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In vitro evaluation of homeopathic drugs against *Alternaria brassicae* (Berk.) Sacc. of Indian mustard (*Brassica juncea* (L.) Czern & Coss.)

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Abstract
Indian mustard [*Brassica juncea* (L.) Czern & Coss] is an important edible oilseed crop in India. The production of oilseed brassicas, second largest oilseed crops grown in the world, is gravely hampered by the fungal diseases; Alternaria blight being one of the most ravaging fungal diseases. The pseudo-fungi, not only leads to yield reduction by causing foliar damage to the crop, but also severely deteriorates the oil quality. In this present investigation to evaluate nine homeopathic drugs *viz.*, Cina, Borex, Selenium, *Nux Vomica*, Siliciea, Sulphur, Phosphorus, *Arnica montana* and *Calcarea carbonicum* at two concentrations (500 and 1000 ppm) against *Alternaria brassicae* and mycelial growth was recorded at 7 days after inoculation. All the tested homeopathic drugs significantly inhibited the mycelial growth of *A. brassicae* at the concentration of 500 and 1000 ppm but none of these drugs could completely inhibited the growth even at 1000 ppm. At 500 ppm, the minimum mycelium growth was obtained in Sulphur (43.67 mm) followed by Siliciea (46.00 mm), Cina (51.00 mm), *Nux vomica* (54.67 mm), Selenium (57.67 mm), Phosphorous (59.33 mm), Borex (62.33 mm), *Arnica montana* (64.33 mm) and *Calcarea carbonicum* (67.00 mm), while maximum mycelial growth was recorded in control (89.00 mm). Sulphur was found most effective at 1000 ppm (13.33 mm) followed by Siliciea (15.00 mm), Cina (21.00 mm), *Nux vomica* (23.67 mm), Selenium (26.67 mm), phosphorous (28.00 mm), Borex (30.33 mm), *Arnica montana* (34.67 mm) and *Calcarea carbonicum* (36.67 mm), while maximum mycelial growth was recorded in control (90.00 mm).

Keywords: Homeopathic drugs, *in vitro*, *Alternaria brassicae*, mustard

Introduction
Rapeseed-mustard group of crops are the major rabi oilseed crops of India. The group is mainly constituted by *Brassica juncea*, *B. napus*, *B. rapa* and *B. carinata*. In India, rapeseed-mustard crops are cultivated on an area of 6.12 million ha with the production of 9.26 million tonnes (Anon 2020). Major mustard growing states of the country are Rajasthan, Haryana Gujarat, Maharashtra, Madhya Pradesh, Karnataka, Telangana and Andhra Pradesh. Among the Rapeseed-mustard group *B. juncea* (Indian mustard) is the major crops of the country, contributing more than 70% out of the total rapeseed-mustard area and production of the country. *B. juncea* is mainly cultivated in the Northern region of the state in Madhya Pradesh rapeseed-mustard crops are cultivated in an area about 0.78 million hectors with the production of 1.11 million tones and productivity 1422 kg/ha (Anon, 2020).

Oil and fats are an important part of the human diet because they provide energy and serve as carriers for fat-soluble vitamins. Oil cake or meal offers a significant nutritional value for animals. Young plant leaves are consumed as a green vegetable by humans. Brassica oilseeds typically include 38 to 57 percent erucic acid, 4.7 to 13% linolenic acid, and 27 percent oleic acid and linolenic acid, all of which are essential nutrients for human health. (Kumar *et al*., 2012) [4].

Mustard crop is affected by the several diseases caused by bacteria, fungi, virus and nematodes. Major fungal diseases of mustard are Alternaria blight/ black spot (*Alternaria brassicae*, *Alternaria brassicicola*, *Alternaria raphanin*), Anthracnose (*Colletotrichum gloeosporoides*), Black leg (*Leptosphaeria maculans*), Cercospora leaf spots (*Cercospora brassicicola*), etc.

Among these diseases, Alternaria blight incited by *Alternaria brassicae* (Berk) Sacc. is an economically important and it is a widely distributed disease throughout the world on mustards and other cruciferous crops.

The diseases appear as brown or greyish spots on the leaves, stem, and on siliquae during ripening stages. Alternaria blight causes substantial yield losses as a result of several factor including reduced photosynthesis potential, early defoliation, flower bud abortion, premature ripening of siliquae, dehiscence, seed shriveling, reduced seed sizes, and impairs seed colours and epidemiology, host pathogen interaction, and its management through various approaches. The yield losses in the range of 35-60 percent due to Alternaria blight in mustard leaves were reported from India.

Materials and Methods

Ten homeopathic drugs *viz.*, Cina, Borex, Selenium, *Nux vomica*, Siliciea, Sulphur, Phosphorus, *Arnica montana* and *Calcarea carbonicum* at two concentrations (500 and 1000 ppm) were tested against *Alternaria brassicae* and mycelial growth was recorded at 7 days after inoculation against *Alternaria brassicae in vitro.* The required quantity of homeopathic drugs was added to melted PDA medium, mixed thoroughly and poured into sterilized Petri plates and allowed to solidify. After solidification, each plate was inoculated with 5 mm disc obtained from seven days old actively growing culture of *Alternaria brassicae***.** These Petri dishes were incubated at 25 ± 1 °C. The observations were recorded after seven days, when the fungus in control plate was grown completely. The experiment was conducted in CRD with three replications. The efficacy of a homeopathic drug was expressed as percent inhibition of mycelial growth over control that was calculated by using the formula suggested by Vincent (1947):

$$PGI = \frac{C\text{-}T}{C} \times 100$$

Where
PGI = Percent growth inhibition
C = Growth in control
T = Growth in homeopathic drugs

Results and Discussion

The laboratory experiment was carried out in the Department of Plant Pathology, College of Agriculture, Gwalior (M.P.) during 2021 to evaluate the fungitoxicity of nine homeopathic drugs *viz.*, Cina, Borex, Selenium, *Nux Vomica*, Siliciea, Sulphur, Phosphorus, *Arnica montana* and *Calcarea carbonicum* at two concentration (500 and 1000 ppm) against *Alternaria brassicae* and data on mycelial growth was recorded at 7 days after inoculation.

In present study, all the tested homeopathic drugs significantly inhibited the mycelial growth of *A. brassicae* at the concentration of 500 and 1000 ppm but none of the drugs could absolutely inhibited the growth even at 1000 ppm.

At 500 ppm, the minimum mycelium growth was obtained in Sulphur (43.67 mm) followed by Siliciea (46.00 mm), Cina (51.00 mm), *Nux vomica* (54.67 mm), Selenium (57.67 mm), Phosphorous (59.33 mm), Borex (62.33 mm), *Arnica montana* (64.33 mm) and *Calcarea carbonicum* (67.00 mm), while maximum mycelial growth was recorded in control (89.00 mm).

Sulphur was also found most effective at 1000 ppm (13.33 mm) followed by Siliciea (15.00 mm), Cina (21.00 mm), *Nux vomica* (23.67 mm), Selenium (26.67 mm), Phosphorous (28.00 mm), Borex (30.33 mm), *Arnica montana* (34.67 mm) and *Calcarea carbonicum* (36.67 mm), while maximum mycelial growth was recorded in control (90.00 mm) (Table 1 and Plate 1).

Toledo *et al.* (2016) [3] conducted a similar experiment and found that mycelial growth in Sulphur and Staphysagria 100 CH was suppressed relative to both controls. Propolis 6, 30, and 60 CH, as well as *Ferrum sulphuricum* 6, 30, and 60 CH, inhibited sporulation, which was different from both controls. Hanif and Dawar (2016) [9] found that homoeopathic medications of *T. occidentalis* and *Arnica montana* in globules 30 CH have fungicidal activity against root rot disease in non-leguminous plants in both *in vitro* and *in vivo* experiments.

Table 1: Evaluation of fungitoxicity of homoeopathic drugs against Alternaria *brassicae* different concentrations *in-vitro* condition.

Homoeopathic Drugs	500ppm		1000ppm	
	Mycelial growth (mm)*	Percent inhibition	Mycelial growth (mm)*	Percent inhibition
Cina	51.00	42.70	21.00	76.67
Borex	62.33	29.96	30.33	66.30
Selenium	57.67	35.21	26.67	70.37
Nux vomica	54.67	38.58	23.67	73.70
Siliciea	46.00	48.31	15.00	83.33
Sulphur	43.67	50.94	13.33	85.19
Phosphorous	59.33	33.33	28.00	68.89
Arnica Montana	64.33	27.72	34.67	61.48
Calcarea carbonicum	67.00	24.72	36.67	59.26
Control	89.00	-	90.00	-
SE m±	1.30		1.35	
CD at 5%	3.87		4.02	

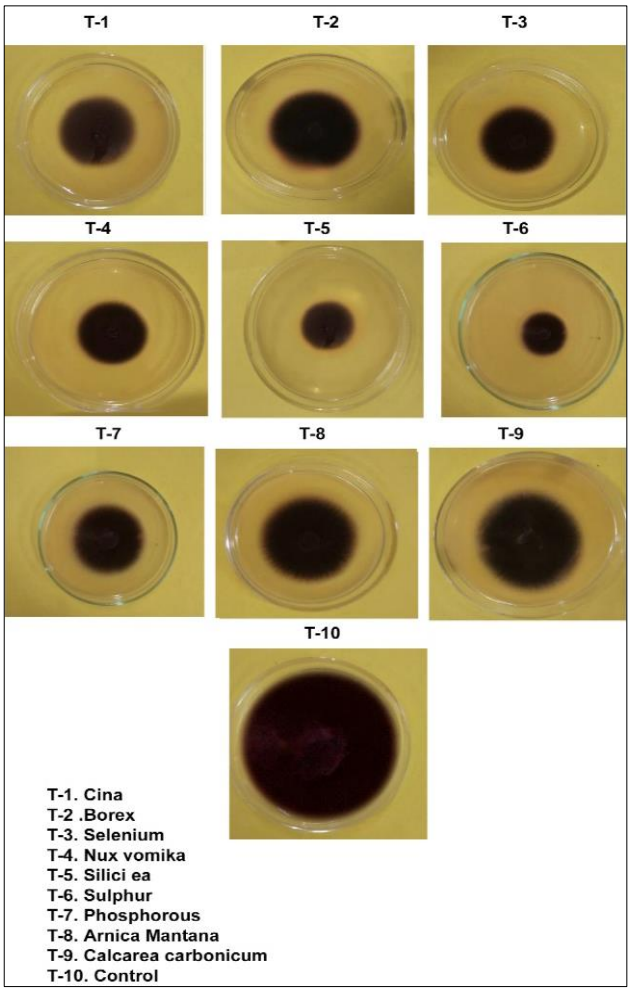

Plate 1: Effect of homeopathic drugs against *Alternaria brassicae* *In-vitro* condition.

Conclusion

Among the nine different homeopathic drugs *viz.*, Cina, Borex, Selenium, *Nux Vomica*, Siliciea, Sulphur, Phosphorus, *Arnica montana* and *Calcarea carbonicum* at two concentration (500 and 1000 ppm) against *Alternaria brassicae* At 500 ppm, the minimum mycelium growth was obtained in Sulphur (43.67mm) followed by Siliciea (46.00mm), Cina (51.00mm), *Nux vomica* (54.67mm), Selenium (57.67mm), Phosphorous (59.33mm), Borex (62.33mm), *Arnica montana* (64.33mm) and *Calcarea carbonicum* (67.00mm), while maximum mycelial growth was recorded in control (89.00mm). Sulphur was also found most effective at 1000 ppm (13.33mm) followed by Siliciea (15.00mm), Cina (21.00mm), *Nux vomica* (23.67mm), Selenium (26.67mm), phosphorous (28.00mm), Borex (30.33mm), *Arnica montana* (34.67mm) and *Calcarea carbonicum* (36.67mm), while maximum mycelial growth was recorded in control (90.00mm). From this study, it is concluded that instead of using hazardous chemicals and pesticides, we can use Homeopathic drugs for plant disease management.

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