Control of Common and Dwarf Bunt of Wheat by Seed Treatment with Thiabendazole

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ABSTRACT

Thiabendazole [2-(4-Thiazolyl)-benzimidazole], 60% active, controlled seed- and soil-borne common bunt of wheat when used as a seed treatment at 1.6 g/liter (2 oz/bu). Dwarf bunt was controlled at most test locations by seed treatment at 3.2 g/liter (4 oz/bu). Effectiveness of Thiabendazole against dwarf bunt increased with lateness of seeding, suggesting that effectiveness depends on the amount of plant growth prior to infection. Control of dwarf bunt by seed treatment indicates that Thiabendazole may persist in the wheat plant for several months. Phytopathology 61:1071-1074.

Additional key words: Tilletia caries, T. foetida, T. controversa, Triticum aestivum, fungicides.

The near elimination of common bunt (*Tilletia caries* [DC.] Tul. and *T. foetida* [Wallr.] Liro) from Pacific Northwest wheat (*Triticum aestivum* L.) during the last decade ranks as a major contribution of plant pathology to the agriculture of this region. This notable achievement is the result of maintenance of high levels of bunt resistance in wheat cultivars and the judicious use of hexachlorobenzene (HCB) seed treatment.

The importance of HCB seed treatment in the long-term control of common bunt in the Pacific Northwest is indicated by several factors. Prior to 1956, before HCB seed treatment was widely used, the breakdown of resistance to bunt was the primary factor responsible for changes in wheat cultivars. After 1956, bunt resistance became of secondary importance, and changes in cultivars were brought about by other diseases (chiefly stripe rust) and by improvement in yield and other agronomic characters. During this period, new common bunt races were identified (1, 5, 6). Some of these races are capable of attacking cultivars now being grown, but they are apparently held in check by HCB seed treatment.

Dwarf bunt, on the other hand, is not controlled by seed treatment and has become increasingly important as a pest of fall-sown wheat. Races of the pathogen (*Tilletia controversa* Kühn) capable of attacking most of the cultivars now being grown have appeared recently, and are becoming widely distributed in the Pacific Northwest (2, 3). The occurrence of dwarf bunt is sporadic; its distribution and severity is to a large extent correlated with a persistent snow cover. In contrast to common bunt, dwarf bunt infection occurs during winter, after the wheat plant has emerged (11). Infection is presumed to occur through the developing tillers from spores at or near the soil surface. Application of HCB or pentachloronitrobenzene (PCNB) to the soil surface after seeding controls the disease (10), but the cost of this treatment has prohibited its use in the USA.

The success of systemic fungicides in controlling loose smut and other smuts of cereals and grasses (8) offers hope of controlling dwarf bunt by seed treatment. Moreover, such materials may be useful as replacements for HCB for control of common bunt. Strains of *T. foetida* tolerant to HCB and related polychlorobenzenes have appeared in Australia (7) and may occur in the USA. In addition, HCB has a narrow spectrum of fungicidal activity. Broad-spectrum materials would be desirable, particularly since the use of organic mercury fungicides has been restricted.

Consequently, evaluation of seed treatment materials for control of common and dwarf bunt has continued at this laboratory, with emphasis given to materials having possible systemic or broad-spectrum activity. This is a report of results obtained with one systemic material, 2-(4-Thiazolyl)-benzimidazole (Thiabendazole).

MATERIALS AND METHODS.—The formulations of Thiabendazole used were Mertect, a wettable powder containing 60% active ingredient, and Mertect-E, a special-patented flowable formulation containing 30% active ingredient. In tests with common bunt, 40% HCB (Anti-Carie 40) and 2.2% cyano (methylmercuri) guanidine (Panogen 15) were used as standards of comparison. Formulations were applied to wheat seed in units of 250 ml. Wettable powders and flowable formulations were applied as slurries; liquid formulations were applied as 1:9 dilutions with water. The method of treatment is described by Purdy (9).

For evaluation of seed treatments for control of common bunt, seed of the winter wheat cultivar Orin, C.I. 12687, was infested with spores of *T. caries,* race T-16, at the rate of about 1 g spores/100 ml of seed.

In tests with seed-borne common bunt, the infested seed was sown in bunt-free soil. In the soil-borne tests, the infested seed was sown in soil inoculated by spraying open furrows with a water suspension of spores so as to apply about 1 g spores/3 m of row. The seed was planted in October 1968 and 1969, in 1.5-m rows with two replications of each treatment in each test at Pullman, Wash., and Pendleton, Ore.

In tests for control of dwarf bunt, treated and untreated seed of Westmont, C.I. 12930, were planted shallowly in 1.5-m rows in naturally infested soil. Tests were conducted at Pullman, Wash., and Kalispell, Mont., in 1968, and, in addition to these locations, at Flora, Ore., and Cavendish, Idaho, in 1969. Additional inoculum was applied at Pullman and Kalispell by spraying the soil surface in rows with a suspension of dwarf bunt spores after seeding. At Pullman, the seed was planted in deep furrows which were filled with vermiculite about 1 December to simulate a snow cover. Two or more replications of each treatment were seeded at each test location. The treatments were evaluated from bunt percentages computed from head counts in each row.

RESULTS.—*Common bunt.*—Seed and soil inoculation resulted in moderate levels of common bunt infection in untreated check rows in 1969 and in high levels of infection in 1970 (Table 1). The standard seed treatment fungicide, HCB, provided excellent control of both seed- and soil-borne bunt in 1969, but only fair control in 1970. Cyano (methylmercuri) guanidine provided excellent control of seed-borne bunt, but was not effective against soil-borne bunt. Thiabendazole 60% provided excellent control of seed-borne bunt at rates of 1.6 and 3.2 g/liter in 1969, and at 0.8, 1.6, and 3.2 g/liter (1, 2, and 4 oz/bu, respectively) in 1970; it was also effective against soil-borne bunt at rates of 1.6 and 3.2 g/liter. It was slightly less effective against soil-borne bunt than HCB in the 1969 tests, but was more effective than HCB in the 1970 tests. Thiabendazole 30%, which was tested only in 1970, controlled seed-borne bunt at 1.6 and 3.2 g/liter, but was effective against soil-borne bunt only at the higher rate (3.2 g/liter).

Dwarf bunt.—Preliminary tests at Pullman, Wash., and Kalispell, Mont., in 1969 indicated that seed treatment with Thiabendazole greatly reduced the incidence of dwarf bunt. These results were confirmed (Table 2) in more extensive tests at these and other locations in 1970. The rate of treatment at which Thiabendazole was effective varied among test locations. For example, in 1970, seed treatment with Thiabendazole 60% at 1.6 g/liter reduced dwarf bunt incidence at Kalispell, Mont., from 65 to 17%. A corresponding reduction in dwarf bunt incidence was obtained with 4.8 g/liter at Pullman, Wash., and 3.2 g/liter at Flora, Ore. (Table 2). Excellent control of dwarf bunt was obtained at all three test locations with the 6.4-g/liter rate. Dwarf bunt infection at Cavendish, Idaho, was too low to permit evaluation.

The effectiveness of Thiabendazole in controlling dwarf bunt also varied with seeding date (Table 3). At Pullman, dwarf bunt was not controlled even by 6.4 g/liter in wheat seeded on 16 September. In wheat seeded on 1 October, dwarf bunt incidence was reduced from 70 to 20% at the 4.8 g/liter rate, whereas in wheat seeded on 15 October, a corresponding reduction in dwarf bunt incidence was obtained at 1.6 g/liter. Dwarf bunt infection in wheat seeded on 3 November was too low to permit evaluation.

Seed treated with Thiabendazole 60% at several rates was planted also by cooperators in dwarf bunt nurseries at Logan, Utah, Preston, Idaho, and Craig, Colo. Observations by cooperators (*personal communications*) indicated that Thiabendazole at 1.6 g/liter was highly effective in controlling dwarf bunt at Logan, Utah, but was totally ineffective even at 6.4 g/liter at

TABLE 1. Per cent common bunt (*Tilletia caries*) in wheat following seed treatment with Thiabendazole and seed and soil inoculation at Pullman, Wash., and Pendleton, Ore.

		% Common bunt[a]							
		1969				1970			
	Treatment rate	Seed-borne bunt		Soil-borne bunt[b]		Seed-borne bunt		Soil-borne bunt[b]	
Fungicide	(g/liter)	Pullman	Pendleton	Pullman	Pendleton	Pullman	Pendleton	Pullman	Pendleton
None (check)									
Noninoculated seed		0	1	48	67	4	0	94	78
Inoculated seed		52	86	50	87	93	95	97	94
HCB 40%	0.8	0	0	4	6	8	0	32	22
	1.6	0	0	1	4	4	0	32	6
Cyano(methylmercuri) guanidine 2.2%	0.4[c]	1	2	40	60	10	1	80	70
	0.6[c]	0	4	54	59	1	0	75	68
Thiabendazole 60%	0.8					4	1	55	25
	1.6	4	0	9	2	0	0	9	2
	3.2	0	0	16	0	0	0	6	2
Thiabendazole 30%	1.6					2	0	68	14
	3.2					0	0	18	2

[a] Each figure is the average of two replications.
[b] Both seed and soil inoculated in the soil-borne tests.
[c] Rate expressed as ml per liter.

TABLE 2. Per cent dwarf bunt (*Tilletia controversa*) in wheat after seed treatment with Thiabendazole, planted in infested soil at Pullman, Wash., Kalispell, Mont., and Flora, Ore.

Fungicide	Treatment rate (g/liter)	Dwarf bunt[a]				
		1969		1970		
		Pullman	Kalispell	Pullman	Kalispell	Flora
None (check)		21	70	70	65	65
Thiabendazole 60%	0.8			55	60	75
	1.6			35	17	65
	2.4			30	5	45
	3.2	13	0	60	8	22
	4.8			20	1	8
	6.4	1	0	10	1	6
Thiabendazole 30%	1.6			55	25	40
	3.2			42	6	25
	6.4			18	1	12

[a] Figures are averages of two replications at Pullman and Flora and four replications at Kalispell.

TABLE 3. Per cent dwarf bunt (*Tilletia controversa*) in wheat seeded on different dates at Pullman, Wash., following seed treatment with Thiabendazole

Thiabendazole (g/liter)	Seeding date and % dwarf bunt[a]			
	16 Sep.	1 Oct.	15 Oct.	3 Nov.
Untreated	40	70	80	3
0.8	50	55	70	3
1.6	65	35	20	1
2.4	70	30	25	6
3.2	65	60	7	1
4.8	55	20	1	1
6.4	60	10	3	1

[a] Figures are averages of two replications.

Preston, Idaho. The test at Craig, Colo., was destroyed and provided no data.

In another experiment at Pullman, Wash., Thiabendazole-treated and untreated seed were space-planted in alternate 1.5-m rows in dwarf bunt-infected soil on 1 October 1969. Infection data taken on individual plants showed (Table 4) that the percentage of both dwarf bunt-infected plants and heads was greatly reduced by Thiabendazole seed treatment at rates of 3.2 g/liter and above. Seed treatment with Thiabendazole also reduced the percentage of completely smutted plants and the number of smutted heads per plant. On the other hand, dwarf bunt infection was not reduced when Thiabendazole was applied as a spray (5.6 kg/hectare) to wheat plants in early spring, after infection had occurred.

TABLE 4. Effect of Thiabendazole seed treatment on dwarf bunt (*Tilletia controversa*) infection in individual plants at Westmont wheat seeded on 1 October 1969 at Pullman, Wash.

	Rate of treatment (g/liter)			
	0	1.6	3.2	6.4
Infected plants (%)	72	66	15	11
Infected heads (%)	77	74	15	11
Infected plants; all heads infected (%)	60	59	14	18
Infected heads/infected plant (avg no.))	9.4	8.9	4.8	5.2

DISCUSSION.—Seed treatment with Thiabendazole 60% at 1.6 g/liter (2 oz/bu) provides a practical level of control of seed- and soil-borne common bunt. At a rate of 3.2 g/liter (4 oz/bu), Thiabendazole is effective also against dwarf bunt, at least under some conditions. No other seed treatment is reported to be effective against dwarf bunt.

The effectiveness of Thiabendazole against dwarf bunt varied with seeding date and test location. Results at Pullman, Wash., indicated that the later the seeding date, the greater the effectiveness of Thiabendazole seed treatment. Records of plant growth taken at Pullman, Wash., and Kalispell, Mont., in late fall suggest that the effectiveness of Thiabendazole may depend on the amount of plant growth prior to infection. For example, wheat seeded at Pullman, Wash., on 16 September had 4-6 tillers by 1 December, whereas wheat seeded at Kalispell, Mont., on 23 September had only begun to tiller by about the same date. It seems likely that the amount of plant growth resulting from early seeding at Pullman, Wash., had reduced the fungicide concentration within the plant to an ineffective level. Inasmuch as weather conditions, rather than actual seeding date, determine to a large extent the amount of seedling growth, it is likely that some variation in effectiveness of Thiabendazole will occur from year to year. Effectiveness of Thiabendazole seed treatment may vary also with wheat cultivars, inasmuch as cultivars differ in their potential for fall growth.

Previous studies (4, 11) show that dwarf bunt infection in the Pacific Northwest generally does not occur before 1 December, but may continue through March. Therefore, the effects of a seed treatment material that protects against dwarf bunt must persist in the wheat plant for a considerable period (3-6 months). This suggests that Thiabendazole is highly persistent in the wheat plant or is exceedingly potent against bunt even at low concentrations.

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