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Evaluation of different fungicides and plant extracts against Alternaria blight of Indian mustard (*Brassica juncea* (L.) Czern & Coss.)

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Abstract
Rapeseed-mustard belongs to family Brassicaceae. It is the most important group of *Rabi* oilseed crops and contribute a major share to the vegetable fat of the country. Experiments were conducted during 2018-19 to 2019-20 crop seasons to effective and economic fungicides and plant extracts for the management of Alternaria blight caused by *Alternaria brassicae* (Berk.) Sacc and *Alternaria brassicicola* (Schw.) Wiltshire. The minimum average diameter of fungal growth (mm) Mancozeb (0.00) @0.20% concentration and maximum percent inhibition over control (100.00%) followed by next best effective fungicides Iprodione, Topsin-M, Achook, Ridomil-MZ, Ziram, Captan and Blitox-50 each recorded (0.00 mm) growth of fungus and these were proved to be the most effective as they inhibited the growth of fungus completely. Among the tested fungicides Karathane was least effective which showed (14.7) mm radial growth and (81.62%) inhibition over control. The minimum lowest effective plant extracts Sadabahar was found maximum radial growth of fungus (22.65 mm) and minimum inhitited (71.68%). In the field spraying of Mancozeb @(0.2%) concentration and Iprodione @(0.2%) concentration at the interval of 15 days was found most effective in minimizing the disease intensity. However, the minimum disease intensity Mancozeb (15.07%) was recorded in highest mean yield (20.16) Q/ha @0.20% concentration followed by Iprodione (21.30%) with corresponding yield 19.34Q/ha. followed by next best effective fungicides Topsin-M (30.52%) with corresponding yield (18.39 Q/ha). Achook (31.66) with yield (18.01 Q/ha) respectively. However, they were statistically at par with each other. The next effective fungicides Ridomil-MZ (34.50%) with corresponding yield 16.65 Q/ha, Ziram (37.08%) with corresponding yield 16.32 Q/ha, Captan (35.68%) with corresponding yield 14.38 Q/ha, Blitox-50 (40.58%) with corresponding yield (13.55) Q/ha, Madar (42.27%) with corresponding yield (12.77) Q/ha. Datura proved to be lowest effective plant extracts and showed the (45.47) per cent disease intensity and its corresponding yield (11.38) Q/ha.

Keywords: Indian-mustard, fungicides, plant extracts, disease intensity and *Alternaria brassicae*

Introduction
Rapeseed-mustard is one of the major oilseed crops cultivated in India and around the world. It is extensively grown traditionally as a pure crop as well as intercrop (mixed crop) in marginal and sub-marginal soils in the Eastern, Northern and North Western States of India. Rapeseed and mustard belong to family Brassicaceae, Indian mustard commonly known as *Rabi* is the most important member of Cruciferous oil seeds occupying nearly 70 per cent of the total area under rapeseed-mustard. The leaves of young plants are used as green vegetable and whole plants as green fodder. The seeds are highly nutritive containing 38 to 57 per cent erucic acid, 4.7 to 13 per cent linoleic acid and 27 per cent oleic acid (Singh *et al.*, 2011) [15]. The rapeseed and mustard group dominates among oilseed crops in area and production on global level. India is one of the largest rapeseed-mustard growing countries in the world, occupying the third position in area and production after China and Canada sharing 12 per cent of world's total production. At global level, rapeseed-mustard is cultivated on 5.96 million hectares with production of 8.32 million tones and productivity of 1397 kg/ha (Anonymous, 2018) [1]. Rapeseed-mustard is the second most important oilseed crop after groundnut and accounts for nearly 30.7 per cent of the total oilseed production in the country. There are several diseases known to affect the mustard crop but foliar diseases like Alternaria leaf spot, white rust (blister), downy mildew and powdery mildews are cause heavy yield losses to the crop. The symptoms are dark brown or black spots on lower leaves of young plants. At older age of leaves, the spots turn into circular, dark brown, sunken necrotic lesions surrounded by light yellow halo and bear conidiophores and conidia in concentric rings at the grayish- white center giving them a target board appearance.

The spots on young stems and green pods appear as black specks. (Fig. 1 and 2). Alternaria blight caused by *Alternaria brassicae* (Berk.) Sacc and *Alternaria brassicicola* (Schw) Wiltshere is a world-widely distributed and economically important disease on rapeseed (*Brassica napus*), mustard (*Brassica campestris*) and other brassicas (Tewari and Conn, 1993, Kumar, 1997, Meah *et al.*, 2002, Meena *et al.*, 2010) [20, 8, 9, 10]. The characteristic symptom is the development of circular spots on leaves and pods with concentric ring. Later on spots coalesce and ultimately the leaves become blighted. This disease is severe yield destabilizing factor causing reduction from 35 to 45 per cent and inflicts very severe losses upto 70 per cent in Indian mustard (Kolte *et al.*, 1987, Saharan, 1992, Kolte, 2002 and Chattopadhyay, 2008) [5, 13, 6, 2]. The disease also adversely affects quality by reducing seed size, impairing seed colour and oil content (Kaushik *et al.*, 1984) [4]. There is no information available on the resistance sources. Chemicals are being successfully used in controlling the disease. However, chemicals pollute our environment so much which is not desirable, so the present study was conducted to assess the yield losses due `to Alternaria blight in different cultivars.

Materials and Methods

The laboratory work was conducted in Department of Plant Pathology of T.D.P.G. College of Jaunpur and the field experiment was conducted at Student Research Farm Pili Kothi of T.D.P.G. College, Jaunpur (U.P.) during 2018-19 and 2019-20 *Rabi* season to test of effectiveness of Plant extracts and fungicides against Alternaria blight in Indian-mustard under natural condition.

Experiment was laid out in plot size of 5x3m and spacing 30x10cm in Randomized Block Design with three replications using highly susceptible Indian-mustard variety 'Varuna'. Fertilizers NPK were applied at the rate of 120 N, 60 P, 60 k, Kg/ha, respectively. Half dose of nitrogen, full dose of phosphorus and potash were applied as basal and remaining half dose of nitrogen was top dressed at first irrigation.

Effect of fungicides and plant extracts against *Altrnaria brassicae In-Vitro*: Fifteenth fungicides were purchases from market and four plant extracts (Table-1) were collected from the Student Research Farm Pili Kothi of T.D.P.G. College, Jaunpur (U.P.) campus and neighboring areas. Leaves parts were serially washed thoroughly with fresh water, sterilized water and then 70% ethanol, chopped and extracted with sterilized distilled water (1:1 w/v) to obtain a stock solution. Mycotoxicity of the extracts against *Alternaria brassicae* for the inhibition was determined by "Poisoned food technique" (Grover and More, 1962) [3]. Requisite amount of fungicides 0.1% to 0.25% and plant extract were added in the medium using sterile pipette to get 10 to 20% concentration (table-1) in medium prior to pouring in Petri dishes. Circular disc of 5 mm circles were cut from 7 days old culture by corn borer. Such disc carrying fungus was placed at centre of each Petri-dishes containing solidified medium with plant extract. The disc was placed reversed and one set of such inoculated Petri-plate without plant extract serve as control. All the treatments were used at three replication with the C.R.D. design. All the treated and control Petri-dishes were incubated for 10 days at 28 ± 2^0C in BOD incubator. After incubation for 10 days the diameter of fungal colony was measured in mm in each treatment. The efficacy of the plant extract was determined against the growth of the pathogen in control plates. Mycotoxicity of the plant extracts and fungicides was recorded in terms of per cent inhibition of mycelia growth, calculated by using following formula given as under

$$\text{Percent mycelial inhibition} = \frac{dc-dt}{dc} \text{ X100}$$

dc= average colony diameter in control
dt= average colony diameter in treatment
The data were recorded on the basis of each replication and these after its mean was were taken to finalized data.

Evaluation of fungicides and plant extracts against Alternaria blight *In-Vivo*: Experiment was laid out in plot size of 5x3m and spacing 30x10cm in Randomized block design with three replications using highly susceptible Indian mustard variety 'Varuna' was sown in the first week of November, during *Rabi* season. Fertilizers NPK were applied at the rate of 120 N, 60 P, 60 K, kg/ha, respectively. Half dose of nitrogen was top dressed at first irrigation.

The required amount of each fungicide was calculated and the spray solution was prepared with water. Each fungicide was dissolved in small amount of water and then volume was made up to desired level and was sprayed by using high volume Knapsak sprayer of 10 litre capacity. Three sprays of each fungicide, first at appearance of the disease and remaining two after 15 days intervals were given. The severity of the disease was assessed one week after last spray using 0-6 point scale (0 = No disease; 1 = Up to 5% leaf area infected; 2 = > 5% to 10% leaf area infected; 3 = > 10% to 20% leaf area infected; 4 = >20% to 30% leaf area infected; 5 = >30% to 50% leaf area infected and 6 = >50% leaf area infected) and the per cent disease intensity (PDI) was calculated. The yield of each plots were recorded in each treatment separately to see the differences in yield ha^{-1} was calculated.

$$\text{Percent disease control} = \frac{\text{Disease intensity in control} - \text{Disease intensity in treatments}}{\text{Disease intensity in control}} \text{x100}$$

Results and Discussion

Evaluation of fungicides and plant extracts against *Alternaria brassicae In-Vitro*:

All the tested fungicides and plant extracts were most effective in inhibiting the growth of pathogen. The present finding *In-Vitro* condition data are also found presented in Table-1 and corresponding histogram Fig.3. The results revealed that all the fungicides and plant extracts inhibited the per cent growth inhibition against test fungus as compared to control. Out of fifteenth fungicides and four plant extracts tested in laboratory, eight fungicides; Mancozeb, Iprodione, Topsin-M, Achook, Ridomil-MZ, Ziram, Captan and Blitox-50 proved to be the most effective as they inhibited the growth of fungus completely. These were showed the 100% inhibition over control the growth of the pathogen. The remaining seven fungicides and four plant extracts inhibited

the growth of fungus to varying degree, but failed to exhibit complete inhibition and therefore, these were considered to be partially effective. Among the partially effective fungicides and plant extracts and minimum per cent inhibition over is Sadabahar (71.68%) were statistically at par with each other in respect to average diameter of fungal growth. Among the tested fungicides and plant extracts. Zineb (93.00%) gave the highest inhibition of fungal growth and was significantly superior on the rest fungicides. Thiram (91.40%) observed to be the next best followed by Duter (89.58%), Calixin (88.22%), Bavistin (86.66%) and Kavach (84.37%) which were different significantly to each other in inhibiting the growth of fungus. Among the tested fungicide Karathane was least effective fungicides which showed (14.70mm) radial growth and 81.62% inhibition over control. The tested plant extracts Madar (79.37%), Datura (77.78%) and Neem (74.86) were the next in order of superiority. Sadabahar (71.68%) was to be last effective as compared fungicides tested but superior to control.

All the fungicides and botanicals tested were significantly effective in inhibiting the growth of pathogen over control and degree of inhibition varied from 33.20% to 67.60% at 5% and 48.90% to 77.80% at 10% concentration. Maximum inhibition was recorded with the leaf extract of Eucalyptus followed by *Dhatura* and bulb extract of Garlic. Congress grass was less effective at both the concentration. Concurrent with present findings Patni and Kolte, (2006) [12] also reported maximum inhibition (92.5%) with Eucalyptus leaf extract in mycelial growth of *Alternaria brassicae* while, Singh and Tiwari (2007) [14] have reported maximum inhibition of mycelial growth with different concentration of garlic bulb extract. The present results are in agreement with the findings of above scientists. The effectiveness of six fungicides were also evaluated by Rajvanshi *et al*., (2020) [11] states and that the evaluated fungicides check the growth of pathogen at a good extent at different concentration of Carbendazim, Iprodione, Nativo (Tebuconazole), Tilt (Propiconazole) Score (Difenoconazole) and Propineb (Antracol).

Evaluation of fungicides and different plant extracts against *Alternaria brassicae In-Vivo*:

The results obtained from the Table-2 and its corresponding histogram (Fig.4 and 5) that all the fungicides and plant extracts proved significantly effective in controlling the disease over control. On pool basis of two years data, all the fungicidal treatment and plant extracts significantly reduced the disease intensity and increases the yield in comparison to untreated (control) plots. Spraying of Mancozeb @ (0.2%) concentration and Iprodione @ (0.2%) concentration at the interval of 15 days was found most effective in minimizing the disease intensity. However, the minimum disease intensity Mancozeb (15.07%) was recorded in highest yield (20.16) Q/ha @0.20% concentration followed by Iprodione (21.30%) with corresponding yield 19.34Q/ha. The next best fungicides Topsin-M, Achook, which showed 30.52 and 31.66 per cent disease intensity and its corresponding yield 18.39 and 18.01 Q/ha, respectively. However, they were statistically at par with each other. The next effective fungicides and plant extracts Ridomil-MZ (34.50%) with corresponding yield 16.65 Q/ha, Ziram (37.08%) with corresponding yield 16.32 Q/ha, Captan (35.68%) with corresponding yield 14.38 Q/ha. Among the spraying of fungicides the Blitox-50 was showed 40.58 per cent maximum average disease intensity and (13.55Q/ha.) mean yield was recorded. Among the plant extracts Madar (42.27%) with corresponding yield 12.77 Q/ha. Datura proved to be least effective plant extracts and showed the 45.47 per cent disease intensity and its corresponding yield 11.38 Q/ha.

Our findings are close agreement with findings of following workers. The spraying of Captafol, Indofil M-45, Indofil Z-78, Cuman L, Daconil, Topsin-M Duter provide effective control of the disease and result should significant increase crop yield (Singh and Singh 2005), [16] Singh *et. al.*, 2017 [17] and Singh *et al.*, 2018 [18]. Iprodione is also highly effective and caused minimum defoliation (Kumar, 1996) [7] and increased the crop yield and oil content as compared to untreated crop (Singh and Bhajan, 2004) [19].

(A) **(B)**

Fig 1: Symptoms on stems and pods (A and B)

Fig 2: Symptoms on leaf (C)

Table 1: Effect of fungicides and plant extracts on the mycelial colony growth (mm) of *Alternaria brassicae In-Vitro* 2018-19 & 2019-20.

S.N.	Treatments	Doses %	Average diameter of fungal colony (mm)	Per cent inhibition over control
1.	Mancozeb	0.20%	0.00	100.00
2.	Iprodione	0.20%	0.00	100.00
3.	Topsin-M	0.20%	0.00	100.00
4.	Achook	0.15%	0.00	100.00
5.	Ridomil-MZ	0.20%	0.00	100.00
6.	Ziram	0.20%	0.00	100.00
7.	Captan	0.10%	0.00	100.00
8.	Blitox-50	0.20%	0.00	100.00
8.	Zineb	0.10%	5.60	93.00
9.	Thiram	0.10%	6.88	91.40
10.	Duter	0.20%	8.33	89.58
11.	Calixin	0.20%	9.42	88.22
12.	Bavistin	0.10%	10.67	86.66
13.	Kavach	0.20%	12.50	84.37
14.	Karathane	0.10%	14.7	81.62
15.	Madar	20.0%	16.50	79.37
16.	Datura	15.0%	17.77	77.78
17.	Neem	10.0%	20.11	74.86
18.	Sadabahar	10.0%	22.65	71.68
19.	Control	-	80.00	-
	CD at 5%		(1.45)	

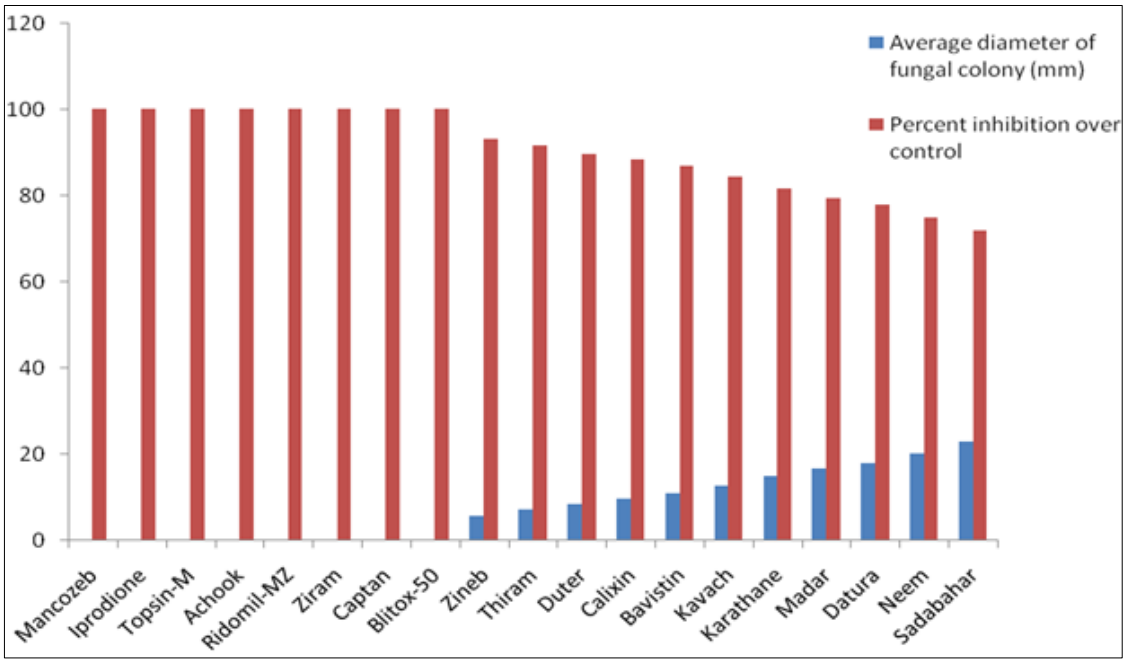

Fig 3: Effect of fungicides and plant extracts against fungal colony growth (mm) of Alternaria brassicae under *In-Vivo*

Table 2: Efficacy of fungicides and plant extracts against Alternaria blight of Indian- mustard *In-Vivo* 2018-19 & 2019-20.

S.N.	Treatments	Doses %	Average disease intensity			Yield (q/ha)		
			2018-19	2019-20	Mean	2018-19	2019-20	Mean
1.	Mancozeb	0.20%	14.80	15.35	15.07	20.76	19.56	20.16
2.	Iprodione	0.20%	22.16	20.45	21.30	20.45	18.23	19.34
3.	Topsin-M	0.20%	24.37	36.67	30.52	18.68	18.10	18.39
4.	Achook	0.15%	30.49	32.83	31.66	17.47	18.56	18.01
4.	Ridomil-MZ	0.20%	33.45	35.56	34.50	16.55	16.76	16.65
5.	Ziram	0.20%	35.20	38.91	37.08	15.55	15.10	15.32
6.	Captan	0.10%	37.21	34.15	35.68	14.64	14.12	14.38
7.	Blitox-50	0.20%	38.38	42.78	40.58	13.78	13.32	13.55
8.	Madar	10%	39.97	44.57	42.27	13.44	12.10	12.77
9.	Datura	15%	41.08	49.78	45.47	12.54	10.22	11.38
10.	Control	-	45.25	50.24	47.76	13.30	10.12	13.22
11.	CD at 5%		(2.083)	(2.06)	(1.55)	(0.90)	(0.72)	(0.78)

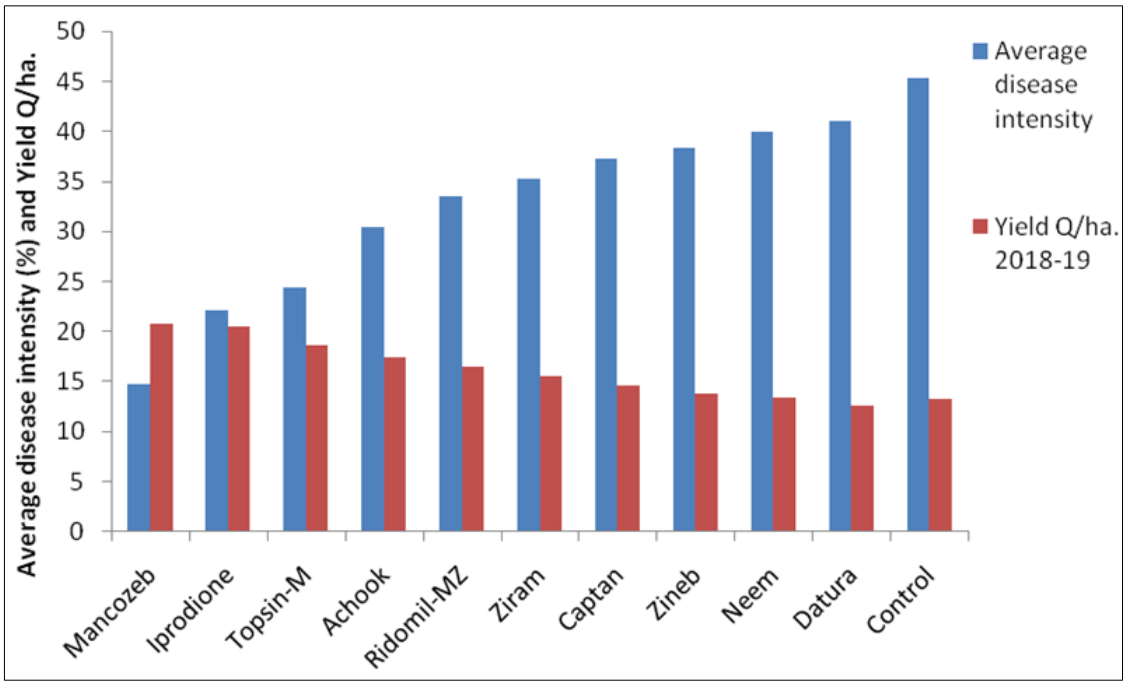

Fig 4: Effect of fungicides and plant extracts against Alternaria leaf spot of Indian- mustard *In-Vivo* and on yield during 2018-19

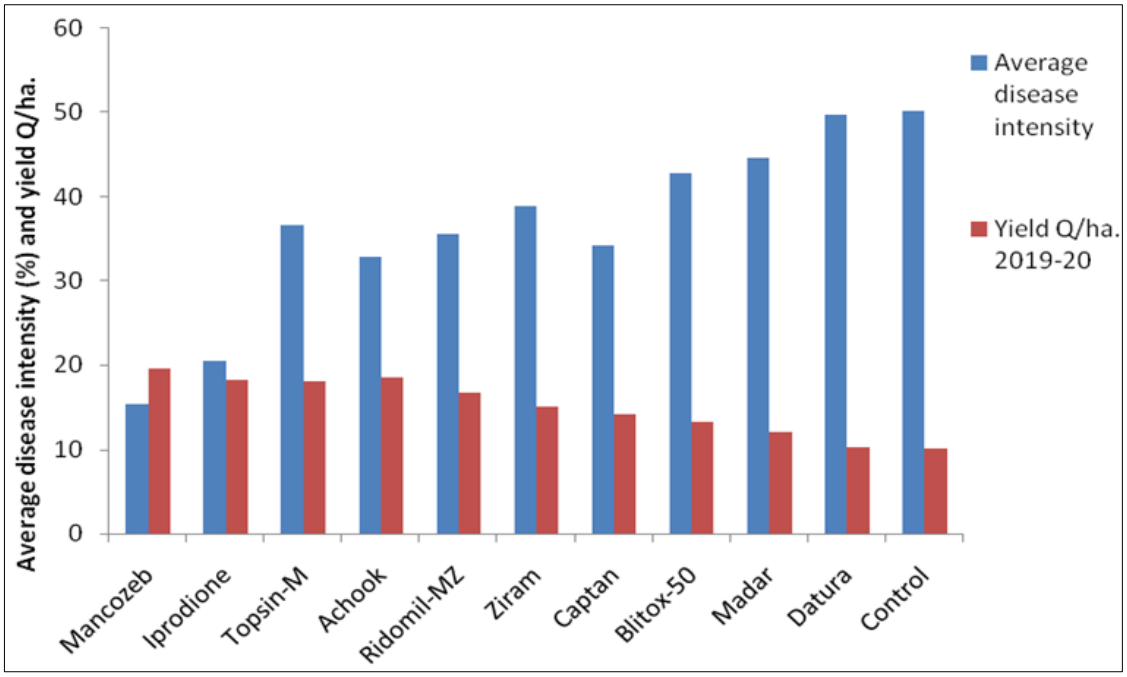

Fig 5: Effect of fungicides and plant extracts against Alternaria leaf spot of Indian- mustard *In-Vivo* and on yield during 2019-20

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