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The Study of Natural Agents for Fungal Inhibition on the Surface of Medium Density Fibreboard during Construction

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Abstract The growth of fungi on the medium density fibreboard (MDF) were investigated for interior and furniture work that affect to health and construction plan.The encountered fungi were controlled by natural agents and evaluated according to Laboratory Manual for Wood decaying Fungi Protection, Thailand Foresty Department. Poisoned food technieque was used to test and resulted to wood vinegar was most effective treatment to inhibit *Aspergillus* sp. with a growth inhibition of 21.75% and spore inhibition of 94.76% which the ED_{50} value was 9.30 µg/ml. Chitosan and nano-elicitor significantly inhibited the growth of tested fungi. It was able to inhibit fungal growth of 35.75% and 34.25%, respectively, while the spore inhibition was 45.06% and 47.86%, respectively. To control *Fusarium* sp., Chitosan was the most effective bioactive compoung which inhibiting the growth of 38.50% and the spore inhibition was 47.86%. It was found that the tested natural products could not inhibited of colony growth of *Penicillium* spp. but it can inhibit the spore production. Nano-elicitor was foung to inhibit the spore production of 58.41% which the ED_{50} value was 4.51 µg/ml. Finally, the testing on pieces of medium density fibreboard showed that the fungi colony occurred at every replicate of inoculation control. While MDF pieces were sprayed with 1000 ppm of biological inhibitiors shown no symptom and less fungal colony on its surface.

Keywords: medium density fiberboard, fungal inhibition

Introduction

Medium density fiber board (MDF) is a wood substitute material that is used for interior and furniture works as decoration, wall, ceiling and built-in furniture. The surface of MDF was painted or finishing sheet such as wallpapers or veneer. These covers act like the skin of MDF to protect growing fungi on the surface. However, construction period is the weakest time of uncovered MDF boards. There is a limitation of airflow management. When the airflow control is inappropriate. Contaminants in the air include microbial, chemical and moisture are encountered. It is not

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possible to take away from the room, thereby managing the infection factors on wood, such as spots, fungi and moisture are problematic factors as a result of fungal infections on the materials of medium-density fiberboard**.**

Natural agents are used to regulate pathogens for disease control. It is environmentally friendly and safe to health. Many researchers have been studied biological control of plant pathogens by using antagonistic fungi against fungal plant pathogens (Soyrtong *et al*., 2001).

Due to the limitation of airflow mentioned above. This research was aimed to investigate the contaminated fungi on MDF, and study in application of natural products to v=control thosed contaminated fungi.

Materials and methods

Fungal isolation and identification

The specimens of medium density fibreboard (MDF) from construction sites were brought to laboratory at Department of Plant Production Technology, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok**.** Isolation was done by placing the spacimens into moist chamber in petri dishes and icubated at room temperature (27-30C), then peroidically isolated the fungi to pure culture in potato dextrose agar(PDA). Pure cultures were morphological identified and kept for further study. At the construction sites in Bangkok, airborne fungi were trapped by placing PDA plates for 3 days, and brought to laboratory to isolate to pure culture for furthur study.

Tesing natural products to contol the contaminated fungi on MDF in laborary

The experiment was set up using 2 factors factorial experiment in Completely Randomized Design (CRD), four replications. Factor A was wood vineagr, nano-elicitor derived from *Chaetomium globosum ,* chitosan and borax; Factor B was the concentrations of 0, 10, 50, 100, 500 and 1000 ppm. Each treatment combination was done by mixed into PDA in each tested concentration and autoclaved at 121 C for 15 lbs/inch^2 for 30 minute, then poured to petri dishes. Each tested fungus was transfrred as a culture agar plug og 0.3 cm onto the middle of tested petri dishes, incubated at room temperature for 5 days. Data were collected as colony diameter (cm) and numer of spores, then statistically computed analysis of variance (ANOV). Treatment means were comprised usinf Duncan Multiple's range testb(DMRT) at P =0.05 and 0.01. Nano-elicitor derved from *C. globosum* is offered by Dr. Kasem Soytong from Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailand.

Testing natural products to control contaminated fungi on MDF in the buiding

The experiment was preformed by CRD with four replications. Treatments were inoculated control with contaminated fungi (T1), wood vineagar (T2), chiotsan (T3) and nano-elicitor (T4). The contaminated fungi, *Aspergillus* sp. *Cladosporium* sp. *Fusarium* sp. and *Penicillium* sp. were cultured in PDA and make to be mixed spore suspension and treated to all MDF samples before treatment and placed in the building for 30 days. Data were collected as degree of infestation rate, 0 = no infestation, 1= <25 % of surface area, 2= infestation 26-50, 3= infestation 51-75, and 4 = infestation 76-100.

Results

Fungal isolation and identification

Result showed that the samples of pieces of MDF from site construction found the infested fungi as *Aspergillus* sp. *Cladosporium* sp. *Fusarium* sp. and *Penicillium* sp. (Fig.1, 2 and 3).

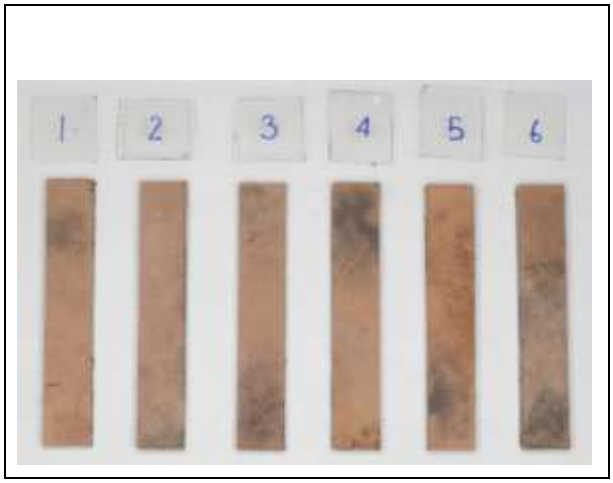
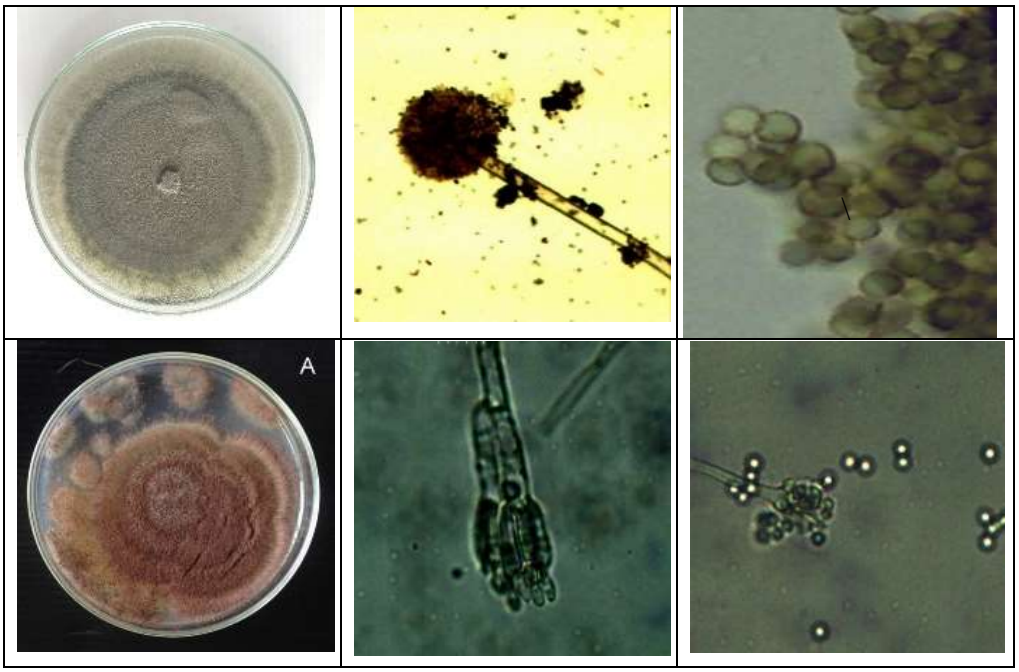
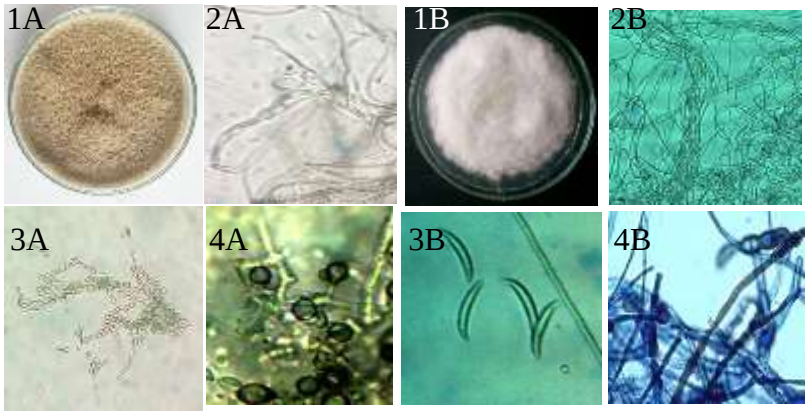


Figure 1. Fungal growth on pieces of MDF from site construction in moist chamber for 7 days .



Figue 2. *Aspergillus* spp.(A)and *Penicillium* spp.(B) on PDA



Figue 3. *Cladosporium* spp. (A) and *Fusarium* spp (B) on PDA

Tesing natural products to contol the contaminated fungi on MDF in laboratory

Tesing natural products to contol *Aspergillus* sp on MDF in laboratory:-

It found that chitosan and nano-elicitor inhibited the growth of fungus by poisoned food technique. The wood vinegar was the most effective inhibited the growth of *Aspergillus* sp. The most of fungal infestation can be ranged

of 3.74 to 4.00 cm., with a percentage of growth inhibition at 1000 ppm was 21.75% , and spores number of 8.85 x 10^7 . The percentage of inhibition of 94.76% (Table 1). It showed that natural products, wood vineagar, nano-elicitor and chitosan gave a good control the fungus which rge ED50 values were 9.30, 5.81 and 9.21 µg/ml respectively when compared to the chemical, borax which rthe ED50 was 5.65 µg/ml.

Tesing natural products to contol *Cladosporium* sp on MDF in laboratory:- It showed that natural products, wood vineagar, nano-elicitor and chitosan were not controlled *Cladosporium* sp at the tested concention of 1,000 ppm when compared to the chemical, borax which rthe ED50 was 5.65 µg/ml (Table 2).

Tesing natural products to contol *Fusarium* sp on MDF in laboratory:- It showed that natural products, wood vineagar, nano-elicitor and chitosan gave a good control the fungus *Fusarium* sp on MDF which the ED50 values were 10.73, 1.27 and 2.26 µg/ml respectively when compared to the chemical, borax which rthe ED50 was 3.81 µg/ml (Table3).

Table 1. The efficacy test of natural products to inhibit *Aspergillus* spp.

Treatments	conc. (ppm)	colony dia. (cm)	growth inhibition, %	spores (10^7)	spore inhibition, %	ED_{50}(µg/ml)
Wood Vinegar	0	5.00[a1]	-	168.85[a]	-	9.30
	10	3.84[ef]	23.25[bc]	28.20[ef]	83.30[fg]	
	50	4.00[bcde]	20.00[cdef]	25.75[ghi]	84.75[f]	
	100	3.74[f]	25.25[b]	16.02[ghi]	90.51[de]	
	500	3.91[def]	21.75[bcde]	10.30[ij]	93.90[ab]	
	1000	3.91[def]	21.75[bcde]	8.85[j]	94.76[a]	
Nano-elicitor	0	5.00[a]	-	168.85[a]	-	5.81
	10	4.02[bcde]	19.50[cdef]	40.25[b]	76.16[j]	
	50	3.96[cdef]	20.75[bcdef]	37.10[bcd]	78.03[ij]	
	100	4.00[bcde]	20.00[cdef]	32.00[def]	81.05[gh]	
	500	4.02[bcde]	19.50[cdef]	26.00[f]	84.60[f]	
	1000	3.94[cdef]	21.25[bcde]	14.90[ghij]	91.18[cd]	
Chitosan	0	5.00[a]	-	168.85[a]	-	9.21
	10	3.98[bcde]	20.50[bcdef]	33.65[cde]	80.07[hi]	
	50	3.88[ef]	22.50[bcd]	30.30[ef]	82.06[fgh]	
	100	4.00[bcde]	20.00[cdef]	27.55[ef]	83.68[fg]	
	500	3.94[cdef]	21.25[bcde]	19.90[g]	88.21[e]	
	1000	4.13[bcd]	17.50[def]	14.60[ghij]	91.35[bcd]	
Borax	0	5.00[a]	-	168.85[a]	-	5.65
	10	3.98[bcde]	20.50[bcdef]	39.30[bc]	76.72j	
	50	4.20[b]	16.00f	31.55[def]	81.31[gh]	
	100	4.16[bc]	16.75ef	19.55[g]	88.42[e]	
	500	3.99[bcde]	20.25[bcdef]	17.15[gh]	89.84[de]	
	1000	3.31[g]	33.75[a]	11.50[hij]	93.19[abc]	
C.V.(%)		3.38		8.03		

[1]Average of four replications, means followed by a common letter are not significantly differed at P= 0.01.

Table 2. The efficacy test of natural products to inhibit *Cladosporium* spp.

Treatments	conc. (ppm)	colony dia. (cm)	growth inhibition, %	spores (10^7)	spore inhibition, %	ED_{50}(µg/ml)
Wood vinegar	0	5.00[a1]	-	17.28[ab]	-	
	10	3.54[bc]	29.25[ghi]	17.27[ab]	0.00[ij]	
	50	3.49[bcjd]	30.25[fghi]	18.72[a]	0.00[j]	
	100	3.57[b]	28.50[i]	13.98[bcd]	18.82[ghi]	-
	500	3.52[bc]	29.50[ghi]	13.45[bcde]	22.74[fgh]	
	1000	3.51[bc]	29.75[ghi]	12.70[cdef]	25.51[efgh]	
Nano-elicitor	0	5.00[a]	-	17.28[ab]	-	
	10	3.47[bcde]	30.50[fghi]	15.20[abc]	12.57[hij]	
	50	3.50[bcd]	30.00[fghi]	10.70[defgh]	37.13[bcdefg]	
	100	3.26[efgh]	34.75[cdef]	11.05[cdefgh]	34.87[cdefg]	-
	500	3.39[bcdef]	32.25[efghi]	10.55[defgh]	36.82[bcdefg]	
	1000	3.21[fghi]	35.75[cde]	9.10[fgh]	45.06[bcde]	
Chitosan	0	5.00[a]	-	17.28[ab]	-	
	10	3.55[b]	29.00[hi]	13.32[bcde]	20.97[fgh]	
	50	3.49[hi]	30.25[fghi]	12.90[cdef]	24.30[efgh]	
	100	3.16[ghi]	36.75[cde]	13.98[bcd]	15.92[cdefg]	-
	500	3.31[cdefg]	33.75[efgh]	12.08[cdef]	30.51[bcdefg]	
	1000	3.29[defg]	34.25[cde]	8.58[gh]	47.86[bcd]	
Borax	0	5.00[a]	-	17.28[ab]	-	
	10	4.86[a]	2.75[j]	9.65[efgh]	42.68[bcdef]	
	50	3.06[hi]	38.75[cd]	7.65[h]	55.34[bc]	1.61
	100	3.04[i]	39.25[c]	7.10[h]	58.09[b]	
	500	1.03[j]	79.50[b]	0.50[i]	97.30[a]	
	1000	0.50[k]	90.00[a]	0.20[i]	98.76[a]	
C.V. (%)		3.93		20.96		

[1]Average of four replications, means followed by a common letter are not significantly differed at P= 0.01.

Table 3. The efficacy test of natural products to inhibit *Fusarium* sp.

Treatment	conc. (ppm)	colony dia. (cm)	growth inhibition, %	spores (10^7)	spore inhibition, %	ED_{50}(µg/ml)
Wood vinegar	0	5.00[a1]	-	93.35[ab]	-	
	10	3.93[bcd]	21.50[def]	26.55[g]	71.40[ab]	
	50	3.96[bc]	20.75[ef]	30.20[efg]	67.47[abc]	
	100	3.81[bcde]	23.75[def]	25.30[g]	72.75[a]	10.73
	500	3.56[cdef]	28.75[cde]	35.65[defg]	61.60[abcd]	
	1000	3.22[fg]	35.50[abc]	34.20[defg]	63.17[abcd]	
Nano-elicitor	0	5.00[a]	-	93.35[ab]	-	
	10	3.90[bcd]	22.00[def]	94.85[ab]	0.00[i]	
	50	3.51[cdef]	29.75[bcde]	102.15[a]	0.00[i]	
	100	3.84[bcde]	23.25[def]	59.70[cdef]	35.70[fgh]	1.27
	500	3.80[bcde]	24.00[def]	43.55[cdefg]	53.10[cde]	
	1000	3.80[bcde]	23.00[def]	41.05[cdefg]	55.79[abcd]	
Chitosan	0	5.00[a]	-	93.35[ab]	-	
	10	3.56[cdef]	28.75[cde]	62.75[cde]	32.42[gh]	
	50	3.57[cdef]	28.50[cde]	47.05[cdefg]	49.33[def]	
	100	3.24[fg]	35.25[abc]	32.85[efg]	64.62[abcd]	2.26
	500	3.64[cdef]	27.25[cde]	28.85[fg]	68.93[ab]	
	1000	3.07[gh]	38.50[ab]	28.20[fg]	69.63[ab]	
Borax	0	5.00[a]	-	93.35[ab]	-	
	10	4.15[b]	17.00[f]	73.20[abc]	21.16[h]	
	50	3.91[bcd]	21.75[def]	65.90[bcd]	29.02[gh]	
	100	3.73[bcde]	25.50[def]	57.05[cdefg]	38.56[efg]	3.81
	500	3.45[efg]	31.00[bcd]	46.10[bcd]	50.10[def]	
	1000	2.84[h]	43.25[a]	31.60[efg]	65.97[abc]	
C.V.(%)		6.62		19.84		

[1]Average of four replications, means followed by a common letter are not significantly differed at P= 0.01.

Tesing natural products to contol *Penicillium* sp on MDF in laboratory:- It showed that natural products, wood vineagar and nano-elicitor gave a good control the fungus *Penicillium* sp on MDF which the ED50 values were 4.48 and 4.51 µg/ml respectively when compared to the chemical, borax which rthe ED50 was 4.74 µg/ml (Table3). The chitosan was less affectyed to control *Penicillium* sp at the concentration of 1,000 ppm (Table 4).

Table 4. The efficacy test of natural products to inhibit *Penicillium* sp.

Treatment	conc. (ppm)	colony dia. (cm)	growth inhibition, %	spores (10^7)	spore inhibition, %	ED_{50}(µg/ml)
Wood vinegar	0	5.00[a1]	-	40.27[ab]	-	4.48
	10	5.00[a]	0.00[b]	28.75[g]	28.61[e]	
	50	5.00[a]	0.00[b]	26.72[efg]	33.64[de]	
	100	5.00[a]	0.00[b]	26.95[defg]	33.08[de]	
	500	5.00[a]	0.00[b]	24.87[defg]	38.24[cde]	
	1000	5.00[a]	0.00[b]	16.77[defg]	58.35[ab]	
Nano-elicitor	0	5.00[a]	0.00[b]	40.27[ab]	-	4.51
	10	5.00[a]	0.00[b]	28.85[ab]	28.37[e]	
	50	5.00[a]	0.00[b]	27.90[a]	30.54[e]	
	100	5.00[a]	0.00[b]	28.75[cdef]	28.61[e]	
	500	5.00[a]	0.00[b]	23.97[cdefg]	40.47[cde]	
	1000	5.00[a]	0.00[b]	16.75[cdefg]	58.41[ab]	
Chitosan	0	5.00[a]	0.00[b]	40.27[ab]	-	-
	10	5.00[a]	0.00[b]	27.92[cde]	30.66[e]	
	50	5.00[a]	0.00[b]	26.80[cdefg]	33.45[de]	
	100	5.00[a]	0.00[b]	25.87[efg]	35.75[cde]	
	500	5.00[a]	0.00[b]	26.67[fg]	33.77[de]	
	1000	5.00[a]	0.00[b]	20.47[fg]	49.16[bcd]	
Borax	0	5.00[a]	0.00[b]	40.27[ab]	-	4.74
	10	5.00[a]	0.00[b]	26.45[abc]	34.33[de]	
	50	5.00[a]	0.00[b]	29.25[bcd]	27.37[e]	
	100	5.00[a]	0.00[b]	26.15[cdefg]	35.07[cde]	
	500	5.00[a]	0.00[b]	19.62[cdefg]	51.27[bc]	
	1000	4.86[b]	2.75[a]	12.55[efg]	68.84[a]	
C.V. (%)		0.65		34.91		

[1]Average of four replications, means followed by a common letter are not significantly differed at P= 0.01.

Tesing natural products to contol the contaminated fungi on MDF

Result showed that wood vinegar and nano-elicitor derived from *Chaetomium globlosum* gave the best to control the contaminated fungi which rthe degree of infestation were 2.25 and 2.75 respectively and followed by chitosan which the degree of infestation was 3.00 when compared to the control that the degree of infestation was 4 (Table 5 and Fig. 4). It concluded that the contaminated fungi, *Aspergillus* sp. *Cladosporium* sp. *Fusarium* sp. and *Penicillium* sp were less in wood vineagar and nano-elicitor from C. globosum then chitosan treatmnent.

Table 5. The rate of fungal growth on MDF after treatments

treatment	R1	R2	R3	R4	Average
control	4	4	4	4	4.00c[2]
Wood vineagr	2[1]	2	2	3	2.25a
Chitosan	3	4	2	3	3.00ab
Nano-eilitor	2	4	3	2	2.75a

[1]Degree of infestation rate, 0 = no infestation, 1= <25 % of surface area, 2= infestation 26-50, 3= infestation 51-75, and 4 = infestation 76-100.

[2]Average of four replications, means followed by a common letter are not significantly differed at P= 0.01.

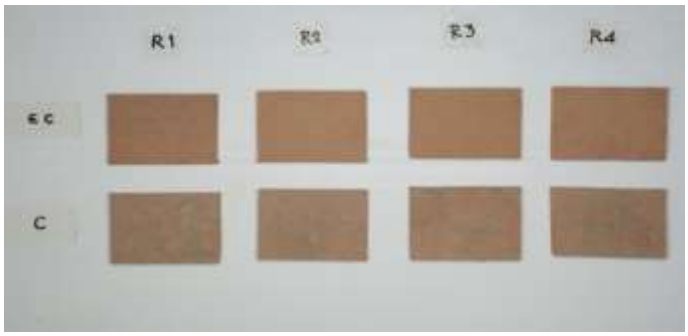


Figure 4. Application of nano-elicitor derived from *Chaetomium globosum* and non-trated control om MDF

Discussion

It was found that wood vinegar was the most inhibition to *Aspergillus* sp. This similar to the report of Shiah and others (2007) to test the ability of wood vinegar from bamboo and airborne fungi that can be easily spread by the air, and ound that causing flourish around 50 – 85%. It may be involved in the phenolic compounds that have been reported as a biological substance to regulate the growth of certain microorganisms by Mungkunkamchao and others (2013) who reported that wood vinegar was mainly composed of organic acids, compounds, phenolic and alkane, as well as alcohol.

Testing natural products to *Cladosporium* sp. found the most effective biological inhibitors, was the nano-elicitor and chitosan, which are similar to the report of the Guerrero and others (2007). The study of chitosan ability

was to inhibit the plant pathogens. In addition, the report of Stan and others (2003) reported that concentration of 2% of chitosan, coating with the effects of strawberries together with potassium sorbate is found to be able to control *Cladosporium* sp.

The testing of natural agents with *Fusarium* spp. found that the most effective inhibitor was similar to result to *Cladosporium* spp. As a result, it is similar to report of Allan and others (1979) which used the Chitosan to control the plant diseases. Chitosan can inhibit the growth of *Fusarium culmorum* and *Fusarium avenaceum* at concentration 250-500 ppm.

The wood vinegar and nano-elicitor derived from *C. globlosu* gave good control the contaminated fungi, *Aspergillus* sp. *Cladosporium* sp. *Fusarium* sp. and *Penicillium* sp. and followed by chitosan. Huyly and Soytong (2017) reported thart nano-elicitors from *Chaetomium cupreum* gave the good control of Curvularia oryzae causing leaf spot of rice.

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