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Ecofriendly Management of *Turcicum* Leaf Blight of Maize

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ABSTRACT

Among the plant extracts, all the plant extracts inhibit the mycelial growth of *Exserohilum turcicum,* Neem (*Azadirachta indica*) seed kernel extract @ 10% was effective in reducing the growth of *Exserohilum turcicum.* Foliar spray of *Azadirachta indica* seed extract was also found most effective among plant extract showing the minimum disease severity (25.4%) and maximum grain yield (24.1q/ha). While *Eucalyptus citriodora* 10% concentration were low effective as comparison to *Azadirachta indica* and *Ocimum sanctum* in inhibition of *Exserohilum turcicum* growth and produced 72.8% lower grain yield as compare to *Azadirachta indica*. Minimum grain yield was recorded in check plots. Six fungicides also tested, Zineb 75 WP @ 0.25 % concentration found most effective in inhibiting the growth of *E. turcicum,* low in disease severity and ultimately produced higher grain yield of maize. Mancozeb 63%+Carbendazim 12% @ 0.25% was found equally effective which can be used as an alternative to Zineb.

Keywords Fungicides, Maize, Plant extracts, *Turcicum* leaf blight.

INTRODUCTION

Maize (*Zea mays* L.) occupies an important place in world agriculture due to its high yield potential and great demand. Among different maize growing countries, India ranks fourth in area and seventh position in production (Prakash and Venkataramana 2023). In India, it is the third important cereal after wheat and rice in account of area and plays an important role in the overall progress of the national economy. As per the latest reports the area, production and productivity of maize in India is 10.4 mha, 33.62 mt and 2.96 t/ha, respectively (ICAR-IIMR 2022). Area and production have increased with the emergence of high-yielding traditional and exotic hybrid varieties and the use of chemical fertilizers. But the crop is prone to so many foliar diseases (Singh *et al.* 2014). Among the foliar diseases affecting maize, the *Turcicum* leaf blight also called as northern leaf blight caused by *Exserohilum turcicum.* Despite its high yield potential, one of the major limiting factors to maize grain yield is its sensitivity to several diseases (ICAR-IIMR 2020). Approximately 65 pathogens

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infect maize (Rai and Singh 2018). Northern Corn Leaf Blight also commonly known as *Turcicum* leaf blight is one of most important foliar disease of maize and caused by *Exserohilum turcicum,* the residue borne fungus. This disease occurs sporadically in most temperate, humid areas where maize is grown. In Bihar, due to *Turcicum* blight of maize losses in grain yield varied from 27.60 to 90.70% depending upon the intensity of infection and loss was directly proportional to the intensity of the disease (Chenulu and Hora 1962). The disease causes leaf necrosis and premature death of foliage which reduces the fodder and grain value of the crop. Although the losses due to *Turcicum* leaf blight can be minimized by the foliar application of fungicides and plant extracts (Wani *et al*. 2017). Use of plant extracts in disease management is considered as eco-friendly, ruling out chances of environmental pollution and sustainable approach for disease management. Moreover, resistance development in pathogen against bio-control agents has not been reported so far while frequent use of fungicides has led to resistance development in various pathogens. Bio-control agents have been used in disease management for long time as seed treatment but their use as foliar spray is rarely followed approach and needs screening in different crops and under different environmental conditions. No doubt in the past few decades chemical pesticides have protected the plants from diseases, their continuous and over use have led to some serious ecological problems, viz. hazardous effects on beneficial organisms in soil, residual effects, pollution and resistant strain development in pathogen. The present study carried out to explore the feasibility of several plant extract and chemical fungicides for the management of *E. turcicum* leaf blight disease of maize *in vitro* and under field conditions.

MATERIALS AND METHODS

Six fungicides namely Metalaxyl 72 WP, Thiophanate methyl 70 WP, Zineb 75 WP, Propineb 70 WP, Copper oxychloride 50 WP and Mancozeb 63% + carbendazim 12%, and six plant extracts of *Allium cepa, Allium sativum, Azadirachta indica, Ocimum sanctum, Eucalyptus citriodora* and *Piper betle* were evaluated against *Exserohilum turcicum in-vitro* as well as in field.

In vitro evaluation of fungicides and plant extract

For *in-vitro* evaluation of fungicides, poison food technique potato dextrose agar as basal medium was followed. The fungicide Metalaxyl and Thiophanate methyl were tested at 0.1% concentration, whereas, rest of the fungicides were tested at 0.25% concentration. The calculated quantities of fungicides were thoroughly mixed in the medium before pouring into petri plates so as to get the desired concentration of active ingredient of each fungicide separately. 20 ml of fungicide amended medium was poured in each of 90 mm sterilized petri plates and allowed to solidify. The plates were inoculated centrally with 8 mm disc of 10 days old young sporulating culture of *Exserohilum turcicum.* Controls without fungicides were also maintained. The inoculated petri plates incubated at room temperature 28±1 ^{0}C in the laboratory. The colony diameter was measured after 10 days when the control plates full of fungal grow.

The fresh leaves and other parts of healthy plants were washed thoroughly with tap water and air dried 10 g of plant tissue was grounded with the help of pestle and mortar by adding equal amount of sterilized distilled water. The extract was filtered through double muslin cloth. The supernatant was taken as standard plant extract solution. Further, the extract was diluted by adding sterilized water to get 10% concentration. Plant extract was incorporated into melted PDA medium by transferring 2 ml of each type of plant extract into a petri dish containing 20 ml melted PDA. The amended PDA plates were inoculated aseptically with *Exserohilum turcicum* by transferring 6 mm disc of 10 days old culture of pathogen to the center of PDA medium in petri dish. Three replications were maintained for each treatment. PDA not amended with plant extract served as control. All the inoculated petri dishes were incubated at 26±1 ^{0}C. After 10 days when the control plates full of fungal grow of test fungus per cent inhibition was calculated by using formula given by Vincent (1927).

$$I = \frac{C - T}{C} \times 100$$

Where, I = Per cent inhibition
C= Colony diameter in control
T = Colony diameter in treatment

In field evaluation of fungicides and plant extracts

To see the effect of foliar spray of all six fungicides and plant extracts on *Turcicum* blight of maize, two different field trials were conducted during *kharif* 2021 and 2022 at Research farm Bihar Agricultural University, Sabour, Bhagalpur (Bihar). Field trials were laid out in Randomized Block Design (RBD) with 3 replication and variety Laxmi. Recommended dose of fertilizer irrigation and spacing was followed. In fungicidal trial as well as plant extract trials, three spraying at 10 days interval were given from first disease appearance. Observations on disease severity were recorded at silk drying stage following 0-5 scale. The yields were recorded after harvest of the crop.

RESULTS AND DISCUSSION

Evaluation of fungicides

The data showed in Table 1 clearly revealed that all the fungicides tested were able to inhibit the growth of *E. turcicum* in *kharif*. Zineb 75 WP which produced 99.10% mycelial growth inhibition was most effective and statistically at par with Mancozeb 63% + carbendazim 12% which inhibit the mycelial growth 98.40%. However, rest of the fungicides was effective to some extent and produced growth inhibition between 51.60-71.10%. Among the fungicides Copper oxychloride 50 WP were least effective (51.60%) to inhibit the mycelial growth of *E.turcicum* in comparison to Thiophanate methyl 70 WP (64.60%), Metalaxyl 72 WP (68.50%) and Propineb 70 WP (71.10%) respectively. The effectiveness of fungicides carboxin, mancozeb and propiconazole against *E. turcicum* has been reported by several authors (Jagadeesh *et al.* 2020, Kumbhar *et al.* 2012, Yang *et al*. 2011, Reddy *et al.* 2013).

Table 1. Effect of fungicides on radial growth of *Exserohilum turcicum.*

Sl. No.	Fungicides	Dose (%)	% inhibition of mycelial growth
1	Metalaxyl 72 WP	0.10	68.50 (55.87)
2	Thiophanate methyl 70 WP	0.10	64.60 (53.51)
3	Zineb 75 WP	0.25	99.10 (85.55)
4	Propineb 70 WP	0.25	71.10 (57.90)
5	Copper oxychloride 50 WP	0.25	51.60 (45.93)
6	Mancozeb 63% +Carbendazim 12%	0.25	98.40 (83.09)
	CD (5%)		0.98

Table 2. Effect of foliar spraying of fungicides on disease severity and grain yield of maize (Mean of 2 year).

Sl. No.	Fungicides	Dose (%)	Disease severity (%)	Grain yield (q/ha)
1	Metalaxyl 72 WP	0.10	32.00	18.75
2	Thiophanate methyl 70 WP	0.10	35.20	17.65
3	Zineb 75 WP	0.25	14.30	29.90
4	Propineb 70 WP	0.25	27.10	22.00
5	Copper oxychloride 50 WP	0.25	40.40	16.65
6	Mancozeb 63% + Carbendazim 12%	0.25	16.00	27.00
7	Check		55.30	13.35
	CD (5%)		1.78	0.94

In three foliar sprays of fungicide at 10 days interval from first disease appearance, all the fungicides were found most effective in reducing the severity of *Turcicum* leaf blight development over check (Table 2). The Lowest disease severity (14.3%) was found with the spray of Zineb 75 WP @ 0.25% concentration, which was statistically at par with spray of Mancozeb 63% + Carbendazim 12% @ 0.25% concentration. Propineb 70 WP @ 0.25%, Metalaxyl 72 WP (0.10%) and Thiophanate methyl 70 WP (0.10%) gave 27.1%, 32% and 35.2% disease severity, respectively. However, copper oxychloride 50 WP @ 0.25% concentration spray was gave maximum (40.4%) disease severity.

The highest grain yield (29.9 q/ha) was recorded with the 3 foliar spray of Zineb 75 WP @ 0.25% concentration at 10 days interval from first disease appearance, which was significantly superior over all the fungicides applied at three time at 10 days interval from first disease appearance (Table 2). Minimum grain yield (13.35 q/ha) was recorded in control plots (without any spray of fungicides). All the fungicidal treatments were significantly superior in grain yield of maize in comparison to control due to lower disease severity. The effectiveness of fungicides carboxin, mancozeb and propiconazole against *E. turcicum* has been reported by other authors (Kumar and Mauriya 2015 and Barad *et al.* 2019). The foliar spray with mancozeb @ 0.25% for three times at an interval of 10 days was found to be more effective

and significantly reduced TLB severity and increased grain yield. The present study revealed that Zineb 75 WP @ 0.25 % concentration found most effective in inhibiting the growth of *E. turcicum,* low in disease severity and ultimately produced higher grain yield of maize. Mancozeb 63%+Carbendazim 12% @ 0.25% was found equally effective which can be used as substitute to Zineb.

Evaluation of plant extracts

Antifungal activity of 6 botanical extracts i.e. *Allium cepa, Piper betle, Allium sativum, Ocimum sanctum, Azadirachta indica* and *Eucalyptus citriodora* was assayed and data on effect of plant extracts on the growth of *E. turcicum* is presented in Table 3. The data revealed that significant reduction in growth of *E. turcicum* was observed in respect of all the plant extracts tested. The results indicated that the neem (*Azadirachta indica*) seed kernel extract @ 10% was effective in reducing the growth. Among the plant extracts tested, neem seed kernel extracts @ 10% concentration caused significantly maximum inhibition of *E. turcicum* growth (56.40%) followed by *Ocimum sanctum* leaf @10% concentration (53.80%), while *Allium cepa* cloves @ 10% concentration, *Piper betle* leaf @ 10% concentration and *Eucalyptus citriodora* 10% concentration were low effective as comparison to *Azadirachta indica* and *Ocimum sanctum* i.e. 24.0, 21.7 and 16.6% inhibition, respectively. The bulb extract of *Allium sativum* @ 10% was also found to be promising against the pathogen (35.06%). In the present study, *Azadirachta indica* seed extract @ 10% has shown considerable promise in reducing the growth of the pathogen. The seed kernel extract of *Azadirachta indica* @ 10% concentration was highly effective which caused significantly maximum inhibition and was closely followed by *Ocimum sanctum* leaf @10% concentration. Similar results on antifungal activity of aqueous extracts of different plants have been documented by Malik *et al.* (2018) and Subedi *et al.* (2019). In the present study, besides seed kernel extract of *Azadirachta indica* @ 10% concentration, *Ocimum sanctum* leaf @10% concentration extract was also fairly effective in inhibiting the growth of *E. turcicum.* The inhibitory action of *Azadirachta indica* may be due to azadirchtin present in seed kernels which retards the growth and activation of the pathogen. The effectiveness of *Allium sativum* (onion) bulb extract may be due to presence of antifungal compounds such as cycloallin and carbohydrate propenyl sulfuric acid. These findings are in agreement with the work of Singh and Singh (2014) and Yoon *et al.* (2010) reported, among the extracts of 35 plants evaluated *in vitro* against *Exserohilum hawaiiensis, Eucalyptus globus* inhibited the maximum mean spore germination (88.48%), followed by *Lantana camara* (87.54%) and *Flacourtia ramontchii* (85.43%). Similar results on antifungal activity of aqueous extracts of different plants have been reported by various workers (Rahman *et al.* 2007 and Hegde *et al.* 2014).

Foliar spray of seed extract of *Azadirachta indica* @ 10% concentration was found most effective among plant extracts showing the minimum disease severity of 25.4% in *kharif* maize (Table 4), which was at par with *Ocimum sanctum* leaf extract. All the foliar spray of plant extract @ 10% concentration was significantly reduced disease severity as compare to check due to considerable reduction of mycelial

Table 3. Effect of plant extracts on radial growth of *Exserohilum turcicum.*

Sl. No.	Plant extracts	Parts used	Concentration (%)	% inhibition of mycelial growth
1	*Allium cepa*	Cloves	10	24.00 (29.30)
2	*Piper betle*	Leaf	10	21.70 (27.78)
3	*Allium sativum*	Bulb	10	35.50 (36.59)
4	*Ocimum sanctum*	Leaf	10	53.80 (47.19)
5	*Azadirachta indica*	Seed	10	56.40 (48.70)
6	*Eucalyptus citriodora*	Leaf	10	16.60 (24.01)
	CD (5%)			0.66

Table 4. Effect of foliar spray of plant extracts on disease severity and grain yield of maize (mean of 2 year).

Sl. No.	Plant extracts	Dose (%)	Disease severity (%)	Grain yield (q/ha)
1	*Allium cepa*	10	48.2	18.90
2	*Piper betle*	10	51.9	16.25
3	*Allium sativum*	10	41.4	20.75
4	*Ocimum sanctum*	10	25.9	22.75
5	*Azadirachta indica*	10	25.4	24.10
6	*Eucalyptus citriodora*	10	55.7	13.95
	Check		63.3	11.15
	CD (5%)		1.82	0.78

growth of the pathogen.

The maximum grain yield (24.10 q/ha) was recorded with the foliar spray of seed extract of *Azadirachta indica* @ 10% concentration, which was significantly superior over all the foliar spray of plant extract @ 10% concentration due to least disease severity. Yield recorded in plot sprayed with *Ocimum sanctum* leaf extract (22.75 q/ha), *Allium sativum* bulb extract (20.75 q/ha), *Allium cepa* cloves extract (18.9 q/ha), *Piper betle* leaf extract (16.25 q/ha) and *Eucalyptus citriodora* leaf extract (13.95 q/ha) significantly higher than those recorded in unsprayed plots (Table 4).

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