Use of Systemic Fungicides Metalaxyl and Fosetyl-Al for Control of Sorghum Downy Mildew in Corn and Sorghum in South Texas. II: Foliar Application

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ABSTRACT

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Metalaxyl was an effective curative of sorghum downy mildew when applied to foliage of systemically infected corn (*Zea mays*) and sorghum (*Sorghum bicolor*) at rates of either 0.96 or 4.8 mg a.i./ml. Phytotoxicity of metalaxyl to corn and sorghum foliage was dependent on fungicide rate and plant age. Fosetyl-Al was an apparent but limited curative of sorghum downy mildew on sorghum when applied to foliage at a rate of 8.00 mg a.i./ml.

Metalaxyl (CGA-48988, Ridomil, Apron) is an effective protectant against and curative of sorghum downy mildew (SDM) (*Peronosclerospora sorghi* (Weston & Uppal) C. G. Shaw) when applied to foliage of sorghum (*Sorghum bicolor* (L.) Moench) in India (1). This systemic fungicide functions similarly for downy mildew (*Sclerospora graminicola* (Sacc.) Schroet) of pearl millet (*Pennisetum americanum* (L.) Leeke) (7) and other downy mildews (3,8).

Fosetyl-Al (Aliette, LS 74-783) is a systemic fungicide that functions as a preventive and curative against several oomycetes (2). Its activity against downy mildew pathogens of graminaceous crops when applied to foliage is not known. This study evaluated the curative activity of metalaxyl against *P. sorghi* on sorghum and corn (*Zea mays* L.) and of fosetyl-Al against *P. sorghi* on sorghum in South Texas when applied to foliage of susceptible plants with and without symptoms of systemic SDM. A companion paper describes the use of these fungicides as seed treatments to control SDM in sorghum and corn in South Texas (5).

MATERIALS AND METHODS

Experimental design. Foliar application experiments were conducted over two growing seasons at Beeville, TX, and are discussed as three individual field experiments designated by crop/year. Each experiment used a randomized complete block design with three replicates of each treatment, including an untreated control. Curative effects (sequential cessation of systemic SDM symptoms in emerging leaves) and SDM incidence (%) were evaluated in all experiments.

Metalaxyl (Ridomil 2E, 24% a.i.) and fosetyl-Al (Aliette 80WP, 80% a.i.) were applied to foliage with a hand sprayer at treatment concentrations until runoff.

Individual experiments. In sorghum/1981, metalaxyl (0.48, 0.96, or 4.80 mg a.i/ml) and fosetyl-Al (0.8, 4.0, or 8.0 mg a.i./ml) were applied 5 wk after planting to foliage of a susceptible line (SC 283) and susceptible commercial hybrid with high incidence of systemic SDM. Because the two sorghums occurred in adjacent rows in a mass planting, adjoining 12-m lengths of row were preselected to maximize SDM incidence in both sorghums and to facilitate fungicide application. Each 12-m length of row represented one replicate and adjoining replicates of each cultivar received the same treatment. Treatments were applied immediately after the initial or pretreatment incidence of SDM (%) was determined. At 3 and 5 wk after fungicide application, the posttreatment incidence of SDM was determined and compared with the pretreatment incidence by computing a posttreatment:pretreatment ratio of disease incidence for each replicate. Plants cured of SDM symptoms and the progression of curing were also noted. Excessive midge damage precluded evaluation of yield differences among treatments. However, the number of primary sorghum heads per treatment replicate was determined 10 wk after fungicide application as an indicator of potential yield differences among treatments.

In sorghum/1982, metalaxyl at either a low (0.96 mg a.i./ml) or high (4.80 mg a.i./ml) rate was applied either 3 or 5 wk after planting to foliage of plants from untreated seed of a susceptible line (SC 283) and susceptible commercial hybrid. Each treatment replicate was 18 m of planted row (6 m in each of three adjacent rows). Curative effects and SDM incidence were evaluated 5, 9, and 14 wk after planting.

Corn/1982 contained the same treatments and replicates as sorghum/1982, except untreated seed of a susceptible corn hybrid was planted at a later, more disease-conducive date (5) and metalaxyl was applied either 4 or 6 wk after planting. Curative activity and SDM incidence were evaluated 6, 8, and 14 wk after planting.

RESULTS

In sorghum/1981, the pretreatment incidences of SDM were 22–70% in the line SC 283 and 14–39% in the hybrid. By 3 and 5 wk after foliar application of metalaxyl, untreated plants of the line and hybrid had the highest posttreatment:pretreatment ratio of SDM incidence (Fig. 1). The lower ratios of SDM incidence noted at 5 wk compared with 3 wk were apparently due to death of some infected untreated plants and continued curing of infected plants by

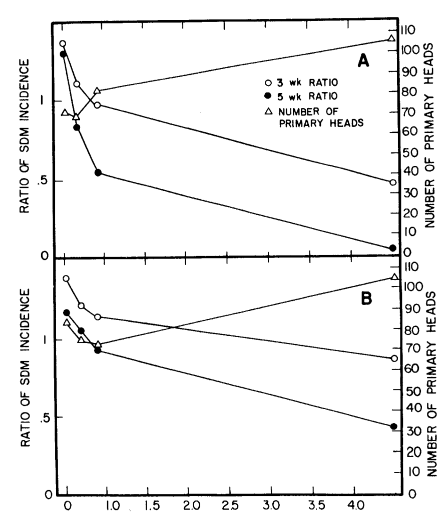

Fig. 1. Sorghum/1981. Effects of metalaxyl foliar application on the posttreatment: pretreatment ratio of SDM incidence and number of primary heads (10 wk posttreatment) of **(A)** the line SC 283 and **(B)** a susceptible hybrid.

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metalaxyl (Fig. 1). Of the plants with systemic SDM, nearly 100% from the line and more than 50% from the hybrid were cured by 5 wk after a foliar application of metalaxyl at the highest rate (Fig. 1).

Plants sprayed with metalaxyl at the highest rate showed no symptoms of phytotoxicity, and by 10 wk posttreatment, had the highest number of primary heads (Fig. 1) despite an approximate 1-wk delay in flowering compared with healthy untreated plants.

Curing of systemic SDM in both sorghums was similar and progressive in development. The first evidence of curing was a newly emerged leaf that was partially free of SDM symptoms. These leaves were slightly thickened and had either wide longitudinal bands of healthy green tissue next to diffuse bands of greenish white tissue (SDM) or the entire leaf was greenish white except for tip and margins. There was no sporulation on the abaxial side of these greenish white areas, unlike infected leaves that emerged before fungicide application. The subsequent leaves had either fewer or nearly indiscernible infected areas, and the third or fourth leaves to emerge after foliar application were fully normal. Complete curing of SDM symptoms in some plants was noted 2 and 3 wk after foliar application.

Curing of SDM symptoms was not observed on any infected plants after spraying foliage with fosetyl-Al at any rate and this lack of effect is evident in the posttreatment:pretreatment ratios of SDM incidence (Fig. 2). However, some symptomless, infected plants of the line, sprayed with fosetyl-Al at the highest rate, were apparently cured of SDM because their ratios of SDM incidence after 3 and 5 wk were both 0.98 compared with 1.42 after 3 wk and 1.37 after 5 wk for untreated plants (Fig. 2A).

When sprayed onto foliage at the rates used, fosetyl-Al was not phytotoxic and had no effect on either time to flowering or number of primary heads at 10 wk posttreatment (Fig. 2) compared with untreated plants.

In sorghum/1982, all plants with systemic SDM that received a single foliar application of metalaxyl at either time (3 or 5 wk after planting) and rate (0.96 or 4.80 mg a.i./ml) were cured of SDM symptoms, and nearly all produced normal plants with grain-bearing heads. Curing was evident on many plants 2 wk after fungicide application, and once complete, all plants in these treatment rows were free of SDM for the remainder of the season. Average incidence of SDM in untreated controls of the hybrid and line were 29 and 26%, respectively.

Metalaxyl at the low rate was slightly phytotoxic (twisting of leaves) to both sorghums when applied at 3 wk after planting but not when applied at 5 wk. Metalaxyl at the high rate was severely phytotoxic (shredding and twisting of leaves) to both sorghums when applied at 3 wk after planting and slightly phytotoxic when applied at 5 wk, but all plants recovered.

There was a very low incidence of SDM in corn/1982, but most plants with systemic SDM that received a single foliar application of metalaxyl at either a low rate (0.96 mg a.i./ml) 4 and 6 wk after planting or a high rate (4.80 mg a.i./ml) 4 wk after planting were cured of SDM symptoms and produced normal plants with grain-bearing ears. The progression of curing occurring within a 2-wk period in corn was similar to sorghum but no banding was observed, and there was progressive resumption of normal leaf shape from the straight, narrow pattern typical of infected corn leaves.

A slight, transient phytotoxicity (twisting of leaves) was observed in corn plants treated wtih metalaxyl at the low rate 4 wk after planting but not in plants treated 6 wk after planting. Severe phytotoxicity (shredding and twisting of leaves) was observed in corn plants treated with metalaxyl at the high rate 4 and 6 wk after planting. Corn plants treated at 4 wk recovered fully to produce normal plants, but those treated at 6 wk remained stunted, without tassel or ear production for the remainder of the season.

The low incidence of SDM in corn did not allow for accurate assessment of late-season occurrence of SDM in plants receiving metalaxyl at any foliar application rate.

DISCUSSION

Probably only curative (eradicant) rather than preventive activity was observed in the sorghum experiments because foliar applications were made when soil temperatures were no longer conducive to further systemic infection from soilborne oospores (4).

Metalaxyl was an effective curative of SDM when applied to foliage of systemically infected and symptomless sorghum plants of a susceptible line and hybrid (Fig. 1). Metalaxyl was also an effective curative of SDM in corn, but the low disease incidence did not allow complete evaluation. In sorghum, considerably higher foliar application rates (0.96 and 4.80 mg a.i./ml) of metalaxyl were required to give SDM control comparable to that obtained at low seed treatment rates (0.05–1.0 g a.i./kg) (5). When fosetyl-Al was applied to sorghum foliage at a high rate, symptomless, infected plants of a susceptible line were apparently cured of SDM but similar plants of a susceptible

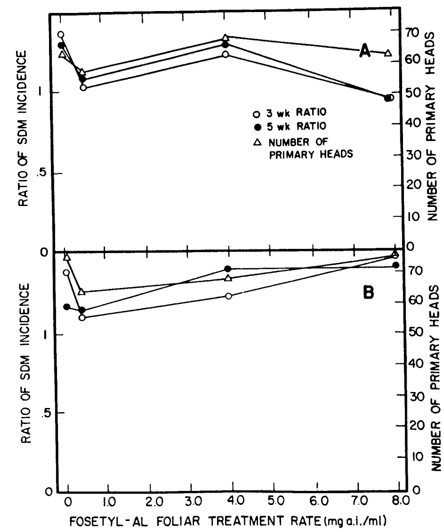

Fig. 2. Sorghum/1981. Effects of fosetyl-Al foliar application on the posttreatment: pretreatment ratio of SDM incidence and number of primary heads (10 wk posttreatment) of **(A)** the line SC 283 and **(B)** a susceptible hybrid.

hybrid were not cured (Fig. 2). Fosetyl-Al may be limited or inconsistent in its curative activity against SDM.

Foliar application of metalaxyl to control SDM in corn and sorghum requires excessive fungicide rates and could enhance selection of metalaxyl-tolerant strains (5,6) because it would be applied to existing infections and does not prevent infections as seed treatments do (5). Under conditions where limited or important germ plasm would be lost to SDM, foliar application of metalaxyl would be justified, but economically and epidemiologically, seed treatments would be more feasible for general use (5).

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