Evaluation of antifungal activities of selected plants for prevention of Fusarium fungal infection to crop plants

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***Abstract*—The antifungal properties of five medicinal plants *Xanthium strumarium* (L.), *Lantana camara* (L.), *Cassia alata* (L.), *Caesealpina bonduc* (L.), and *Muntingia calabura* (L.) which were extracted using water, dimethyl formamide, ethanol, acetone, isopropanol, and toluene were evaluated against several *Fusarium* species. At different concentrations, all of the extracts prevented mycellial proliferation. The best inhibition against a range of *Fusarium* was shown in water, ethanol, acetone, and isopropanol extracts of certain plants. For *Fusarium solani*, *Fusarium oxysporum*, *Fusarium graminearum*, and *Fusarium moniliformae*, toluene and dimethyl formamide plant samples shown substantial suppression in all chosen plant extracts. The strongest inhibitory towards all *Fusarium* species was shown by the aqueous extract of *Lantana camara* (L.) and *Xanthium strumarium* (L.). The acetone extracts of *Caesealpina bonduc* (L.) and *Lantana camara* (L.) exhibited the strongest effectiveness against the *Fusarium solani* (132 µg/ml) and *Fusarium pseudocircinatum* (142 µg/ml) among the plant extracts.**

***Index Terms*—Antifungal activity, crop plants, plant extracts, *Fusarium* species**

I. INTRODUCTION

Fusarium is a common and extremely prevalent soil borne pathogen that may infect a wide range of hosts and induce significant infections as a main or subsequent invader. They may infect vegetables, cereals, grains, and many agricultural plants, causing diseases such as crown rot, stalk rot, crop blight, and scab. In addition, it promotes root rots in soybeans, peanuts, and legumes microvascular wilts in a number of agricultural crops, such as tomatoes, and other diseases (Agbenin et al., 2006). The mycotoxins that specific varieties of *Fusarium* produce secondary substances that trigger a range of physiologic and chemical responses in both plants and animals have been additionally the subject of much investigation. Numerous locations, such as soil, roots of plants and aerial tissues, decaying plants and other organic substrates, might contain *Fusarium* species. In addition to arid regions, alpine, and arctic habitats, they frequently occur in tropical and moderate temperatures. Crop disease by *Fusarium* may happen at any stage of development, from seed germination to mature vegetative tissues, based on the host plant and *Fusarium* species (Dissanayake, 2014).

Plant infections may seriously damage crops throughout the farming and postharvest phases, resulting in low quality crops such as grains, vegetables, and fruits and a 30% reduction in worldwide productivity. Abiotic stressors and biotic stressors pose a major hazard to crop development. The production and post-harvest storage of several fruits and vegetables are seriously threatened by *Fusarium* wilt, which is brought on by *Fusarium oxysporum* and *Fusarium solani* (Akkopru & Demir, 2005). *Fusarium* often enters plant tissues via incisions and multiplies through the soil, wind, and irrigation water. Because the stems of many fruits and vegetables, such as bananas, tomatoes, pigeon peas, and almost any plant species, rot and weaken, it results in significant financial losses. Chemical fungicides are currently primarily employed for managing *fusarium* wilt; however, the extensive use of chemical fungicides has resulted in numerous serious issues, including ecological imbalances, pollution of the environment, and human and animal health issues, as a result of anthropogenic activities such as improper fertiliser application. In addition, infections will become resistant to chemical fungicides and exhibit reduced susceptibility to them as a result of regular fungicide treatment (Siva et al., 2008). Thus, further research is required to develop natural fungicides that are highly effective, low toxicity, and residue-free. Plants contain abundance

in compounds and secondary metabolites which promote the plant's defense mechanism (Bhardwaj, 2012). The plant is protected against microbial and fungal mycelium invasion by a variety of phytochemicals, including flavonoids, alkaloid compounds, saponins, tannins, and others. Numerous plant extracts have been shown to have inhibitory effects on fungal illnesses, and academic focus has been drawn to investigations on botanical fungicides and antifungal plant compounds.

II. MATERIALS AND METHODS

Plant material:

A taxonomist from Department of Botany, Yeshwant Mahavidyalaya, Nanded-431602, Maharashtra, identified and verified the plants *Xanthium strumarium* (L.), *Lantana camara* (L.), *Cassia alata (*L.), *Caesealpina bonduc* (L.), and *Muntingia calabura* (L.), and these were collected from the Bhokar area of the District Nanded.

Plant extracts preparations:

Lantana camara (leaves), *Cassia alata* (leaves), *Caesealpina bonduc* (leaves), *Muntingia calabura* (leaves), and *Xanthium strumarium* (whole plant) were collected and allowed to dry in the shade. Following drying out, the plant materials were ground to an extremely fine powder in a mixing grinder. The Soxhlet appratus and many solvents, including water, dimethyl formamide, ethanol, acetone, isopropanol, and toluene, were used to extract the plants from the fine powder. The sample were concentrated after extraction and kept in the fridge for utilise in a variety of experiments.

Test microorganisms:

Fusarium oxysporum, *Fusarium proliferatum*, *Fusarium pseudocircinatum*, *Fusarium graminearum*, *Fusarium solani*, and *Fusarium moniliformae* were among the test organisms used in this work. Colony shape, colour, hyphae, spores, and conidia were used to identify them after they were separated from field soil and diseased plant parts. For the present antifungal experiment, the fungal cultures were then routinely subcultured.

Antifungal assay by well diffusion method:

The antifungal activity of several plant extracts was investigated using the well diffusion technique. Solidified potato dextrose agar medium was used to evenly distribute *Fusarium* fungus inoculums of several species on the sterilised petriplates. Using a sterile cork borer, three wells were created on each agar plate. Different concentrations of various samples were added to each well. Voriconazole, a common fungicide, serves as a reference substance. The zone of inhibition for each of this fungus was measured in diameter (mm) around the wells of the culture plates after they had been cultured for 72 hours at 25°C to 30°C (Kutaw et al., 2018).

III. RESULTS AND DISCUSSION

Table 1 summarizes the antifungal qualities of several extracts of *Xanthium strumarium* (L.*), Lantana camara* (L.), *Cassia alata* (L.), *Caesealpina bonduc* (L.), and *Muntingia calabura* (L.) made using different solvents against *Fusarium* species. The water extract of *Xanthium strumarium* had highest antifungal activity with MIC (182 µg/ml) against *Fusarium oxysporum*, (151 µg/ml) against *Fusarium proliferatum*, (163 µg/ml) against *Fusarium graminearum*, (146 µg/ml) against *Fusarium solani* and (153 µg/ml) against *Fusarium moniliformae* and dimethyl formamide extract of *Xanthium strumarium* showed (158 µg/ml) against *Fusarium pseudocircinatum*.

Followed by acetone extract of *Muntingia calabura* exhibited antifungal activity with MIC (180 µg/ml) against *Fusarium oxysporum*, (280 µg/ml) against *Fusarium pseudocircinatum* , (193 µg/ml) against *Fusarium proliferatum*, (138 µg/ml) against *Fusarium graminearum*, (182 µg/ml) against *Fusarium solani* and (190 µg/ml) against *Fusarium moniliformae* and in case of isopropanol extract showed MIC (195 µg/ml) against *Fusarium oxysporum*.

The moderate antifungal activity observed in acetone extract of *Caesealpina bonduc* with MIC (198 µg/ml) against *Fusarium oxysporum*, (160 µg/ml) against *Fusarium pseudocircinatum* , (142 µg/ml) against *Fusarium proliferatum*.

The significant antifungal activity observed in water extract of *Lantana camara* with MIC (160µg/ml) against *Fusarium oxysporum*, (222 µg/ml) against *Fusarium pseudocircinatum* , (144 µg/ml) against *Fusarium proliferatum*, (187 µg/ml) against *Fusarium graminearum*, (190 µg/ml) against *Fusarium solani* and (211 µg/ml) against *Fusarium moniliformae*. In case of dimethyl formamide extract

of *Lantana camara* with MIC (190 µg/ml) against *Fusarium graminearum*, (188 µg/ml) against *Fusarium solani*.

The considerable antifungal activity observed in ethanol extract of *Cassia alata* with MIC (205 µg/ml) against *Fusarium oxysporum*, (219 µg/ml) against *Fusarium pseudocircinatum* , (186 µg/ml) against *Fusarium proliferatum*, (240 µg/ml) against *Fusarium graminearum*, (211 µg/ml) against *Fusarium solani* and (255 µg/ml) against *Fusarium moniliformae*.

The lowest antifungal activity observed in isopropanol extract of *Caesealpina bonduc* with MIC (388 µg/ml) against *Fusarium oxysporum*, (372 µg/ml) against *Fusarium pseudocircinatum* , (522 µg/ml) against *Fusarium proliferatum*, (334 µg/ml) against *Fusarium graminearum*, (302 µg/ml) against *Fusarium solani* and (222 µg/ml) against *Fusarium moniliformae*.

In case of dimethyl formamide extract of *Caesealpina bonduc* with MIC (310 µg/ml) against *Fusarium oxysporum*, (202 µg/ml) against *Fusarium pseudocircinatum* , (152 µg/ml) against *Fusarium proliferatum*, (230 µg/ml) against *Fusarium graminearum*, (262 µg/ml) against *Fusarium solani* and (244 µg/ml) against *Fusarium moniliformae*. The antifungal activity of different plant extracts was compared with Voriconazole as reference compound with MIC (63 µg/ml) against *Fusarium oxysporum*, (61 µg/ml) against *Fusarium pseudocircinatum* , (61 µg/ml) against *Fusarium proliferatum*, (57 µg/ml) against *Fusarium graminearum*, (59 µg/ml) against *Fusarium solani* and (64 µg/ml) against *Fusarium moniliformae*.

It was believed that assessing the antifungal capabilities of readily available local flora would be helpful, considering the necessity for a more environmentally friendly method of managing the phytopathogen. The results of this study show that plant preparations have a variety of effects on the mycelium development of *Fusarium* species, and there is a definite potential for a new, effective fungicide since several of these extracts significantly restrict the test fungus's mycelium multiplication. Among the several plants examined, *Xanthium strumarium* & *Lantana camara* various components had the inhibitoriest effects on different species of *Fusarium*. This might be because the plant samples included secondary metabolites that are antifungal, and it has a variety of medicinal uses (Arif et al., 2009). Therefore, using *Cassia alata, Caesealpina bonduc various* solvent components to sick plants may also provide defense against harmful pathogens like *Fusarium* species. Plant extracts include phytochemicals with a variety of medicinal properties, including alkaloids, saponins, tannins, and glycosides (Mussarat et al., 2014). Mixing these two or more plant extracts may boost activity, according to many studies. This might be because combining a variety of phytochemicals has been shown to have a synergistic effect on pathogenic organisms. Numerous *Fusarium* species are out of control, directly and indirectly damaging vegetables, grain crops, oil seed plants, and some fruit plants. Numerous bio-control strategies exist, and a wide range of plant extract applications will provide a substantial platform for the organic prevention of various plant diseases.

IV. CONCLUSION

Significant antifungal action is shown by the aqueous, ethanolic, dimethyl formamide, acetone, and isopropanol extracts of *Xanthium strumarium* (whole plant), *Lantana camara* (leaves), and *Cassia alata* (leaves). The suppression of growth of various *Fusarium* species may be facilitated by the presence of certain bioactive phytochemicals in selected plants. Further investigation is needed, to find and comprehend the structure of the bioactive components in plant extracts that seem to be in role in the antifungal activity of these plants.

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Table-1 Summary of antifungal activity of different plant extracts

Sr. No.	Name of the plant	Different solvent extract	Minimum inhibitory concentration (µg/ml)					
			Fusarium oxysporum	*Fusarium proliferatum*	*Fusarium pseudocircinatum*	*Fusarium graminearum*	*Fusarium solani*	*Fusarium moniliformae*
1	*Xanthium strumarium* (L.)	Water	182	151	239	163	146	153
		Dimethyl formamide	248	340	158	278	430	655
		Ethanol	340	189	255	369	288	222
		Acetone	219	143	433	270	410	344
		Isopropanol	377	352	310	401	350	450
		Toluene	244	269	288	426	409	378
2	*Lantana camara* (L.)	Water	160	222	144	187	190	211
		Dimethyl formamide	280	368	340	190	188	323
		Ethanol	250	292	235	381	383	270
		Acetone	179	190	420	230	132	167
		Isopropanol	288	291	455	357	301	332
		Toluene	199	344	387	241	368	310
3	*Cassia alata* (L.)	Water	255	392	292	452	322	289
		Dimethyl formamide	260	168	320	188	260	267
		Ethanol	205	219	186	240	211	255

		Acetone	177	210	412	344	184	278
		Isopropanol	201	180	443	233	300	230
		Toluene	343	438	252	184	287	180
4	*Caesealpina bonduc* (L.)	Water	344	367	211	288	202	273
		Dimethyl formamide	310	202	152	230	262	244
		Ethanol	200	455	304	227	283	163
		Acetone	198	160	142	411	346	243
		Isopropanol	388	372	522	334	302	222
		Toluene	189	292	233	473	386	190
5	*Muntingia calabura* (L.)	Water	288	310	404	190	196	220
		Dimethyl formamide	172	278	450	230	246	534
		Ethanol	342	444	280	296	200	168
		Acetone	180	280	193	138	182	190
		Isopropanol	195	329	366	244	321	277
		Toluene	263	288	544	177	249	386
6	Voriconazole	--	63	61	61	57	59	64