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Effect of some fungicides on mycelium growth of *Fusarium avenaceum* (Fr.) Sacc. pathogenic to chrysanthemum (*Dendranthema grandiflora* Tzvelev)

M. Kopacki and A. Wagner

Department of Plant Protection and Quarantine, Agricultural University, Leszczynskiego 7, 20-069 Lublin, Poland; e-mail: marek.kopacki@ar.lublin.pl

Abstract. Ten fungicides were tested *in vitro* for their effectiveness to inhibit the linear growth of three isolates of *Fusarium avenaceum* of proven pathogenicity to chrysanthemum. The measurements were taken after 4 and 8 days of fungus growth in the presence of fungicides in three concentrations. The most effective *in vitro* proved to be the fungicides containing difenaconazole, carbendazim and flusilazol while the least effective were mancozeb, chlorothalonil and captan. The isolates of *F. avenaceum* differed in their susceptibility to tested fungicides.

Key words: *Fusarium avenaceum,* chrysanthemum, fungicides

INTRODUCTION

Fusarium avenaceum (Fr.) Sacc. can be the cause of stem base rot (Orlikowski et al., 1984) and bud rot (Horita & Kodama, 1996). Our earlier study proved that this species is pathogenic to chrysanthemum cultivated under covers. As chrysanthemums are very important ornamentals in Poland, effective fungicides of *F. avenaceum* are in demand. The chemical control of this pathogen is well described for carnation (Horst & Nelson, 1969, Nelson et al., 1975), lisianthus (McGovern & Harbaugh, 1998) and cereals (Parry et al., 1985, Lacicowa & Pieta, 1994) but there are no full recommendations for fungicide application in chrysanthemum plantations. Our aim was to evaluate some fungicides for their antifungal activity against *F. avenaceum* and susceptibility of individual isolates to chemical control.

MATERIALS AND METHODS

Three isolates of *F. avenaceum* (Fa31, Fa221 and Fa401) were selected for the experiment on their high pathogenicity to chrysanthemum tested in inoculation trials. Their macro- and microscopic features were characteristic for the species as described by Booth (1971). Ten fungicides, recommended for *F. avenaceum* control in other crops were applied in three concentrations: 1 ppm, 10 ppm and 100 ppm. They were: Penncozeb 80 WP (80% of mankozeb), Bravo 500 SC (50% of chlorothalonil), Rovral Flo 255 SC (25,5% of iprodione), Kaptan 50 WP (50% of captan), Sarfun 500 EC (50% of carbendazim), Topsin M 500 SC (50% of methylthiophanate), Punch 400 EC (40% of flusilazol), Score 250 EC (25% of difenoconazole), Amistar 250 SC (25% of

azoksystrobin) and Discus 500 WG (50% of kresoxim-methyl). The experiment was conducted with the method recommended for laboratory tests with fungicides (Wojdyla, 1993). Fungal colonies were grown on potato-dextrose agar (PDA Difco) with or without fungicides. The diameters of colonies were measured after 4 and 8 days of the experiment. The results were analysed statistically with Tukey's test (Oktaba, 1966). The efficacy of fungicides was determined by the percentage of mycelium growth inhibition (Borecki, 1984). If the growth of fungus was inhibited by 100%, mycelium disks were moved to Petri dishes filled with PDA without the amendment to determine fungistatic or fungicidal effect of the fungicide. Approximate doses of fungicides that caused 50% response of fungi exposed to treatments (ED50) for tested isolates were estimated, and afterwards the investigated fungicides were included into one of four groups regarding their antifungal activity.

RESULTS AND DISCUSSION

No single fungicide of those tested caused the death of *F. avenaceum* but all of them inhibited the linear growth of mycelium in different degrees. In some cases the inhibition was slight, especially in lower concentrations (Table 1). Statistical analysis showed the significant differences in susceptibility to fungicides between tested isolates after both 4 and 8 days of the experiment (Table 2).

The most effective proved to be the fungicides containing difenoconazole, carbendazim and flusilazol. Their efficacy increased with the increase of concentration. Iprodione showed slightly lower activity. All these fungicides were included into the group I, i.e. the compounds of high antifungal activity. Also included in this group were fungicides containing strobilurins. However, their activity was decreasing with time, especially at the combinations with the isolates Fa31 and Fa401 (Table 1).

Methylthiophanate did not inhibit the growth of *F. avenaceum* very strongly in lower concentrations but at the concentrations of 100 ppm its effect increased up to 100%. Based upon its effect after 4 days, this fungicide was included in the group III (i.e. medium antifungal activity).

The fungicides containing mancozeb, chlorothalonil and captan were the least effective. Even at the concentration of 100 ppm the percentage of mycelium growth inhibition was no higher than 50%. These fungicides were included in the groups III and IV (i.e. medium or low antifungal activity).

The results of our investigations partially confirm those of other authors (Wojdyla, 1993, Urban & Filipowicz, 2004). However, methylthiophanate and carbendazim compounds in the investigations of Wojdyla (1993) with *F. avenaceum* pathogenic to carnations were not effective and their effect was similar to that of controls.

As the resistance of certain isolates of fungus to these fungicides is known (Kawchuk et al., 2002), perhaps the author worked with the isolates collected from plants under an intensive chemical control and already resistant to these fungicides.

Table 1. Percentage of inhibition of linear growth of *F. avenaceum* by tested fungicides.

Active ingredient	After 4 days			After 8 days		
	Fa31	Fa221	Fa401	Fa31	Fa221	Fa401
Mancozeb 1ppm	44	47	25	44	42	24
Mancozeb 10ppm	59	53	38	58	47	31
Mancozeb 100ppm	81	53	50	74	48	40
Chlorothalonil 1ppm	30	50	50	34	41	62
Chlorothalonil 10ppm	41	53	67	48	50	69
Chlorothalonil 100ppm	48	57	75	60	70	76
Iprodione 1ppm	85	87	79	82	86	84
Iprodione 10ppm	85	87	83	90	91	85
Iprodione 100ppm	85	87	83	91	92	93
Captan 1ppm	37	47	42	31	41	28
Captan 10ppm	22	50	54	35	44	35
Captan 100ppm	37	57	63	42	50	51
Carbendazim 1ppm	100	100	100	89	100	94
Carbendazim 10ppm	100	100	100	90	100	94
Carbendazim 100ppm	100	100	100	90	100	94
Methylthiophanate 1ppm	22	43	25	19	58	29
Methylthiophanate 10ppm	22	53	33	35	65	43
Methylthiophanate 100ppm	100	100	79	84	100	72
Flusilazol 1ppm	74	73	79	76	79	90
Flusilazol 10ppm	85	80	83	90	88	91
Flusilazol 100ppm	100	87	100	94	92	94
Difenoconazole 1ppm	100	100	100	71	100	100
Difenoconazole 10ppm	100	100	100	77	100	100
Difenoconazole 100ppm	100	100	100	100	100	100
Azoksystrobin 1ppm	63	70	75	45	67	50
Azoksystrobin 10ppm	67	83	83	52	82	63
Azoksystrobin 100ppm	81	87	83	76	88	78
Kresoxim-methyl 1ppm	52	67	71	45	58	54
Kresoxim-methyl 10ppm	67	70	71	53	64	54
Kresoxim-methyl 100ppm	67	73	75	61	68	57

Table 2. Mean mycelium growth of tested isolates under effect of all fungicides.

Isolate	Mean mycelium growth after 4 days (in cm)	Mean mycelium growth after 8 days (in cm)
Fa410	0.670000 a*	2.48333 a
Fa221	0.782000 b	1.74000 b
Fa31	0.849333 c	2.18667 ab
$HSD_{0.05}$	0.0455981	0.539217

* mean values in columns differ significantly ($P \leq 0.05$), if they are not marked the same letter.

CONCLUSIONS

For chemical control of chrysanthemum stem rot caused by *F. avenaceum* the fungicides Score 250 EC (difenoconazole), Punch 400 EC (flusilazol) and Sarfun 500 EC (carbendazim) can be recommended. Not only were they efficient at the lowest

concentration but also their effect on the pathogen was long-lasting. Instead, the fungicides containing captan, mancozeb and chlorothalonil should be avoided.

In designing chemical control, the biodiversity of *F. avenaceum* populations should be taken into consideration, as it was noted that the isolates differ in their susceptibility to the fungicides.

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