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EFFECT OF FUNGICIDES ON COLONY GROWTH OF *COLLETOTRICHUM LINDEMUTHIANUM* (SACC. & MAGN.) SCRIB.

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Abstract: *Colletotrichum lindemuthianum* (Sacc. & Magn.) Scrib. is the causal agent of the anthracnose of common bean (*Phaseolus vulgaris* L.), a fungal disease of a great significance in brazilian bean cultures. The goals of this work were to evaluate the *in vitro* colony growth and to determine the ED_{50} interval of twenty *C. lindemuthianum* isolates from different regions of Brazil to five fungicides of different active ingredients and to some blendings (carbendazim, chlorothalonil, thiophanate-methyl, chlorothalonil + thiophanate-methyl, trifloxystrobin, propiconazole and trifloxystrobin + propiconazole), at concentrations of 0, 1, 10, 100 and 1000 μg/ml, in a potato-dextrose-agar culture medium. The results revealed seven isolates with low sensitivity to carbendazim and thiophanate-methyl (ED_{50} interval greater than 1000 μg/ml) thus suggesting cross-resistance. Isolate sensitivity to chlorothalonil ranged from ED_{50} interval less than 1 μg/ml to greater than 1000 μg/ml. Those isolates with high sensitivity to thiophanate-methyl, ED_{50} interval less than 1 μg/ml, did also show it with respect to chlorothalonil + thiophanate-methyl. Sixteen isolates showed a high sensitivity to trifloxystrobin with a ED_{50} interval less than 1 μg/ml. Nineteen isolates of *C. lindemuthianum* showed high sensitivity to propiconazole and to trifloxystrobin + propiconazole with ED_{50} interval less than 1 μg/ml. Isolates with low sensitivity to carbendazim and thiophanate-methyl were sensitive to propiconazole and to trifloxystrobin + propiconazole. Variability was found in the sensitivity of the colony growth of *C. lindemuthianum* isolates from different regions of Brazil to the fungicides evaluated.

Key words: *Colletotrichum lindemuthianum*, anthracnose of common bean, *Phaseolus vulgaris*, fungicide

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INTRODUCTION

Brazil is one of the world's leading common bean producers and consumers. Bean culture is omnipresent in that country with several different technologies. Among the fungal diseases occurring at the aerial part of plant, anthracnose, caused by *Colletotrichum lindemuthianum* (Sacc. & Magn.) Scrib., is one of the most important and may cause considerable damage when infected seeds and susceptible cultivars are used under weather conditions favourable to the development of epidemics (Giniasi 2002). Damages from anthracnose are greater when the epidemic arises at the early stages of plant development thus infecting leaves, stems, branches and seeds (Canteri 1991). Disease development is favoured by temperatures near 21°C and relative humidity above 92% (Rava 2002).

One of the strategies for common bean anthracnose control is spraying with fungicides over the aerial part of the plant. A number of chemicals are available in Brazil for this disease control as, for example, benzimidazoles, strobilurines, triazoles and isophthalonitriles, among others (Agrofit 2007).

According to Oliveira (2003), spraying common bean plants with trifloxystrobin + propiconazole and propiconazole + fentin hydroxide resulted in a satisfactory control of anthracnose in field conditions. Rava (2002) found that spraying with pyraclostrobin or pyraclostrobin + epoxiconazole reduced the severity of anthracnose leading to a significant grain yield increase.

In order to evaluate the effect of different fungicides on the mycelial growth of *C. lindemuthianum* using different concentrations of thiophanate-methyl + chlorothalonil, chlorothalonil, fentin hydroxide and benomyl, Balardin and Rodrigues (1994) found that benomyl caused greatest inhibition in the mycelial growth of the isolates. Maringoni and Barros (2002), evaluating the *in vitro* sensitivity of five isolates of *C. lindemuthianum* to benomyl, carbendazim, thiophanate-methyl and chlorothalonil observed a low sensitivity of isolates to fungicides of the group of benzimidazoles (benomyl, carbendazim and thiophanate-methyl) although those isolates were found to be sensitive to chlorothalonil. Recently, Sartorato (2006) reported low sensitivity of isolates of *C. lindemuthianum* to thiophanate-methyl.

Systemic benzimidazole group fungicides are considered as high risk of resistance for having a specific action, that is, for acting in only one site of the metabolism of the organisms therefore not requiring mutations in many points before selecting a population resistance (Ghini and Kimati 2000). However, resistance may also occur to other fungicide chemical groups, like triazoles, in a gradual manner, as already verified in some fungi of agricultural importance (Shepers 1985; Waard *et al.* 1986; Smith 1989).

The goal of this work was to evaluate the mycelial growth and determine the ED_{50} interval of twenty isolates of *C. lindemuthianum* from different regions of Brazil, to fungicides of the group of benzimidazoles, chloronitrile, strobilurin, and triazoles.

MATERIALS AND METHODS

Twenty *C. lindemuthianum* isolates (Table 1) from different regions of Brazil underwent *in vitro* essays in order to determine fungicide fungitoxicity (Table 2).

Inoculation was performed by transfering a 50 mm disks of the colony of each isolate into Petri dishes with potato-dextrose-agar (PDA) with the active ingredients

Table 1. *Colletotrichum lindemuthianum* isolates tested and their origin

Identification	Code of origin	Institution/locality*	State	Year of isolation
I-1	3823	IAC	Paraná	1982
I-2	3008 C 5222	IAPAR	Paraná	–
I-3	2993	IB	São Paulo	2005
I-4	2990 C13147	IAC/Capão Bonito	São Paulo	2004
I-5	3010 R89	IAPAR/Irati	Paraná	–
I-6	3009 C65/I1	UFSC	Minas Gerais	2002
I-7	2990 C13039	IAC/Capão Bonito	São Paulo	2004
I-8	3007 C5121	IAPAR	Paraná	–
I-9	9253	IAC	São Paulo	1995
I-10	6225	IAC/Capão Bonito	São Paulo	1991
I-11	2767	FCA/Itaí	São Paulo	1998
I-12	2768	FCA/Coronel Macedo	São Paulo	1998
I-13	3017	FCA/Taquarituba	São Paulo	2005
I-14	3009 C73/I1	UFSC/Ituporanga	Santa Catarina	2003
I-15	2995	EMBRAPA/Dourados	Mato Grosso do Sul	–
I-16	CML 0335	UFLA	Minas Gerais	–
I-17	3009 C 73/I2	UFSC/Petrolândia	Santa Catarina	2003
I-18	3009 C81/I1	UFSC	Minas Gerais	2002
I-19	3009 C81/I3	UFSC	Minas Gerais	2002
I-20	3010 R 95	IAPAR/São João do Ivaí	Paraná	–

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Table 2. Fungicides evaluated in the experiments

Active substance	Concentration	Formulation	Chemical group
Thiophanate-methyl	700 g/kg	wettable powderl	benzimidazole
Thiophanate-methyl + chlorothalonil	200 g/kg +500 g/kg	wettable powder	benzimidazole + chloronitrile
Chlorothalonil	750 g/kg	wettable powder	isoftalonitrile
Carbendazim	500 g/l	suspention concentrate	benzimidazole
Trifloxystrobin	500 g/kg	wettable granular	strubilurin
Trifloxystrobin + propiconazole	125 g/l + 125 g/l	emulsionable concentrate	strubilurin + triazole
Propiconazole	250 g/l	emulsionable concentrate	triazole

of different fungicides at 1, 10, 100 and 1000 µg/ml concentrations. Fungicides were suspended in distilled and sterilized water and added to the sterilized PDA culture medium in a melted state at the temperature of 50°C in order to obtain the desired concentrations. PDA without fungicide addition was used as control. For every fungicide dosage, four repetitions were carried out for each fungal isolate. After seven days of incubation at 25°C, the average diameter of the colonies was evaluated, colony growth inhibition percentage computed and the ED_{50} (µg/ml) interval, the effective dose capable of reducing 50% of the colony growth (Azevedo 2003), was determined for each isolate following Tozze Junior *et al.* (2006).

RESULTS AND DISCUSSION

Eleven *C. lindemuthianum* isolates (I-1, I-2, I-5, I-8, I-9, I-10, I-15, I-16, I-17, I-18 and I-20) showed high sensitivity to carbendazim (Table 3) and to thiophanate-methyl (Table 4) with ED_{50} interval less than 1 µg/ml. Also, seven isolates showed low sensitivity to both carbendazim and thiophanate-methyl (I-4, I-6, I-7, I-11, I-12, I-13 and I-19) with ED_{50} interval greater than 1000 µg/ml, suggesting cross-resistance to these fungicides (Dekker and Georgopoulos 1982; Ghini and Kimati 2000). Isolates I-3 and I-14 were more sensitive to carbendazim, with ED_{50} interval between 1 and 10 µg/ml, than to thiophanate-methyl having ED_{50} greater than 1000 µg/ml and between 100–1000 µg/ml, respectively. Figure 1 shows isolate I-3 colony growth both in the presence and in the absence of thiophanate-methyl.

Table 3. Percentage of colony growth inhibition and ED_{50} interval of twenty *C. lindemuthianum* isolates to four carbendazim concentrations

Isolate	Percentage of the colony growth inhibition at concentration [µg/ml]				ED_{50} interval [µg/ml]
	1	10	100	1000	
I-1	100	100	100	100	< 1
I-2	100	100	100	100	< 1
I-3	15.5	61.8	59.2	65.3	1–10
I-4	0	1.6	17.8	18.8	> 1000
I-5	97.3	97.3	94.6	94.6	< 1
I-6	11.4	9.65	23.7	29.8	> 1000
I-7	0	0	8.8	25.8	> 1000
I-8	100	100	100	100	< 1
I-9	100	100	100	100	< 1
I-10	100	96.9	96.9	100	< 1
I-11	0	9.6	40.4	45.2	> 1000
I-12	0	9.6	40.4	46.2	> 1000
I-13	2.4	0	11.9	20.8	> 1000
I-14	8.7	52.8	60.5	66.8	1–10
I-15	100	100	100	100	< 1
I-16	100	94.9	92.3	98.3	< 1
I-17	95.0	95.0	99.0	95.0	< 1
I-18	100	100	100	100	< 1
I-19	0	24.3	23.2	32.0	> 1000
I-20	89.8	89.8	100	100	< 1

Table 4. Percentage of colony growth inhibition and ED_{50} interval of twenty *C. lindemuthianum* isolates to four thiophanate-methyl concentrations

Isolate	Percentage of the colony inhibition at concentration [μg/ml]				ED_{50} interval [μg/ml]
	1	10	100	1000	
I-1	91.4	87.1	94.8	96.6	< 1
I-2	95.3	91.8	93.0	91.8	< 1
I-3	2.9	6.8	31.7	39.4	> 1000
I-4	0	1.3	10.9	8.1	> 1000
I-5	85.0	90.2	93.3	95.7	< 1
I-6	6.2	8.9	13.4	14.3	> 1000
I-7	0	3.1	8.1	4.1	> 1000
I-8	88.4	100	100	100	< 1
I-9	90.1	95.6	95.6	93.4	< 1
I-10	92.4	96.6	96.6	95.8	< 1
I-11	0	0	7.4	0	> 1000
I-12	0	0	5.5	6.5	> 1000
I-13	0	4.3	3.5	5.2	> 1000
I-14	9.4	22.7	32.0	61.7	100–1000
I-15	95.3	100	100	100	< 1
I-16	95.1	96.1	96.1	96.1	< 1
I-17	95.3	96.3	96.3	96.3	< 1
I-18	99	100	100	100	< 1
I-19	9.2	3.6	20.4	27.1	> 1000
I-20	95.5	98.9	100	100	< 1

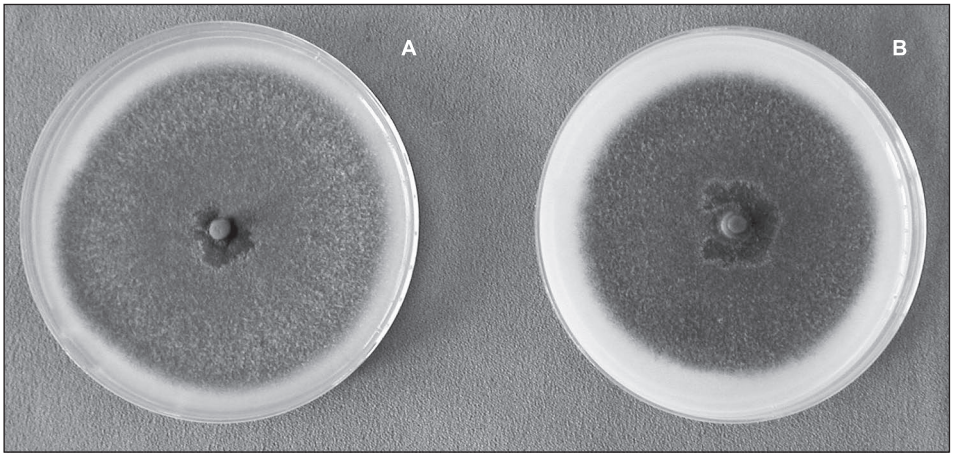

Fig. 1. Colony growth of I-13 isolate on PDA medium in the absence (A) and in the presence (B) of thiophanate-methyl (1000 μg/ml) after seven days of incubation

Of the isolates with low sensitivity to carbendazim, five came from State of São Paulo and two from State of Minas Gerais. For thiophanate-methyl, six came from State of São Paulo, two from State of Minas Gerais and one from State of Santa Catarina. It is likely that the low sensitivity of these isolates to fungicides of the group of benzimidazoles is due to resistance, as previously noted by Maringoni and Barros (2002) and Sartorato (2006). Fungal resistance to benzimidazoles is due to the mutation of the β-tubulin gene which causes changes in the base sequences and consequently in the synthesis of amino acids, mainly in codons 198 or 200 (Mckay and Cook 1997; Mckay *et al*. 1998). In Brazil (Ghini and Kimati 2000) and in other countries (Dekker and Georgopoulos 1982) there are countless examples of phytopathogenic fungi resistant to fungicides of the benzimidazole group.

Sensitivity of *C. lindemuthianum* isolates showed variations with respect to different concentrations of chlorothalonil (Table 5) since ten isolates had ED_{50} between 100–1 000 μg/ml or superior to 1 000 μg/ml. Results herein agree with those given by Rava *et al*. (1998) and by Maringoni and Barros (2002) at a concentration of 100 μg/ml for *C. lindemuthianum* isolates. Sartorato (2007) found 83.7 to 99.6% inhibition in the mycelial growth of eight isolates of *C. lindemuthianum* using chlorothalonil at 3 500 μg/ml. Differences in mycelial growth sensitivity to chlorothalonil were described for isolates of *Sphaeropsis pinea* in China (Wu and Hong 2000), and *Fusarium avenaceum* in Poland (Kopacki and Wagner 2006), is being in agreement with results presented herein for *C. lindemuthianum*.

Table 5. Percentage of colony growth inhibition and ED_{50} interval of twenty *C. lindemuthianum* isolates to four chlorothalonil concentrations

Isolate	Percentage of the colony growth inhibition at concentration [μg/ml]				ED_{50} interval [μg/ml]
	1	10	100	1 000	
I-1	33.4	59.0	67.6	82.1	1–10
I-2	29.3	59.2	65.7	98.4	1–10
I-3	21.7	30.2	39.4	69.8	100–1 000
I-4	15.0	18.5	17.5	67.5	100–1 000
I-5	4.5	11.4	13.2	73.9	100–1 000
I-6	20.5	37.5	40.2	65.2	100–1 000
I-7	26.6	24.4	55.0	61.3	10–100
I-8	33.5	47.8	51.4	97.3	10–100
I-9	29.8	58.1	66.4	92.6	1–10
I-10	35.7	25.9	40.2	100	100–1 000
I-11	36.0	35.1	39.5	45.6	> 1 000
I-12	24.9	23.0	34.4	32.5	> 1 000
I-13	26.4	31.5	24.3	43.9	> 1 000
I-14	17.7	34.7	48.4	79.0	100–1 000
I-15	19.6	23.6	35.4	48.2	> 1 000
I-16	50.0	60.4	70.8	93.8	1
I-17	63.5	76.4	80.7	92.5	< 1
I-18	43.6	53.2	76.6	100	1–10
I-19	45.6	57.6	69.0	80.5	1–10
I-20	47.8	80.9	93.6	100	1–10

C. lindemuthianum isolates that presented high sensitivity to thiophanate-methyl, ED_{50} interval less than 1 μg/ml, also were sensitive to thiophanate-methyl plus chlorothalonil (Table 6). Isolates I-4, I-7 and I-5 showed ED_{50} intervals smaller for a blend of thiophanate-methyl and chlorothalonil than for thiophanate-methyl. This greater sensitivity to blends can be explained by the presence of chlorothalonil since this fungicide's action on fungal metabolism is different from that of thiophanate-methyl (Ghini and Kimati 2000; Azevedo 2003). This fact was also observed by Sartorato (2006) for concentrations of 1250 μg/ml and 3125 μg/ml for thiophanate-methyl and chlorothalonil. In the results observed by Balardin and Rodrigues (1995), all *C. lindemuthianum* isolates were inhibited by thiophanate-methyl at 50 μg/ml as well as by chlorothalonil and by a blend of these two ingredients. However in the present work were found differences in the sensitivity of *C. lindemuthianum* isolates to those active principles.

Table 6. Percentage of colony growth inhibition and ED_{50} interval of twenty *C. lindemuthianum* isolates to four thiophanate-methyl plus chlorothalonil concentrations

Isolate	Percentage of the colony growth inhibition at concentration [μg/ml]				ED_{50} interval [μg/ml]
	1	10	100	1000	
I-1	75.3	100	100	100	< 1
I-2	90.0	95.6	95.6	93.3	< 1
I-3	24.1	34.3	43.5	71.3	100–1000
I-4	12.3	32.4	30.0	41.8	> 1000
I-5	68.5	94.6	94.6	94.6	< 1
I-6	31.5	35.6	45.5	46.4	> 1000
I-7	20.5	23.8	38.3	53.4	100–1000
I-8	90.2	100	100	100	< 1
I-9	90.9	94.8	94.8	94.8	< 1
I-10	100	100	100	100	< 1
I-11	32.5	40.4	39.5	46.5	> 1000
I-12	16.1	21.4	21.4	26.7	> 1000
I-13	19.5	23.3	24.7	30.9	> 1000
I-14	18.9	30.9	52.2	75.3	10–100
I-15	62.2	94.3	97.6	100	< 1
I-16	92.9	100	100	96.9	< 1
I-17	100	100	100	100	< 1
I-18	100	100	100	100	< 1
I-19	42.1	47.4	58.2	78.5	10–100
I-20	100	100	100	100	< 1

Nineteen out of twenty *C. lindemuthianum* isolates showed high sensitivity to propiconazole with ED_{50} less than 1 µg/ml and only isolate I-13 showed an interval ED_{50} between 1–10 µg/ml, as indicated in Table 7. Figure 2 shows the mycelial growth of isolate I-2 in the presence and in the absence of propiconazole. These results demonstrate that the isolates of *C. lindemuthianum* evaluated in this study had a high sensitivity to propiconazole which has made it possible to inhibit the mycelial growth of the isolates that showed low sensitivity to carbendazim and to thiophanate-methyl (Tables 3 and 4). Although low sensitivity of *C. lindemuthianum* isolates to propiconazole was not found, there are reports in the literature about the development of gradual resistance of *Sphaerotheca fuliginea* (Sherps 1985), *Erysiphe graminis* f. sp. *tritic*i (Waard *et al.* 1986) and *Venturia inaequalis* (Smith 1989) to fungicides of the triazole group.

Table 7. Percentage of colony growth inhibition and ED_{50} interval of twenty *Colletotrichum lindemuthianum* isolates to four propiconazole concentrations

Isolate	Percentage of the colony growth inhibition at concentration [µg/ml]				ED_{50} interval [µg/ml]
	1	10	100	1 000	
I-1	100	100	100	100	< 1
I-2	100	100	100	100	< 1
I-3	100	100	100	100	< 1
I-4	90.7	99.0	100	100	< 1
I-5	100	100	100	100	< 1
I-6	100	100	100	100	< 1
I-7	95.0	100	100	100	< 1
I-8	100	100	100	100	< 1
I-9	94.7	100	100	100	< 1
I-10	92.7	100	100	100	< 1
I-11	100	100	100	100	< 1
I-12	100	100	100	100	< 1
I-13	35.8	62.7	83.6	85.1	1–10
I-14	96.8	100	100	100	< 1
I-15	83.2	98.0	100	100	< 1
I-16	91.2	100	100	100	< 1
I-17	92.4	100	100	100	< 1
I-18	100	100	100	100	< 1
I-19	100	100	100	100	< 1
I-20	94.1	100	100	100	< 1

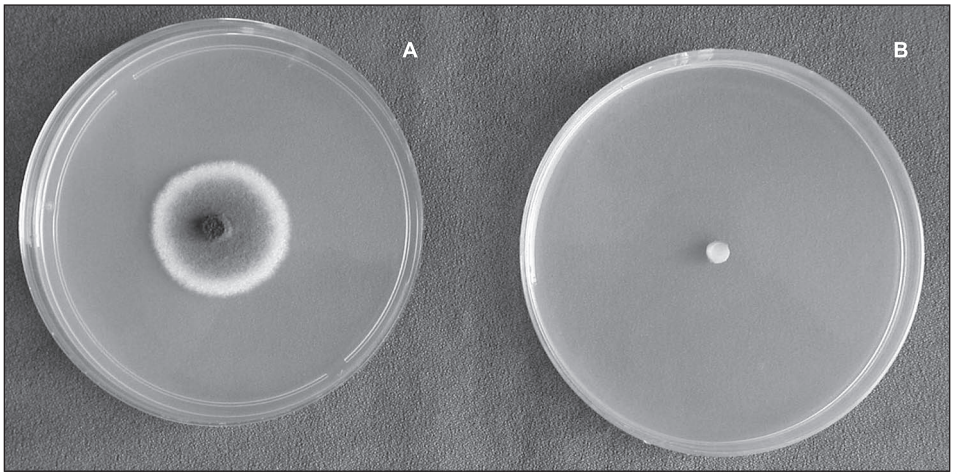

Fig. 2. Colony growth of I-2 isolate on PDA medium in the absence (A) and in the presence (B) of propiconazole (1000 μg/ml) after seven days of incubation

Table 8. Percentage of colony growth inhibition and ED_{50} interval of twenty *Colletotrichum lindemuthianum* isolates to four trifloxystrobin concentrations

Isolate	Percentage of the colony growth inhibition at concentration [μg/ml]				ED_{50} interval [μg/ml]
	1	10	100	1000	
I-1	74.3	91.4	98.6	100	< 1
I-2	95.1	100	100	100	< 1
I-3	88.4	91.6	91.6	92.6	< 1
I-4	56.7	58.0	62.2	76.6	< 1
I-5	100	100	100	100	< 1
I-6	92.5	96.7	95.0	96.7	< 1
I-7	62.4	65.1	70.1	98.7	< 1
I-8	88.3	90.8	90.8	100	< 1
I-9	86.2	86.2	87.5	100	< 1
I-10	100	100	100	100	< 1
I-11	48.1	49.1	53.7	78.7	10–100
I-12	34.4	33.5	30.6	64.8	100–1000
I-13	0	0.5	18.3	55.4	100–1000
I-14	96.4	100	100	100	< 1
I-15	48.1	39.7	51.3	76.8	10–100
I-16	98.1	100	100	100	< 1
I-17	93.1	92.1	100	100	< 1
I-18	94.1	92.6	86.8	97.1	< 1
I-19	100	100	100	100	< 1
I-20	99.0	96.1	99.0	100	< 1

Table 8 shows results for trifloxystrobin. Sixteen isolates showed high sensitivity to that fungicide, with ED_{50} interval less than 1 µg/ml, and four isolates had moderate sensitivity, with ED_{50} interval between 10–100 µg/ml and 100–1 000 µg/ml.

Except for I-13 isolate, all *C. lindemuthianum* isolates showed a ED_{50} less than 1 µg/ml for a trifloxystrobin plus propiconazole mixture (Table 9), a result similar to that of propiconazole (Table 7). Isolate I-13, from Taquarituba, State of São Paulo, showed the least sensitivity to trifloxystrobin, propiconazole, propiconazole + trifloxystrobin, carbendazim, thiophanate-methyl, chlorothalonil and chlorothalonil + thiophanate-methyl. This observation showed the possibility of many mutation points in the genom of isolate I-13 thus permitting to metabolise the various active ingredients of the fungicide which makes the chemical control of anthracnose more difficult where this type of fungal isolate is present.

Table 9. Percentage of colony growth inhibition and ED_{50} interval of twenty *Colletotrichum lindemuthianum* isolates to four propiconazole + trifloxystrobin concentrations

Isolate	Percentage of the colony growth inhibition at concentration [µg/ml]				ED_{50} interval [µg/ml]
	1	10	100	1 000	
I-1	100	100	100	100	< 1
I-2	100	100	100	100	< 1
I-3	100	100	100	100	< 1
I-4	84.3	97.4	100	100	< 1
I-5	100	100	100	100	< 1
I-6	100	100	100	100	< 1
I-7	89.6	98.2	100	100	< 1
I-8	100	100	100	100	< 1
I-9	100	100	100	100	< 1
I-10	100	100	100	100	< 1
I-11	100	100	100	100	< 1
I-12	100	100	100	100	< 1
I-13	18.6	59.7	81.5	91.6	1–10
I-14	100	100	100	100	< 1
I-15	81.0	92.0	100	100	< 1
I-16	100	100	100	100	< 1
I-17	100	100	100	100	< 1
I-18	100	100	100	100	< 1
I-19	97.7	100	100	100	< 1
I-20	100	100	100	100	< 1

Results obtained in this work show a large variation in the sensitivity of *C. lindemuthianum* isolates to the various groups of fungicides studied. These results are important in the design of anthracnose chemical control using fungicides of different active ingredients, either in alternated spraying or blending, in order to reduce the

selection of resistant or low sensitivity isolates and thus the chance of treatment failure as it has been the case in Brazil (Maringoni and Barros 2002; Sartorato 2006) with fungicides of the benzimidazole group.

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POLISH SUMMARY

DZIAŁANIE FUNGICYDÓW NA WZROST KOLONII *COLLETOTRICHUM LINDEMUTHIANUM* (SACC. & MAGN.) SCRIB.

Colletotrichum lindemuthianum (Sacc. & Magn.) Scrib. jest czynnikiem sprawczym antraktozy fasoli zwyczajnej (*Phaseolus vulgaris* L.), choroby o dużym znaczeniu w brazylijskich uprawach fasoli. Przedmiotem wykonanej pracy była *in vitro* wzrostu grzybni w celu określenia przedziału ED_{50} dla 20 izolatów *C. lindemuthianum* pochodzących z różnych rejonów Brazylii na 5 różnych składników aktywnych, a także kilku mieszanek tych składników (karbendazym, chlorothalonil, tiofanat metylu, chlorothalonil + tiofanat metylu, trifloksystrobina, propikonazol i trifloksystrobina + propikonazol). W badaniach uwzględniono stężenia fungicydów wynoszące 0, 1, 10, 100 i 1000 μg/ml w pożywce agarowo-ziemniaczanej z glukozą. W wyniku przeprowadzonych badań stwierdzono, że 7 izolatów wykazywało niską wrażliwość na karbendazym i tiofanat metylu (przedział ED_{50} większy niż 1000 μg/ml), co wskazywało na odporność krzyżową. Wrażliwość izolatów na chlorothalonil wahała się w granicach przedziału ED_{50} niższego niż 1 mg/ml^{-1} do większego niż 1000 μg/ml. Izobaty posiadające wysoką wrażliwość na tifanat metylu i mające przedział ED_{50} mniejszy niż 1 $\mu g/ml^{-1}$ wykazywały również dużą wrażliwość na mieszaninę chlorothalonil + tiofanat metylu. Szesnaście izolatów wykazywało dużą wrażliwość na trifloksystrobinę z przedziałem ED_{50} mniejszym niż 1 μg/ml. Dziewiętnaście izolatów *C. lindemuthianum* charakteryzowało się wysoką wrażliwością na mieszaninę trifloksystrobina + propikonazol i miało również przedział ED_{50} mniejszy niż 1 μg/ml. Izobaty posiadające niską wrażliwość na karbendazym i tiofanat metylu były wrażliwe na propikonazol i mieszaninę trifloksystrobina + propikonazol. Zaobserwowano zmienność wrażliwości wyrażoną wzrostem grzybni *C. lindemuthianum* z różnych rejonów Brazylii na oceniane fungicydy.