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In vitro efficacy of fungicides against *Alternaria* blight of linseed caused by *Alternaria lini*

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Abstract
Alternaria lini casing *Alternaria* blight is probably the main disease problem facing the linseed grower. *Alternaria* blight can cause severe damage to seedlings, seedlings may be seriously weakened or killed which may result in substantial reduction in plant stand. A total eight fungicides at their recommended dosages were evaluated *in vitro* by poisoned food technique, against *Alternaria lini* causing *Alternaria* blight of linseed. The systemic fungicides *viz*., Carbendazim 50% WP, Thiophanate methyl 70% WP, Tebuconazole 25% WG, contact fungicides *viz*., Captan 75% WP, Mancozeb 75% WP and combi fungicides *viz*., Carboxin 37.5% + Thiram 37.5% 75 WP, Carbendazim 12% + Mancozeb 63% WP were evaluated. However, the fungicide *viz*., Carboxin 37.5% + Thiram 37.5% 75WP was found most effective with 92.04 per cent mycelial growth inhibition of *Alternaria lini* followed by Tebuconazole 25% WG (89.93%), Captan 75% WP (72.37%), Carbendazim 12% + Mancozeb 63% 75WP (60.11%), Mancozeb 75% WP (28.82%), Carbendazim 50% WP (22.15%) and Thiophanate methyl 70% WP (12.26%) were found effective against *Alternaria lini*.

Keywords: *In vitro*, linseed, fungicide, *Alternaria lini*

Introduction
Linseed (*Linum usitatissimum* L.) (2n=30) is one of the oldest oilseed crop which belongs to the family Linaceae and genus *Linum*. It is mostly cultivated in temperate, subtropical and tropical regions of the world (Khade and Kamble, 2018) [3]. Linseed is the sixth largest oilseed crop of the world and is cultivated in more than 50 countries with a production of 27.94 lakh tonnes. India ranks fifth in the world in terms of production of 174 thousand tonnes over an area of 326 thousand hectares with productivity 533 kg/ha. Linseed is an important industrial and edible oil and fiber producing crop. It is also used as medicinal plant as it is rich in oil and protein which makes it useful as a dietary supplement (Jhala and Linda, 2010) [2]. Every part of the linseed plant is utilized commercially, either directly or after processing. On a very small scale, the seed is directly used for edible purposes. About 20% of the total oil produced is used at farmers' level and the rest 80% oil goes to industries for the manufacturing of paints, oil cloth, varnish, pad-ink, printed ink, linoleum etc. The oil-cake is a good feed for milch cattle and poultries (Singh *et al*., 2018) [12]. In linseed a variety of oil, proteins and carbohydrates are present in the seed, which makes the seed liable to attack by a range of seed-borne pathogens. The predominant fungi associated with linseed seeds causing seed and seedling rot are *Alternaria alternata, A. linicola, Aspergillus flavus, A. niger, Colletotrichum linicola, Curvularia lunata, Fusarium moniliforme, F. oxysporum* f. sp. *lini, Fusarium pallidoroseum, Rhizoctonia bataticola, R. solani, Phoma exiguea*, var. *linicola* are predominant (Kumar *et al*., 1997) [4]. *Alternaria lini* is probably the main disease problem facing the linseed grower. *Alternaria* blight can cause severe damage to seedlings, seedlings may be seriously weakened or killed which may result in substantial reduction in plant stand (Singh *et al*., 2017) [10]. Present investigation was carried out with *in vitro* evaluation of fungicides for the control of *Alternaria lini* causing *Alternaria* blight disease of Linseed.

Material and Methods
The experiment (*in vitro*) was conducted at Department of Plant pathology, College of Agriculture, Latur. Efficacy of various seed dressing fungicides was evaluated by applying Poisoned food technique (Nene and Thapliyal, 1993) [7] and using Potato dextrose agar (PDA) as a basal culture medium. The different fungicide concentrations were prepared in flasks by dissolving required quantities of each fungicide in warm media. The fungicides were added after the media had been autoclaved and cooled (45 ^{0}C). Flask without fungicide served as control. PDA medium was then poured (20 ml / plate) separately and aseptically in petri plates (90 mm dia.) and allowed to solidify at room temperature.

After solidification, the plates were inoculated with a 5 mm disc of week-old pure culture of *Alternaria lini*. Three replicate plates were used for each concentration of fungicide. Test pathogen was assessed separately. Petri plates filled with plain PDA (without fungicide) and inoculated with the culture disc of *Alternaria lini* was maintained as untreated control. Both treated and untreated plates were incubated at 26±2 ^{0}C, for a week.

Experimental details

Design : CRD (Completely Randomized Design)
Replications : Three
Treatments : Eight

Table. Treatments details

Tr. No.	Treatments	Conc. (%)	Tr. No.	Treatments	Conc. (%)
T_1	Carbendazim 50% WP	0.1	T_5	Mancozeb 75% WP	0.25
T_2	Thiophanate methyl 70% WP	0.1	T_6	Carboxin 37.5% + Thiram 37.5% 75 WP	0.25
T_3	Tebuconazole 25% WG	0.2	T_7	Carbendazim12% +Mancozeb 63% WP	0.25
T_4	Captan 75% WP	0.3	T_8	Control (Untreated)	-

Observations on radial mycelial growth/colony diameter were recorded at 24 hrs. interval and continued till growth on the control plate covered the plate. Per cent inhibition of radial mycelial growth of *A. lini* over untreated control was computed by using the formula (Vincent, 1927) [12].

$$\text{Per cent inhibition} = \frac{C - T}{C} \times 100$$

Where,
C = growth of the test fungus in untreated control plate
T = growth of the test fungus in treated plate

Results and Discussion

A total eight fungicides at their recommended dosages were evaluated *in vitro* by poisoned food technique, against *Alternaria lini* of linseed which was detected in seed health testing methods and the results obtained on their colony diameter (mm) and per cent inhibition of mycelial growth are presented in (Table 1).

The result revealed that, all the tested fungicides significantly inhibited mycelial growth of the *Alternaria lini*, over untreated control. However, the fungicides *viz*., Carboxin 37.5% + Thiram 37.5% 75WP (92.04%), followed by Tebuconazole 25% WG (89.93%), Captan 75% WP (72.37%), Carbendazim 12% + Mancozeb 63% 75WP (60.11%), Mancozeb 75% WP (28.82%), Carbendazim 50% WP (22.15%) and Thiophanate methyl 70% WP (12.26%) were found effective against *Alternaria lini*. Except Mancozeb, Carbendazim and Thiophanate methyl rest of the fungicides caused significant mycelial growth inhibition of *Alternaria lini*. Similar results were earlier reported by several workers (Singh *et al*. 2001; Zorato and Henningh, 2001; Sharma *et al*. 2002; Kumar *et al*. 2003; Meena, 2005; Afzal *et al*. 2010; Singh *et al*. 2017 and Khade and Kamble, 2018) [9, 13, 8, 5, 6, 1, 10, 3].

Table 1: *In vitro* efficacy of several fungicides against *Alternaria lini* of linseed seeds

Sr. No	Treatments	*Alternaria lini*	
		Colony diameter (mm)	Mycelial growth Inhibition (%)
T_1	Carbendazim 50% WP	70.06	22.15 (28.07)
T_2	Thiophanate methyl 70% WP	78.96	12.26 (20.49)
T_3	Tebuconazole 25% WG	9.06	89.93 (71.49)
T_4	Captan 75% WP	24.86	72.37 (58.28)
T_5	Mancozeb 75% WP	64.06	28.82 (32.46)
T_6	Carboxin 37.5% + Thiram 37.5% 75WP	7.16	92.04 (73.61)
T_7	Carbendazim 12% + Mancozeb 63% WP	35.90	60.11 (50.83)
T_8	Control (Untreated)	90.00	0.00 (00.00)
SE±		0.63	0.70
CD (P=s0.01%)		1.84	2.05

Figures in parentheses are arcsine transformed values

Plate I: *In vitro* efficacy of several fungicides against *Alternaria lini* of linseed seeds

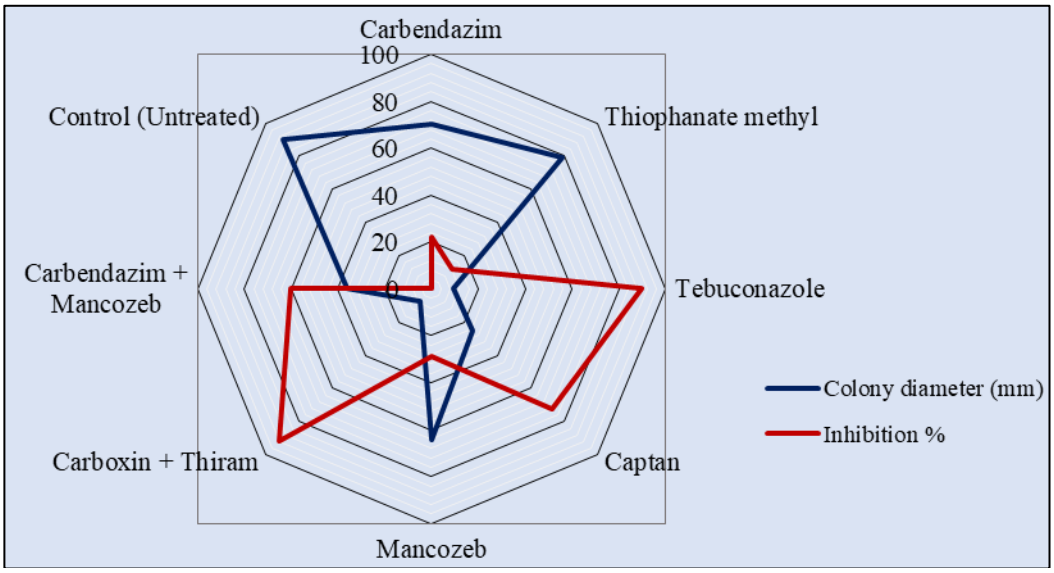

Fig 1: *In vitro* efficacy of several fungicides against *Alternaria lini* of linseed seeds

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