EVALUATION OF CHEMICALS IN TIMED-RELEASE PELLETS FOR CONTROL OF COMMON ROOT ROT OF WHEAT

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Abstract

In test plots at Regina, Saskatchewan, timed release pellets consisting of a nucleus of pearl barley coated with molasses and limestone, significantly reduced root rot of wheat caused by Cochliobolus sativus when compared with pearl barley alone. However, similar treatment at Morden, Manitoba, did not significantly reduce root rot. Differences in rainfall following sowing and in the microflora of the soil at the two locations may have contributed to the differing results. The addition of fungicides, chitin, or soybean meal to the pellets did not give additional control.

Introduction

Attempts to control common root rot of cereals caused by soil-borne Cochliobolus sativus (Ito & Kurib.) Drechsl. ex Dastur by seed treatment have generally not been effective (5,9). Fungicides may be effective in laboratory tests, but under field conditions they are probably not present in the region of the sub-crown internode 3-10 weeks after sowing. Timed-release pellets have been developed (8) that are broken down by soil moisture, thereby releasing chemicals incorporated within the pellets. In the present work such pellets were used to release fungicides for direct action on C. sativus and to release other substances known to stimulate antagonists of the pathogen. The fungicides used are at least partly effective against the pathogen in the field (10) and in the laboratory (7, and Mills, unpublished data); soybean meal and sugar beet molasses (1) are known to promote germination of C. sativus, and chitin (3) promotes growth of Streptomyces spp., known to be antagonistic to the pathogen.

Materials and methods

The manufacturers[4] of the 10 fungicides used in this study and the active ingredient and formulation of each, where known, are as follows: Green Cross, SWF 910; Hoechst, 2874, 2981, 2988, 2989; Murphy, MC 25 monosulphate (bis-[8-guanidinooctyl]amine sulphate), MC 25 sesquisulphate (bis-[8-guanidinooctyl]sesquisulphate); Nor-Am, Panogen PX (0.9% methyl mercuric dicyandiamide); Rohm & Haas, Uithane M45 (zinc coordinated maneb); and Uniroyal, Vitavax (5,6-dihydro-2-methyl-1, 4-oxathiin-3-carboxanilide).

The pellets all had a nucleus of pearl barley. The coating process consisted of coating 1150 g of pearl barley with a mixture of 337 g ground limestone, 40 g flour, 75 ml sugar beet molasses, 450 ml water, and 63 g fungicide formulation, or chitin (Sigma Chemical Co., St. Louis), or soybean meal (Canada Packers, Feed Division, Winnipeg). The resulting pellets were coated with a latex formulation, the thickness of which determined the time of release, i.e. after approximately 30, 50, and 70 days. Pearl barley was coated with the substances by using Wurster air suspension equipment (11). Substances were used without special preparation except that the limestone was ground commercially to pass a 200 mesh screen; the chitin was ball milled for 22 hr; and the soybean meal was ball milled for 3 hr. Forty-two grams of pellets consisting of equal amounts of each of the 30, 50, and 70 day lots of a particular treatment were used in each 12 ft row. However, in each row of treatment no. 15 (Table 1), 7 g of the mixture of 30-, 50-, and 70-day release pellets from each of treatment nos. 2 and 14 were applied. Forty-two grams of instant release pellets, those without latex coats, were applied to each row of treatment no. 16. In addition to being used at the standard rate, Panogen PX (treatment 4) was also used at the lower rate of 16 g of formulation to 1150 g of pearl barley.

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Wheat (Triticum aestivum L. 'Cypress') seed from the 1968 crop was sown in single row plots 12 ft long and 1 ft apart. Each plot was replicated six times at each location. Plots were sown at Morden, Man., on May 16 and at Regina, Sask., on May 27, 1969. Two hundred seeds were sown 2 inches deep in each row with a twin cone seeder (6), and the pellets were simultaneously placed about 1 inch above the seed. Double guard rows of 'Cypress' wheat were sown at the end of each block of replicates. The plants were pulled while in the late milk–early dough stages (71–73 days after seeding) and 100 plants in each row were rated for root rot on a 0–5 scale (4). The disease rating percentage for each treatment was determined by the following formula:

$$\text{Disease rating \%} = \frac{\text{Avg of numerical ratings of individual plants} \times 100}{5}$$

The results from all replicates were subjected to an analysis of variance. Pellets were collected from soil adjacent to the subcrown internodes from all rows, plated with adherent soil on moistened filter paper, and examined for fungi after 15 days.

Results and discussion

Root rot disease ratings at Regina ranged from 20.6% to 14.32, depending on treatment; 12 treatments and the molasses control (treatment 2) gave significant control ($P < 0.05$) (Table 1), but there were no differences among the 12 treatments and the molasses control.

Root rot disease ratings at Morden ranged from 21.2% to 17.9%, but none of the treatments had statistically significant effects.

Pellets that did not contain fungicides (treatments 2, 14, 15, and 16) taken from the Regina plots generally possessed a different microflora than pellets with fungicides (Table 1). For example, Doratomyces purpureofuscus (Fr.) Morton & Smith was found on pellets of treatment nos. 2 and 15 only; Chaetomium perlucidum Sergej on those of nos. 2 and 16 only; Dactylella asthenopaga Dreschler on those of 2, 14, and 16: and a non–sporulating green shiny-mycelium on those of nos. 2, 14, 15, and 16. Penicillium crustosurn Thom was found in abundance on Panogen pellets (treatments 3 and 4) and was visible in the adjacent soil. Absidia lichtheimii (Lucet and Constantin) Lendner, Gliocladium c.f. solani (Hartig) Petch, Fusarium solani (Mart.) Sacc. and a species of Melanospora were commonly present on pellets both with and without fungicides. Cochliobolus sativus was observed only on root fragments in treatment no. 2. Stachybotrys atra Corda was observed in treatment nos. 2 and 8 (Hoechst 2981); nematodes were found on pellets of nos. 6 (SWF 910) and 7 (Hoechst 2874) only.

Table 1. Composition of pellets and results of field trials at Regina and Morden for control of soil-borne root rot

Treatment no.	Constituents†	% root rot (means of 6 replicates) Regina	Morden
1	Control (pearl barley)	20.6	19.1
2	Control (pearl barley + molasses + limestone)	16.6	20.2
3	Panogen PX	16.5	19.7
4	Panogen PX	16.9	20.0
5	Dithane M45	14.4	21.2
6	SWF 910	15.1	19.5
7	Hoechst 2874	16.6	20.5
8	Hoechst 2981	4.3	19.0
9	Vitavax	8.8	18.4
10	Hoechst 2988	6.9	20.6
11	Hoechst 2989	6.1	20.5
12	MC25 monosulphate	6.3	17.9
13	MC25 sesquisulphate	5.6	19.1
14	Chitin	15.9	20.4
15	Mixture of treatments 2 and 14	16.4	21.0
16	Soybean meal††	19.3	18.3
LSD (0.05)		3.3	NS

† Treatments 3 to 16 consisted of pearl barley coated with a mixture of the named ingredient, molasses, and limestone.
†† Instant release only.
NS = not significant.

Pellets taken from Morden soil often possessed Stachybotrys atra, Gonatobotrys simplex Corda, Fusarium solani, Alcaligenes faecalis Castellani & Chalmers, and a Bacillus belonging to the B. subtilis group. Occasionally Cochliobolus sativus was seen sporulating on root fragments. Penicillium crustosum Thom and P. patulum Bain. were associated with Panogen PX (treatments 3 and 4), and Gliocladium c.f. solani (Hartig) Petch and G. roseum Bain. with other fungicides (treatments 6,8,9,10,11,12). Cladosporium cladosporioides (Fresen.) De Vries was found only on pellets without

fungicides (treatments 1,14,15). Melanospora sp. was present on pellets of treatments 1 and 3 only, and nematodes were observed on those of 2 and 9. Absidia lichtheimii, although occurring on pellets both with and without fungicide, was at much lower levels than at Regina. Dactylella asthenopaga was observed once on a pellet of treatment no. 14, and the nonsporulating green shiny mycelium once on a pellet of no. 16: Chaetomium and Doratomyces were not observed. Streptomyces sp. was seen on pellets of treatments 2,4,11, and 14 at Morden but was not observed at Regina.

The materials in the pellets are released by moisture. Total rainfall during the periods between seeding and harvesting at Morden and Regina was 6.80 inches and 5.29 inches respectively. The rainfall during the 40 day period immediately after seeding, during which the 30-day pellets were scheduled to break down, was almost identical at the two locations (Table 2). The rainfall

Table 2. Rainfall (in inches) at Regina and Morden during the interval between sowing and the day before harvest

	Days after sowing		
Location	0-40	41-60	61-harvest
Regina	2.65	1.33	1.31
Morden	2.70	3.35	0.75

41–60 days after sowing, which would help degrade the 50-day release pellets, was much heavier at Morden than at Regina, and the reverse was true for the period beyond 60 days after seeding which would affect the breakdown of the 70-day release pellets. It is suggested that most infection resulted at Morden during the period of low rainfall as there probably was inadequate release of the 70-day pellets. Further, there may have been some leaching of chemicals from the 70-day pellets during the period of heavy rainfall 41–60 days from sowing. Rainfall was more evenly distributed during the 50- and 70-day pellet release periods at Regina, thus resulting in the better control.

There was adequate infection in the controls (treatment 1) at both locations (Table 1). Some root rot control was obtained at Regina, but not at Morden, and was effected with pellets that contained molasses both with and without fungicides. The control mechanism is not apparent, but it may involve stimulation by the molasses of germination of C. sativus spores and subsequent lysis of mycelium (2) or stimulation of antagonists, or both. The microflora on the pellets and on the adherent soil from Regina and Morden differed, and possibly there were more antagonistic microorganisms in the Regina soil.

Acknowledgments

The writers thank the staff of the Morden and Regina Research Stations for making land available for these experiments, and the Director and staff of the Commonwealth Mycological Institute, Kew, England for identification of microorganisms.

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