Efficacy of fungicides and mixtures of fungicides for management of gladiolus rust in Mexico

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Introduction

Uromyces transversalis, the causal agent of gladiolus rust, is an invasive pathogen of gladiolus in the United States. *U. transversalis* also infects other members of the Iridaceae family—including *Crocosmia*, *Tritonia*, and *Watsonia*. *Gladiolus* is grown in the U.S. as an ornamental plant for cut flowers and for commercial and residential landscapes. In 2009, the U.S. farm gate value of gladiolus cut flower production was $24 million (2009 USDA NASS Census of Horticulture, 2010) with the bulk of this production occurring in Florida. Gladiolus flowers are imported into the U.S. from several countries, including Mexico. Mexican farm gate value for gladiolus production is $77 million (Dec. 2009). Gladiolus rust is endemic in the gladiolus production areas of Mexico and thus a potential source of primary inoculum for gladiolus plants grown in the U.S.

At the current time, *U. transversalis* has been found infecting gladiolus in California, Florida, and Minnesota. In California, these infections have been restricted to residential and landscaped areas. In Florida, infections have been discovered in commercial production fields. Crop destruction, quarantines, and use of preventative application of fungicides have been the tools used to attempt to contain and eradicate this invasive pathogen. Fungicides in the triazole class along with chlorothalonil and azoxystrobin are the primary fungicides applied in Florida. The modes of action for triazoles and QoI (strobilurins) fungicides are single sites in the metabolic pathways of target fungi and, thus, are more susceptible to the development of resistance in fungus populations. We present here results from experiments to identify fungicides that will be effective for long-term management of gladiolus rust.

Materials & Methods

- Two trials were conducted during Sep-Nov 2011in commercial gladiolus fields in Cuautla, Morelos and Santa Isabel Cholula, Puebla states of Mexico
- Natural rust infections were augmented every 2 weeks with inoculations of *U. transversalis* spores starting Sep 17
- Four replicate plots (3m x 3m)
- Fourteen fungicides were applied four times at 14-day intervals using a hand-held CO_2 backpack sprayer starting Sep 24 (Table 1)
- Disease severity as percent foliar surface with symptoms for each plot was recorded each week for 7 weeks after the first application
- Disease ratings for each treatment were converted to a 1 to 12 scale and then the areas under disease progress curves (AUDPC) were calculated

  1 = 0%, 2 = 0-3%, 3 = 3-6%, 4 = 6-12%, 5 = 12-25%, 6 = 25-50%, 7 = 50-75%, 8 = 75-87%, 9 = 87-94%, 10 = 94-97%, 11 = 97-100%, 12 = 100%

Conclusions

- In general, disease management was good with triazole fungicides
- Disease management was good to excellent with tank mix combinations of fungicides from different FRAC classes
- Acibenzolar-s-methyl was effective on plants in Cuautla, Morelos but not on plants in Santa Isabel Cholula, Puebla—possibly due to differential levels of native inocula contributing to earlier low-level infections at this site
- For Mexican growers, most of the tested products are registered for use on rust diseases:
  - Alto (cyproconazole)
  - Amistar (azoxystrobin)
  - Daconil 2787 (chlorothalonil)
  - Folicur (tebuconazole)
  - Opus (epoxiconazole)
  - Plantvax (oxycarboxin)
  - Rally (myclobutanil)
  - Score (difenconazole)
  - Tilt (propiconazole)
- Growers in the U.S. have several registered options for managing gladiolus rust:
  - DisArm 480SC (fluoxastrobin)
  - Eagle (myclobutanil)
  - Pageant (boscalid + pyraclostrobin)
  - ProStar (flutolanil
  - Torque (tebuconazole)

Results

Cuautla, Morelos. Disease pressure was moderate with disease severity starting at 1.3% and finishing at 42.5% in the plots with non-inoculated, non-treated plants. Starting October 22, 2011, all fungicide applications significantly reduced disease severity (Table 1) compared to the inoculated, untreated plots. By November 5, 2011, most single fungicide programs reduced disease incidence (acibenzolar-s-methyl, cyproconazole, difenconazole, epoxiconazole, flutalonil). However, tank mixes of fungicides from different mode of action classes exhibited exceptional disease management, in that disease did not occur on plants sprayed with six fungicide combinations (azoxystrobin + difenconazole, azoxystrobin + epoxiconazole, azoxystrobin + propiconazole, chlorothalonil + epoxiconazole, chlorothalonil + propiconazole, and oxycarboxin + trifloxystrobin).

Santa Isabel Cholula, Puebla. In this experiment, disease pressure was high with disease severity starting at 2.5% and finishing at 58.8% in the uninoculated, untreated plots. Starting October 15, significantly less disease was observed with single fungicide programs and tank mix programs compared to the inoculated, non-treated plots, except for acibenzolar-s-methyl and cyproconazole (Table 1). By October 22, both acibenzolar-s-methyl and cyproconazole exhibited statistically less disease than the inoculated, non-treated plots. On November 5, all treatments had very low disease levels except acibenzolar-s-methyl and chlorothalonil plots where disease was intermediate between the other fungicide programs and the non-treated plots. According to statistical analysis of the Area Under the Disease Progress Curve (AUDPC), most treatments provided significantly less disease throughout the season.

Table 1. Gladiolus rust disease severity after fall fungicide applications in commercial fields in Mexico

Active Ingredient(s)	Trade Name	Product rate per liter (per 100 gal)	Cuautla, Morelos				Santa Isabel Cholula, Puebla			
			Disease Severity				Disease Severity			
			10/8	10/22	11/5	AUDPC	10/8	10/22	11/5	AUDPC
Acibenzolar-s-methyl	Actigard 50GS	60 mg (0.8 oz)	0.0 a [z]	0.0 a	7.5 a	10.3 a	5.0 a	21.0 d	32.0 b	26.5 c
Azoxystrobin + Difenoconazole	Amistar+Score	600 mg + 1,000 uL (8.0 oz + 12.8 fl oz)	0.0 a	0.0 a	0.0 a	7.5 a	3.8 a	2.0 ab	0.0 a	11.8 ab
Azoxystrobin + Epoxiconazole	Amistar + Opus 125	600 mg + 1,500 uL (8.0 oz + 19.2 fl oz)	0.0 a	0.0 a	0.0 a	7.5 a	0.0 a	0.0 a	0.0 a	7.8 a
Azoxystrobin + Propiconazole	Amistar + Tilt	600 mg + 2,000 uL (8.0 oz + 25.6 fl oz)	0.0 a	0.0 a	0.0 a	7.5 a	0.0 a	0.0 a	0.5 a	7.8 a
Chlorothalonil	Daconil 2787	3,000 mg (2.5 lb)	0.5 a	5.3 a	22.0 b	17.8 b	7.3 a	15.8 cd	36.3 b	26.3 c
Chlorothalonil + Epoxiconazole	Daconil 2787 + Opus 125	3,000 mg + 1,500 uL (2.5 lb + 19.2 fl oz)	0.0 a	0.0 a	0.0 a	7.5 a	0.5 a	0.5 a	0.3 a	9.5 ab
Chlorothalonil + Propiconazole	Daconil 2787 + Tilt	3,000 mg + 2,000 uL (2.5 lb + 25.6 fl oz)	0.0 a	0.0 a	0.0 a	7.5 a	0.8 a	0.3 a	2.5 a	10.3 ab
Cyproconazole	Alto 100 SL	800 uL (10.2 fl oz)	0.0 a	0.0 a	0.5 a	8.5 a	6.5 a	14.0 bcd	0.0 a	18.8 b
Difenconazole	Score	1,000 uL (12.8 fl oz)	0.0 a	4.8 a	2.3 a	14.0 ab	0.5 a	0.0 a	0.0 a	9.0 a
Epoxiconazole	Opus 125	1,500 uL (19.2 fl oz)	0.0 a	0.0 a	0.3 a	8.3 a	0.8 a	5.0 abc	0.0 a	13.5 ab
Fluoxastrobin + Myclobutanil	Disarm	1.928 g (26.4 oz)	0.0 a	0.0 a	0.3 a	8.3 a	0.0 a	3.8 abc	1.0 a	13.8 ab
Flutolanil	Moncut 50WP	4,000 mg (25.6 fl oz)	0.3 a	0.0 a	3.5 a	14.3 ab	0.8 a	3.8 abc	1.0 a	13 ab
Oxycarboxin + Tebuconazole	Plantvax + Folicur	3,000 mg + 1,200 uL (2.5 lb + 15.4 floz)	0.0 a	0.0 a	0.8 a	8.3 a	0.8 a	0.0 a	0.0 a	8.0 a
Oxycarboxin + Trifloxystrobin	Plantvax + Flint	3,000 mg + 500 mg (2.5 lb + 6.7 oz)	0.0 a	0.0 a	0.0 a	7.5 a	0.0 a	0.8 a	1.8 a	10.0 ab
Non-treated, non-inoculated			1.3 a	23.5 b	42.5 c	23.5 b	7.0 a	35.8 e	58.8 c	30.8 c
Non-treated, inoculated			0.0 a	24.3 b	24.3 b	21.0 b	6.5 a	38.0 e	60.0 c	31.5 c

[z] Means followed by same letter do not differ significantly based on Fisher's LSD (p=0.05); shaded averages are significantly different from the untreated inoculated treatments.

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