza	7.1	43.9
Lerma Rojo 64	15.0	52.2
Inia 66R	13.4	47.4
Siete Cerros 66	10.2	<1

**T. caries* obtained from Washington State University.
†*T. foetida* collected in Sutter County, 1971.
‡Sonora 64 is not related to Sonora and Sonora 37.

TABLE 2. Efficacy of Certain Fungicides in Control of Stinking Smut of Wheat (*Tilletia caries* or *T. foetida*)

		Percent smutted heads							
	Cultivar— bunt species: rate/cwt	1973 Inia 66R *T. caries*		1974 Pitic 62 *T. caries*		1975 Anza *T. foetida*		1976 Anza *T. caries*	
Treatment*	as formulated	UCD†	SCFS†	UCD	SCFS	UCD	UCR†	UCD	UCR
Inoculated ck.		<1	30.5	18.7	14.3	86.3	36.3	11.5	23.4
Ceresan L	1 oz.	0	0	0	0	<1	0	0	0
Vitavax 200	2 fl. oz.	0	<1	0	0	—	—	—	—
	3 fl. oz.	—	—	—	—	2.2	<1	0	<1
TerraCoat LT-2	3.3 fl. oz.	—	—	—	—	0	7.3	0	<1
	4.1 fl. oz.	0	<1	0	0	—	—	0	<1
Granox NM WP	1.6 oz.	—	—	0	0	0	0	—	—
Granox NM FL	2.7 fl. oz.	—	—	0	<1	—	—	0	<1
Manzate 200	2 oz.	0	<1	—	—	—	—	—	—
	4 oz.	0	0	0	0	—	—	—	—
Dithane M-45	2 oz.	0	—	—	—	—	—	—	—
	4 oz.	0	—	—	—	—	—	—	—
Ortho-Vitavax 2+2	3 fl. oz.	—	—	—	—	—	—	1	—
Ortho-HCB 2+2	2.5 oz.	—	—	—	—	—	—	0	—
Difolatan-Vitavax 2+2‡	3 fl.oz.	—	—	—	—	—	—	0	—

*Chemicals listed are registered trade names.
†UCD = University of California, Davis Campus
UCR = University of California, Riverside Campus
SCFS = University of California, South Coast Field Station
‡Not registered for use at this writing.

University of California, Davis and Riverside campuses, at Tulelake and South Coast Field stations, and in 1974-75 at two additional locations in the San Joaquin Valley. A barley cultivar, Grande, naturally infected with barley stripe, was used in initial screening trials. Later the cultivar Briggs was used to develop a seed source in which about 50 percent of the seed were infected with the stripe fungus. Incidence of barley stripe disease was determined by making stand counts of seedlings, then counting stripe-infected plants shortly after heading and calculating the percent of plants infected.

Chemicals to be screened were applied to seed of both barley and wheat by atomizing with a deVilbis atomizer a suspension of the chemicals onto the seed as they tumbled in a fluted rotating drum. In a few instances certain chemicals could not be applied through an atomizer, and these were applied as slurries. The amount of seed treated was never less than 200 grams for each treatment. Ceresan L (an alkyl mercury) was included in all tests as a standard for comparing performance of test chemicals.

The effectiveness of each chemical tested was based on reduced disease incidence as compared with that in the control, and on consistency of performance among locations and years. A reduction to less than 1 percent was considered adequate control of the diseases under all conditions except in those trials where disease incidence was low in the untreated control. In addition to disease reduction, the following four criteria were established to aid in selecting safe as well as useful compounds: the fungicide should (1) have biological activity equal or similar to that of the mercuries against target organisms; (2) be nonphytotoxic to seedlings; (3) be effective at relatively low rates; and (4) not be appreciably hazardous to man or other animals.

During the course of these studies, over fifty chemicals or combinations of chemicals were screened. PCNB, carboxin, mancozeb, and maneb plus HCB all provided excellent control of seed-borne wheat bunt and were equal to control achieved by the alkyl mercuries (table 2). Many of the fungicides used reduced the incidence of both test diseases, but only those treatments containing carboxin alone or in combination gave consistent control of the deep-seated type of diseases as exemplified by barley stripe disease (table 3). The tests clearly demonstrated that seed-borne disease of winter cereals can be effectively controlled with compounds that do not contain mercury.

TABLE 3. Comparison of Carboxin Fungicides to Alkyl Mercury for Control of Barley Stripe Disease *(Helminthosporium gramineum)*

Location	Year	Untreated check	Ceresan L 1 oz*	Vitavax 200 2 oz	Vitavax 200 4 oz	Vitavax 75 WP 4 oz
Tulelake	1972	13.4	1.8	—	—	—
	1973	5.9	<1	<1	<1	—
	1974	7.9	<1	—	<1	—
Davis	1972	5.8	0	—	—	<1
	1973	1.5	0	0	0	—
	1974	15.2	<1	—	0	—
	1975	7.0	0	0	—	—
Riverside	1972	3.5	<1	—	—	<1
	1973	2.8	0	0	<1	—
	1974	14.4	<1	—	0	—
Kings Co.	1975	11.4	0	—	<1	—

*Rate used per 100 pounds of seed.

Dennis L. Hall, Beth L. Teviotdale, and Albert O. Paulus are Extension Plant Pathologists at Davis, Parlier, and Riverside, respectively.

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Environmental influences on corn hybrids

John D. Prato ■ Jack P. Orr ■ Franz R. Kegel ■ Thomas E. Kearney ■ Everett F. Nourse

Single- and three-way-cross hybrids, and differences in soil types and climate, have made single-environment testing of corn hybrids inapplicable for variety evaluation. Growers must test varieties under their own growing conditions before making selections.

Most of California's grain corn acreage is in the great Central Valley. Major production is in the Delta—about 50 miles long and 20 miles wide, where Sacramento and San Joaquin rivers converge before entering San Francisco Bay.

For a number of years the University of California used a single site for evaluating corn hybrid varieties from other areas of the United States for adaptation to the Delta production area. This limited program was made difficult to continue by the increasing numbers of hybrids. A change to single- and three-way-cross hybrids also raised questions about the applicability of a single test environment to evaluate these hybrid types. The possibility existed that these types were less uniform in performance from one location to another than older double-cross hybrids.

During 1970 and 1971, a study was made to determine the validity of using a single test location for evaluating corn hybrids for planting in the Delta. Information was needed on the influence of years by weather and location on the relative performance of hybrids.

The study was conducted at seven test sites in each of the two years. Three