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Management strategies against stem and root rot of sesame incited by *Macrophomina phaseolina*

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Abstract
The present investigation carried out against stem and root rot of sesame incited by *Macrophomina phaseolina***.** Eight Contact and translocate fungicides like carbendazim, carbxin + thiram, carbendazim + mancozeb, propiconazole, hexaconazole, thiophanate methyl, propineb and tebuconazole were tested in laboratory conditions and found that the carbendazim + mancozeb and carbendazim were inhibited mycelial growth completely (100, 100 and 100%) at all the concentration *i.e.* 100, 200 and 300 ppm concentration followed by carboxin + thiram 85.00, 95.17 and 100 per cent at 100, 200 and 300 ppm concentrations, respectively. However, thiophanate methyl and propineb were found less effective to inhibit mycelial growth over control. Eight botanical extracts tested against *M. phaseolina* under *in vitro* condition, all botanicals found superiorly significantly over control, in which Garlic clove extract found most superior to inhibit mycelial growth (76.67, 89.33 and 100%) at concentrations 5, 10 and 15% respectively on PDA followed by neem leaf extract (76.30, 81.25 and 85.06%). Mean mycelial growth inhibited (88.67%) with garlic extract followed by neem leaf extract (80.87%) was observed. Aak extract found least effective with minimum mean mycelial growth inhibition (17.85%).

Keywords: Carbendazim, fungicides, *Macrophomina Phaseolina*, mycelial

Introduction
Sesame (*Sesamum indicum* L.) is valuable and edible seed crop belongs to family *Padaliaceae*. In India, it is grown from ancient times (Weiss, 1971) [22]. It is generally called as "Til" and popularly known as "Queen of oilseeds". It has good quality parameters and resistance to oxidation (Bedigian and Harlen, 1986) [1]. Sesame seed enriched with 50 per cent edible oil, 20 per cent protein and contains about 39 per cent linolenic acid and 47 per cent oleic acid. (Shyu and Hwang, 2002) [15]. Sesame oil cake contains average 32 per cent crude. Seed is highly rich in quality proteins and essential amino acids, especially methionine which is considered as rejuvenative and anti-aging for human body. Sesame oil is useful for soap making, skin care industries, health food industries and cosmatic purpose. Sesame oil is cholestrol free and stable doesn't form rancid. Its seed used as sweets making and medicinal forms. Sesame varieties are both white and black seeded. White seeded varieties used for bakery products and black seeded varieties used for medicinal purpose. In South India sesame oil used for cooking. Sesame ranked first among oil seed crops in oil content (50-52%) with significant dietary energy (6335 kcal per kg) (Kumar and Goel, 1994) [8]. *Macrophomina phaseolina* is mainly a soil-borne pathogen with wide host range and can survive under soil as a saprophyte up to 15 year. It causes high yield losses in the oilseed, pulses and vegetable crops and producing the different symptoms like charcoal rot, stem and root rot, dry root rot, seedling blight and ashy stem blight (Kaur *et al.*, 2012 and Su *et al.*, 2001) [6]. The fungus can survive under dry conditions and reported to be soil, seed and stubble borne. The severity of the fungus depends on the population of sclerotia present in the soil. The pathogen is facultative soil borne in nature and affects the xylem vessels of the plants (Khan, 2007) [7].
Macrophomina phaseolina can infect the sesame plant at any stage of growth when temperature varies from 28 ^{0}C to 32 ^{0}C and germination of microsclerotia showed maximum growth at 30-33 ^{0}C (Viana and De Souza, 2002) [20]. The symptoms may appear on both arial and collar region. The stem ruptures upward and becomes blackish in colour. The roots become brittle and black colour dots appear on stem. In severe the diseased plants show blackening of capsules with immature and shriveled seeds. The assortment of host species and their wide availability have revealed that *M. phaseolina* is non-host specific and heterogeneous. (Kaur *et al.*, 2012) [6] The present investigations may carried out for safe use of fungicides for disease management without caused hazardous effect.

Now-a- days need to production of good quality and high quantity food grain to feed for world population. Therefore, effective management practices needs to protect from disease incidence. Application of fungicides is good option to manage diseases but also caused hazardous impact for human health and crop. Excessive used of fungicides caused soil pollution and environment deterioration. Multisite fungicides have broad spectrum and both contact and systemic in nature. In India fungicide used for disease management, however continuous and irrational application of fungicides may caused environmental pollution. Seed treatment and spray application of fungicides against seed and soil borne pathogen in combination with bio- agents minimize the disease incidence (Goswami *et al.*, 2018) [5].

Materials and Methods

Experimental site: The investigations were carried out in controlled conditions in Department of Plant Pathology, S.K.N. College of Agriculture, Sri Karan Narendra Agriculture University, Jobner, Jaipur Rajasthan. Jobner.

Management through fungicides

The activity of eight fungicides will be evaluated using poisoned food technique (*in vitro*) at different concentrations. The following fungicides will be evaluated.

Table 1: Show the common and trade and doses

S. No.	Common name	Trade name	Doses (ppm)
1.	Carbendazim	Bavistin	100, 200 & 300
2.	Thiophanate methyl	Topsin M	100, 200 & 300
3.	Hexaconazole	Sitara	100, 200 & 300
4..	Propiconazole	Tilt	100, 200 & 300
5.	Carboxin + Thiram	Vitavax power	100, 200 & 300
6.	Tebuconazole	Raxil	100, 200 & 300
7.	Propineb	Antracol	100, 200 & 300
8.	Carbendazim+Mancozeb	Saaf	100, 200 & 300
9.	Control		

Efficacy of above mentioned eight systemic and non-systemic fungicides was tested against mycelial growth of Macrophomina phaseolina by Poisoned Food Technique. Required quantity of each fungicide was added aseptically to 100 ml sterilized PDA medium in 150 ml flask so as to get concentration of 100, 200 and 300 ppm. Just before pouring in sterilized Petri plates, the flasks were shaken several times to ensure proper and uniform distribution of the fungicide. Poisoned medium was poured in sterilized Petri plates and allowed to solidify. Medium without fungicide served as control. Three replications were maintained for each treatment. Each plate was inoculated with 5 mm mycelium bit of the pathogen in the centre of plate. Inoculated plates were incubated at 25+1^{0}C for 7 days. The linear growth of test fungus was recorded and per cent growth inhibition was calculated by Vincent's (1947) formula:

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

Whereas,
C = Diameter of the colony in check (average of both diagonals),
T = Diameter of colony in treatment (average of both diagonals)

Management through plant extracts

Preparation of the plant extract

Plant materials such as fresh leaves/cloves of botanicals under test were harvested and thoroughly washed with tap water. Hundred grams from each plant was collected and washed 2-3 times with water and allowed to dry at room temperature (25±1 °C) for six hours. Before extraction, leaves of each plant (100g) were crushed separately with 100 ml sterilized distilled water. The extract was filtered through muslin cloth and centrifuged at 5000 rpm for 15 min. The extracts were then sterilized by passing them through a Millipore filter using a swimming filter adapter. The supernatant obtained was considered as 100 per cent and diluted accordingly and stored at 5 ^{0}C for further use.

In vitro efficacy of plant extracts on mycelial growth inhibition against Macrophomina phaseolina

In recent years, many phyto-extracts are being used as phytotoxicants for the management of various plant diseases. The present investigation was carried out using eight different natural phyto-extracts to see their antimycotic behaviour on the growth of *Macrophomina phaseolina in vitro*. The extract of each plant species was diluted in order to achieve three concentrations *viz.*, 5, 10 and 15 per cet. Petri plates containing PDA supplemented with different phyto-extracts, each with three concentrations and replicated three times. Plates were inoculated with 7 days old culture (5 mm diameter disc). A suitable check was also maintained. Fungal colony was measured after 7 days of incubation at 25±1 °C.

The linear growth of test fungus was recorded and per cent growth inhibition was calculated

Table 2: List of the plant extracts used for evalution against *M. phaseolina* (*In vitro*)

S. No.	Name of Plant	Botanical Name	Plant part use	Concentration (%)
1.	Aak	*Calotropis gigantea*	Leaves	5, 10, 15
2.	Turmeric	*Curcuma longa*	Rhizomes	5, 10, 15
3.	Ginger	*Zingiber officinale*	Rhizomes	5, 10, 15
4.	Datura	*Datura stramonium*	Leaves	5, 10, 15
5.	Garlic	*Allium sativum*	Clove	5, 10, 15
6.	Neem	*Azadirachta indica*	Leaves	5, 10, 15
7.	Tulsi	*Ocimum tenuiflorum*	Leaves	5, 10, 15
8.	Giloy	*Tinospora cordifolia*	Leaves	5, 10, 15
9.	Control	-	-	

In vitro efficacy of fungicides on mycelial growth inhibition against *Macrophomina phaseolina*

Eight fungicides were evaluated into the controlled condition by poisoned food techniques against stem and root rot of sesame pathogen. All the tested fungicides showed significantly higher mycelial growth inhibition over control (Table: 2). Among these fungicides, carbendazim + mancozeb and carbendazim gave complete mycelial growth inhibition (100%) at 100, 200 and 300 ppm concentrations, respectively. Carboxin + thiram also gave 85.00, 95.17 and 100.00 per cent inhibition of growth at 100, 200 and 300 ppm respectively. Hexaconazole inhibited mycelial growth by 84.44, 89.50 and 100.00 per cent at 100, 200 and 300 ppm, respectively and was found at par with carboxin + thiram. Propiconazole and Tebuconazole were found moderately effective mycelial growth by 80.50, 86.50 and 90.67 per cent and 75.00, 83.95

and 94.50 per cent at 100, 200 and 300 ppm concentration, respectively. Propineb and Thiophanate methyl were found least effective with inhibition of mycelial growth by 71.25, 79.75 and 84.00 per cent and 60.50, 68.34 and 75.25 per cent at 100, 200 and 300 ppm concentration, respectively. The data presented in Table 2 reflected that for mean mycelial growth inhibition the fungicides was maximum in case of carbendazim + mancozeb (100%) and carbendazim (100%) followed by carboxin + thiram (93.39%), hexaconazole (91.31%), propiconazole (85.89%), tebuconazole (84.48%), propineb (78.33%), thiophanate methyl (68.03%). Similar results were also observed by Singh *et al.* (2003) [16], Choudhary *et al.* (2004) [2] and Kumar and Jain (2004) they studied the efficacy of different fungicides and found that the carbenzadim inhibited maximum mycelium growth at *in vitro* condition. According to Rajpurohit and Bishnoi (2004) [12] application of thiram + carbendazim as seed treatment and mancozeb as spray application was found most superior and significantly decreased the disease incidence of *Macrophomina phaseolina* in sesame and increased seed yield of sesame. Tandel *et al.* (2010) [18] studied seven fungicides and found that carbendazim + mancozeb was significantly superior with minimum disease incidence (8.13%) for management of leaf spot of mungbean. Deepthi *et al.* (2014) [3] evaluated some fungicides at field condition and found that the carboxin + thiram gave highest seed germination and less mortality in sesame.

In vitro efficacy of plant extracts against mycelial growth inhibition of _Macrophomina phaseolina_

Efficacy of eight plant extracts tested under laboratory conditions through poisoned food techniques against stem and root rot of sesame at three concentration *viz*., 5, 10 and 15%. All the tested plant extracts showed significantly higher mycelial growth inhibition over control. Among these, garlic plant extracts extract found superior. Garlic extract was recorded mycelial growth inhibition of 76.67, 89.33 and 100% at 5, 10 and 15% concentrations, respectively. Neem leaf and ginger extracts inhibited mycelial growth 76.30, 81.12 and 85.06 per cent and 68.11, 82.12 and 89.33 per cent at 5, 10, and 15% concentrations, respectively. Turmeric and tulsi extracts were found moderately effective against *M. phaseolina* 66.50, 73.50 and 81.00% and 41.50, 48.16 and 53.60% inhibition of growth at 5, 10 and 15% concentrations, respectively. Giloy, datura and aak extracts were observed least effective to control the mycelial growth *of M. phaseolina* (25.00, 31.66 and 49.00%), (30.46, 36.75 and 45.50%) and (10.00, 18.55 and 25.00%) 5, 10 and 15% concentration, respectively. The data presented in table 2 reflected that for mean mycelial growth inhibition in case of the plant extracts was maximum in garlic (88.67%) followed by neem (80.87%), ginger (79.86%), turmeric (73.76%), tulsi (47.75%), datura (37.57%), giloy (35.22%) and aak (17.85%). Our results were supported by Mandhare and Suryawanshi (2009) studied on antimycotic properties of the phyto extracts (10% each) against *Rhizoctonia bataticola* in chickpea and found that the aqueous solution of garlic clove and neem leaf were restricted the fungal growth with 77.77 and 64.44 per cent, respectively. Dhingani *et al*. (2013) [4] worked on *Macrophomina* rot in chickpea and Savaliya *et al.* (2015) [13] also worked on efficacy of plant extracts against root rot in sesame, in which they found that garlic extract was inhibited highest mycelial growth of the pathogen. Thombre and Kohire (2018) [19] were also reported that foliar spray @ 10% of *Allium sativum* and *Allium cepa* were found effective recorded maximum disease control over unprotected plots, When concentration was increased, plant extracts showed the maximum inhibition against pathogen under controlled conditions and reported strongly reduction against soil borne pathogen. These statements agreed with co- workers (Sharma, 2009; Kumar *et al*., 2011) [14].

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