Control of Ustilago striiformis and Urocystis agropyri in Poa pratensis by Thiophanate Fungicides

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ABSTRACT

Thiophanate-methyl, 1,2-bis(3-methoxycarbonyl-2-thioureido)benzene, applied at 160 mg/600 ml soil in the root zone, eradicated *Ustilago striiformis* (stripe smut) in small diseased plants of *Poa pratensis* 'Merion', but at 160 mg this chemical produced incomplete control of *Urocystis agropyri* (flag smut). Thiophanate, 1,2-bis(3-ethoxycarbonyl-2-thioureido)benzene, was virtually inactive against both smuts. No apparent control of *Puccinia striiformis* (stripe rust) in Merion Kentucky bluegrass plants resulted from applications of either chemical at 10-160 mg/160 ml soil.

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The prospects for control of grass smut diseases were greatly improved when several new systemic fungicides, especially derivatives of 1,4-oxathiin, benzimidazole, thiazole, and pyrimidine, were found to be chemotherapeutically active against *Ustilago striiformis* (West.) Niessl (stripe smut) and *Urocystis agropyri* (Preuss) Schroet. (flag smut) in grasses (3, 4, 5, 6, 7, 8). These chemicals may be too expensive for use in grass fields because of the high dosage required for eradication of these pathogens. In the present study, two additional chemicals were evaluated for systemic fungicidal activity against *U. striiformis* and *U. agropyri* by soil application and root uptake in *Poa pratensis* L. 'Merion' in a continuing search for more effective chemicals.

MATERIALS AND METHODS.–Tests were conducted in the greenhouse with plants of *P. pratensis* 'Merion' systemically infected with either *U. striiformis* or *U. agropyri*. Infected plants were originally collected in field plantings, and were propagated vegetatively in the greenhouse. Small plants were transplanted to 600 ml of a sandy-loam soil, pH 5.8, in 4-inch plastic pots, each with four bottom drainage holes. Sixty to 90 days after transplanting, when good root development had occurred, the plants and soil were transferred to pots without drainage holes to prevent loss of chemical. Healthy Merion Kentucky bluegrass plants were prepared in the same manner for tests with *Puccinia striiformis* West.

The chemicals, 1,2-bis(3-ethoxycarbonyl-2-thioureido)benzene (thiophanate) and 1,2-bis(3-methoxycarbonyl-2-thioureido)benzene (thiophanate-methyl) were supplied by Pennwalt Corporation as wettable powders under the code numbers TD-1604 and TD-1771, respectively. Molecular structures of the two compounds are very similar. At the 1 and 2 carbons of the benzene ring are attached the two identical side chains of -NH-CS-NH-$COOCH_3$ for thiophanate-methyl and of -NH-CS-NH-$COOC_2H_5$ for thiophanate. Desired rates of the chemicals suspended in water were pipetted into 2-cm deep holes in the soil at four locations surrounding the plant in each pot. Plants in three pots treated with each chemical dosage were compared with three untreated plants.

Fungicide activity against *U. striiformis* and *U. agropyri* was evidenced by the development of smut-free leaf tissue. The degree of control was evaluated by periodic counting of the healthy and smutted shoots. Stripe rust control was evaluated at 14 and 28 days after inoculation by the noting of the presence or absence and type of rust infections.

RESULTS.–Thiophanate-methyl eradicated *U. striiformis* after soil application and root uptake in *P. pratensis* 'Merion'. In tests with infected plants, each with 15-26 shoots at the time of treatments, 160 mg of thiophanate-methyl/600 ml soil was required for eradication of *U. striiformis* (Table 1). Control of stripe smut was first apparent 7 weeks after chemical application, when healthy tissue gradually appeared in the new growth of leaves of infected shoots. In one test, shoots in treated plants remained smut free beyond 42 weeks, demonstrating eradication of *U. striiformis*. Thiophanate, in contrast, applied at 10 through 160 mg/600 ml of soil, did not control *U. striiformis* (Table 1).

Thiophanate-methyl was much less active against *U. agropyri*, and produced incomplete control at 10-160 mg/600 ml of soil in pots holding infected plants each with 21-25 shoots at the time of treatment (Table 2). Thiophanate, at 10-160 mg/600 ml of soil, was not active against *U. agropyri* in parallel tests.

No apparent control of stripe rust (*P. striiformis*) resulted from application of thiophanate or thiophanate-methyl at 10-160 mg/600 ml of soil in pots holding healthy plants of *P. pratensis* 'Merion', each with 11-18 shoots, when the plants were inoculated 7 days after chemical treatment.

No apparent plant injury to *P. pratensis* resulted

TABLE 1. Control of *Ustilago striiformis* in *Poa pratensis* 'Merion' by root uptake of thiophanate fungicides to soil

Chemical	mg/600 ml soil	Smutted shoots/total shoots in three pots				
		Weeks after chemical application				
		0	8	12	16	26
Thiophanate-methyl	80	52/52	23/112	5/109	39/222	29/295
	100	51/51	13/59	0/94	21/168	48/244
	120	52/52	9/90	0/102	0/200	2/221
	140	52/52	3/121	0/143	0/232	23/266
	160	52/52	0/67	0/101	0/192	0/268
Thiophanate	80	44/44	76/86	84/84	86/86	138/138
	100	42/42	100/100	106/110	158/158	152/152
	120	42/42	73/73	76/78	106/106	178/178
	140	43/43	77/77	67/72	100/100	153/153
	160	44/44	85/85	86/88	119/119	186/186
None		36/36	57/57	57/57	86/86	86/86

TABLE 2. Control of *Urocystis agropyri* in *Poa pratensis* 'Merion' by thiophanate-methyl applied to soil in the root zone

Chemical	mg/600 ml soil	Smutted shoots/total shoots in three pots				
		Weeks after chemical application				
		0	8	12	16	26
Thiophanate-methyl	80	69/69	23/129	0/185	179/272	102/285
	100	68/68	22/176	0/191	90/272	81/276
	120	69/69	22/118	0/171	63/266	36/273
	140	71/71	11/124	0/168	16/243	8/250
	160	76/76	4/139	0/147	23/280	12/286
None		70/70	110/110	113/113	153/153	157/157

from either thiophanate or thiophanate-methyl applied at 10-160 mg/600 ml of soil in pots holding healthy plants with 11-18 shoots. Although stripe smut was not controlled, treatment with thiophanate resulted in increased growth of infected plants (Table 1).

DISCUSSION.—Demonstration of fungicidal activity of thiophanate-methyl against *U. striiformis* adds another family of chemicals to the growing list of systemic fungicides known to be chemotherapeutically active against stripe smut (3, 4, 5, 6, 7, 8). Systemic chemicals previously known to be active against *U. striiformis* have generally shown stronger activity against *U. agropyri*. Thiophanate-methyl is exceptional in this respect, because it is more effective against *U. striiformis* than against *U. agropyri*.

Despite the slight difference in molecular form, striking differences in fungicidal activity of the two chemicals were demonstrated. Since the effect on fungicidal activity against *U. striiformis* of a methoxy group compared to an ethoxy group is so striking, it would appear worthwhile to evaluate other thiophanate derivatives to determine if other molecular forms have greater activity than thiophanate-methyl against smuts and other fungi. Although the dosage requirement of thiophanate-methyl for control of *U. striiformis* in *P. pratensis* is fairly high (about 120-160 lb./acre), the thiophanate fungicides are attractive for exploration because they have also shown good activity against other diseases (1, 2, 9).

LITERATURE CITED

1. ANONYMOUS. 1969. Broad spectrum fungicide. Cercobin W. P. WP 50%. Nippon Soda Co., Ltd. Tokyo. 40 p.
2. ANONYMOUS. 1970. Systemic fungicide with power. Nippon Soda Co., Ltd. Tokyo. 94 p.
3. HARDISON, J. R. 1966. Chemotherapy of Urocystis agropyri in Merion Kentucky bluegrass (Poa pratensis L.) with two derivatives of 1,4-oxathiin. Crop Sci. 6:384.
4. HARDISON, J. R. 1967. Chemotherapeutic control of stripe smut (Ustilago striiformis) in grasses by two derivatives of 1,4-oxathiin. Phytopathology 57:242-245.
5. HARDISON, J. R. 1968. Systemic activity of Fungicide 1991, a derivative of benzimidazole, against diverse grass diseases. Plant Dis. Reptr. 52:205.
6. HARDISON, J. R. 1971. Relationships of molecular structure of 1,4-oxathiin fungicides to chemotherapeutic activity against rust and smut fungi in grasses. Phytopathology 61:731-735.

7. HARDISON, J. R. 1971. Chemotherapeutic eradication of Ustilago striiformis and Urocystis agropyri in Poa pratensis 'Merion' by root uptake of a-(2,4-dichlorophenyl-a-phenyl-5-pyrimidinemethanol) (EL-273). Crop Sci. 11:345-347.
8. HARDISON, J. R. 1971. Chemotherapy of smut and rust pathogens in Poa pratensis by thiazole compounds. Phytopathology 61: 1396-1399.
9. SOLEL, Z. 1970. The systemic fungicidal effect of benzimidazole derivatives and thiophanate against Cercospora leaf spot of sugarbeet. Phytopathology 60:1186-1190.