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Management of *Alternaria alternata* of blond Psyllium (*Plantago ovata* L.) through fungicides *in vitro* and natural condition

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Abstract
The experiments were conducted at Department of Plant Pathology, S.K.N. College of Agriculture, Jobner (Rajasthan). *Alternaria alternata* was isolated from leaves of isabgol and observed to be pathogenic under artificial conditions. An attempt was more find out the efficacy of different fungicides were against in *Alternaria alternata in vitro* and *in vivo* condition. Among five fungicides mancozeb + carbendazim was found most effective against *Alternaria alternata in vitro* conditions followed by mancozeb and carbendazim. In potted plant minimum disease intensity were obtained in mancozeb + carbenxazim and mancozeb followed by carbendazim + difencozole. All treatments as foliar sprays were able to reduce disease severity over untreated control of 0.2% followed by 0.25% concentration. Carbendazim + mancozeb, and mancozeb were found effective in management of leaf blight of isabgol by *Alternaria alternata in vitro* and *in vivo* conditions.

Keywords: *Alternaria alternata*, fungicide, leaf blight and *plantago ovate*, isabgol

1. Introduction
Blond psyllium (*Plantago ovata* Forsk.) commonly known as *isabgol*, is an annual herb with narrow linear rosette like leaves belonging to the family Plantaginaceae. *Isabgol* is an important cash crop cultivated for its export and being of important medicinal value is reported to have larger demands and is traded in major medicinal markets of the world. *Isabgol* has pharmaceutical importance to treat dysentery, chronic constipation and chronic diarrhoea and as laxative demulcents, emollients and diuretics. India commands nearly monopoly in the production and export of the seed and husk to the world market. India is earning about Rs. 1600 million as foreign exchange from the export of blond psyllium products to countries like USA, Germany, France, England, Spain and Belgium [1].

In India, the *isabgol* crop is mainly grown as commercial crop in Gujarat, Rajasthan and Madhya Pradesh. However, the crop is spreading to other non-traditional parts of the country such as Haryana, Uttar Pradesh and Karnataka. In Rajasthan, it is being cultivated in 190081 hectares area with a total production of 99950 tonnes of seeds with an average productivity of 525 kg/ha [2]. In Rajasthan, lsabgol mainly cultivated in Barmer, Jalore, Nagaur, Jodhpur and Jaisalmer districts. Presently, Rajasthan is on the top in productivity in India.

[3] reported a number of pathogens viz., Fusarium wilt (*Fusarium oxysporum),* damping off (*Pythium ultimum* trow), leaf blight (*Alternaria alternata* (Fr.) Keissler), downy mildews (*Peronospora plantaginis*) and powdery mildew (*Erysiphe cichoracearum* D.C.) affecting this crop. Alternaria blight has become a serious problem in recent years. It has been found that downy mildew affected crop is more prone to be attacked by *A. alternata*. It causes considerable damage every year and sometimes become very severe which results in total loss of yield [4]. Hence, present investigations were carried out to test the efficacy of plant extracts and fungicides against leaf blight of isabgol incited by *A. alternata*.

2. Material and methods
Efficacy of different fungicides were evaluated against *Alternaria alternata*.

Efficacy of fungicides against *Alternaria alternata* (*in vitro* and *in vivo*)
The efficacy of five systemic and non-systemic fungicides against mycelial growth of *Alternaria alternata* was tested by Poisoned Food Technique (PFT) suggested by [5].

Four different concentrations *viz*., 100, 300, 500 and 700 ppm of each fungicide were tested *in vitro*. Required quantities of each fungicides were added separately in to molten and cooled PDA so as to get the desired concentration of the fungicides later on 20 ml of poisoned medium was poured sterilie petern plated mycelial rises of 5 mm size from gets very growing culture of the fungus were cut by a sterlle cork borer and one such rise was placed at the centre of each agar plate then such plates were incubated 25 ± 1 ^{0}C for 7 days and radial growth was measured. The mycelial growth of the test fungus was recorded and per cent growth inhibition was calculated by [6] formula given below. The experiment was conducted in completely randomized design with three replications.

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

Where,
C=Diameter of colony in check (Average of both diagonals)
T=Diameter of colony in treatment (Average of both diagonals)

Efficacy of fungicides (*in vivo*):
The field experiments of the fungicides was conducted during 2013-14 in mini plots (1x1 m) of Department of Plant Pathology, SKN COA, Jobner, Jaipur in RBD manner with four replication plots during rabi season to know the efficacy of fungicide against leaf blight of isabgol under natural condition. All the recommended agronomic practices were followed to raise the crop. The fungicides viz., thiophanate methyl (0.2%), carbendazim *0.1%), mancozeb (0.25%), carbendazim + mancozeb (0.2%) and difenoconazole (0.2%) were tested by applying as foliar spray (40 DAS). The middle two rows of each plot were rated for disease incidence (the presence or absence of one or more lesions) at 60 DAS by examining five leaves from five adjacent plants at 5 random sites within each plot for a total of 25 leaves per plot. The per cent disease intensity (PDI) was assessed for each plot on a disease rating scale of 1-9 [7] based on the percentage of leaf area symptomatic (1= 0% tissue symptomatic, 2= up to 1%, 3= 2-5%, 4= 6-10%, 5= 11-20%, 6= 21-30%, 7= 31-40%, 8= 41-50%, and 9= over 50%). The intensity was calculated by using the formula of [8].

$$\text{PDI} = \frac{\text{Sum of individual ratings}}{\text{Number of leaves observed x Maximum disease rating}} \times 100$$

The per cent disease control was calculated by using the following formula:

$$\text{PDC} = \frac{\text{Disease in control} - \text{Disease in treatment}}{\text{Disease in control}} \times 100$$

3. Result and discussion

Efficacy of fungicides *in vitro*
The data (table 1) suggested that increase in concentrations of the fungicides caused increased inhibition of mycelial growth of the fungus. Among five fungicides tested, carbendazim+mancozeb (Companion) was found most effective which was showing 66.66, 79.99, 87.77 and 94.44 per cent inhibition of mycelial growth of *Alternaria alternata* at 100, 300, 500 and 700 ppm concentrations, respectively followed by mancozeb (48.88, 71.11, 83.33 and 87.77, respectively). Thiophanate methyl was found to be least effective in inhibiting mycelial growth. This experiment shows that carbendazim+mancozeb is highly effective in inhibiting the mycelial growth of *Alternaria alternata in vitro*. Similar observations were observed by earlier worker [9].

Efficacy of fungicides in reducing disease intensity (*in vivo*)
On the basis of performance of fungicide *in vitro* all five fungicdies viz. mancozeb, carbendizim+mancazeb, thiophanate methyl and difenoconazole each of 0.25, 0.2 and 0.2 per cent were evaluated in field conditions through foliar sprays against blight disease of isabgol. The results (Table 2) revealed that there was clear reduction disease in intensity when fungicides were applied as foliar spray maximum per cent efficacy of disease control was observed at 0.2 % (31.07 per cent) foliar spray of carbenxazim + mancozeb) which was followed by foliar spray of mancozeb 0.25% (20.71 per cent) carbenxazim 0.1% (19.93 per cent) difenconazole 0.25% (13.94 per cent) and thiophonate 0.1% (11.95 per cent) efficacy of disease control respectively.
These studied will be helpful in controlling the blight incidence in the field effectively. Present results are in accordance with [10, 11, 9, 12].
Similar results were obtained by [12, 9, 13].

Table 1: Comparative efficiacy of different fungicides on mycelial growth of *Alternaria alternata in vitro* after 7 days of incubation at 25 ± 1 ^{0}C

Fungicides	Per cent growth inhibition at various concentration (ppm)*				Mean
	100	300	500	700	
Mancozeb	48.88 (44.36)	71.11 (57.49)	83.33 (65.90)	87.77 (69.53)	73.33 (59.32)
Carbendazim	42.22 (40.52)	48.88 (44.36)	54.44 (47.55)	60.00 (50.77)	51.39 (45.80)
Thiophanate methyl	19.00 (25.84)	42.22 (40.52)	51.11 (45.64)	65.00 (53.73)	44.71 (41.43)
Carbendazim+mancozeb	66.66 (54.73)	79.99 (63.43)	87.77 (69.53)	94.44 (76.36)	82.21 (66.01)
Difenoconazole	40.00 (39.23)	44.44 (41.81)	51.11 (45.64)	70.00 (56.79)	49.72 (45.86)
Check	0.00	0.00	0.00	0.00	0.00
			SEm±	CD (p=0.05)	
		F	0.60	1.72	
		C	0.49	1.40	
		FxC	1.21	3.44	

* Average of 4 replications
Figures given in parentheses are angular transformed values

Table 2: Effect of fungicidal foliar spray on disease intensity (*in vivo*)

S. No.	Fungicides	Dose (%)	Per cent disease intensity*	Per cent disease intensity reduction over control
1	Carbendazim+ mancozeb	0.2	43.25 (41.12)	31.07
2	Mancozeb	0.25	49.75 (44.86)	20.71
3	Carbendazim	0.1	52.75 (46.58)	19.93
4	Thiophanate methyl	0.2	55.25 (47.29)	11.95
5	Difenoconazole	0.2	54.25 (47.44)	13.94
6	Control	-	62.75 (52.39)	-
SEm±			1.44	
CD (p=0.05)			4.21	

Figures given in parentheses are angular transformed values
* Average of four replications

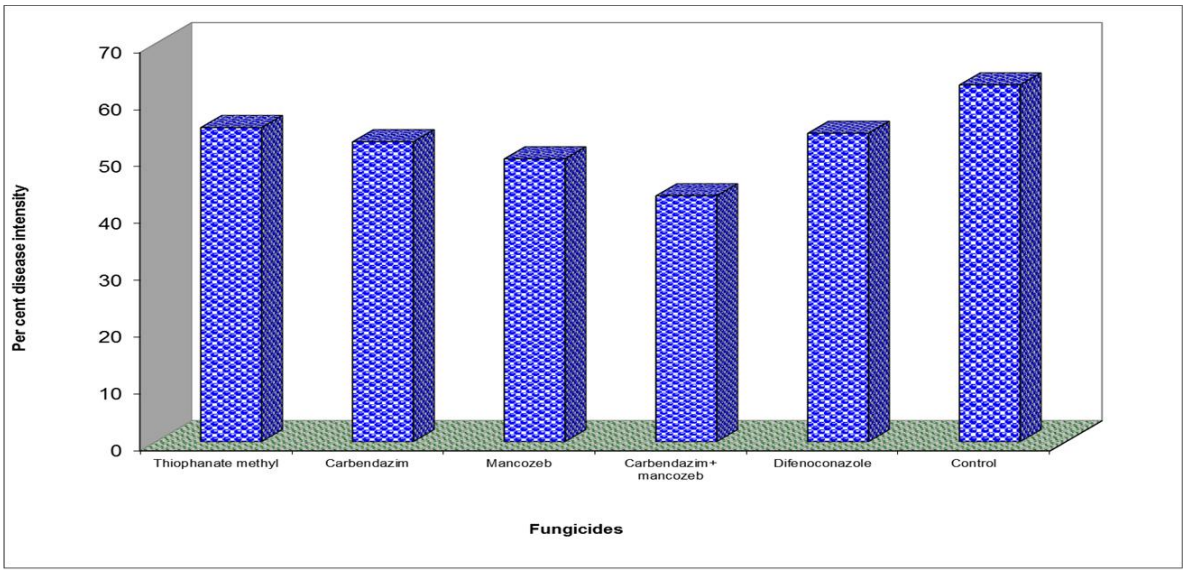

Fig. 6 Effect of fungicidal foliar spray of disease intensity (*in vivo*)

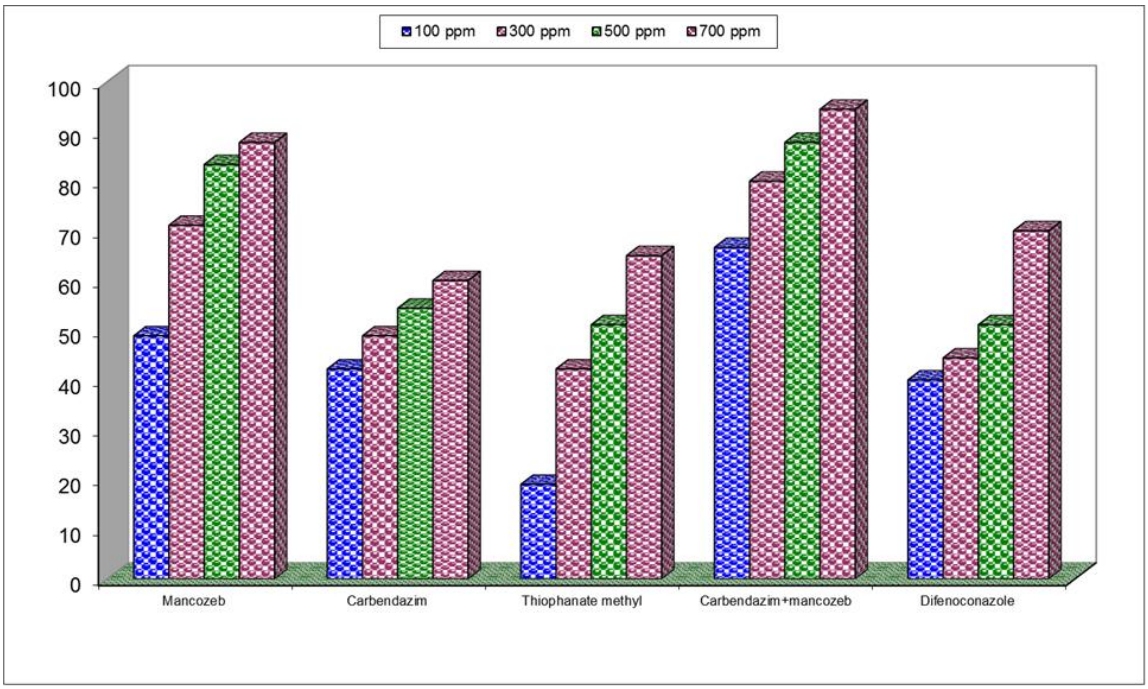

Fig. 7 Comparative efficiacy of different fungicides on mycelial growth of *Alternaria alternata in vitro* after 7 days of incubation at 25 ± 1 °C

Plate 4. Efficacy of different fungicides against *A. alternata* (*in vitro*)

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