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Full Length Research Paper

Cellulose decomposing fungi and cellulase activity as affected by amistar and moncut fungicides

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Spray application of the two fungicides; Amistar (25% Azoxystrobin) and Moncut (25% Flutolanil) on faba bean plants in the field exhibited an inhibitive effect on the total and individual counts of cellulose decomposing fungi associated with roots and shoots of plants. The inhibitive effect of these fungicides depended mainly on the fungicide concentration. The inhibitive effect was increased with the increase in fungicide concentration at different periods of treatment. Forty four fungal isolates representing 35 species and 2 varieties belonging to 19 genera were screened for their abilities to produce exo-β-1,4 glucanase and endo-β-1,4 glucanase enzymes. All fungal isolates tested had the ability to produce cellulase enzymes, but with variable degrees. For exo-β-1, 4 glucanase, six isolates (represent 13.7% of total isolates) showed high cellulase activity. However, twenty one isolates (47.7% of total isolates) were found to be moderate in their cellulase activity. The remaining isolates (17 isolates, represent 38.6% of total isolates) were low producers of cellulase. For endo-β-1, 4 glucanase enzyme, five isolates (represent 11.4% of total isolates) showed high cellulase activity and twenty one isolates (47.7% of total isolates) had moderate ability to produce cellulase. The remaining isolates (18 isolates, represent 40.9% of total isolates) were low producers of cellulase. When these fungicides (at 100-800 ppm) were incorporated individually into the liquid culture medium specified for growth and an extracellular cellulase production was exerted an inhibitive effect on both mycelial growth and cellulase production of *Aspergillus flavus* var. *columnaris*, *A. fumigatus*, *A. ochraceous*, *Mucor hiemalis* and *Trichoderma harzianum*.

Key words: Fungicides, faba bean, cellulose decomposing fungi, cellulase enzymes.

INTRODUCTION

Broad bean (*Vicia faba* L.) is one of the most important winter crops in many parts of the world. It's production is concentrated in nine major regions; Northern Europe, Mediterranean, the Nile Valley, Ethiopia, Central Asia, East Asia, Oceana, Latin America and North America. Sometimes it is grown for green manure, but more generally for stock feed. Cultivated faba bean is used as human and animal food in many countries of the world. It can be used as a vegetable, green or dried, fresh or canned (Bond et al., 1985). Faba bean is attacked by several fungi causing many diseases including chocolate spot (*Botrytis fabae* and *B. cinerea*), rust (*Uromyces viciae fabae*), black root rot (*Thielaviopsis basicola*), stem rots (*Sclerotina trifoliorum*, *S. sclerotiorum*), root rots and damping-off (*Pythium* spp. and *Rhizoctonia* spp.), downy mildew (*Pernospora viciae*), leaf and pod spots or blight (*Ascochyta fabae*), foot rots (*Fusarium* spp.) (Van Emden et al., 1988). Recently, *Alternaria tenuissima* was found to be the pathogen of broad bean causing new leaf spot disease in Japan (Rahman et al., 2002).

Cellulose is the major component of plant biomass and the most abundant organic polymer on the earth. It is a linear homo-polysaccharide consisting of anhydrous glucose units that are linked by β-1,4-glycosidic bonds. Cellulases are capable of hydrolyzing β-1,4-glycosidic bonds in cellulose and have been broadly divided into

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Table 1. Fungicides used, their names, active ingredients and manufacturers.

Fungicides	Amistar	Moncut
Chemical name	Methyl (αE)-2-[6-(2 cyanophenoxy)-4-pyrimidinyl] oxy]-α (methoxymethylene) benzeneacetate.	N-[3-(1-methylethoxy) phenyl]-2-(trifluoromethyl) benzamide
Active ingredient	Azoxystrobin 25% SC	Flutolanil 25%
Manufacturer	Syngenta Agro, Switzerland	Nihon Nohyako, Japan

Table 2. Doses of fungicides used for treatment of faba bean plants in the field.

Doses fungicides	Low	Recommended	High	Unit
Amistar	0.215	0.43	0.86	ml
Moncut	0.535	1.071	2.142	g

three types: endoglucanase (endo-1,4-D-glucanase, EG), cellobiohydrolase (exo-1,4-D-glucanase, CBH) and glucosidase (1,4-D-glucosidase, BG). EG acts in random fashion, cleaving linked bonds within the cellulose molecule. CBH removes cellobiose units from the nonreducing ends of the cellulose chain and BG degrades cellobiose and cellooligosaccharides to glucose (Saha, 2004). In nature there are many microorganisms, fungal and bacterial, produce enzymes that are capable of catalyzing the hydrolysis of cellulose. These fungi are members of *Aspergillus*, *Chaetomium*, *Mucor*, *Penicillium*, *Trichoderma* and Dematiaceous hyphomycetes as reported by several workers (Nelly, 1991; Abdel-Hafez et al., 1995; Moharram et al., 2004; El-Said et al., 2005, 2006; Vasil'chenko et al., 2005; El-Said and Saleem, 2008).

Several investigations were conducted on the effect of different fungicides on fungi in different places of the world (El-Ghaouth et al., 2001; Culbreath et al., 2002; Buck and Williams, 2003; Fravel et al., 2005; Meyer et al., 2006; Das et al., 2007; Groth, 2008; Sahile et al., 2008) as well as on mycelial growth and extracellular enzymes production by different fungal species (Abdel-Kader et al., 1989; Hassan, 1993; Saleem, 1995; Choi et al., 1997; Tsuji et al., 1997; Omar and Abd-Alla, 2000; Moharram et al., 2004; Fravel et al., 2005). This article was conducted to determine the selective effect of Amistar and Moncut fungicides on cellulose decomposing fungi associated with both roots and leaves of faba bean plant. In addition to the effect of these fungicides on cellulase enzyme production by the most active isolates of fungi.

MATERIALS AND METHODS

Pesticides used in the present investigation

Two fungicides commonly used in Egypt were employed in the present investigation namely Amistar and Moncut. The fungicides are recently used in Egypt for controlling several fungal diseases of fruit trees, vegetables and economic crops. Their chemical names, active ingredients and their manufacturers are shown in Table 1.

Effect of fungicides on the mycobiota of faba bean plants

Treatment of plants by fungicides

Plants of 3 weeks age were sprayed with three doses of fungicides (low, medium 'recommended field dose' and high doses) as shown in Table 2. Untreated plants served as control.

Determination of rhizosphere, rhizoplane, phyllosphere and phylloplane fungi of faba bean

Plants treated and untreated with fungicides were removed from the soil and transferred to the mycological laboratory for assaying their fungal contents of rhizosphere, rhizoplane (root surface), phyllosphere and phylloplane (leaf surface) at intervals of 1, 2, 4, 6, 8 and 10 weeks of treatment.

Determination of rhizosphere soil fungi

Plants were randomly chosen and pulled from the soil. Soil particles adhered to roots treated and untreated with fungicides were collected. Rhizosphere soil fungi were determined using the dilution plate method (Johnson and Curl, 1972). Cultivated plates were incubated at 28°C for 7 days. The developing fungi were identified and counted. The numbers of fungi were calculated per mg of dry soil.

Determination of root surface (rhizoplane) fungi

Roots were subjected to series of washing by sterile distilled water. They were thoroughly dried between sterile filter papers, cut into equal segments (1 cm each) which were then palced on the surface of cellulose-Czapek's agar medium (4 plates). Plates were incubated at 28°C for 7 days and the developing fungi were identified, counted and calculated/20 root segments.

Determination of phyllosphere fungi

Known weights of treated and untreated leaves of faba bean were placed individually in sterile conical flasks containing 100 ml sterile distilled water. Flasks were shaken for 10 min. Ten ml of the suspension were transferred into flask (250 ml) containing 90 ml sterile distilled water. After five minutes of shaking, one ml of the final dilution was transferred to a sterile Petri-dish followed by addition of ~ 15 ml of liquid cellulose-Czapek's agar medium. Four replicates were prepared for each treatment and control. Plates were incubated at 28°C for 7 days and the developing fungi were identified, counted and calculated per mg of fresh weight of leaves.

Determination of leaf surface (phylloplane) fungi

Leaf samples from fungicides-treated and untreated faba bean plants were subjected to a series of washing with sterile distilled water. They were thoroughly dried between sterile filter papers, cut into equal segments (1 cm^2 each). Five segments were placed on the surface of cellulose-Czapek's agar medium in each plate. Four plates were prepared for each treatment and control. Plates were incubated at 28°C for 7 days, and the developing fungi were identified, counted and calculated/20 leaf segments.

Medium used for isolation of cellulose decomposing fungi

Cellulose-Czapek's agar medium (g/liter): Sodium nitrate, 3.0; Potassium dihydrogen phosphate, 1.0; Magnesium sulphate, 0.5; Potassium chloride, 0.5; Ferrous sulphate, 0.01; Cellulose powder, 20.0; Agar 15.0) was used for isolation of cellulose decomposing fungi. Rose bengal (0.1 mg/ml) and Chloramphenicol (0.5 mg/ml) were used as bacteriostatic agents (Smith and Dawson, 1944; Al-Doory, 1980).

Cellulase enzymes

Screening of fungal isolates for production of extracellular cellulase enzymes

Forty four fungal isolates (recovered from different parts of faba bean plants) representing 35 species and 2 varieties related to 19 genera were screened for their abilities to produce exo- and endo-β-1,4-glucanase enzymes on the solid media. Exo-β-1,4-glucanase (C_1-cellulase) and endo-β-1, 4-glucanase (C_x cellulase) were estimated according to the methods described by Eggins and Pugh (1962), Dingle et al. (1953) and Prasan and Verma (1979).

Effect of fungicides on mycelial growth and cellulase production by some fungi

Cultivation and culture conditions

Five fungal isolates namely, *Aspergillus flavus* var. *columnaris*, *A. fumigates*, *A. ochraceus*, *M. hiemalis* and *T. harzianum* were used to study the effect of fungicides on mycelial growth and cellulase production since these fungi were found to be the highest activity of cellulase enzyme. Different doses of the two fungicides used ranging from 100 to 800 ppm were incorporated into 50 ml aliquots liquid medium. Cultures were inoculated with 2 agar mycelial discs (10 mm diameter) on which fungal species were allowed to grow. Modified Czapek's solution containing cellulose as a substrate was used for production of cellulase enzyme. After 7 days of incubation at 28°C, cultures were filtered and the harvested mycelium was oven dried and weighed. Aliquots of 1 ml of the crude filtrate were assayed for enzymatic activity.

Determination of cellulase activity

Cellulase activity was assayed spectrophotometrically according to the method described by Nelson (1944) and modified by Naguib (1964), where 1 ml of 1% cellulose solution in acetate buffer (pH= 6) was used for exo-β-1, 4-glucanase enzyme. The activity was calculated as µg reducing sugars per 1 ml of culture medium. Similar reaction mixtures using heated inactive enzyme solution were also used as control and water with reagents was used as a blank. A standard curve was plotted using aqueous solution of D-glucose with concentration from 10-120 µg/ml.

Statistical analysis

Statistical analysis of data was carried out by one way analysis of variance and the means were separated by Tukey's honest significant difference test using Biostat 2007 statistical analysis program (Copyright © 2001-2009 Analystsoft).

RESULTS AND DISCUSSION

Effect of fungicides on cellulose decomposing fungi isolated from root surface of faba bean plant

Amistar and Moncut fungicides exhibited an inhibitive effect on the total counts of cellulose decomposing fungi isolated from rhizosphere and rhizoplane of faba bean plant by all doses used after all periods of treatment. The inhibitive effect was increased with the increasing of fungicide concentration after different period of treatment (Tables 3 to 6). The selective effect of different fungicides on rhizosphere and rhizoplane fungi was recorded by several workers (Abdel-Kader et al., 1983; Moubasher et al., 1984, 1991; Nan et al., 1991; Nan, 1995; Benignia and Bompeix, 2004; Moharram et al., 2004). Tridemorph and Benomyl fungicides exerted a toxic effect on the total count of root surface fungi of *Vigna sinensis* by the three doses used after all periods of treatment (Abdel-Kader et al., 1983; Moubasher et al., 1984). Nan et al. (1991) reported that, the total populations of fungi in the roots of red clover plants cultivated in pots treated with prochloraz fungicide (at concentration 240 mg/Kg dry soil) were lower than those from untreated controls. Nan (1995) reported that seed treatments with thiophanate-methyl fungicide or sulphuric acid copper+zinc complex reducing fungal infection of roots and reduced the total percentages of root segments yielding fungal colonies and frequencies of *Fusarium oxysporum* and *F. solani* and other speicies of *Fusarium*. Recently, Moharram et al. (2004) studied the effect of Kocide and Ridomil plus fungicides on cellulose decomposing fungi isolated from roots of tomato plant. They showed that, these fungicides had an inhibitive effect on cellulose decomposing fungi of tomato by all doses used after different periods of

Table 3. Count (per mg of dry soil) of rhizosphere fungi after different periods of faba bean treatment with various doses of Amistar on cellulose-Czapek's agar at 28℃.

Weeks after treatment	1				2				4				6				8				10			
Doses / Genera and species	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H
Total count	3.7	2.1*	1.4*	0.7*	4.9	4.0	2.3*	1.6*	5.0	2.9*	1.6*	1.3*	4.7	3.2*	2.0*	1.2*	4.7*	2.5*	1.9*	1.2*	5.0	3.2*	2.1*	1.8*
Alternaria alternata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Aspergillus	0.8	0.5	0.4*	0.1*	1.8	1.6	1.2*	0.8*	2.3	1.4*	0.7*	0.7*	1.3	1.0	0.8*	0.5*	1.1	0.5*	0.4*	0.3*	1.2	1.2	0.8	0.8
A. flavus	0.4	0.4	0.3	0.1	0.4	0.4	0.4	0.2	0.5	0.2	0.2	0.1*	0.3	0.2	0.2	0.1	0.4	0.2	0.2	0.1	0.4	0.3	0.2	0.2
A. fumigatus	0.2	0.0	0.1	0.0	0.4	0.3	0.3	0.2	0.8	0.6	0.3*	0.4*	0.8	0.5	0.3*	0.3*	0.2	0.1	0.0	0.0	0.2	0.2	0.1	0.1
A. niger	0.0	0.0	0.0	0.0	0.6	0.6	0.4	0.3	0.6	0.4	0.2*	0.2*	0.2	0.2	0.2	0.1	0.3	0.1	0.1	0.1	0.3	0.3	0.2	0.2
A. ochraceous	0.2	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.2
A. terreus	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.1	0.3	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.1	0.1	0.0	0.3	0.2	0.1	0.1
Chaetomium globosum	0.4	0.2	0.1	0.1	0.5	0.4	0.2	0.1*	0.2	0.1	0.1	0.0	0.4	0.2	0.1	0.2	0.3	0.2	0.1	0.0	0.4	0.3	0.3	0.2
Emericella	1.0	0.5*	0.2*	0.2*	1.4	1.3	0.6*	0.4*	1.4	1.2	0.7*	0.6*	1.2	0.8	0.5*	0.3*	1.6	0.9*	0.8*	0.3*	1.5	0.9*	0.6*	0.6*
E. nidulans	0.4	0.3	0.1	0.1	0.6	0.4	0.2*	0.2*	0.8	0.5	0.3*	0.3*	0.8	0.6	0.3*	0.2*	0.7	0.4	0.4	0.1*	0.8	0.4*	0.2*	0.2*
E. nidulans var. *lata*	0.6	0.2*	0.1*	0.1*	0.8	0.9	0.4*	0.2*	0.6	0.7	0.4	0.3	0.4	0.2	0.2	0.1	0.9	0.5*	0.4*	0.2*	0.7	0.5	0.4	0.4
Fusarium oxysporum	0.1	0.0	0.2	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.1	0.0	0.3	0.1	0.2	0.1	0.2	0.1	0.1	0.0
Gibberella fujikuroi	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.4	0.2	0.1	0.1	0.2	0.1	0.1	0.0
Mucor hiemalis	0.1	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.3	0.1	0.0	0.0	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Myrothecium roridum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.1	0.1
Nectria haematococca	0.5	0.4	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.1	0.0	0.0	0.4	0.3	0.2	0.0*	0.3	0.2	0.2	0.2	0.3	0.1	0.0	0.0
Penicillium chrysogenum	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.2	0.1	0.1	0.3	0.2	0.0	0.1	0.2	0.1	0.1	0.1
Phoma hebarum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rhizopus stolinifer	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Stachybotrys chartarum	0.7	0.4	0.3*	0.1*	0.4	0.3	0.0*	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.0*	0.0*

C = Control; L= Low dose; R = Recommended dose; H = High dose; Astrisked values mean significant difference from control.

treatment.

Aspergillus, *Chaetomium*, *Emericella*, *Fusarium*, *Gibberella* and *Nectria* were the most common genera of fungi isolated from root surface of faba bean plant on cellulose-Czapek's agar. The counts of these genera were decreased by all doses used after different periods of treatment; except in some cases, the counts were increased or not affected at certain periods and doses. From the previous genera, *Aspergillus flavus*, *A. fumigatus*, *A. niger*, *Chaetomium globosum*, *Emericella nidulans*, *E. nidulans* var. *lata*, *Fusarium oxysporum*, *Gibberella fujikuroi* and *Nectria haematococca* were the most common species. The counts of these species were decreased by all doses used after all periods of treatment; except in some cases, the counts were not affected or increased at certain doses and periods (Tables 3 to 6). The selective effect of various fungicides on cellulose decomposing fungi was recorded by several workers (Abdel-Kader et

Table 4. Count (per mg of dry soil) of rhizosphere fungi after different periods of faba bean treatment with various doses of Moncut on cellulose-Czapek's agar at 28℃.

Weeks after treatment	1				2				4				6				8				10			
Doses / Genera and species	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H
Total count	3.7	2.5*	1.5*	1.4*	4.9	3.0*	2.1*	1.7*	5.0	3.0*	2.5*	2.1*	4.7	3.1*	2.1*	1.5*	4.7	2.6*	1.7*	1.4*	5.0	3.0*	2.4*	1.8*
Alternaria alternata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Aspergillus	0.8	0.6	0.6	0.4	1.8	1.3	1.0*	0.7*	2.3	1.5*	1.1*	0.7*	1.3	0.8	0.3*	0.4*	1.1	0.5*	0.3*	0.2*	1.2	0.6*	0.4*	0.4*
A. flavus	0.4	0.3	0.3	0.2	0.4	0.2	0.2	0.1	0.5	0.4	0.2	0.2	0.3	0.2	0.1	0.1	0.4	0.2	0.1	0.1	0.4	0.1	0.1	0.1
A. fumigatus	0.2	0.2	0.2	0.1	0.4	0.4	0.4	0.2	0.8	0.5	0.5	0.2*	0.8	0.4*	0.1*	0.1*	0.2	0.1	0.0	0.0	0.2	0.1	0.1	0.1
A. niger	0.0	0.0	0.0	0.0	0.6	0.4	0.2*	0.2*	0.6	0.3	0.1*	0.1*	0.2	0.1	0.1	0.1	0.3	0.1	0.1	0.0	0.3	0.2	0.1	0.1
A. ochraceous	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
A. terreus	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.1	0.3	0.3	0.3	0.2	0.0	0.1	0.0	0.1	0.2	0.1	0.0	0.0	0.3	0.2	0.1	0.1
Chaetomium globosum	0.4	0.2	0.1	0.1	0.5	0.0*	0.2	0.1*	0.2	0.1	0.0	0.0	0.4	0.2	0.1	0.0*	0.3	0.1	0.0	0.0	0.4	0.3	0.3	0.2
Emericella	1.0	0.8	0.5*	0.5*	1.4	0.8*	0.5*	0.4*	1.4	0.8*	0.6*	0.6*	1.2	0.9	0.6*	0.4*	1.6	1.0*	0.6*	0.6*	1.5	1.0*	0.6*	0.5*
E. nidulans	0.4	0.4	0.3	0.3	0.6	0.3	0.2*	0.2*	0.8	0.5	0.4*	0.4*	0.8	0.6	0.3*	0.3*	0.7	0.4	0.2*	0.2*	0.8	0.5	0.2*	0.2*
E. nidulans var. *lata*	0.6	0.4	0.2*	0.2*	0.8	0.5	0.3*	0.2*	0.6	0.3	0.2*	0.2*	0.4	0.3	0.3	0.1	0.9	0.6	0.4*	0.4*	0.7	0.5	0.4	0.3*
Fusarium oxysporum	0.1	0.1	0.0	0.2	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.3	0.1	0.1	0.1	0.2	0.2	0.2	0.1
Gibberella fujikuroi	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.4	0.2	0.1	0.1	0.2	0.1	0.1	0.1
Mucor hiemalis	0.1	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.2	0.1	0.1	0.1	0.3	0.2	0.1	0.0	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Myrothecium roridum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.2	0.1
Nectria haematococca	0.5	0.3	0.1*	0.1*	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.4	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.2
Penicillium chrysogenum	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.3	0.2	0.2	0.1	0.2	0.1	0.1	0.1
Phoma herbarum	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rhizopus stolinifer	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.2	0.2	0.1	0.3	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.1
Stachybotrys chartarum	0.7	0.3*	0.1*	0.1*	0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.2	0.0*

C = Control; L= Low dose; R = Recommended dose; H = High dose; Astrisked values mean significant difference from control.

al., 1983; Moubasher et al., 1984, 1987; Das et al., 1995). Moharram et al. (2004) studied the effect of Kocide and Ridomil plus fungicides on cellulose decomposing fungi isolated from roots of tomato plant. They showed that, these fungicides had an inhibitive effect on cellulose decomposing fungi by all doses used after different periods of treatment. The most common fungi were *Alternaria alternata*, *Aspergillus flavus*, *A. fumigates*, *A. niger*, *A. terreus*, *Cochliobolus spicifer*, *Emericella nidulans*, *E. nidulans* var. *lata*, *Mycosphaerella tassiana*, *Penicillium chrysogenum* and *P. oxalicum*. Their counts were reduced or completely eliminated by all doses used after different periods of treatment. Fravel et al. (2005) studied the effect of azoxystrobin, chlorothalonil, mancozeb, mefenoxam and thiram fungicides on *Fusarium* wilt caused by *Fusarium oxysporum*. Azoxystrobin and chlorothalonil were most toxic to the fungus and reduced growth rate and final colony size at 10 ppm or greater concentrations.

Effect of fungicides on cellulose decomposing fungi isolated from leaf surface of faba bean plant

The two fungicides tested exhibited a depressive effect on the total counts of cellulose decomposing fungi isolated from phyllosphere and phylloplane fungi of faba bean plant by all doses used after all periods of treatment. Gererally, the depressive effect was increased with the increasing of fungicide concentration (Tables 7 to

Table 5. Count (per 20 root segments) of rhizoplane fungi after different periods of faba bean treatment with various doses of Amistar on cellulose-Czapek's agar at 28℃.

Weeks after treatment	1				2				4				6				8				10			
Doses / Genera and species	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H
Total Count	25	23	19	12*	28	25	21*	18*	41	28*	24*	19*	42	33	27*	26*	38	34	24*	19*	44	40	30*	29*
Acremonium strictum	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	2	1	1	0	2	1	1	1
Alternaria alternata	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0
Aspergillus	0	0	0	0	0	0	0	0	4	2	1	1	9	5*	3*	3*	10	8	3*	1*	12	12	6*	5*
A. flavus	0	0	0	0	0	0	0	0	2	1	1	1	3	2	1	1	4	2	1	1	6	6	2*	2*
A. fumigatus	0	0	0	0	0	0	0	0	0	0	0	0	4	2	2	2	4	4	2	0*	4	4	2	2
A. niger	0	0	0	0	0	0	0	0	2	1	0	0	2	1	0	0	2	2	0	0	2	2	2	1
Cochliobolus spicifer	0	0	0	0	0	0	0	0	2	1	1	0	2	2	1	1	0	0	0	0	3	2	1	1
Emericella nidulans var. *lata*	0	0	0	0	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fusarium	3	2	2	1	6	4	4	3	2	1	1	1	4	3	2	2	6	6	4	4	4	3	3	3
F. oxysporum	3	2	2	1	4	3	3	2	2	1	1	1	3	2	2	2	4	4	3	3	4	3	3	3
F. semitectum	0	0	0	0	2	1	1	1	0	0	0	0	1	1	0	0	2	2	1	1	0	0	0	0
Gibberella	2	1	1	1	2	2	1	1	5	3	3	3	2	2	2	2	4	4	1	1	4	4	3	3
G. fujikuroi	2	1	1	1	2	2	1	1	3	2	2	2	2	2	2	2	2	2	0	0	4	4	3	3
G. pulicaris	0	0	0	0	0	0	0	0	2	1	1	1	0	0	0	0	2	2	1	1	0	0	0	0
Nectria haematococca	20	20	16*	10*	16	15	14	14	20	16*	16*	12*	20	18	16*	16*	15	14	14	13	16	16	14	14
Phoma herbarum	0	0	0	0	4	3	2	0*	5	3	2	2	0	0	0	0	0	0	0	0	3	2	2	2
Rhizopus stolonifer	0	0	0	0	0	0	0	0	0	0	0	0	3	2	2	2	0	0	0	0	0	0	0	0

C = Control; L= Low dose; R = Recommended dose; H = High dose; Astrisked values mean significant difference from control.

10). In this respect, Abdel-Kader et al. (1983) reported that, the fungicide Tridemorph was almost regularly inhibited the total counts of phyllosphere and phylloplane fungi of *Vigna sinensis* by three doses after 10 days and till the end of the experiment. Moubasher et al. (1984) reported that, Benomyl was almost regularly toxic to the total counts of phyllosphere and phylloplane fungi and the toxicity persisted till the end of the experiment. Recently, Moharram et al. (2004) studied the effect of Kocide and Ridomil plus fungicides on the phyllosphere and phylloplane fungi of tomato plant. They reported that, the two fungicides had an inhibitive effect on cellulose decomposing fungi of tomato by all doses used after different periods of treatment.

A. alternata, *Aspergillus flavus*, *A. fumigatus*, *A. niger*, *Emericella nidulans* var. *lata*, *P. chrysogenum* and *Rhizopus stolonifer* were the most common fungi isolated on cellulose-Czapek's agar. The counts of these fungi were reduced by all doses of fungicides after different periods of treament; except in some cases, the counts of these fungi was not affected or increased at certain periods and treatments (Tables 7 to 10). Annapurna and Rao (1982) studied the effect of foliar application of Captan, Dithane, Carbaryl and Atrataf on leaf extract and phylloplane counts of maize fungi. Generally the microbial counts in treated samples were less than the control.

In Egypt, the phyllosphere and phylloplane fungi of *Vigna sinensis* were markedly reduced as a result of treatment with Tridemorph and Benomyl fungicides (Abdel-Kader et al., 1983; Moubasher et al. 1984). Moharram et al. (2004) investigated

Table 6. Count (per 20 root segments) of rhizoplane fungi after different periods of faba bean treatment with various doses of Moncut on cellulose-Czapek's agar at 28℃.

Weeks after treatment	1				2				4				6				8				10			
Doses / Genera and species	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H
Total Count	25	21	19	14*	28	27	18*	11*	41	31*	25*	19*	42	37	30*	22*	38	33	24*	19*	44	38	32*	27*
Acremonium strictum	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	2	1	1	0	2	2	1	1
Alternaria alternata	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
Aspergillus	0	0	0	0	0	0	0	0	4	2	1	1	9	12	7	3*	10	8	5*	3*	12	11	7*	6*
A. flavus	0	0	0	0	0	0	0	0	2	2	1	1	3	6	2	2	4	4	2	2	6	6	3	3
A. fumigatus	0	0	0	0	0	0	0	0	0	0	0	0	4	4	4	0*	4	2	2	0*	4	3	3	2
A. niger	0	0	0	0	0	0	0	0	2	0	0	0	2	2	1	1	2	2	1	1	2	2	1	1
Cochliobolus spicifer	0	0	0	0	0	1	0	0	2	2	0	0	2	2	2	1	0	0	0	0	3	2	1	1
Emericella nidulans var. *lata*	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fusarium	3	2	2	0	6	6	3	0*	2	2	1	1	4	2	2	1	6	6	2*	2*	4	4	4	3
F. oxysporum	3	2	2	0	4	4	2	0*	2	2	0	0	3	2	2	1	4	4	2	2	4	3	3	3
F. poae	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0
F. semitectum	0	0	0	0	2	1	1	0	0	0	0	0	1	0	0	0	2	2	0	0	0	0	0	0
Gibberella	2	1	1	1	2	2	1	1	5	4	4	1*	2	2	1	1	4	3	1	1	4	5	5	4
G. fujikuroi	2	1	1	1	2	2	1	1	3	2	2	0	2	2	1	1	2	2	1	1	4	4	4	3
G. intricans	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1
G. pulicaris	0	0	0	0	0	0	0	0	2	1	1	1	0	0	0	0	2	1	0	0	0	0	0	0
Nectria haematococca	20	18	16*	13*	16	16	14	10*	20	18	16*	14*	20	16*	16*	16*	15	14	14	13	16	12*	12*	10*
Phoma herbarum	0	0	0	0	4	2	0*	0*	5	3	3	2	0	0	0	0	0	0	0	0	3	2	2	2
Rhizopus stolonifer	0	0	0	0	0	0	0	0	0	0	0	0	3	2	2	0	0	0	0	0	0	0	0	0

C = Control; L= Low dose; R = Recommended dose; H = High dose; Astrisked values mean significant difference from control.

the effect of Kocide and Ridomil plus fungicides on the phyllosphere and phylloplane fungi of tomato plant. They found that, the two fungicides had an inhibitive effect on several cellulose decomposing fungi associated with tomato leaves and these were *A. alternata*, *Aspergillus flavus*, *A. fumigatus*, *A. niger*, *A. terreus*, *Cochliobolus specifer*, *Emericella nidulans*, *E. nidulans* var. *lata*, *Mycosphaerella tassiana*, *Nectria haematococca*, *P. chrysogenum* and *P. oxalicum*.

It is worth to mention that, several plant diseases caused by numerous pathogenic fungi were found to be controlled by various fungicides includes maize smut fungus *Sphacelotheca reiliana* (Ramirez and Medrano, 1991), downy mildew of onion caused by *Peronospora destructor* (Obrien, 1992), wheat leaf rust caused by *Puccinia recondite* (Scott, 1995), oat leaf stripe pathogen*Pyrenophora avenae* (Brear et al., 1997), apple powdery mildew fungus *Podosphaera leucotticha* (Reuveni et al., 1998), daylily rust caused by *Puccinia hemerocallidis* (Buck and Williams, 2003), tomato *Fusarium* wilt caused by *Fusarium oxysporum* (Fravel et al., 2005), sugar beet leaf spot caused by *Cercospora beticola* (Khan and Smith, 2005), *Rhizoctonia* foliar blight of soybean (Meyer et al., 2006), barely leaf rust caused by *Puccinia hordei* (Das et al., 2007), rice sheath blight caused by *Rhizoctonia solani* (Groth, 2008) and faba bean chocolate spot

Table 7. Count (per mg leaves) of phyllosphere fungi after different periods of faba bean treatment with various doses of Amistar on cellulose-Czapek's agar at 28℃.

Weeks after treatment	1				2				4				6				8				10			
Doses / Genera and species	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H
Total Count	4.0	2.3*	1.5*	0.6*	4.9	3.7*	2.8*	1.6*	5.7	4.3*	3.3*	2.9*	2.6	2.0	1.5*	1.2*	5.0	3.4*	2.4*	1.5*	5.9	5.3	4.0*	2.9*
Altrnaria alternata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.6	0.6	0.8	0.6	0.6	0.5	0.9	0.7	0.4*	0.3*	0.0	0.0	0.0	0.0
Aspergillus	0.6	0.4	0.2*	0.1*	3.1	2.4	2.2*	1.1*	3.1	2.3	1.9*	1.5*	0.4	0.3	0.3	0.0	1.1	0.6*	0.3*	0.1*	1.9	1.7	1.5*	1.1*
A. flavus	0.3	0.1	0.0	0.0	0.7	0.5	0.3*	0.2*	1.4	1.0*	0.8*	0.7*	0.1	0.1	0.1	0.0	0.5	0.3	0.1*	0.1*	0.3	0.3	0.3	0.2
A. fumigatus	0.2	0.2	0.2	0.1	0.8	0.5	0.4*	0.1*	1.0	0.7	0.7	0.6*	0.2	0.1	0.1	0.0	0.3	0.2	0.1	0.0	0.5	0.5	0.4	0.4
A. niger	0.0	0.0	0.0	0.0	1.5	1.4	1.3	0.7*	0.4	0.3	0.3	0.1	0.1	0.1	0.1	0.0	0.2	0.1	0.1	0.0	0.6	0.5	0.5	0.3
A. ochraceous	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.4	0.3	0.2	0.2
A. terreus	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
Curvularia launata	0.3	0.1	0.1	0.0	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Emericella	0.2	0.1	0.1	0.0	0.6	0.4	0.1*	0.2*	0.2	0.1	0.0	0.1	0.3	0.2	0.1	0.1	0.2	0.2	0.1	0.0	1.3	1.1	0.8*	0.8*
E. nidulans	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.3	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.6	0.5	0.3	0.3
E. nidulans var. *lata*	0.2	0.1	0.1	0.0	0.5	0.3	0.1*	0.1*	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.7	0.6	0.5	0.5
Fusarium oxysporum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.4	0.3	0.3	0.0	0.0	0.0	0.1	0.5	0.3	0.2	0.2	0.0	0.0	0.0	0.0
Humicola grisea	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.1
Mucor racemosus	0.5	0.3	0.3	0.2	0.0	0.0	0.0	0.0	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.2	0.1	0.1
Mycosphaerella tassiana	0.9	0.6	0.4*	0.1*	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.4	0.2	0.2	0.1	0.5	0.4	0.3	0.1*
Myrothecium roridum	0.6	0.3	0.3	0.1*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.6	0.5	0.4	0.2*
Nectria haematococca	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.3	0.3	0.2	0.4	0.4	0.2	0.2
Penicillium chrysgenum	0.2	0.1	0.0	0.0	0.3	0.2	0.2	0.1	0.1	0.1	0.0	0.0	0.4	0.4	0.3	0.3	0.8	0.6	0.6	0.5	0.3	0.3	0.2	0.1
Scopulariopsis brevicaulis	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0
Setosphaeria rostrata	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.2	0.1
Stachybotrys chartarum	0.6	0.4	0.1*	0.1*	0.0	0.0	0.0	0.1	0.4	0.3	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.1	0.1

C = Control; L= Low dose; R = Recommended dose; H = High dose; Astrisked values mean significant difference from control.

caused by *Botrytis faba* (Sahile et al., 2008).

Screening of fungi for cellulase production

Forty four fungal isolates represent 35 species and 2 varieties including 19 genera were screened for their abilities to produce exo-β-1, 4 glucanase and endo-β-1,4 glucanase. All isolates were recovered from different parts of faba bean plant. All fungal isolates tested had the ability to produce cellulase enzymes, but with variable degrees. For exo-β-1, 4 glucanase, Six isolates (represent 13.7% of total isolates) showed highcellulase activity. Twenty one isolates (47.7% of total isolates) were found to be moderate cellulase activity.The remaining isolates (17 isolates, 38.6% of total isolates) were low

Table 8. Count (per mg leaves) of phyllosphere fungi after different periods of faba bean treatment with various doses of Moncut on cellulose-Czapek's agar at 28℃.

Weeks after treatment	1				2				4				6				8				10			
Doses / Genera and species	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H
Total Count	4.0	2.3*	1.4*	1.0*	4.9	3.8*	2.8*	2.1*	5.7	4.8	3.4*	1.8*	2.6	2.2	1.5*	0.8*	5.0	3.1*	1.7*	1.8*	5.9	4.4*	3.7*	2.8*
Alternaria alternata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.6	0.4	0.3*	0.8	0.7	0.5	0.3*	0.9	0.5*	0.2*	0.2*	0.0	0.0	0.0	0.0
Aspergillus	0.6	0.3	0.2*	0.0*	3.1	2.6	2.1*	1.8*	3.1	2.6	1.9*	0.9*	0.4	0.3	0.3	0.0*	1.1	0.7*	0.2*	0.2*	1.9	1.5	1.2*	0.9*
A. flavus	0.3	0.1	0.1	0.0	0.7	0.5	0.4	0.4	1.4	1.1	0.8*	0.5*	0.1	0.1	0.1	0.0	0.5	0.3	0.1*	0.1*	0.3	0.1	0.1	0.1
A. fumigatus	0.2	0.1	0.1	0.0	0.8	0.7	0.7	0.5	1.0	0.9	0.6*	0.2*	0.2	0.1	0.1	0.0	0.3	0.2	0.1	0.0	0.5	0.5	0.4	0.3
A. niger	0.0	0.0	0.0	0.0	1.5	1.3	1.0*	0.8*	0.4	0.3	0.3	0.1	0.1	0.1	0.1	0.0	0.2	0.1	0.0	0.1	0.6	0.4	0.4	0.2*
A. ochraceous	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.4	0.4	0.3	0.3
A. terreus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Curvularia launata	0.3	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Emericella	0.2	0.2	0.1	0.0	0.6	0.4	0.3	0.2*	0.2	0.2	0.1	0.2	0.3	0.2	0.2	0.1	0.2	0.1	0.0	0.0	1.3	0.9*	0.9*	0.7*
E. nidulans	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.3	0.2	0.2	0.1	0.1	0.1	0.0	0.0	0.6	0.4	0.4	0.3
E. nidulans var. *lata*	0.2	0.2	0.1	0.0	0.5	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.7	0.5	0.5	0.4
Fusarium oxysporum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.4	0.1*	0.0	0.0	0.0	0.0	0.5	0.3	0.2	0.2	0.0	0.0	0.0	0.0
Humicola grisea	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.1
Mucor racemosus	0.5	0.4	0.2	0.2	0.0	0.0	0.0	0.0	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.0
Mycosphaerella tassiana	0.9	0.5*	0.3*	0.3*	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.4	0.3	0.2	0.2	0.5	0.3	0.3	0.2
Myrothecium roridum	0.6	0.3	0.3	0.2*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.6	0.4	0.4	0.3
Nectria haematococca	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.4	0.3	0.3	0.4	0.3	0.3	0.2
Penicillium chrysgenum	0.2	0.1	0.0	0.0	0.3	0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.4	0.4	0.3	0.3	0.8	0.5	0.4*	0.4*	0.3	0.2	0.2	0.1
Scopulariopsis brevicaulis	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.2	0.2	0.0	0.0	0.0	0.0
Setosphaeria rostrata	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.2	0.2
Stachybotrys chartarum	0.6	0.3	0.3	0.2*	0.0	0.0	0.0	0.0	0.4	0.3	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.1	0.1

C = Control; L= Low dose; R = Recommended dose; H = High dose; Astrisked values mean significant difference from control.

producers of cellulase. For endo-β-1, 4 glucanase enzyme, Five isolates (represent 11.4% of total isolates) showed high cellulase activity. However, twenty one isolates (47.7% of total isolates) had moderate ability to produce cellulase and the remaining isolates (18 isolates, 40.9% of total isolates) were low producers of cellulase (Table 11). Moharram et al. (2004) screened seventy two fungal isolates recovered from tomato plant for their ability to produce cellulase enzymes. They showed that all fungal isolates tested had the ability to produce cellulase enzymes, but with variable degrees. *Aspergillus flavus*, *Cunninghamella echinulata*, *Emericella nidulans* var. *lata*, *Fusarium oxysporum* and *Penicillium*

Table 9. Count (per 20 leaf segments) of phylloplane fungi after different periods of faba bean treatment with various doses of Amistar on cellulose-Czapek's agar at 28℃.

Weeks after treatment	1				2				4				6				8				10			
Doses / Genera and species	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H
Total count	40	29*	22*	20*	62	43*	37*	25*	65	50*	38*	29*	70	55*	45	36*	70	45*	36*	18*	71	54*	42*	42*
Acremonium strictum	0	0	0	0	0	0	0	0	4	2	1	1	0	0	0	0	8	4*	2*	2*	3	2	2	2
Alternaria alternata	0	0	0	0	10	7	5*	2*	14	11	11	8*	12	8*	7*	7*	6	2*	2*	0*	4	3	0*	0*
Aspergillus	36	27	22*	20*	34	28	25	18*	22	20	14*	12*	16	14	11*	8*	27	18*	18*	10*	40	34	28*	28*
A. flavus	10	9	8	8	10	9	7	7	8	7	7	4*	4	3	2	2	9	6	6	4*	10	9	9	9
A. fumigatus	10	8	6*	4*	4	3	3	2	4	4	2	2	8	8	6	4*	4	4	4	2	12	12	8*	8*
A. niger	8	6	4*	4*	10	9	9	5*	8	8	4*	4*	4	3	3	2	6	4	4	4	14	11	9*	9*
A. ochraceous	8	4*	4*	4*	6	4	4	2*	2	1	1	1	0	0	0	0	6	2*	2*	0*	4	2	2	2
A. terreus	0	0	0	0	4	3	2	2	0	0	0	1	0	0	0	0	2	2	2	0	0	0	0	0
Chaetomium globosum	0	0	0	0	0	0	0	0	4	2	2	0*	0	0	0	0	5	3	2	2	4	3	3	3
Cochliobolus spicifer	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	2	2	0	0	0	0	0	0
Emericella nidulans var. *lata*	4	2	0*	0*	2	1	1	0	4	3	2	0*	0	0	0	0	4	4	2	0*	9	4*	4*	4*
Fusarium oxysporum	0	0	0	0	0	0	0	0	4	3	2	2	6	4	4	2*	2	2	0	0	0	0	0	0
Myrothecium roridum	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	2	2
Nectria haematococca	0	0	0	0	4	3	2	2	6	4	2*	2*	8	6	6	6	4	2	2	0*	0	0	0	0
Penicillium chrysogenum	0	0	0	0	6	4	4	3	5	4	4	4	10	8	6*	4*	4	2	2	0*	4	3	1	1
Rhizopus stolonifer	0	0	0	0	4	0*	0*	0*	0	0	0	0	13	11	11	9*	8	6	6	4*	4	3	2	2
Ulochladium botrytis	0	0	0	0	0	0	0	0	2	1	0	0	3	2	0	0	0	0	0	0	0	0	0	0

C = Control; L= Low dose; R = Recommended dose; H = High dose; Astrisked values mean significant difference from control.

aurantiogriseum, *chrysogenum* were the most active producers of exo-β-1,4 glucanase. However, *Alternariaalternate*, *Aspergillus tamarii*, *Cunninghamella echinulata*, *Emericella nidulans* and *P. chrysogenum* were the most active fungal isolates for endo-β-1,4 glucanase. El-Said and Saleem (2008) screened 42 fungal isolates recovered from soil for their abilities to produce endo 1,4-ß-glucanase enzyme (CMase) on solid medium. Ten isolates (23.80% of total isolates) showed high cellulolytic activity and these were *A. alternata*, *Aspergillus flavus*, *A. fumigatus*, *Chaetomium globosum*, *Cladosporium cladosporioides*, *Fusarium oxysporum*, *Mucor racemosus*, *Papulaspora immersa*, *Rhizopus stolonifer* and Sterile mycelia. Sixteen isolates (38.09%) were either moderate or low producers of cellulase enzyme. Several fungal species were reported as cellulase producers with variable degrees by several workers (Abdel-Hafez et al., 1995; El- Said, 2001; El-Said et al., 2006; El-Said and Saleem, 2008).

Effect of fungicides on mycelial growth and cellulase production of some fungi

Since these fungi (*Aspergillus flavus* var. *columnaris*, *A. fumigatus*, *A. ochraceous*, *M. hiemalis* and *T. harzianum*) were found to be the

Table 10. Count (per 20 leaf segments) of phylloplane fungi after different periods of faba bean treatment with various doses of Moncut on cellulose-Czapek's agar at 28℃.

Weeks after treatment	1				2				4				6				8				10			
Doses / Genera and species	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H	C	L	R	H
Total count	40	37	23*	20*	62	42*	31*	21*	65	48*	35*	22*	70	57*	45*	27*	70	54*	46*	29*	71	45*	42*	36*
Acremonium strictum	0	0	0	0	0	0	0	0	4	2	2	0*	0	0	0	0	8	4*	2*	0*	3	2	2	2
Alternaria alternata	0	0	0	0	10	6*	2*	2*	14	12	12	9*	12	12	10	6*	6	4	4	2*	4	3	2	2
Aspergillus	36	35	23*	20*	34	28	21*	17*	22	19	15*	10*	16	13	10*	5*	27	25	19*	15*	40	27*	25*	23*
A. flavus	10	9	6*	6*	10	9	8	8	8	7	6	4*	4	3	3	2	9	9	7	7	10	10	8	8
A. fumigatus	10	8	6*	6*	4	2	2	0*	4	4	3	2	8	6	4*	3*	4	4	4	2	12	4*	4*	4*
A. niger	8	10	7	6	10	9	9	7	8	6	6	4*	4	4	3	0*	6	8	6	6	14	10*	10*	8*
A. ochraceous	8	8	4*	2*	6	4	2*	2*	2	2	0	0	0	0	0	0	6	2*	0*	0*	4	3	3	3
A. terreus	0	0	0	0	4	4	0*	0*	0	0	0	0	0	0	0	0	2	2	2	0	0	0	0	0
Chaetomium globosum	0	0	0	0	0	0	0	0	4	3	2	2	0	0	0	0	5	4	4	4	4	3	3	3
Cochliobolus spicifer	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	1	2	2	2	0	0	0	0	0
Emericella nidulans var. *lata*	4	2	0*	0*	2	1	1	0	4	2	0*	0*	0	0	0	0	4	2	2	2	9	4*	4*	0*
Fusarium oxysporum	0	0	0	0	0	0	0	0	4	2	2	0*	6	4	4	2*	2	2	2	0	0	0	0	0
Myrothecium roridum	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	1
Nectria haematococca	0	0	0	0	4	2	2	0*	6	4	0*	0*	8	6	4*	3*	4	3	3	2	0	0	0	0
Penicillium chrysogenum	0	0	0	0	6	4	4	2*	5	2	2	1*	10	8	6*	2*	4	4	4	2	4	2	2	2
Rhizopus stolonifer	0	0	0	0	4	1	1	0*	0	0	0	0	13	11	9*	8*	8	4*	4*	2*	4	3	3	3
Ulochladium botrytis	0	0	0	0	0	0	0	0	2	2	0	0	3	1	1	0	0	0	0	0	0	0	0	0

C = Control; L= Low dose; R = Recommended dose; H = High dose; Astrisked values mean significant difference from control.

most active cellulase producers, they employed to study the effect of fungicides on cellulase production. Cellulase production of *Aspergillus flavus* var. *columnaris*, *A. fumigatus*, *A. ochraceous*, *M. hiemalis* and *T. harzianum* was inhibited by all doses of fungicides. The degree of inhibition depended mainly on the fungicide concentration in the culture medium for enzyme production. Generally, the inhibitive effect of the fungicides was increased with the increasing of fungicide concentration. On the other hand, the effect of fungicides on the mycelial growth of *Aspergillus flavus* var. *columnaris*, *A. fumigatus*, *A. ochraceous*, *M. hiemalis* and *T. harzianum* was similar to their effect on the enzyme production.

The fungicides tested inhibited the mycelial growth of all tested fungi and the inhibitive effect was increased with the increasing of fungicide concentration in the culture medium (Tables 12 and 13). Peterauer et al. (1992) investigated the effect of Benomyl on growth and cellulase formation of *Trichoderma reesei*, *T. harzianum* and the Benomyl-resistant mutant *T. harzianum*. *T. reesei* produced the highest amount of cellulase and *T. harzianum* produced the lowest cellulase amounts. Growth of both strains was equaly inhibited by 2 µg/ml of Benomyl. Recently, Moharram et al. (2004) investigated the effect of two systemic fungicides Kocide and Ridomil plus on mycelial growth and cellulase production bydifferent fungal species including *Alternaria alternata*, *Aspergillus flavus*, *A. tamarii*, *Cunninghamella echinulata*, *Emericella nidulans*, *E. nidulans* var. *lata*, *Fusarium oxysporum*, *Penicillium aurantiogriseum* and *P. chrysogenum*. They recorded reduction effect on mycelial growth and cellulase production by tested fungi particularly at high doses (200-400 ppm) of fungicides.

Table 11. Screening of fungal isolates for their abilities to produce cellulase enzymes.

Fungal isolates	Source	Cellulases	
		C_1	C_X
Acremonium strictum	Phylloplane	24 M	21 M
Alternaria alternata	Phylloplane	26 M	26 M
Aspergillus carneus	Phyllosphere	20 L	24 M
A. flavus	Phyllosphere	19 L	20 L
A. flavus	Rhizosphere	20 L	21 M
A. flavus var. *columnaris*	Phyllosphere	33 H	30 H
A. fumigatus	Phylloplane	35 H	30 H
A. fumigatus	Phyllosphere	33 H	28 M
A. fumigatus	Rhizosphere	35 H	29 H
A. niger	Rhizosphere	19 L	22 M
A. ochraceous	Rhizoplane	21 M	21 M
A. ochraceous	Phylloplane	32 H	29 H
A. sydowii	Phyllosphere	21 M	22 M
A. sydowii	Rhizosphere	20 L	23 M
A. tamarii	Phyllosphere	25 M	21 M
A. terreus	Phyllosphere	23 M	19 L
A. terreus	Rhizosphere	25 M	24 M
A. ustus	Rhizosphere	20 L	23 M
A. versicolor	Phylloplane	22 M	21 M
Cladosporium cladosporioides	Phyllosphere	18 L	17 L
Chaetomium globosum	Phylloplane	20 L	14 L
Curvularia lunata	Phyllosphere	24 M	19 L
Emericella nidulans	Phyllosphere	20 L	20 L
E. nidulans var. *lata*	Phyllosphere	22 M	25 M
Fusarium oxysporum	Rhizoplane	14 L	20 L
F. poae	Rhizoplane	23 M	16 L
F. semitectum	Rhizoplane	21 M	14 L
Gibberella fujikuroi	Rhizoplane	25 M	18 L
G. intricans	Rhizoplane	20 L	15 L
G. pulicaris	Rhizoplane	17 L	16 L
Mucor hiemalis	Rhizosphere	29 H	15 L
M. racemosus	Phyllosphere	20 L	16 L
Mycosphaerella tassiana	Phylloplane	26 M	22 M
Myrothecium roridum	Phylloplane	20 L	18 L
Nectria haematococca	Rhizoplane	20 L	15 L
Penicillium brevicompactum	Phylloplane	25 M	24 M
P. chrysogenum	Phylloplane	26 M	27 M
P. chrysogenum	Phyllosphere	24 M	28 M
P. funiculosum	Phyllosphere	24 M	22 M
Phoma herbarum	Rhizoplane	24 M	26 M
Rhizopus stolonifer	Rhizosphere	25 M	27 M
Setosphaeria rostrata	Phylloplane	18 L	16 L
Stachybotrys chartarum	Phyllosphere	16 L	17 L
Trichoderma harzianum	Phyllosphere	24 M	30 H

High activity > 28; Moderate activity = 21-28; Low activity < 21.

The inhibitive effect of different fungicides on mycelial growth and extracelluar enzymes of several fungi was recorded by many workers (Abdel-Kader et al., 1989; Saleem, 1995; Omar and Abd-Alla, 2000; Fravel et al.,

Table 12. Effect of Amistar on growth and cellulase production by some fungi after 7 days of incubation at 28℃.

Fungi dose (ppm)	*A. flavus* var. *columnaris*		*A. fumigatus*		*A. ochraceous*		*M. hiemalis*		*T. harzianum*	
	EP	D wt	EP	D wt	EP	D wt	EP	D wt	EP	D wt
0 (control)	4.28	192	4.36	210	5.42	150	3.48	149	5.06	183
100	4.08	159*	4.16	153*	4.60*	132*	3.06*	130	4.76	162*
200	3.66*	140*	3.82*	125*	3.44*	117*	2.80*	108*	4.40*	155*
400	3.36*	118*	3.56*	116*	3.28*	102*	2.54*	92*	4.14*	138*
600	3.06*	85*	3.24*	104*	3.00*	87*	2.08*	87*	3.84*	121*
800	2.46*	68*	3.06*	89*	2.76*	74*	1.54*	72*	3.72*	109*

E.P = Enzyme production (µg/ml) D wt = Dry weight (mg/100 ml) Asterisked values mean significant difference from the control.

Table 13. Effect of Moncut on growth and cellulase production by some fungi after 7 days of incubation at 28℃.

Fungi dose (ppm)	*A. flavus* var. *columnaris*		*A. fumigatus*		*A. ochraceous*		*M. hiemalis*		*T. harzianum*	
	EP	D wt	EP	D wt	EP	D wt	EP	D wt	EP	D wt
0 (control)	4.28	192	4.36	210	5.42	150	3.48	149	5.06	183
100	3.86	160*	4.22	189	5.18	143	2.94*	118*	4.82	171
200	3.68*	148*	4.02	165*	4.86*	133*	2.64*	109*	4.56*	157*
400	3.50*	125*	3.78*	137*	4.40*	118*	2.46*	96*	4.20*	143*
600	3.00*	88*	3.46*	116*	4.06*	103*	2.14*	82*	4.12*	127*
800	2.74*	60*	3.18*	103*	3.74*	88*	1.92*	67*	3.96*	104*

E.P = Enzyme production (µg/ml); D wt = Dry weight (mg/100 ml); Asterisked values mean significant difference from the control.

2005; Meyer et al., 2006).

REFERENCES

Abdel-Hafez SII, El–Said AHM, Gherabawy YAMH (1995). Mycoflora of leaf surface, stem, bagasse and juice of adult sugarcane (*Saccharum officinarum* L.) plant and cellulolytic ability in Egypt. Bull. Fac. Sci. Assiut. Univ., 24: 113–130.

Abdel-Kader MIA, Moubasher AH, Abdel-Mallek AY (1983). Selective effect of the systemic fungicide Tridemorph on Egyptian soil and leaf- and root surface fungi. Bull. Fac. of Sci., Assiut Univ., 12: 19-34.

Abdel-Kader MIA, Moubasher AH, Abdel-Mallek AY (1989). studies on the effect of the fungicide Euparen on cellulose-decomposing fungi in Egyptian soil. J. Basic Microbiol., 29: 329-335.

Al-Doory Y (1980). Laboratory medical mycology. Lea and Febiger, Philadelphia Kimpton Publishers, London, pp. 410.

Annapurna Y, Rao PR (1982). Influence of foliar application of pesticides on leaf extracts and phylloplane microflora of corn. Folia Microbiol., 27: 250-255.

Annapurna Y, Rao PR (1991). Foliar spray of fungicides and rhizosphere microflora of maize. Rev. Plant Pathol., 70: 724.

Benigni M, Bompeix G (2004). Control of *Phytophthora cryptogea* (Pethyb.and Laff.) of witloof chicory (*Cichorium intybus* L.) with azoxystrobin applied before the forcing period. Crop Protect., 23: 1011–1014.

Biostat (2007). Biostat Statistical Analysis Program. Version 2007, Copyright© 2001-2007 Analystsoft.

Bond DA, Lawes DA, Hawtin GC, Saxena MC, Stephens JS (1985). Faba bean (*Vicia faba* L.). In: R.J. Summerfield and E.H. Roberts (eds.), Grain Legume Crops. William Collins Sons Co. Ltd., London, UK, pp. 199-265.

Brear K, Walters D, Robins D (1997). Synthesis and antifungal activity of six benzylic diamines. Fems Microbiol. Lett., 157: 291-294.

Buck JW, Williams JL (2003). The effect of fungicides on urediniospore germination and disease development of daylily rust. Crop Protect., 22: 135–140.

Choi GJ, Lee HJ, Cho KY (1997): Involvement of Catalase and superoxide dismtase in resistance of *Botrytis cinerea* to dicaroximide fungicide vinclozollin. Pesticide Biochem. Physiol., 59: 1-10.

Culbreath AK, Stevenson KL, Brenneman TB (2002). Management of late leaf spot of Peanut with Benomyl and Chlorothalonil: A study in preserving fungicides utility. Am. Phytopathol. Soc., 86: 349-355.

Das AC, Chakravarty A, Sukul P, Mukherjee D (1995). Insecticides: their effect on microorganisms and persistence in rice soil. Microbiol. Res., 150: 187-194.

Das MK, Griffey CA, Baldwin RE, Waldenmaier CM, Vaughn ME, Price AM, Brooks WS (2007). Host resistance and fungicide control of leaf rust (*Puccinia hordei*) in barley (*Hordeum vulgare*) and effects on grain yield and yield components. Crop Protect., 26: 1422-1430.

Dingle J, Reid WW, Solomons GL (1953). The enzymatic degradation of pectic and other polysaccharides. II- Application of the “Cup-Plate” assay to estimation of enzymes. J. Sci. Food Agric., 4: 149.

Eggins HOW, Pugh GJF (1962). Isolation of cellulose decomposing fungi from the soil. Nature, 193: 94-95.

El-Ghaouth A, Joseph LS, Eldon GB, Antonio I, Charles LW (2001). Control of decay of apple and citrus in semicommercial tests with *Candida saitoana* and 2-Deoxy-D-glucose. Biol. Control, 20: 96-101.

El-Said AHM, Saleem A (2008). Ecological and physiological studies on soil fungi at Western Region, Libya. Mycobiology, 36 (1):1-9.

El–Said AHM (2001). Phyllosphere and phylloplane fungi of banana cultivated in Upper Egypt and their cellulolytic ability. Mycobiology, 29(4): 210-217.

El-Said AHM, Abdel-Hafez SII, Saleem A (2005). Effect of Herbizid and Touchdown herbicides on soil fungi and production of some extracellular enzumes. Acta Microbiologica et Immunologica Hungarica, 52(1): 103-128.

El-Said AHM, Maghraby TA, El-Shahir AA (2006). Phyllosphere and phylloplane fungi of *Vicia faba* cultivated in Upper Egypt and their cellulolytic ability. The second International Conference of Environmental Science, March, South Valley Univ., Qena, Egypt, 28-

30.
Fravel DR, Deahl KL, Stommel JR (2005). Compatibility of the biocontrol fungus *Fusarium oxysporum* strain CS-20 with selected fungicides. Biol. Control, 34:165-169.
Groth DE (2008). Effects of cultivar resistance and single fungicide application on rice sheath blight, yield, and quality. Crop Protect., 27: 1125-1130.
Hassan HAH (1993). Fungicide inhibition of aflatoxins, diacetoxy-scirpenol and zearalenone production. Folia Microbiol. 38: 295-298.
Johnson LE, Curl EA (1972). Method for research on ecology of soil-borne pathogens. Burgress Publ. Co. Minneapolis, pp. 247.
Khan MFR, Smith LJ (2005). Evaluating fungicides for controlling *Cercospora* leaf spot on sugar beet. Crop Protect., 24:79-86.
Meyer MC, Bueno CJ, Souza NL, Yorinori JT (2006). Effect of doses of fungicides and plant resistance activators on the control of *Rhizoctonia* foliar blight of soybean, and on *Rhizoctonia solani* AG1–IA in vitro development. Crop Protect., 25: 848-854.
Moharram AM, Abdel-Hafez SII, El-Said AHM, Saleem A (2004). Effect of two systemic fungicides on cellulose decomposing fungi of tomato plants and on some enzymatic activities. Acta Microbiologica et Immunologica Hungarica, 51: 403-430.
Moubasher AH, Abdel-Kader MIA, Abdel-Mallek AY (1984). Effect of Benomyl on soil, root-surface and leaf-surface fungi. Zbl. Microbiol., 139: 281-291.
Moubasher AH, Abdel-Kader MIA, Abdel-Mallek AY (1987). Effect of Dithane M_{45} on cellulose-decomposing fungi in Egytian soil. Intern. Biodeter., 23: 105-113.
Naguib MI (1964). Effect of Seven on the carbohydrate and nitrogen metabolism during the germination of cotton seeds. Ind. J. Expert. Biol., 2: 149-152.
Nan ZB (1995). Fungicide seed treatments of sainfoin control seed-borne and root-invading fungi. New Zealand J. Agric. Res., 38: 413-420.
Nan ZB, Skipp RA, Long PG (1991). Use of fungicides to assess the effects of root disease: Effects of prochloraz on red clover and microbial population in soil and roots. Soil Boil. Biochem., 23: 743-750.
Nelly C (1991). Cellulases of *Trichoderma reesei*: Influence of culture conditions upon the enzymatic profile. Enzyme Microb. Technol., 13: 104–109.
Nelson N (1944). A photometric adaptation of the somogyi method for determination of glucose. J. Biol. Chem., 153: 375-380.
Obrien RG (1992). Control of onion downy mildew in the presence of phenylamide-resistant stranis of *Peronospora destructor* (Berk.) Caspary. Austral. J. Expert. Agric., 32: 669-674.
Omar SA, Abd-Alla MH (2000). Physiological aspects of fungi isolated from root nodules of faba bean (*Vicia faba* L.). Microbiol. Res., 154: 339-347.
Peterauer CK, Heidenreich E, Baker RT, Kubiced CP (1992). Effect of benomy and benomyl resistance on cellulase formation by *Trichoderma reesei* and *Trichoderma harzianum*. Can. J. Microbiol., 38: 1292-1297.
Prasan JS, Verma RAB (1979). Investigation on the diseases of papya. III- Studies on pectolytic and cellulolytic enzymes production in vivo and in vetro by six pathogens. Physiology of Parasitism.Today and Tomorrows Printer and Publisher, India.
Rahman MZ, Honda Y, Islam SZ, Muroguchi N, Arase S (2002). Leaf spot disease of broad bean (*Vicia faba* L.) caused by *Alternaria tenuissima* a new disease in Japan. J. Gen. Plant Pathol., 68: 31-37.
Reuveni M, Oppenheim D, Reuveni R (1998). Integrated control of powdery mildew on apple trees by foliar sprays of mono-potassium phosphate fertilizer and sterol inhibiting fungicides. Crop Protect., 17: 563-568.
Saha BC (2004). Production, purification and properties of endoglucanase from a newly isolated strain of *Mucor circinelloides*. Process Biochem., 39: 1871–1876.
Sahile S, Fininsa C, Sakhuja PK, Ahmed S (2008). Effect of mixed cropping and fungicides on chocolate spot (*Botrytis fabae*) of faba bean (*Vicia faba*) in Ethiopia. Crop Protect., 27: 275-282.
Saleem A (1995). Effect of some pesticides on the mycoflora of soybean seeds and production of lipase and protease enzymes. M.Sc. Thesis, Botany Dept., Fac. of Sci., South Valley Univ., Qena, Egypt.
Scott DB (1995). Disease control and yield improvement obtained with fungicide applications to spring wheat in South Africa. Crop Protect., 15: 167-170.
Smith NR, Dawson VT (1944). The bacteriostatic action of rose bengal in media used for the plate count of soil fungi. Soil Soc., 58: 467-471.
Tsuji G, Takeda T, Furusawa I, Horino O, Kubo Y (1997). Carpropamid, an anti-rice blast fungicide, inhibits scytalone dehydratase activity and appressorial penetration in *Colletotrichum lagenarium*. Pesticide Biochem. Physiol., 57: 211-219.
Van Emden HF, Ball SL, Rao MR (1988). Pest, disease and weed problems in pea, lentil, faba bean and chickpea. In: R.J. Summerfield (ed.), World Crops: Cool Season Food Legumes. Kluwer Academic Publishers, Dordrecht, Netherlands, pp. 519-534.
Vasil'chenko LG, Khromonygina VV, Karapetyan KN, Vasilenko OV, Rabinovich ML (2005). Cellobiose dehydrogenase formation by filamentous fungus *Chaetomium* sp. INBI 2-26 (−). J. Biotechnol., 119: 44-59.