

# FINAL REPORT

***In vitro, In vivo* and phytoalexin testing of nanomaterial treated tomatoes infected with *Fusarium oxysporum* f. sp. *lycopersici***

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## Abstract

Efficiency of nano-materials derived from *Chaetomium brasiliense* and *Chaetomium cochliodes* to induce tomatoes against wilt disease which caused by *Fusarium oxysporum* f.sp. *lycopersici* were tested in vitro and in vivo. Results showed that at the concentration 10 ppm of nano-materials of *Chaetomium brasiliense* could inhibit the colonial growth at 20.00% and the conidia at 57.89% and nano-materials of *Chaetomium cochliodes* could inhibit the colonial growth at 29.00% and the conidia at 79.73 % in vitro.

When nano-materials of *Chaetomium brasiliense* and *Chaetomium cochliodes* were tested to control fusarium wilt in tomatoes in vivo. Results showed that nano-materials from the antagonistic fungi which used to control fusarium wilt in tomatoes affected significantly to plant growth when compared to inoculated control. Nano-materials of *Chaetomium brasiliense* and *Chaetomium cochliodes* could reduce disease severity index at 58.82 % and 52.94% respectively. It revealed that all tested nano-materials are induced immunity by production of phytoalexin, alpha-tomarine for wilting disease of tomato caused by *Fusarium oxysporum* f.sp. *lycopersici*.

## Methodology

Morphology of *Fusarium oxysporum* f.sp. *lycopersici* and *Chaetomium brasiliense* and *Chaetomium cochliodes* were studied under binocular compound microscope. Pathogenicity test was done by follow the method of Sibounnavong *et al.* (2010).

Bioactive metabolites from *Chaetomium brasiliense* and *Chaetomium cochliodes* were extracted by following the method of Kanokmedhakul *et al* (2006) to get crude extracts of hexane, ethyl acetate and methanol. Nano-particles were done by followed the method of Dar and Soyong (2014).

Evaluation of nano-materials derived from *Chaetomium brasiliense* and *Chaetomium cochliodes* to suppress the growth of *Fusarium oxysporum* f.sp. *lycopersici* in vitro was conducted with Completely Randomized Design (CRD) with four replications by following the method of Tann and Soyong (2016). Evaluation of Nano materials derived from *Chaetomium brasiliense* and *Chaetomium cochliodes* to control *Fusarium oxysporum* f.sp. *lycopersici* in vitro. Tomato var Sida was used to inoculated spore suspension of *Fusarium* sp at concentration of  $1 \times 10^6$  spore/ml by dipping tomato roots for n15 minutes before planting into pot which contained sterilized soil. Randomized Complete Block Design (RCBD) was performed with 4 replications and treatment were as follows:- T1 = Non - Inoculated Control, T2 = Inoculated Control, T3 = Nano materials from *Chaetomium brasiliense* at 10 ppm, T4 = Nano materials from *Chaetomium cochliodes* at 10 ppm and T5 = Inoculated Control + chemical fungicide (prochloraz 0.1 g/ 100 ml).

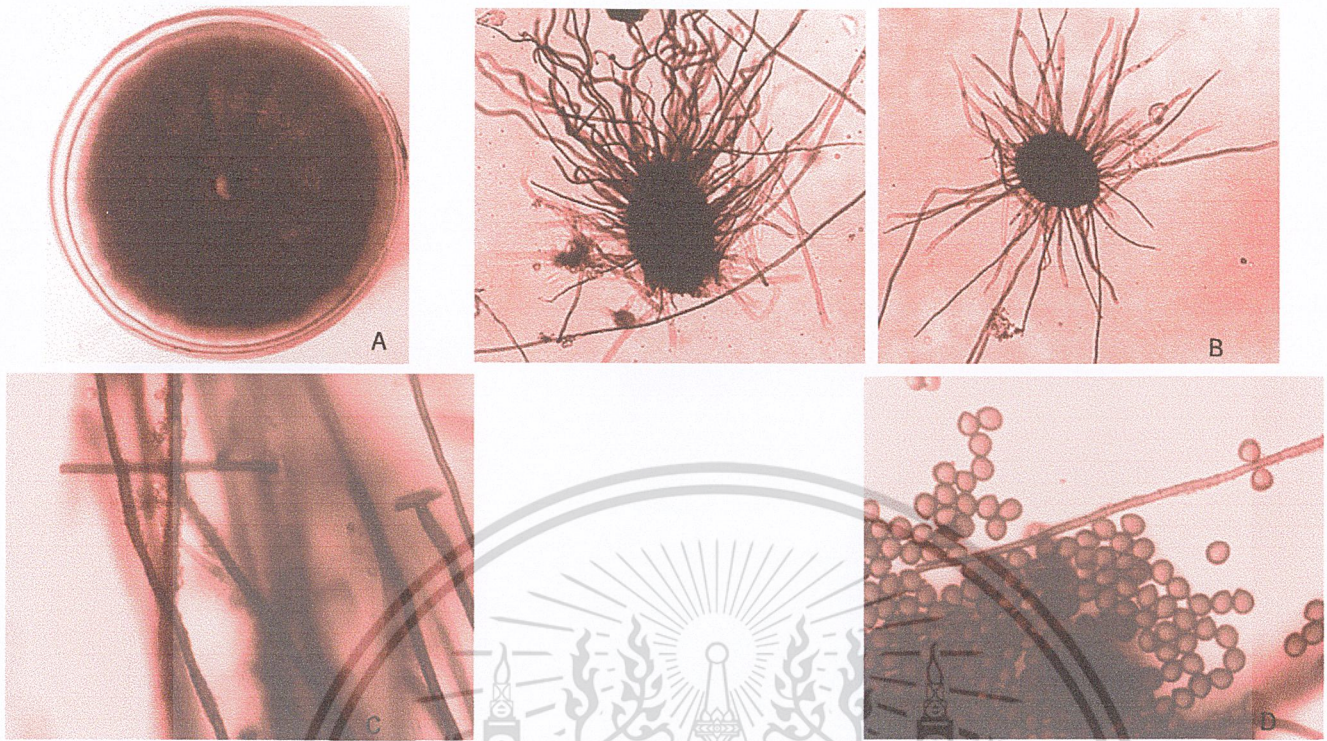
Data were collected as plant height (cm) and disease index (DI). Disease index (DI) was modified method of Sibounnavong *et al.* (2012), as follows: 1= no symptom; 2= yellowing leaves and root rot 1-20%, 3= yellowing leaves and root rot 21- 40%, 4= yellowing leaves and root rot 41-60%, 5= yellowing leaves and root rot 61-80%, and 6= yellowing leaves and root rot 81-100% or die. Means were compared using Duncan Multiple Range Test (DMRT) at P=0.05 and P=0.01.

## Results

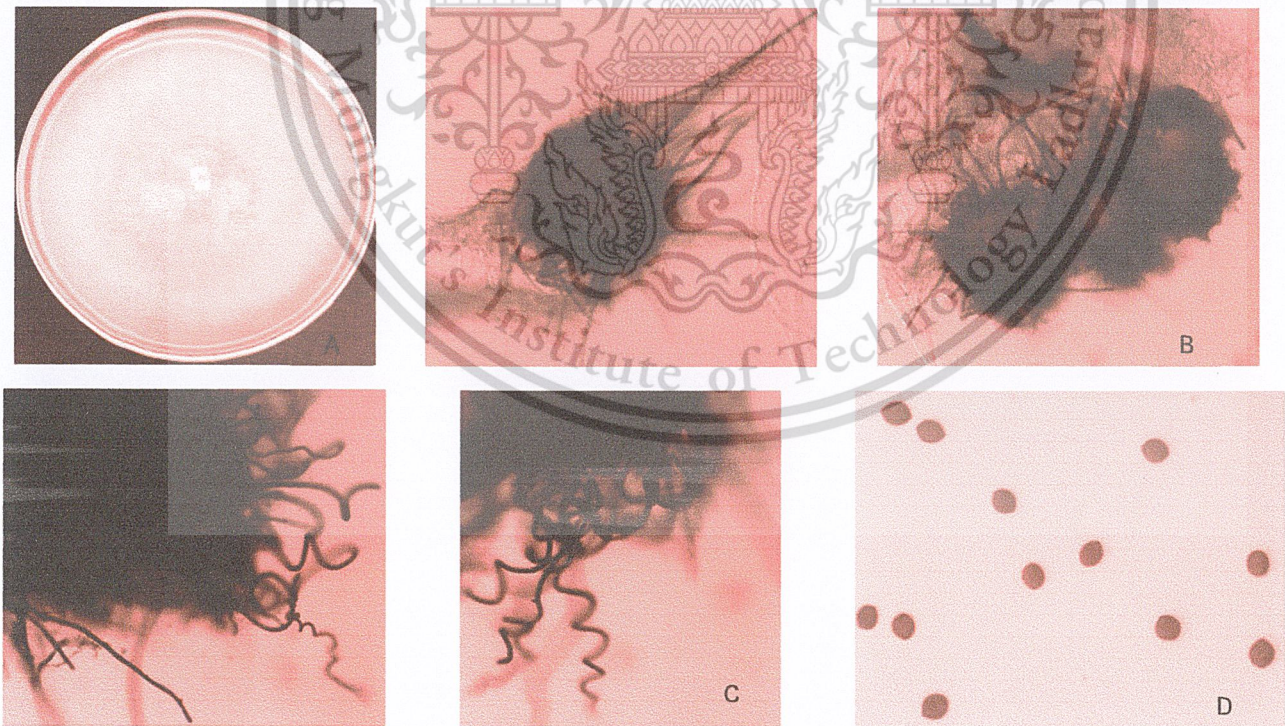
*Fusarium oxysporum* f.sp. *lycopersici* was studied under compound microscope (Fig.1). It produced septate mycelia, macroconidia, microconidia and chlamydospores terminal or intercalary. *Chaetomium brasiliense* produced subglobose perithecia as fruiting bodies, undulate terminal hairs, asci cylindrical, 8 ascospores per ascus (Fig.2). *Chaetomium cochliodes* produced globose perithecia as fruiting bodies, several coils and spring-like terminal hairs, asci clavate, 8 ascospores per ascus (Fig.3).



Figure 1. *Fusarium oxysporum* f.sp. *lycopersici*



**Figure 2.** *Chaetomium brasiliense*, A = culture on PDA, B= perithecia, C= terminal hairs, D= ascospores



**Figure 3.** *Chaetomium cochliodes* , A = culture on PDA, B= perithecia, C= terminal hairs, D= ascospores

*Fusarium oxysporum* f.sp. *lycopersici* was proved to be pathogenic isolate and wilt appeared within 20 days after inoculation (Fig. 4).

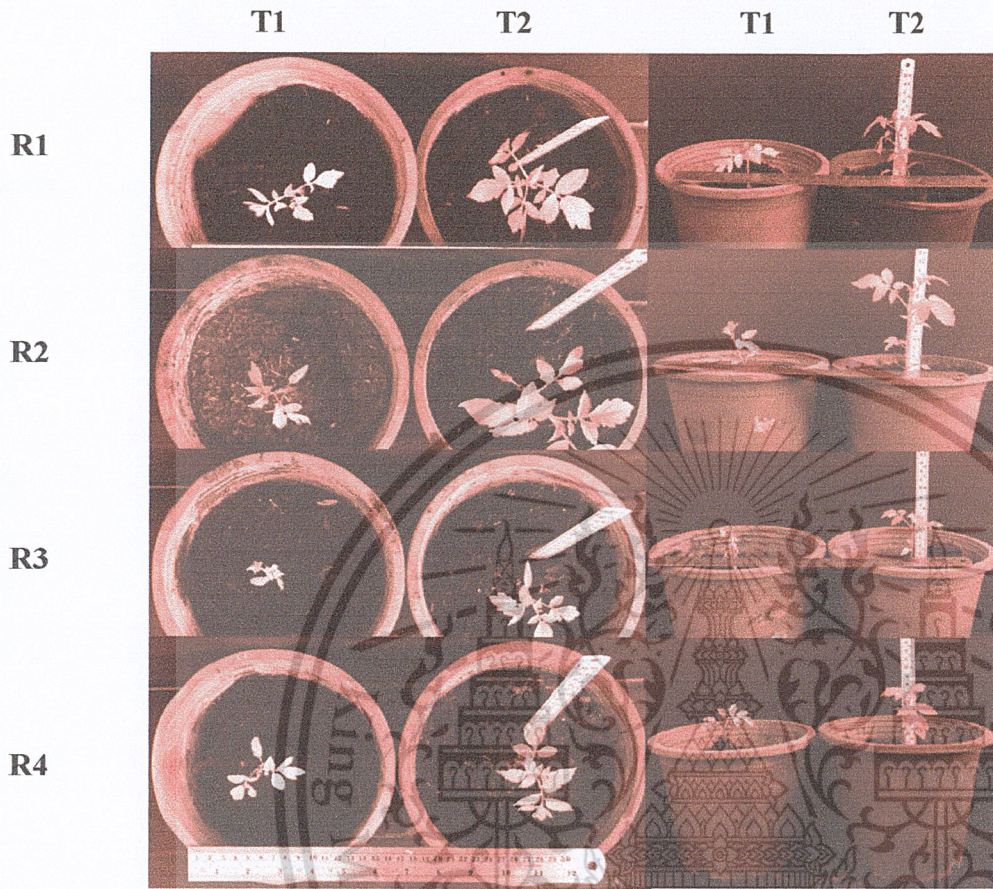


Figure 4. Pathogenicity test , T1 = Inoculated Control – T2 = Non - Inoculated Control

#### Evaluation of nano-materials derived from *Chaetomium brasiliense* and *Chaetomium cochliodes* to suppress the growth of *Fusarium oxysporum* f.sp. *lycopersici* in laboratory

Result showed that nano-materials from *Chaetomium brasiliense* mostly inhibited *Fusarium oxysporum* f.sp. *lycopersici* in vitro at 10 ppm. Which colony diameter of 4.00 cm, and followed by the control which was 3 ppm. *Fusarium oxysporum* f.sp. *lycopersici* was shown the most inhibition of sporulation thereafter treated with nano-materials of *Chaetomium brasiliense* at 10 ppm, followed by 5 and 3 ppm which percent inhibition were 57.89, 32.23 and 15.13, respectively.

Nano-materials of *Chaetomium cochliodes* at 10 ppm gave mostly significant inhibited the growth of *Fusarium oxysporum* f.sp. *lycopersici* and followed by 5 and 3 ppm, respectively. Moreover, the tested nano-materials inhibited sporulation of *Fusarium oxysporum* f.sp. *lycopersici* at 10, 5 and 3 ppm, which were 79.73, 64.86 and 30.41 percent, respectively (Table 1, Fig. 5).

**Table 1.** nano-materials derived from *Chaetomium brasiliense* and *Chaetomium cochliodes* to inhibit the growth of *Fusarium oxysporum* f.sp. *lycopersici* in laboratory

Nano-materials	Conc. (ppm)	Colony dia. (cm.) <sup>2/</sup>	spores	Growth inhibition <sup>1/</sup>	Spore inhibition <sup>1</sup>	ED <sub>50</sub> (ppm)
<i>C.brasiliense</i>	0	5.00a	38.00a	0.00	0.002	4.957
	3	4.38b	32.25b	12.4	15.13	
	5	4.30b	25.75c	14.00	32.23	
	10	4.00c	16.00d	20.00	57.89	
	C.V. (%)	4.17%	10.28%			
<i>C.cochliodes</i>	0	5.00a	37.00a	0.00	0.00	4.763
	3	4.10b	25.75b	18.00	30.41	
	5	3.78b	13.00c	24.4	64.86	
	10	3.55b	7.50d	29.00	79.73	
	C.V. (%)	6.03%	9.78%			



**Figure 5.** Effects of nano-particles from *Chaetomium brasiliense* and *Chaetomium cochliodes* to inhibit *Fusarium oxysporum* f.sp. *lycopersici* , Verticle rows from left was 0, 10, 5 and 3 ppm., respectively. Horizontal rows from upper was replication 1,2,3 and 4 respectively.

#### Evaluation of nano materials derived from *Chaetomium brasiliense* and *Chaetomium cochliodes* to control *Fusarium oxysporum* f.sp. *lycopersici* in pot experiment

Result showed that nano-materials from *Chaetomium brasiliense* and *Chaetomium cochliodes* significantly controlled tomato wilt caused by *Fusarium oxysporum* f.sp. *lycopersici*. The inoculated tomatoes var sida were sprayed with **nano-particles from *Chaetomium brasiliense*** after 30, 40 and 50 days resulted the plant height of 26.70 , 52.50 and 68.20 cm, respectively. Moreover, the inoculated tomatoes which sprayed with nano-particles from *Chaetomium cochliodes* at 30, 45 and 60 days showed the plant height of 26.68 ,51.00 and 67.78 cm, respectively. The inoculated control at 45 and 60 days gave the plant height of 30.60 and 42.93 cm, respectively (Table 2, 3 and Fig.

6,7 and 8). Moreover, result revealed non-significantly different in increased plant height percentage at 60 days after treated with nanoparticles from *C. brasiliense* and *C. cochliodes*, and prochloraz chemical fungicide as 37, 36 and 43 %, respectively when compared to the non-inoculated control (Table 4 ). All tested nano-materials are increased in plant growth parameters (Tables 6, 7, Figs. 6-11).

**Table 2.** Effect of nano-materials from *Chaetomium* spp for plant height of tomatoes at 30 days in pot experiment

treatments	Plant height(cm) <sup>1/</sup>	Increased plant height (%) <sup>2/</sup>
T1 Non - Inoculated Control	35.80a	45.73
T2 Inoculated Control	19.43c	0.00
T3 <i>Chaetomium brasiliense</i>	26.70b	27.23
T4 <i>Chaetomium cochliodes</i>	26.68b	27.17
T5 Prochloraz	27.05b	28.17
C.V. %	20.96	

1/ Means of four replications which followed by the same letters are not significant different bat P = 0.05. 2/increased plant height (%) = plant height in treatment – plant height in treat control / plant height in treatment X 100.

**Table 3.** Effect of nano-materials from *Chaetomium* spp for plant height of tomatoes at 45 days in pot experiment

treatments	Plant height(cm) <sup>1/</sup>	Increased plant height (%) <sup>2/</sup>
T1 Non - Inoculated Control	53.50a	42.80
T2 Inoculated Control	30.60b	0.00
T3 <i>Chaetomium brasiliense</i>	52.50a	41.71
T4 <i>Chaetomium cochliodes</i>	51.00a	40.0
T5 Prochloraz	48.00a	19.58
C.V. %	12.9627	

1/ Means of four replications which followed by the same letters are not significant different bat P = 0.05. 2/increased plant height (%) = plant height in treatment – plant height in treat control / plant height in treatment X 100.

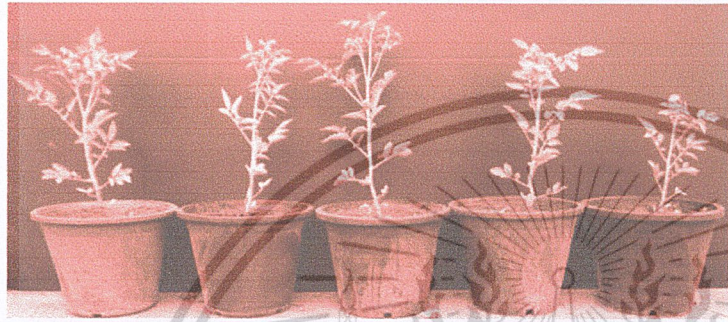
**Table 4.** Effect of nano-materials from *Chaetomium* spp for plant height of tomatoes at 60 days in pot experiment

treatments	Plant height(cm) <sup>1/</sup>	Increased plant height (%) <sup>2/</sup>
T1 Non - Inoculated Control	69.28a	38.03
T2 Inoculated Control	42.93b	0.00
T3 <i>Chaetomium brasiliense</i>	68.20a	37.05
T4 <i>Chaetomium cochliodes</i>	67.78a	36.66
T5 prochloraz	75.50a	43.14
C.V. %	13.39	

1/ Means of four replications which followed by the same letters are not significant different at P = 0.05. 2/increased plant height (%) = plant height in treatment – plant height in treat control / plant height in treatment X 100.



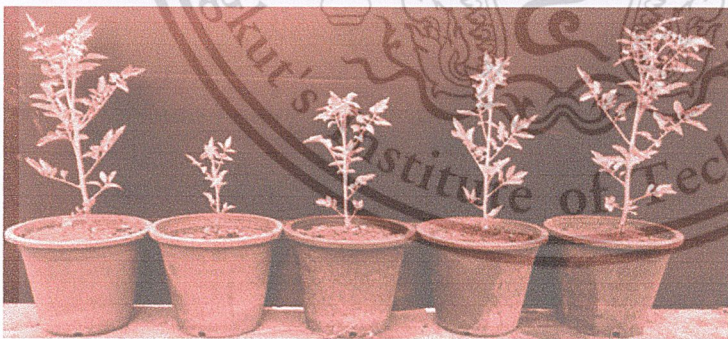
R1



R2



R3



R4

T1      T2      T3      T4      T5

**Figure 6** Effect of nano-materials from *Chaetomium brasiliense* and *Chaetomium cochliodes* to control tomato wilt caused by *Fusarium oxysporum* f.sp. *lycopersici* in [pot experiment at 30 days. ( T1 = Non - Inoculated Control, T2 = Inoculated Control, T3 = Nano materials *Chaetomium brasiliense*, T4 = Nano materials *Chaetomium cochliodes*, T5 = prochloraz )



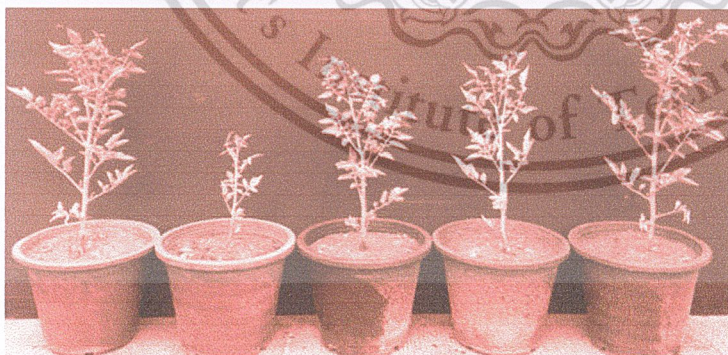
R1



R2



R3



R4

T1

T2

T3

T4

T5

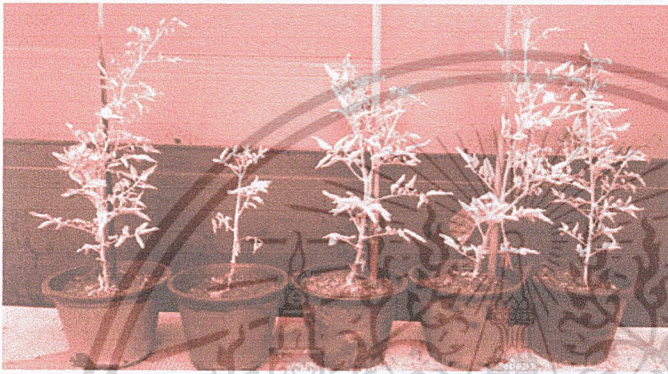
**Figure 7.** Effect of nano-materials from *Chaetomium brasiliense* and *Chaetomium cochliodes* to control tomato wilt caused by *Fusarium oxysporum* f.sp. *lycopersici* in [pot experiment at 45 days. ( T1 = Non - Inoculated Control, T2 = Inoculated Control, T3 = Nano materials *Chaetomium brasiliense*, T4 = Nano materials *Chaetomium cochliodes*, T5 = prochloraz )

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R1



R2



R3



R4

T1    T2    T3    T4    T5

**Figure 8** Effect of nano-materials from *Chaetomium brasiliense* and *Chaetomium cochliodes* to control tomato wilt caused by *Fusarium oxysporum* f.sp. *lycopersici* in [pot experiment at 60 days. ( T1 = Non - Inoculated Control, T2 = Inoculated Control, T3 = Nano materials *Chaetomium brasiliense*, T4 = Nano materials *Chaetomium cochliodes*, T5 = prochloraz

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The research finding revealed that non-inoculated with *Fusarium oxysporum* f.sp. *lycopersici* shown no symptom but the inoculated control pathogen gave significantly highest disease index (4.25) when compared to nano-materials from *C. brasiliense* and *C. cochliodes* and prochloraz chemical fungicide which were 1.75, 2.00 and 1.75, respectively (Table5). It revealed that all tested nano-materials are induced immunity by production of phytoalexin, alpha-tomarine for wilting disease of tomato caused by *Fusarium oxysporum* f.sp. *lycopersici*.

**Table 5.** Disease index of tomato wilt caused by *Fusarium oxysporum* f.sp. *lycopersici* after treated nano-materials from *Chaetomium brasiliense* and *Chaetomium cochliodes* at 60 days.

Treatments	DI <sup>1/</sup>	DR <sup>2/</sup>
Non - Inoculated Control	1.00b	-
Inoculated Control	4.25a	-
<i>Chaetomium brasiliense</i>	1.75b	58.82
<i>Chaetomium cochliodes</i>	2.00b	52.94
Prochloraz	1.75b	58.82
C.V.%	39.7998	

1/ Means of four replications which followed by the same letters are not significant different at P = 0.05. 2/DR: Disease reduction) = DI of inoculated control – DI of treatment / inoculated control X 100

**Table 6.** Effect of nano-materials from *Chaetomium brasiliense* and *Chaetomium cochliodes* for plant growth of tomatoes in pot experiment at 60 days

Treatments	stems			roots		Yield/plant (g)
	Fresh weight(g)	Dried weight(g)	length (cm)	Fresh weight(g)	Dried weight(g)	
T1	84.20a	44.22a	42.95ab	23.03a	5.28a	62.74b
T2	10.17b	6.12b	32.40b	5.13b	0.83c	0.00e
T3	80.86a	44.52a	45.08a	18.16a	4.37ab	39.73c
T4	74.41a	35.37a	40.70ab	15.91a	3.57b	75.43a
T5	81.21a	44.43a	47.13a	21.33a	3.92ab	32.41d
C.V.%						

1/ Means of four replications which followed by the same letters are not significant different at P = 0.05. 2/ T1 = Non - Inoculated Control, T2 = Inoculated Control, T3 = Nano materials *Chaetomium brasiliense*, T4 = Nano materials *Chaetomium cochliodes*, T5 = prochloraz

**Table 7** Increased plant growth percentage after treated with nano-materials from *Chaetomium brasiliense* and *Chaetomium cochliodes* in pot experiment at 60 days

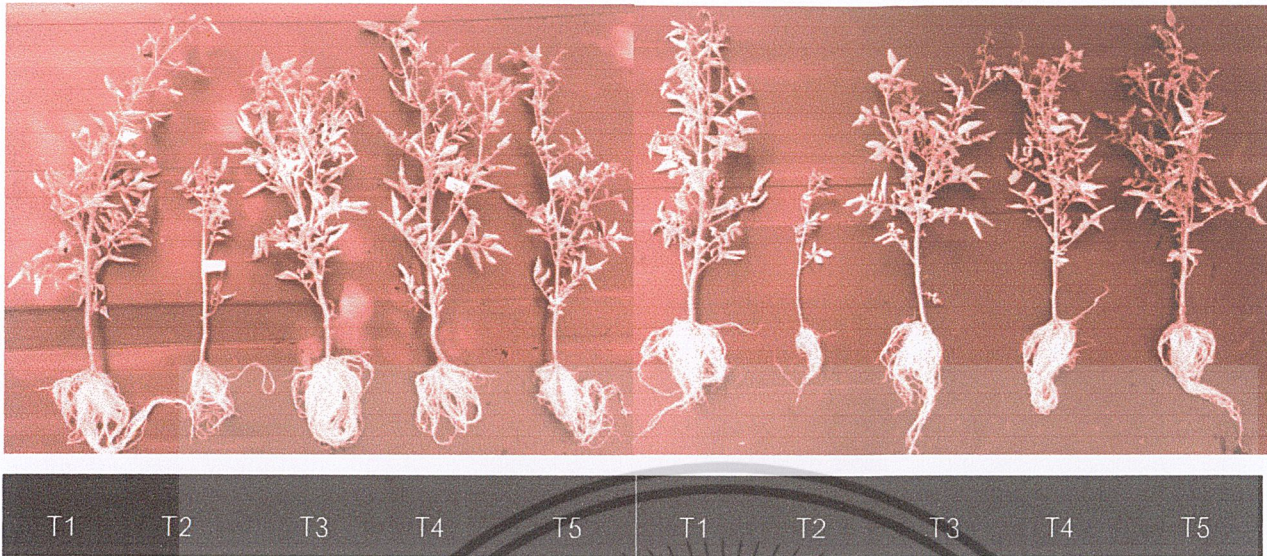
Treatments	stems			roots	
	Fresh weight	Dried weight	Length	Fresh weight	Dried weight
T3 <sup>2</sup>	87.4 <sup>1</sup>	86.25	28.1	71.8	81.01
T4	86.3	82.70	20.4	67.8	76.74
T5	87.5	86.23	31.3	75.9	78.83

1/ increased plant growth (%) = treatment – inoculated control/treatment x 100

2/ T3 = Nano materials *Chaetomium brasiliense*, T4 = Nano materials *Chaetomium cochliodes*, T5 = prochloraz

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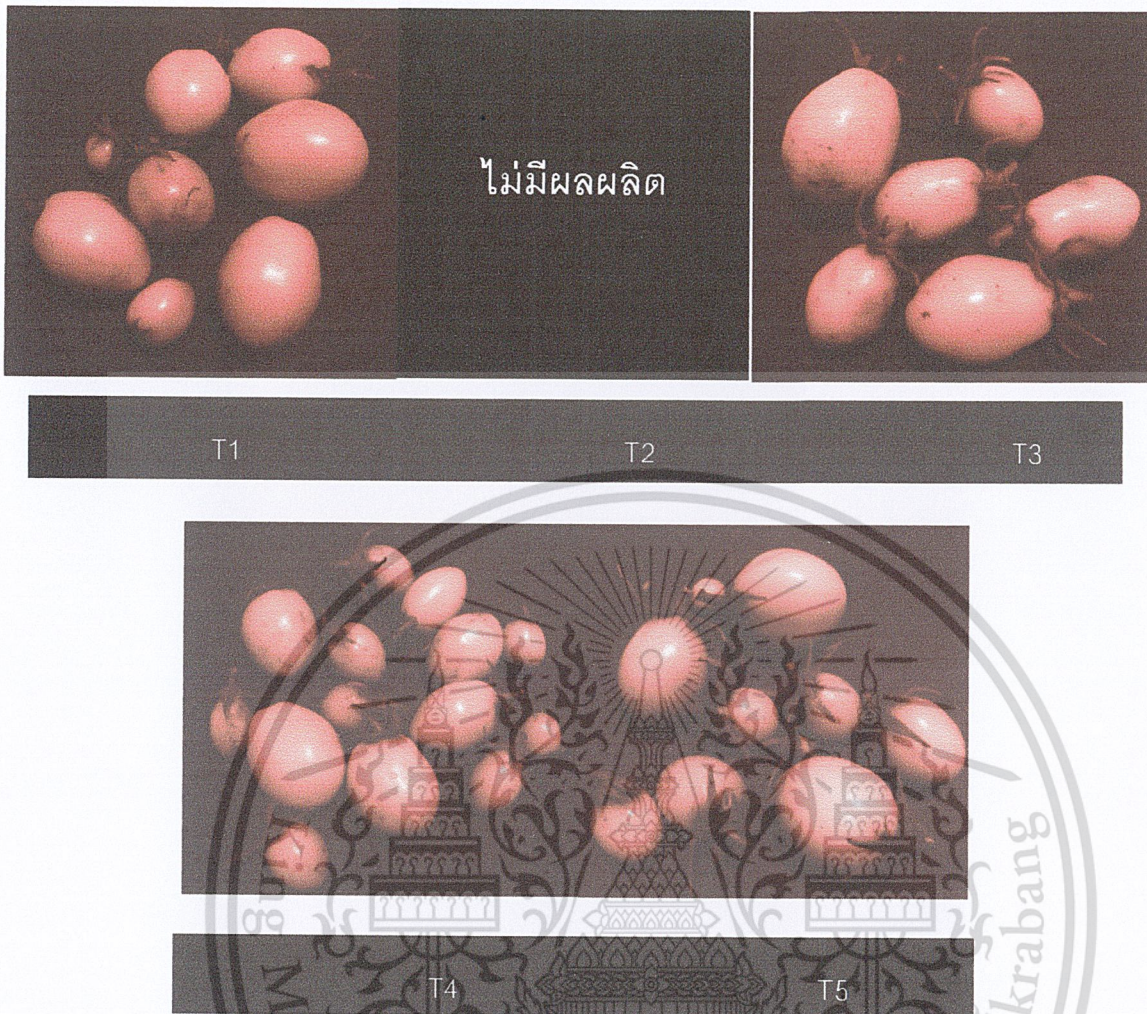
**Figure 9** Effect of plant growth after treated Nano Particles from *Chaetomium brasiliense* and *Chaetomium cochliodes* at 60 days. (T1 = Non - Inoculated Control, T2 = Inoculated Control, T3 = Nano materials *Chaetomium brasiliense*, T4 = Nano materials *Chaetomium cochliodes*, T5 = prochloraz)



**Figure 10.** Effect of root growth after treated nano materials from *Chaetomium brasiliense* and *Chaetomium cochliodes* at 60 days. (T1 = Non - Inoculated Control, T2 = Inoculated Control, T3 = Nano materials *Chaetomium brasiliense*, T4 = Nano materials *Chaetomium cochliodes*, T5 = prochloraz)

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**Figure 11.** Effect of yield after treated nano materias from *Chaetomium brasiliense* and *Chaetomium cochliodes* at 60 days (T1 = Non - Inoculated Control, T2 = Inoculated Control, T3 = Nano materials *Chaetomium brasiliense*, T4 = Nano materials *Chaetomium cochliodes*, T5 = prochloraz)

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## Appendix

ตารางภาคผนวกที่ 1 แสดงระดับการเกิดโรค ที่อายุมะเขือเทศ 20 วัน

Treatment	ระดับการเกิดโรค				
	1	2	3	4	เฉลี่ย
Non – Inoculated	1	1	1	1	1
Inoculated	4	4	6	4	4.5

ตารางภาคผนวกที่ 2 แสดงขนาดเส้นผ่านศูนย์กลางโคโลนี

Treatment	ความเข้มข้น (ppm)	ขนาดเส้นผ่านศูนย์กลางโคโลนี (ซม.)				Average
		R1	R2	R3	R4	
control	0	5	5	5	5	5
<i>Ch. brasiliense</i>	3	4.6	4	4.4	4.5	4.36
	5	4	4.3	4.3	4.6	4.3
	10	4	4	3.9	4.1	4
<i>Ch. cochliodes</i>	3	3.9	4	4	4.5	4.1
	5	3.8	3.8	4	3.5	3.78
	10	3.7	3.5	4	3	3.55

ตารางภาคผนวกที่ 3 การวิเคราะห์ผลทางสถิติของตารางภาคผนวกที่ 2

SOV	df	SS	MS	F	Ft	Ft
Treatment	3	2.1169	0.7056	20.78	0.05	0.01
Error	12	0.4075	0.0340		3.49	5.95
total	15	2.5244	0.1683			

Highly significant at P = 0.05

GRAND MEAN = 4.418

CV = 4.1704 %

LSD .05 = 0.283

LSD .01 = 0.398

ตารางภาคผนวกที่ 4 แสดงปริมาณสปอร์

Treatment	ความเข้มข้น (ppm)	ปริมาณสปอร์				Average
		R1	R2	R3	R4	
control	0	37	41	39	35	38
<i>Ch. brasiliense</i>	3	35	33	29	32	32.25
	5	24	29	23	27	25.75
	10	15	19	13	17	16.00
<i>Ch. cochliodes</i>	3	27	23	27	26	25.75
	5	10	14	12	16	13.00
	10	10	7	6	7	7.50

ตารางภาคผนวกที่ 5 การวิเคราะห์ผลทางสถิติของตารางภาคผนวกที่ 4

SOV	df	SS	MS	F	Ft
Treatment	3	2098.68	699.56	168.74	0.05
Error	12	49.75	4.14		0.01
total	15	2148.43	143.23		5.95

Highly significant at P = 0.05

GRAND MEAN = 20.812

CV = 9.783 %

LSD .05 = 3.137

LSD .01 = 4.398

ตารางภาคผนวกที่ 6 ความสูงของลำต้นจากระดับดิน (30 วัน)

วิธีการ		ความสูง(ซม.)				เฉลี่ย
		1	2	3	4	
T1	Non - Inoculated Control	34.8	31.3	40.1	37	35.8
T2	Inoculated Control	11.3	29.1	13.9	18.4	19.43
T3	<i>Chaetomium brasiliense</i>	24.3	36.7	25.8	20	26.7
T4	<i>Chaetomium cochliodes</i>	25.2	30.1	26.4	25	26.68
T5	Prochloraz	22	26	24.2	36	27.05

ตารางภาคผนวกที่ 7 การวิเคราะห์ผลทางสถิติของตารางภาคผนวกที่ 6

SOV	df	SS	MS	F	Ft
Treatment	4	539.73	134.93	4.17	0.05
Error	15	485.20	32.34		0.01
total	19	1024.94	53.94		4.89

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Hight significant at P = 0.05

GRAND MEAN = 27.129

CV = 20.9637 %

LSD .05 = 8.570

LSD .01 = 11.851

ตารางภาคผนวกที่ 8 ความสูงของลำต้นจากระดับดิน (45 วัน)

วิธีการ		ความสูง(ซม.)				
		1	2	3	4	เฉลี่ย
T1	Non - Inoculated Control	54.5	50.5	57	52	53.5
T2	Inoculated Control	23.4	40.3	30.1	28.6	30.6
T3	<i>Chaetomium brasiliense</i>	53.2	57.5	56.5	42.8	52.5
T4	<i>Chaetomium cochliodes</i>	54.1	52	55	42.9	51
T5	Prochloraz	46.1	44	43.2	58.7	48

ตารางภาคผนวกที่ 9 การวิเคราะห์ผลทางสถิติของตารางภาคผนวกที่ 8

SOV	df	SS	MS	F	Ft	
Treatment	4	9.61	1433.55	358.38	3.06	0.01
Error	15	559.62	37.30			4.89
total	19	1993.17	104.90			

Highly significant at P = 0.05

GRAND MEAN = 47.119

CV = 12.9627 %

LSD .05 = 9.203

LSD .01 = 12.728

ตารางภาคผนวกที่ 10 ความสูงของลำต้นจากระดับดิน (60 วัน)

วิธีการ		ความสูง(ซม.)				
		1	2	3	4	เฉลี่ย
T1	Non - Inoculated Control	75.6	84	62.9	54.6	69.28
T2	Inoculated Control	36.5	42.6	48.2	44.4	42.93
T3	<i>Chaetomium brasiliense</i>	72.1	64.8	78.3	57.6	68.20
T4	<i>Chaetomium cochliodes</i>	68.5	75	71.2	56.4	67.78
T5	Prochloraz	73	72.4	56.4	84.5	75.50

ตารางภาคผนวกที่ 11 การวิเคราะห์ผลทางสถิติของตารางภาคผนวกที่ 10

SOV	df	SS	MS	F	Ft	
					0.05	0.01
Treatment	4	8.43	2533.68	633.42	3.06	4.89
Error	15	1127.62	75.17			
total	19	3661.30	192.70			

Hight significant at P = 0.05

GRAND MEAN = 64.735

CV = 13.3936 %

LSD .05 = 13.064

LSD .01 = 18.067

ตารางภาคผนวกที่ 12 น้ำหนักสดของลำต้น

วิธีการ		น้ำหนัก(กรัม)				เฉลี่ย
		1	2	3	4	
T1	Non - Inoculated Control	81.83	61.27	94.70	99.01	84.20
T2	Inoculated Control	7.59	14.72	8.77	9.59	10.17
T3	<i>Chaetomium brasiliense</i>	88.06	79.83	84.35	71.21	80.86
T4	<i>Chaetomium cochliodes</i>	76.36	90.25	95.56	35.47	74.41
T5	Prochloraz	84.25	30.96	86.58	123.04	81.21

ตารางภาคผนวกที่ 13 การวิเคราะห์ผลทางสถิติของตารางภาคผนวกที่ 12

SOV	df	SS	MS	F	Ft	
					0.05	0.01
Treatment	4	15884.42	3971.10	7.86	3.06	4.89
Error	15	7579.95	505.33			
total	19	23464.37	1234.96			

Hight significant at P = 0.05

GRAND MEAN = 66.169

CV = 33.9727 %

LSD .05 = 33.873

LSD .01 = 46.843

ตารางภาคผนวกที่ 14 น้ำหนักแห้งของลำต้น

วิธีการ		น้ำหนัก(กรัม)				
		1	2	3	4	เฉลี่ย
T1	Non - Inoculated Control	48.32	38.30	45.18	45.07	44.22
T2	Inoculated Control	4.05	9.95	6.42	4.07	6.12
T3	<i>Chaetomium brasiliense</i>	49.21	45.63	46.62	36.62	44.52
T4	<i>Chaetomium cochliodes</i>	38.89	45.37	39.48	17.73	35.37
T5	Prochloraz	48.27	20.04	44.35	65.06	44.43

ตารางภาคผนวกที่ 15 การวิเคราะห์ผลทางสถิติของตารางภาคผนวกที่ 14

SOV	df	SS	MS	F	Ft	
						0.05
						0.01
Treatment	4	4394.15	1098.53	10.03	3.06	4.89
Error	15	1642.46	109.49			
total	19	6036.62	317.71			

High significant at P = 0.05

GRAND MEAN = 34.931

CV = 29.9561 %

LSD .05 = 15.767

LSD .01 = 21.805

ตารางภาคผนวกที่ 16 ความยาวราก

วิธีการ		ความยาว(ซม.)				
		1	2	3	4	เฉลี่ย
T1	Non - Inoculated Control	37	43.2	48.6	43	42.95
T2	Inoculated Control	27	45.6	30	27	32.4
T3	<i>Chaetomium brasiliense</i>	35.6	45	51.3	48.4	45.08
T4	<i>Chaetomium cochliodes</i>	49.1	39.5	45.7	31.5	40.7
T5	Prochloraz	42.3	53.4	45	47.8	47.13

ตารางภาคผนวกที่ 17 การวิเคราะห์ผลทางสถิติของตารางภาคผนวกที่ 16

SOV	df	SS	MS	F	Ft	
						0.05
						0.01
Treatment	4	515.54	128.88	2.79	3.06	4.89
Error	15	692.31	46.15			
total	19	1207.86	63.57			

Highly significant at P = 0.05

GRAND MEAN = 41.799

CV = 16.2529 %

LSD .05 = 10.237

LSD .01 = 14.157

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ตารางภาคผนวกที่ 18 น้ำหนักสดราก

วิธีการ		น้ำหนัก(กรัม)				
		1	2	3	4	เฉลี่ย
T1	Non - Inoculated Control	19.38	22.28	19.01	31.45	23.33
T2	Inoculated Control	5.76	7.09	4.58	3.09	5.13
T3	<i>Chaetomium brasiliense</i>	20.55	20.24	11.47	20.39	18.26
T4	<i>Chaetomium cochliodes</i>	16.77	14.11	23.02	9.74	15.91
T5	Prochloraz	22.32	11.52	26.52	24.96	21.33

ตารางภาคผนวกที่ 19 การวิเคราะห์ผลทางสถิติของตารางภาคผนวกที่ 18

SOV	df	SS	MS	F	Ft	
					0.05	0.01
Treatment	4	792.34	198.08	7.44	3.06	4.89
Error	15	399.19	26.61			
total	19	1191.54	62.71			

Highly significant at P = 0.05

GRAND MEAN = 16.711

CV = 30.8697 %

LSD .05 = 7.773

LSD .01 = 10.750

ตารางภาคผนวกที่ 20 น้ำหนักแห้งราก

วิธีการ		น้ำหนัก(กรัม)				
		1	2	3	4	เฉลี่ย
T1	Non - Inoculated Control	5.17	4.88	5.08	5.99	5.28
T2	Inoculated Control	0.5	1.33	0.76	0.72	0.83
T3	<i>Chaetomium brasiliense</i>	4.53	5.46	3.14	4.36	4.37
T4	<i>Chaetomium cochliodes</i>	3.67	3.54	5.25	1.8	3.57
T5	Prochloraz	4.57	2.24	3.81	5.05	3.92

ตารางภาคผนวกที่ 21 การวิเคราะห์ผลทางสถิติของตารางภาคผนวกที่ 20

SOV	df	SS	MS	F	Ft	
					0.05	0.01
Treatment	4	44.8307	11.2077	11.74	3.06	4.89
Error	15	14.3187	0.9546			
total	19	59.1494	3.1131			

Highly significant at P = 0.05

GRAND MEAN = 3.592

CV = 27.1963 %

LSD .05 = 1.472

LSD .01 = 2.035

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ตารางภาคผนวกที่ 22 แสดงระดับการเกิดโรค

วิธีการ		ระดับการเกิดโรค				
		1	2	3	4	เฉลี่ย
T1	Non - Inoculated Control	1	1	1	1	1
T2	Inoculated Control	4	4	5	5	4.25
T3	<i>Chaetomium brasiliense</i>	1	2	3	3	1.75
T4	<i>Chaetomium cochliodes</i>	2	1	4	1	2
T5	Prochloraz	2	3	2	1	2

ตารางภาคผนวกที่ 23 การวิเคราะห์ผลทางสถิติของตารางภาคผนวกที่ 22

SOV	df	SS	MS	F	Ft	
					0.05	0.01
Treatment	4	23.70	5.92	7.73	3.06	4.89
Error	15	11.50	0.76			
total	19	35.20	1.85			

Highly significant at P = 0.05

GRAND MEAN = 2.200

CV = 39.7998 %

LSD .05 = 1.319

LSD .01 = 1.824

