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Integrated disease management (IDM) approaches for management of Alternaria blight disease in linseed (*Linum usitatissimum* L.) caused by *Alternaria lini* Dey

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Abstract
The management of the disease can be done through fungicides, bio-agents and plant extract but Integrated Disease Management (IDM) strategy has proved better as compare to other strategies. IDM practice also significantly increased the shoot and root length of linseed plant than untreated treatment (check). The maximum shoot (62.48 cm) and root (14.25 cm) length, seed yield (1370.70 kg/ha) and minimum disease severity (19.19% on leaves and 14.78% on buds) were recorded in treatment T_4 treatment (ST with T. harzianum + two foliar sprays Propiconazole). The maximum cost: benefit ratio 1:5.26 was calculated in treatment T_7, followed by 1:4.21 in T_3 treatment.

Keywords: Bio-agents, chemicals, IDM, cost benefit ratio

Introduction
Linseed (*Linum usitatissimum* L.) is considered as a founding crop as it is cultivated among the first domesticated plants which began its cultivation in Mesopotamia (Zohary and Holf, 1993; Smith, 1995) [40, 35].
Flax seed is the source of omega-3 fatty acids which are nutritionally important because they reduce the risk of cardio vascular disease (Hurteau, 2004) [15]. Flax seed protein was effective in lowering plasma cholesterol and triglycerides (Bhathena *et al*., 2002) [5]. Flax seeds, which also contain dietary fibre is therefore a promising food to help decrease the risk of lifestyle related diseases (Fukumitsu *et al.*, 2008) [13]. The antioxidant activity of the flaxseed has been shown to reduce the total cholesterol (Bierenbaum *et al.*, 1993) [7] as well as platelet aggregation (Allman *et al.*, 1995) [2]. Linatine antibiotic can also be obtained from seeds of linseed (Gill, 1987) [14].
Flax seed is also an important source of both soluble and insoluble fibers, which are very important for effective digestion. Soluble fibre also serves as an effective cholesterol lowering agent (Jhala and Hall, 2010) [16].
Linseed is adversely affected by number of fungal diseases. Among these Alternaria blight caused by *Alternaria lini* Dey is a major disease which causes huge amount losses in terms of quality and quantity of fiber and seed. The disease was first reported by Dey (1933) [12] from flower bud at Kanpur, Uttar Pradesh in 1933 [12] (Kolte and Fitt, 1997) [17]. Later, Siddiqui (1963) [26] reported the occurrence of Alternaria blight on linseed at IARI, New Delhi and other parts of the country. The fungus was named as *Alternaria lini* after the first report of this disease by Dey in the year 1933 [12]. Arya and Prasad (1952) [3] recorded a severe outbreak of the disease at Delhi in the year 1949 and reported that the pathogen was identical with *Alternaria brassicae* (Berk) Sacc. var. *macrospora* (Broun) in morphology, pathogenicity and physiology. The disease appears on all the aerial parts of the plant. In India, Alternaria blight was previously designated as minor disease but now become a major problem in different parts of the country (Chauhan and Shrivastava, 1975) [9].
Arya and Prasada (1952) [3] reported that *A. lini* was identical with *A. brassicae* (Berk) Sacco. In morphology, pathogenicity and physiology. The pathogen is perpetuated in seed and also soil through infected plant debris. The management of disease can be done through cultural *i.e.*, crop rotation (Rani and Sudini, 2013) [24], changing in sowing date (Singh and Singh, 2004b, Singh *et al.*, 2008, Singh *et al.*, 2015) [32, 28, 34], destruction of plant debris (Rani and Sudini, 2013) [24], soil solarization (Patel *et al.*, 2014) [21], use of resistant cultivars (Ramakant *et al.*, 2008) [23], chemical (Holi and Meena, 2015), biological management (Bhoye *et al.*, 2011, Biswas *et al*, 2015) [6].

Cultural and biological strategies are mostly effective at initial stage, specially at sowing time of crops and they can not manage the disease in standing crop and even after appearance of disease. Use of resistant cultivar is also reasonable and easy method for disease management but due to development of new strain among the pathogens, resistant may be break down to susceptible one.

Chemical strategy is very effective but also delicate to environmental pollution, residual effect in grain and killing the non-target organisms (Kumar and Singh, 2017) [18]. Development of fungicide resistance in plant pathogens is a major obstacle of chemical strategy when use continuous and separately (Patel *et al.*, 2014) [21]. Therefore, all the methods have some limitations and draw back and due to least efficiency of single strategy of disease management, integration of various strategies (IDM) is the foremost need for management of plant disease in near future of agriculture. IDM act as safeguarding against the longer term risks of environmental pollution, hazard to human health and reduced agricultural sustainability (Ciancio and Mukerji, 2007) [10]. Singh and Singh (2007) [33] used IDM strategy against Alternaria blight of linseed (cv. *Shekhar*) and get better result than single mode of disease management practice in term of benefit cost ratio. Similar result also founded by Singh and Singh (2005) [29] on *Sheela* and *Chambal* varieties of linseed. Singh *et al.*, (2013) [30] found that integration of *T. viride*, fungicides and plant extracts are the most effective for management of Alternaria blight of linseed. Singh and Kerkhi (2010) [27] reported that *T. viride*, *T. harzianum*, leaf extract of *Azadirachta indica* and Rovral (iprodione) are very effective when used in IDM strategy against Alternaria blight in linseed cv. Chambal.

Keeping above point in view for study of under taken as “Integrated Disease Management (IDM) approaches for management of Alternaria blight disease in linseed (*Linum usitatissimum* L.) caused by *Alternaria lini* Dey” in the present investigation.

Material and methods

Integrated effect of bio-agents, fungicides and plant extracts as seed treatment and foliar spray was recorded against Alternaria blight in field condition during 2014-15 and 2015-16. Alternaria blight of linseed was studies with Shekhar variety of linseed at Oilseed Farm of this University. The experiment was conducted in 4×3 meter plot size in Randomized Block Design with three replications and sixteen treatments. The observations were taken on growth parameter, disease severity and yield parameter. The details of treatment combinations are given below:

Treatment details

T1 ST with T. viride (4g/kg seed) + 2 FS of mancozeb (0.25%). First spray was given at disease initiation stage followed by second spray after 15 days interval.

T2 ST with T. viride (4g/kg seed) + 2 FS of propiconazole (0.1%). First spray was given at disease initiation stage followed by second spray after 15 days interval.

T3 ST with T. harzianum (4g/kg seed) + 2 FS of mancozeb (0.25%). First spray was given at disease initiation stage followed by second spray after 15 days interval.

T4 ST with T. harzianum (4g/kg seed) +2 FS of propiconazole (0.1%). First spray was given at disease initiation stage followed by second spray after 15 days interval.

T5 ST with combination of carboxin (37.5%) and thiram (37.5%) (2g/kg seed) + 2 FS of mancozeb (0.25%). First spray was given at DIS followed by second spray after 15 days interval.

T6 ST with combination of carboxin (37.5%) and thiram (37.5%) (2g/kg seed) + 2 FS of propiconazole (0.1%). First spray was given at disease initiation stage followed by second spray after 15 days interval.

T7 ST with combination of carboxin (37.5%) and thiram (37.5%) (2g/kg seed) + 2 FS of carbendazim (0.1%). First spray was given at disease initiation stage followed by second spray after 15 days interval.

T8 ST with carbendazim (2g/kg seed) + 2 FS of mancozeb (0.25%). First spray was given at disease initiation stage followed by second spray after 15 days interval.

T9 ST with carbendazim (2g/kg seed) + 2 FS of propiconazole (0.1%). First spray was given at disease initiation stage followed by second spray after 15 days interval.

T10 ST with T. viride (4g/kg seed) + 2 FS of T. viride (106 spores/ml). First spray was given at disease initiation stage followed by second and third spray after 6 days interval.

T11 ST with T. harzinum (4g/kg seed) + 3 FS of T. harzinum (106 spores/ml). First spray was given at disease initiation stage followed by second and third spray after 6 days interval.

T12 ST with T. viride (4g/kg seed) + 3 FS of neem leaf extract (5%). First spray was given at disease initiation stage followed by second and third spray after 6 days interval.

T13 ST with T. viride (4g/kg seed) + 3 FS of tulsi leaf extract (5%). First spray was given at disease initiation stage followed by second and third spray after 6 days interval

T14 ST with T. harzinum (4g/kg seed) + 3 FS of neem leaf extract (5%). First spray was given at disease initiation stage followed by second and third spray after 6 days interval

T15 ST with T. harzinum (4g/kg seed) + 3 FS of tulsi leaf extract (5%). First spray was given at disease initiation stage followed by second and third spray after 6 days interval

T16 Untreated check.

Seed treatment and foliar spray

Seed treatments with fungicides like carbendazim (0.1%), mencozeb (0.25%), mixture of carboxin (37.5%) and thiram (37.5%), Propiconazole (0.1%) @ 2g/kg seed and *Trichoderma* spp. used in seed treatment @ 4g/kg linseed seed before sowing according to treatments. The required dose of fungicides and *Trichoderma* spp. were calculated and weight. The spray solution/suspension of fungicides, *Trichoderma* spp. and plant extracts were prepared in required quantity of water for each treatment, at the rate of 800-litre water/ha. The prepared solution were sprayed using volume knap sack sprayer of 10 liter capacity spraying was done when the wind was calm to avoid drift from spray plot to neighboring plots. The spraying of carbendazim (0.1%), mencozeb (0.25%), mixture of carboxin (37.5%) and thiram (37.5%) and propiconzole (0.1%), *Trichoderma* spp @ 10^6 spores/ml and plant extracts was done twice @ 5%. The first spray was given as soon as the appearance of first symptoms of the disease and second spray was given after 15 days of the first spray.

Measurement of disease severity

After germination, the crop was regularly watched for first appearance of disease. The observation on disease severity was recorded by selecting ten plants randomly from each genotype. The disease severity was recorded at pre-senescence stage. The disease reaction on leaves and buds were recorded in each genotype by 0-5 scale (Das *et al.*, 2016). These numerical ratings were used to calculate the per cent disease severity (PDS) as follows:

Per cent Disease Control (PDC)
The per cent disease control was calculated by using the following formula:

Table 1: 0-5 scale adapted to indicate degree of resistance against *Alternaria* blight of linseed

Scale	Disease Intensity	Disease Rection
0	Free from disease	Free (F)
1	1-10% infection	Resistant (R)
2	10.1-25% infection	Moderate Resistant (MR)
3	25.1-50% infection	Moderate Susceptible (MS)
4	50.1-75% infection	Susceptible (S)
5	75.1-100%	Highly Susceptible (HS)

Per cent increase in yield
Seed yield was recorded in each treatment separately in quintal per hectare (q/ha) and per cent increase in seed yield (q/ha) was calculated by using the following formula:

Benefit cost ratio
The benefit cost ratio was calculated on the basis of seed yield of each treatment by using following formula.

Result and Discussion
Root and Shoot length
It has been found from the present investigations, all the treatments significantly increase shoot and root length of linseed plant than untreated treatment (check). The maximum shoot (62.48 cm) and root (14.25 cm) length were recorded in treatment T_4 treatment (ST with T. harzinum + two foliar sprays propiconazole), followed by T3 treatment (ST with T. harzianum +two foliar sprays of mancozeb) indicating 62.24 cm and 35.49 cm shoot and root length, respectively. However, minimum shoot (48.60 cm) and root (9.27 cm) length were recorded in untreated plot (control). Trichoderma act as antagonists (Rajendiran *et al.*, 2010; Svetlana *et al.* 2010; Agarwal *et al.*, 2011; Bhoye *et al.*, 2011 and Leelavathi *et al.*, 2014) [22, 36, 1, 6, 19] as well as plant growth promotor (Vinale *et al.*, 2006; Verma *et al.*, 2007; Bai *et al.*, 2008, Vinale *et al.*, 2008 and Savazzini *et al.*, 2009) [38, 37, 4, 39, 25]. Mishra *et al.*, (2016) [20] were found maximum shoot and root length of tomato when apply FYM, *T. harzianum* and mancozeb in IDM strategy to manage early blight of tomato (*A. solani*).

Effect of IDM practices on severity of Alternaria blight
The effect of IDM strategy on disease severity was recorded on leaf and bud of plants, separately. All the treatments were significantly superior over check. Severity of disease ranged from 19.19% to 56.43% on leaves. The minimum disease severity on leaves was recorded in treatment T_4 (ST with T. harzinum + two foliar sprays of propiconazole), followed by T3 (ST with T. harzianum+two foliar sprays of mancozeb. However, maximum desease severity (56.43%) was recorded in untreated plot (control).
On bud, disease severity ranged from 14.78-41.21 per cent. The minimum disease severity (14.78%) on bud was recorded in treatment T_4 (ST with T. harzinum +two foliar sprays of propiconazole) followed by 16.61% in T3- treatment (ST with T. harzianum+two foliar sprays of mancozeb. However, maximum (41.21%) desease severity was recorded in untreated plot (control). The present results similar to the findings of Singh and Kerkhi (2010) [27] they have reported that maximum disease control by combination of neam leaf (5%) and *T. harzianum.* Singh *et al.* (2013) [30] also manage Alternaria blight of linseed with integration of *T. viride*, fungicides and plant extracts. They found that seed treatment with *T. viride* (4 g/kg seed) followed by two foliar sprays of mancozeb (0.25%) decreased the 56.16% blight intensity and 55.64% bud damage.

Yield parameters
There is several reports support to IDM practices that increased the yield of linseed crops (Singh and Singh, 2005; Singh and Singh, 2007 and Dash *et al.*, 2017) [29, 33, 11]. In the present study, all the treatments produced significantly higher yield than check. Treatment T_4 (ST with T. harzinum+two foliar sprays of propiconazole) produced maximum test weight (8.04g) and seed yield (1370.70 kg/ha) followed by treatment T3 (ST with T. harzianum+Two foliar sprays of mancozeb). However, minimum test weight (7.30, 7.23 and 7.27g) and seed yield (986.50, 908.60, 947.55 kg/ha) were recorded in untreated plot (control) during 2015-16, 2016-17 and in pooled analysis, respectively. Dash *et al.*, (2017) [11] were found maximum seed yield (1354.12 kg ha^{-1}) with maximum net return (Rs. 13953.60/ha) was obtained from the treatment ST with Carboxin 37.5%+Thiram 37.5% (2 g kg^{-1} seed)+2 FS of Carbendazim 25%+Mancozeb 63% (0.1%) followed by treatment ST with *T. viride*+2 FS of Carbendazim 25%+Mancozeb 63% @ 0.1%.

Table 2: Effect of IDM practices on disease severity of Alternaria blight (leaf and bud)

Treatments	Leaf			Bud		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
T_1	23.36	24.06	23.71	20.56	21.18	20.87
T_2	21.66	22.31	21.98	19.26	19.84	19.55
T_3	19.63	20.22	19.92	16.36	16.85	16.61
T_4	18.91	19.48	19.19	14.56	15.00	14.78
T_5	24.00	24.72	24.36	23.56	24.27	23.91
T_6	26.85	27.66	27.25	24.56	25.30	24.93
T_7	23.66	24.37	24.01	21.56	22.21	21.88
T_8	26.00	24.56	25.28	23.66	24.37	24.01
T_9	25.56	26.33	25.94	23.92	24.64	24.28
T_{10}	25.51	29.90	27.71	27.10	27.78	27.44
T_{11}	27.10	27.91	27.51	26.85	27.66	27.25
T_{12}	33.66	39.30	36.48	27.96	28.80	28.38
T_{13}	45.66	47.03	46.34	35.60	36.67	36.13

T_{14}	27.96	28.80	28.38	27.10	27.91	27.51
T_{15}	40.00	38.60	39.30	29.56	30.15	29.86
T_{16}	55.60	57.27	56.43	40.60	41.82	41.21
CD at 5%	0.949	0.977	0.963	0.857	0.881	0.867
SE m ±	0.372	0.337	0.332	0.229	0.295	0.303

Treatments details
T_1-ST with *T. viride* (4g/kg seed) + 2 FS of mancozeb (0.25%).
T_2-ST with *T. viride* (4g/kg seed) + 2 FS of propiconazole (0.1%).
T_3-ST with *T. harzianum* (4g/kg seed) + 2 FS of mancozeb (0.25%).
T_4-ST with *T. harzianum* (4g/kg seed) + 2 FS of propiconazole (0.1%).
T_5-ST with combination of carboxin (37.5%) and thiram (37.5%) (2g/kg seed) + 2 FS of mancozeb (0.25%).
T_6-ST with combination of carboxin (37.5%) and thiram (37.5%) (2g/kg seed) + 2 FS of propiconazole (0.1%).
T_7-ST with combination of carboxin (37.5%) and thiram (37.5%) (2g/kg seed) + 2 FS of carbendazim (0.1%).
T_8-ST with carbendazim (2g/kg seed) + Two FS of mancozeb (0.25%).
T_9-ST with carbendazim (2g/kg seed) + Two FS of propiconazole (0.1%).
T_{10}-ST with *T. viride* (4g/kg seed) + Three FS of *T. viride* (10^6 spores/ml).
T_{11}-ST with *T. harzinum* (4g/kg seed) + 3 FS of *T. harzinum* (10^6 spores/ml).
T_{12}-ST with *T. viride* (4g/kg seed) + 3 FS of neem leaf extract (5%).
T_{13}-ST with *T. viride* (4g/kg seed) + 3 FS of tulsi leaf extract (5%).
T_{14}-ST with *T. harzinum* (4g/kg seed) + 3 FS of neem leaf extract (5%).
T_{15}-ST with *T. harzinum* (4g/kg seed) + 3 FS of tulsi leaf extract (5%).
T_{16}-Untreated check.

Table 3: Effect of IDM practices on test weight and seed yield of linseed

Treatments	Test Weight (g)		Pooled Data	Seed Yield (kg/ha)		Pooled Data
	2014-15	2015-16		2014-15	2015-16	
T_1	7.73	7.62	7.68	1316.25	1296.80	1306.53
T_2	7.77	7.66	7.72	1329.65	1310.00	1319.83
T_3	8.07	7.95	8.01	1350.00	1305.00	1327.50
T_4	8.10	7.98	8.04	1380.91	1360.50	1370.70
T_5	7.45	7.65	7.55	1304.61	1285.33	1294.97
T_6	7.56	7.48	7.52	1264.28	1245.60	1254.94
T_7	7.67	7.56	7.62	1310.93	1291.56	1301.25
T_8	7.59	7.48	7.54	1297.40	1278.23	1287.81
T_9	7.59	7.48	7.53	1279.41	1260.50	1269.95
T_{10}	7.50	7.49	7.50	1245.20	1226.80	1236.00
T_{11}	7.56	7.45	7.51	1255.11	1236.56	1245.83
T_{12}	7.50	7.39	7.45	1218.00	1200.00	1209.00
T_{13}	7.44	7.33	7.38	1116.50	1100.00	1108.25
T_{14}	7.51	7.40	7.46	1238.71	1220.40	1229.55
T_{15}	7.46	7.35	7.41	1167.86	1150.60	1159.23
T_{16}	7.30	7.23	7.27	0986.50	0908.60	0947.55
CD at 5%	0.261	0.263	0.265	43.12	42.12	44.03
SE m ±	0.100	0.09	0.99	15.10	14.23	14.89

Economics of treatments

The economics of the treatments was determined in term of cost: benefit ratio. The maximum cost: benefit ratio (1:5.26) was calculated in treatment T_7 (ST with combination of carboxin (37.5%) and thiram (37.5%) (2g/kg seed)+2 FS of carbendazim (0.1%). followed by T_3 as seed treatment with T. harzinum (4g/kg seed) + two foliar sprays of mancozeb (0.25%). It is also cleared that cost: benefit ratio was superiar in all the treatments over control. Singh *et al.* (2014) [31] were found maximum seed yield (1440 kg ha^{-1}) with maximum net return (Rs. 15352/ha) and benefit cost ratio (1:11.04) with treatment ST with vitavax power + 2 FS of Neem leaf extract followed by treatment ST with vitavax power+2 FS of Saaf (1378 kg ha^{-1}).

Table 4: Effect of IDM practices on shoot and root length of linseed

Treatments	Shoot length (cm)		Pooled Data	% increased over control	Root Length (cm)		Pooled Data	% increased over control
	2014-15	2015-16			2014-15	2015-16		
T_1	60.40	60.80	60.60	24.69	11.75	11.35	11.55	24.59
T_2	60.01	62.02	62.03	27.63	11.80	11.87	11.84	27.72
T_3	62.78	61.71	62.24	28.07	12.88	12.25	12.56	35.49
T_4	62.53	62.43	62.48	28.56	14.35	14.15	14.25	53.72
T_5	59.20	59.37	59.29	21.99	11.43	11.18	11.30	21.89
T_6	58.05	58.15	58.10	19.55	11.30	10.57	10.94	18.01
T_7	60.30	60.50	60.40	24.27	11.53	11.32	11.42	23.19
T_8	59.13	59.11	59.12	21.65	10.93	11.45	11.19	20.71
T_9	58.50	58.75	58.63	20.64	10.86	11.28	11.07	19.42
T_{10}	57.28	57.30	57.29	17.88	09.78	09.77	09.77	05.39
T_{11}	57.35	57.54	57.45	18.21	10.85	10.68	10.77	16.18

T_{12}	57.13	57.12	57.12	17.53	09.65	09.34	09.50	02.48
T_{13}	54.95	55.01	54.98	13.13	09.33	09.43	09.38	01.19
T_{14}	57.25	57.15	57.20	17.69	09.50	09.65	09.58	03.34
T_{15}	56.30	56.80	56.55	16.36	09.65	09.12	09.39	01.29
T_{16}	48.63	48.58	48.60	00.00	09.00	09.54	09.27	00.00
CD at 5%	2.03	2.03	2.13	-	0.384	0.38	0.388	-
SE m ±	0.71	0.77	0.78	-	0.132	0.131	0.134	-

Table 5: Economic feasibility of different treatments

Treatments	Dose/ha	Cost of treatment	No of labour/ha	Labour cost (Rs/ha)	Total expenditure (Rs/ha)	Yield (Kg/ha)	Gross income (Rs/ha)	Net return over control (Rs/ha)	C:B
T_1	120g, 3000g	1212.00	8	2400	3612.0	1306.53	52261.2	14359.2	1:3.98
T_2	120g, 2000ml	2012.00	8	2400	4412.0	1319.83	52793.2	14891.2	1:3.38
T_3	120g, 3000g	1212.00	8	2400	3612.0	1327.50	53100.0	15198.0	1:4.21
T_4	120g, 2000ml	2120.00	8	2400	4520.0	1370.70	54828.0	16926.0	1:3.74
T_5	60g, 3000g	1320.00	8	2400	3720.0	1294.97	51798.8	13896.8	1:3.74
T_6	60g, 2000ml	2120.00	8	2400	4520.0	1254.94	50197.6	12295.6	1:2.72
T_7	60g, 600g	0291.00	8	2400	2691.0	1301.25	52050.0	14148.0	1:5.26
T_8	60g, 3000g	1217.10	8	2400	3617.1	1287.81	51512.4	13610.4	1:3.76
T_9	60g, 2000ml	2017.10	8	2400	4417.1	1269.95	50798.0	12896.0	1:2.92
T_{10}	120g, 120g	0024.00	12	3600	3624.0	1236.00	49440.0	11538.0	1:3.18
T_{11}	120g, 120g	0024.00	12	3600	3624.0	1245.83	49833.2	11931.2	1:3.29
T_{12}	120g, 187.5 kg	2812.50	18	5400	8212.5	1209.00	48360.0	10458.0	1:1.27
T_{13}	120g, 187.5 kg	9375.00	18	5400	14775.0	1108.25	44330.0	06428.0	1:0.44
T_{14}	120g, 187.5 kg	2812.50	18	5400	8212.5	1229.55	49182.0	11280.0	1:1.37
T_{15}	120g, 187.5 kg	9375.00	18	5400	14775.0	1159.23	46369.2	8467.2	1:0.57
T_{16}	-	-	-	-	-	0947.55	37902.0	0	-

Conclusion

Chemical based strategies among the various strategies used in agriculture have been so far dominating. Use of synthetic chemicals has led to the emergence of several problems like environmental pollution, residual effect in grain and killing of non-target organism(s). Development of resistant strains of plant pathogens are serious problem of diseases management, increase due to the application of only pesticide strategies for plant diseases management. To minimize the chemicals related problems, *Trichoderma* is a best biological weapon for crop protection. *Trichoderma* spp. has been an exceptionally good bio-control agent as well as growth promoter because it is ubiquitous easy to isolate and grow rapidly on many substrates, affects wide range of plant pathogens and compatible with some agrochemicals. The combined use of bio-control agents and pesticides has attracted much attention in successful crop production to combat the pest. The success of bio control agents is dependent on its compatibility with other disease management system. However, the compatibility of *Trichoderma* to chemicals needs confirmation before its use in sustainable agriculture.

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