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Qualitative phytochemical screening of botanical extracts and their effect on yield parameters of rice against sheath blight

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Abstract

The present study was aimed at evaluating the antifungal potential of botanical extracts prepared from the fruits, bark and leaves in two different solvents (aqueous and 50% ethanolic) of two meliaceae species (Azadirachta indica and Melia azedarach) against the sheath blight of rice. The fruits of Neem and Dhrek had maximum secondary metabolites on the basis of qualitative phytochemical screening tests followed by the leaf extracts. In general, ethanol extracts recorded a higher number of secondary metabolites than aqueous ones. Considering the hazardous effects of fungicides, an eco-friendly approach was adopted to manage this disease by using botanical extracts on rice cultivar PR 121. A field experiment conducted over two consecutive years (2021–2022) revealed that pre-treatment with doses of botanical extracts, followed by challenge inoculation 48 hours after foliar application significantly reduced the disease incidence of treated plants compared to the control. The foliar application of botanical extracts resulted in a significant increase in yield parameters compared to uninoculated (C1) and inoculated (C2) sites. Compared to control plants, the number of filled grains, test weight, panicle weight and fertility also increased. Neem provided best control, followed by M. azedarach, which reduced the disease's progression. The results of this study are significant for developing an environmentally friendly biocide, which could lead to efficient management of this disease.

Keywords: Botanicals, Fertility, Incidence, *Rhizoctonia*, Yield

INTRODUCTION

Rice, which has been cultivated in our country for many years, is more than a cereal; it is a staple food and the second most important crop after wheat (Tony Cisse, 2005). India is one of Asia's foremost producers of paddy. It suffers significantly from a number of fungal diseases which cause yield losses (Chhabra *et al.,* 2023) The impact of fungal diseases on rice crop health and yield is among the most significant biotic constraints (Chhabra and Vij, 2019). In India, 23.3% of the total cropped area is devoted to rice cultivation, which accounts for 46 percent of the country's total cereal output.

Rhizoctonia solani Kühn infects many agricultural and horticultural goods around the world and causes diseases that are economically lethal (Singh *et al.,* 2003). The species in general are poorly understood due to the lack of distinct morphological characteristics and the lack of information regarding reproduction and mating relationships. This disease was first identified in Japan and has since spread to all of the world's main rice-growing regions. The causal agent can endure in the form of sclerotia in soil for many years (Singh *et al.,* 2019). Midway through the 1960s, the disease became destructive due to the introduction of semi-dwarf, early-maturing rice varieties (Deephi *et al.,* 2007). Its resilience is associated with the mature form of sclerotia, which has impenetrable cell walls and a high nutritional content. In the cytoplasm of Sclerotia, there is a rich nutrient reserve that serves as a source of energy during extreme conditions and aid in re-infection (Srinivasachary *et al.,* 2011).
Approximately 70–80 percent of agricultural production losses due to microbial disease are attributed to fungal pathogens. Chemical fungicides have been used to combat plant diseases since 1882. With chemical fungicides alone, it is impossible to control such a significant number of fungal species. Even if it was feasible, it would have detrimental effects on the human health. Toxic chemicals present in chemicals degrade soil properties, endanger human health and negatively affect non-target organisms. According to Yoon *et al.,* (2013), they also enhance the resistance capacity of fungal pathogens. In addition, their residues reach water sources via discharge and have a negative impact on the aquatic ecosystem. Currently, scientists seek to investigate the potential of

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botanical extracts derived from a variety of plants. Botanical fungicides are the most viable and sustainable option in this regard, it has been determined. They are biodegradable, preserve soil properties and are harmless to humans and the environment (Hahn, 2014). These phytochemicals may be effective against fungal pathogens and their brief persistence and simple decomposition are their finest qualities. Due to their distinct mode of action from that of synthetic fungicides, they lack cross-resistance. Botanical fungicides are simpler to make by the cultivators and have an edge over chemical fungicides because they are less expensive (Hashim and Devi, 2003). Nguefack *et al.* (2008) investigated the antifungal activities of essential oils against rice seed-borne fungi and demonstrated that citrus and thymeessential oils could be used to control seed-borne fungi in rice. Khoa *et al.* (2011) demonstrated that foliar spraying and seed soaking with *Chromolaena odorata* extracts led to a 68% reduction in sheath blight lesion length which further led to the reduction disease incidence. According to Reglinski (2009), Milsana (an ethanol-based extract from *Reynoutria sachalinensis*) controls powdery mildew development in wheat through a combination of direct antifungal activity and induced resistance. Several secondary metabolites that tree naturally make have antifungal properties that make trees resistant to diseases caused by pathogens (Shabana *et al.,* 2017). Extracts of tree species have been documented to contain high levels of secondary metabolites, viz., alkaloids, phenols, flavonoids, tannins, terpenoids, and many more (Thakur *et al.,* 2023). The extraction of the plant sample in a suitable solvent leads to the isolation of a specific bioactive molecule. The extracts prepared from dried plant parts of the family Meliaceae have shown direct inhibitory effects on the growth of many phytopathogens and are able to kill them even at low concentration (Kaur *et al.,* 2023). However, the complete potential of extracts of the plants of the family Meliaceae has not been exploited for plant disease management due to a lack of research, proper standardization of extraction methods and the identification of bioactive compounds (Deephi *et al.,* 2007). The current research was designed to control sheath blight occurrence of rice to increase its yield, while lowering production costs by using botanical extracts while avoiding environmental pollution and devising safe control options for managing the sheath blight of rice.

MATERIAL AND METHODS

Botanical Extract Preparation: Between March and August, the leaves of Neem and Dhrek were harvested from different trees growing at the Research Farm, Department of Forestry and Natural Resources, PAU. The age of these trees ranged from 11 to 13 years. While the fruits of Neem were taken during the peak fruiting season in July and August, the fully ripened fruits of Dhrek were collected in May and June. After drying for a week at 60°C, the plant samples were ground into a fine powder in an electric grinder. For 48 hours, dry powdered tissues were mixed in a 1:1 w/v ratio with water or a fractionated 50% ethanolic solvent. After centrifuging the extract for 30 minutes at 4000 rpm, the supernatant was filtered through Whatman No. 1 filter paper and kept aseptically in a brown bottle at 5°C. As crude extracts (100% concentration), the obtained extracts were used for phytochrmical study (Hussain *et al.,* 2012).

Qualitative phytochemical analysis: Phytochemical analysis of the different crude extracts was conducted in the PG laboratory of the Department of Botany, PAU, Ludhiana. Analysis of major phytoconstituents from the aqueous and 50% ethanolic botanical extracts was undertaken using standard qualitative methods and phytochemical tests as described by Rizk and Bashir (1980).

1. Steroids (Liebermann-Burchard reaction): To 1 ml of extract added chloroform. Also added 1-2 ml of acetic anhydride and 2 drops of sulphuric acid from the sides of the test tube. Observed it for the appearance of blue and green colours, which confirmed the presence of steroids.

2. Saponins (froathing test): Added one drop of sodium bicarbonate solution to five millilitres of sample extract and vigorously agitated for three minutes. A honeycomb-like foam formed, confirming the presence of saponins.

3. Glycosides (Kellar-Killiani test): Sulphuric acid was added to a test tube containing 2 ml of extract, glacial acetic acid, and one drop of 5% ferric chloride; a reddish-brown color formed at the junction of the two

4. liquids, and the top layers appeared bluish green, indicating the presence of glycosides.

5. Tannins (ferric chloride test): Added a few drops of the 5% ferric chloride solution to 1-2 ml of the extract. Tannins were indicated by a brown colour.

6. Terpenoids (Salkowski test): The extract was dissolved in 2 ml of chloroform and dried using an evaporator. After that, 2 ml of concentrated sulfuric acid was added and heated for 2 minutes. Terpenoids were indicated by a grey colour.

7. Phenols (lead acetate test): In 5 ml of distilled water and 3 ml of a 10% lead acetate solution, the extract was dissolved. The presence of phenols was confirmed by the white precipitate.

8. Flavonoids (Alkaline reagent test): Added one ml of extract to two ml of 2% sodium hydroxide solution, followed by a few droplets of diluted hydrochloric acid. With the addition of diluted acid, a brilliant yellow hue was eliminated.

9. Alkaloids (Iodine Test): A 1 mL extract solution was mixed with a few droplets of iodine solution. A blue colour that dissipates on boiling and reappears on cooling indicated the presence of alkaloids.

Plant material and sowing: The seeds of selected rice cultivars were procured from the Department of Plant Breeding and Genetics, PAU. PAU's standard agronomic procedures were used to sow the seeds of the rice cultivar PR 121 (highly susceptible to sheath blight). The nursery was planted in the middle of June (2021 and 2022). After thirty days, seedlings were transplanted into a plot measuring 2×1 m^2 in the Department of Plant Pathology's field area. With a row-to-row distance of 20 cm, the plot-to-plot distance was maintained at 15 cm. The dosages of nitrogen, phosphorus and potash were used in accordance with PAU recommendations. Each plot received adequate irrigation following transplanting.

Foliar spray of botanical extracts and *Rhizoctonia solani* inoculation procedure: Foliar sprays of botanical extracts viz., Neem leaf extract (aqueous), Neem leaf extract (50% ethanolic) Neem fruit extract (aqueous), Neem fruit extract (50% ethanolic), Dhrek leaf extract (aqueous), Dhrek leaf extract (50% ethanolic), Dhrek fruit extract (aqueous), Dhrek fruit extract (50% ethanolic) at 50 % concentration and Propiconazole @0.1% (standard chemical check) were made at the maximum tillering stage in case of sheath blight. After 2 days of foliar spray, pathogen inoculation was performed. Uninoculated (water spray) and Inoculated (without botanical spray) were also kept as control plants. The Department of Plant Pathology at Punjab Agricultural University provided a pure culture of *R. solani* (Rs-1). The fungus rapidly multiplied on a medium of potato dextrose when it was incubated at 25°C. Rice plants (PR 121) were artificially inoculated after 45 days of transplanting using the suggested Willocquet *et al.* (2012) method. The pathogen inoculum was made up of sclerotium and mycelium and prepared on maize meal sand medium. The inoculum was prepared and incubated at room temperature for seven days prior to inoculation. In the late afternoon, 5g of the mixture was spread between the tillers at the base of the central hill at the maximum tillering stage.

Percent disease incidence: Percent disease incidence (PDI) in terms of the percentage of diseased plants from each plot at 7, 14, 21, and 28 days after inoculation was calculated.

$$PDI = \frac{\text{No. of infected plants in plot}}{\text{Total no. of plants assessed in each plot}} \times 100$$

Yield assessment: Five panicles were chosen at random from each treatment plot, and their weights were recorded so that an average could be calculated. The ratio of full to empty grains in each panicle was calculated for each experimental plot. Straw was sun-dried for three to four days on each plot and then weighted to determine the net plot area. Quintals per acre were used to measure the harvests. Each treatment's quintal per acre biological yield was determined by summing the grain and straw yields. Grain weights were recorded for each net plot. Quintals per acre were used to represent grain yield data. Each plot's cereal harvest was sampled at random, and one thousand grains were weighed on an electronic scale. The weight in grams of one thousand granules was provided. Total number of grains and empty

grains per panicle were used to determine fertility rate. Traditional methods were also applied to calculate the harvest index.

Statistical analysis: SPSS statistical software was used to evaluate the two-year data (2021 and 2022). The differences were regarded statistically significant at the level of probability levels of 5%.

RESULTS AND DISCUSSION

Qualitative phytochemical screening

Phytochemical analysis of the fruit, leaf, and bark of *Azadirachta indica* and *Melia azedarach* in aqueous and 50% ethanolic solvents was conducted in order to confirm the presence of different metabolites, viz., phenols, flavonoids, steroids, tannins, glycosides, alkaloids, terpenoids, and saponins. Qualitative phytochemical screening (Table 1) revealed that different phytochemicals were present in aqueous and ethanolic extracts in different plant parts of selected tree species. The aqueous and ethanolic leaf, fruit, and bark extracts of all three species confirmed the presence of flavonoids, phenols and alkaloids invariably. In neem, the aqueous and ethanolic extracts of fruits recorded the presence of terpenes, steroids, saponins, glycosides and tannins. Similarly, the results obtained from its bark aqueous extracts confirmed the presence of phenols, flavonoids, glycosides, terpenes, saponins, alkaloids and tannins. Additionally, steroids were identified only in 50% ethanolic bark extracts. The leaf extracts of neem contained saponins, glycosides, steroids, terpenoids, and tannins in both solvents. Similar phytochemical components in Neem have been established by Biswas *et al.* (2002). Several studies have linked the presence of these bioactive compounds in the Meliaceae family to antifungal activity. Neem is also called the storehouse of several phytochemicals.

Different phytochemical compositions were recorded for different plant parts of *M. azedarach*. The aqueous and 50% ethanolic extracts of fruits confirmed the presence of terpenes, tannins and saponins. In both the bark extracts, the presence of terpenes, steroids, saponins, glycosides and alkaloids were recorded, except tannins. Aqueous leaf extracts recorded the presence of all the bioactive compounds except saponins, whereas their 50% ethanolic counterparts recorded all the tested phytochemicals. The findings are in conformity with those of Rishi and Singh (2003), who reported a similar phytochemical composition of *M. azedarach*. Dhrek is also an important source of some aromatic components like coumarin, glycosides, tannins, flavonoids, phenols, triterpenoids and steroids and their presence has been confirmed several times by previous research (Rana 2008).

The fruit and leaf extracts of Neem and Dhrek confirmed more secondary metabolites in comparison to the bark. Among all the species, neem followed by dhrek identified a greater number of secondary metabolites in their aqueous and 50% ethanolic extracts. In general, ethanolic extracts recorded more metabolites than aqueous extracts. It may be due to the better extraction efficiency of the ethanolic solvent, which can draw a greater variety of plant constituents than the other solvents. Similarly, Paulsamy and Jeeshna (2011) highlighted that hydro-ethanolic solvents tend to draw a higher variety of chemical constituents than other solvents. The secondary metabolites found in these extracts are known to cause toxicity to fungal cell walls and cell organelles which further weaken the pathogenicity of the fungal strain (Doltsinis *et al.,* 2006).

Efficacy of botanicals in reducing sheath blight incidence

For the management of sheath blight disease in a sustainable manner, the exploration of various eco-friendly and safe strategies involving botanical extracts has gained importance. Table 2 displays data on the effect of different concentrations of botanical extracts on disease incidence reduction. Experiments conducted in the field during the *Kharif* 2021–22 to evaluate the efficacy of botanical extracts against sheath blight revealed that foliar application of botanical extracts substantially inhibited the development of the disease on treated plants compared to the inoculated plants. All of the tested botanicals were found to be substantially effective at reducing the incidence of sheath blight. During the investigation, the highest disease incidence (86.32%) was observed on inoculated plants (C2) that did not

Table 1: Qualitative analysis of various secondary metabolites in different crude extracts of selected tree species

Tree Species	Part used	Phytochemicals															
		Phenols		Flavonoids		Steroids		Tannins		Glycosides		Alkaloids		Terpenoids		Saponins	
		Aqueous	50% ethanolic	Aqueous	50% ethanolic	Aqueous	50% ethanolic	Aqueous	50% ethanolic	Aqueous	50% ethanolic	Aqueous	50% ethanolic	Aqueous	50% ethanolic	Aqueous	50% ethanolic
Neem	Leaf	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Bark	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+
	Fruit	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Dhrek	Leaf	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+
	Bark	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+
	Fruit	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Table 2: Effect of foliar spray of selected botanical extracts on sheath blight incidence of rice cultivar PR 121 under field conditions

Treatment		Sheath blight incidence (%)				
		7 DAI	14 DAI	21 DAI	28 DAI	MEAN
Uninoculated control (water spray)	C1	0.02	0.04	0.08	0.08	0.05^{j}
Inoculated control (without botanical spray)	C2	75.66	83.13	90.01	96.48	86.32^{a}
Neem leaf extract (aqueous)	T1	26.11	31.06	37.49	43.33	34.50^{e}
Neem leaf extract (50% ethanolic)	T2	23.00	29.99	35.84	39.13	31.99^{f}
Neem fruit extract (aqueous)	T3	20.33	26.68	33.15	35.71	28.97^{g}
Neem fruit extract (50% ethanolic)	T4	19.00	24.91	28.88	32.37	26.29^{h}
Dhrek leaf extract (aqueous)	T5	29.33	39.35	45.38	56.21	42.57^{b}
Dhrek leaf extract (50% ethanolic)	T6	27.33	37.25	43.25	54.96	40.70^{c}
Dhrek fruit extract (aqueous)	T7	24.00	41.37	44.92	50.28	40.14^{c}
Dhrek fruit extract (50% ethanolic)	T8	22.00	35.15	38.84	47.89	35.97^{d}
Propiconazole @0.1% (standard chemical check)	T9	0.01	1.16	4.23	7.28	3.17^{i}
MEAN		24.25^{d}	31.82^{c}	36.54^{b}	42.15^{a}	33.69

Values represented by same letter are not significantly different ($p \leq 0.05$) as per Tukey's test; DAI denoted Days After Inoculation

receive any treatment, while the lowest incidence was observed on non-inoculated plants (0.05%). The peak incidence of disease was observed 28 days after pathogen inoculation. During the time-course of evaluation, plants treated with foliar sprays of botanicals showed little variation. Neem fruit extract (ethanolic) recorded a considerably lower disease incidence (26.29%) than its aqueous counterpart based on mean data. Comparatively, Dhrek fruits significantly reduced disease incidence in comparison to control plants, demonstrating their protective nature. According to the findings of Hassan et al. (2008), the utilization of particular plant extracts resulted in a decrease in the occurrence of potato wilt disease and a subsequent rise in potato tuber yield when compared to a control group that was infected. This phenomenon may be attributed to the reduced pathogen load in treated plants and the activation of antioxidant enzymes, which contribute to pathogen suppression inside the plant tissues.

Efficacy of botanicals on enhancing yield attributes

The coordinated interaction between growth characteristics and yield qualities determines the yield of a crop. The application of various treatments exerted a notable influence on the yields of paddy grain and straw during the years 2020 and 2021. The findings reported in Table 3 clearly indicate that the yield components seen in plants treated with various botanical extracts were significantly higher. This suggests that these extracts possess protective properties against phytopathogens. The plots treated with a fruit ethanolic extract of Neem had the highest reported values for straw, grain, and biological yield. This was followed by plants that were sprayed with a fruit aqueous extract. Significant increase in all yield parameters were seen in the treatment of ethanolic and aqueous extracts derived from Dhrek fruit as compared to the aqueous and ethanolic extracts obtained from the leaves. All treatments had a notably high harvest index, with no statistically significant difference seen among them except for the infected control plants (C2), which displayed a substantially lower value of 21.00%. Draz et al. (2019) observed that the application of extracts of *M. azedarach* to wheat plants infected with rust resulted in considerable enhancement of yield components as compared to the control plants.

Table 3: Effect of foliar spray of selected botanical extracts on yield and related parameters of rice cultivar PR 121 under artificial epiphytotics of sheath blight

Treatment		Straw yield (q/ac)	Grain yield (q/ac)	Biological yield (q/ac)	Harvest index (%)
Uninoculated control (water spray)	C1	88.85[a]	38.77[a]	135.3[a]	30.43[a]
Inoculated control (without botanical spray)	C2	64.33[b]	19.29[b]	89.71[b]	21.00[b]
Neem leaf extract (aqueous)	T1	96.63[a]	38.09[a]	138.9[a]	27.54[a]
Neem leaf extract (50% ethanolic)	T2	98.28[a]	36.45[a]	134.7[a]	27.08[a]
Neem fruit extract (aqueous)	T3	100.09[a]	40.93[a]	133.7[a]	30.63[a]
Neem fruit extract (50% ethanolic)	T4	100.79[a]	40.78[a]	137.4[a]	31.12[a]
Dhrek leaf extract (aqueous)	T5	95.02[a]	38.24[a]	133.3[a]	28.70[a]
Dhrek leaf extract (50% ethanolic)	T6	83.21[a]	38.39[a]	138.5[a]	27.80[a]
Dhrek fruit extract (aqueous)	T7	87.72[a]	35.28[a]	129.0[a]	28.70[a]
Dhrek fruit extract (50% ethanolic)	T8	91.36[a]	34.75[a]	129.8[a]	28.53[a]
Propiconazole @0.1% (standard chemical check)	T9	92.81[a]	39.09[a]	125.7[a]	30.86[a]

Values represented by same letter are not significantly different ($p \leq 0.05$) as per Tukey's test

In relation to the grain weight parameters given in Table 4, the data revealed that the application of plant extracts resulted in an increase in the test weight of treated plants. This rise was found to be comparable to that observed in control plants that were not subjected to any inoculation. The plants treated with botanical extracts exhibited the maximum 1000 grain weight and were statistically at par to one another. In the control plants that were inoculated, a notable decrease in grain weight was observed. There was a significant variation observed in the quantity of filled and unfilled grains among the different treatments and control plants. Inoculated plants exhibited notably elevated levels of maximal unfilled

Table 4: Effect of foliar spray of selected botanical extracts on grain count and spikelet fertility of rice cultivar PR 121 under artificial epiphytotics of sheath blight

Treatment		1000 grain weight (g)	Unfilled grains (No.)	Filled grains (No.)	Spikelet fertility (%)	Panicle weight (g)
Uninoculated control (water spray)	C1	29.12^{ab}	10.33^{e}	112.33^{a}	91.63^{a}	14.33^{a}
Inoculated (without botanical spray)	C2	13.35^{f}	63.00^{a}	45.00^{f}	41.53^{g}	3.43^{b}
Neem leaf extract (aqueous)	T1	20.79^{d}	17.33^{bc}	101.67^{cd}	85.44^{def}	9.00^{ab}
Neem leaf extract (50% ethanolic)	T2	21.95^{d}	18.33^{bc}	104.67^{bc}	85.92^{cde}	13.00^{a}
Neem fruit extract (aqueous)	T3	24.73^{c}	15.67^{cd}	109.00^{ab}	87.43^{bcd}	15.67^{a}
Neem fruit extract (50% ethanolic)	T4	25.96^{c}	12.67^{de}	109.67^{ab}	89.64^{abc}	12.33^{a}
Dhrek leaf extract (aqueous)	T5	16.81^{e}	21.30^{b}	95.67^{e}	81.78	7.00^{ab}
Dhrek leaf extract (50% ethanolic)	T6	17.97^{e}	21.33^{b}	99.00^{de}	82.28^{ef}	10.33^{ab}
Dhrek fruit extract (aqueous)	T7	20.75^{d}	19.67^{bc}	105.00^{bc}	84.22	14.66^{a}
Dhrek fruit extract (50% ethanolic)	T8	20.98^{d}	16.67^{c}	105.67^{bc}	86.37^{cd}	12.23^{a}
Propiconazole @0.1% (standard chemical check)	T9	30.02^{a}	11.67^{e}	115.00^{a}	90.80^{ab}	12.67^{a}

Values represented by same letter are not significantly different ($p \leq 0.05$) as per Tukey's test

grains, whereas all other botanical treatments showed significantly superior performance compared to C1 and C2.

In addition to disease control, the use of botanical extracts resulted in enhanced yield contributing traits as compared to the control. The increased production of grain-filled structures and higher panicle weight in the treated specimen supported the findings that the application of the extract did not have any negative effects on the plants. These results agree with those of Abd El-Malik and Abbas (2017), who found that spraying eucalyptus, garlic, pomegranate, cactus and neem extracts on the leaves of wheat plants had a positive effect on yield contributing factors 1000 kernel weight and spike weight when leaf rust was present.

The data pertaining to spikelet fertility is presented in Table 4. The highest spikelet fertility was observed in the fruit extracts of neem with the leaf extracts of the same plant exhibiting lower fertility rate. The treatment with propiconazole had the highest spikelet fertility, reaching 90.80%. This result was found to be statistically similar to all treatments, except for treatment C2. The pathogen is recognized for its ability to induce panicle infection which leads to the formation of seeds that are either empty or partially filled. These seeds exhibit discoloration and are marked by the presence of brownish black dots or black to ashy gray patches (Biswas *et al.,* 2008). The phenomenon of decreased spikelet fertility is widely recognized as a prevalent factor contributing to diminished rates of rice seed-setting and subsequent economic yield.

CONCLUSION

Chemical profiling of various tree species frequently reveals vast genetic variability and variations in phytochemistry that may result from genetic differences or genotype-environment interactions. By isolating these phytochemical constituents and utilizing their biological activity it will be possible to attain desirable results for management of the disease. This study infers that these tree species have phytopharmaceutical value due to the large number of bioactive compounds they contain. This manuscript elucidates the antifungal and protective attributes of plant extracts that can be employed as foliar remedies for the prevention of sheath blight disease of rice. These extracts can be used as preventive measure to mitigate the detrimental effects of pathogen on crop plants. Environmentally safe solutions can play a crucial role in disease control programs that prioritize environmental sustainability, particularly when the economic aspects of these options are taken into account.

REFERENCES

Abd El-Malik, N.I. and Abbas, I.K. (2017) Evaluation of certain plant extracts for the control of wheat leaf rust disease. *Egyptian Journal of Biological Pest Control* **27**(1):23–33.

Biswas, S.K., Ratan, V., Srivastava, S.S.L., Singh, R. (2008) Influence of seed treatment with biocides and foliar spray with fungicides for management of brown leaf spot and sheath blight of paddy. *Indian Phytopathology***61**:55–59.

Biswas, K., Chattopadhyay, I., Banerjee, R. K.and Bandyopadhyay, U. (2002) Biological Activities and Medicinal Properties of Neem (*Azadirachta indica). Current Science* **82**:1336-45.

Chhabra, R. and Vij, L. (2019) Grain discoloration and its management: an emerging threat to paddy cultivation. *Journal of Plant Disease Protection* **127:** 1-8.

Chhabra R., Sharma R., Hunjan M.S., Sharma, V.K., Thakur, S. and Chauhan, S. (2023) Efficacy of botanical extracts on imparting systemic acquired resistance against rice sheath blight incited by *Rhizoctonia solani. Journal of Plant diseases and Protection* **130:** 551–569.

Deephi, N., Madhusudhan, K.N., Shankar, A.C., Bhnuvanendra, K.H., Prakash, H.S., Shetty, H.S. (2007) Effect of plant extracts and acetone precipitated proteins from six medicinal plants against Tobamovirus infection. *International Journal of Virology* **3**:80-87.

Doltsinis, S.K, Markellou, E., Kasselaki, A.M., Fanouraki M N. and Koumaki, C.M. (2006) Efficacy of milsana, a formulated plant extract from *Reynoutria sachalinensis,* against powdery mildew of tomato (*Leveillula taurica*). *Biocontrol* **51**:375-92.

Draz, I. S., Elkhwaga, A., Elzaawely, A., ElZahaby, H.M. and Ismail, A. (2019) Application of plant extracts as inducers to challenge leaf rust of wheat. *Egyptian Journal of Biological Pest Control* **29**:6.

Hahn, M. (2014) The rising threat of fungicide resistance in plant pathogenic fungi:Botrytis as a case study. *Journal of Chemical Biology* **7**:133-41.

Hashim, M.S. and Devi K.S. (2003) Insecticidal action of the polyphenolic rich fractions from the stem bark of Streblus as per on *Dysdercus cingulatus.Fitoterapia* **74(7-8)**:670-76.

Hassan, M.A., Bereika, M.F.F., Abo-Elnaga, H.I.G., and Sallam, M .A. A. (2008) Management of potato bacterial wilt using plant extracts, essential oils, antagonistic bacteria and resistance chemical inducers. *Assiut Journal of Agricultural Sciences* **39**:141-59.

Hussain, A.I., Chatha, S. A. S., Noor, S., Khan, Z.A., Arshad, M. U., Rathore, H.A. and Sattar, M.Z. (2012) Effect of extraction techniques and solvent systems on the extraction of antioxidant components from peanut (*Arachis hypogaea* L) Hulls. *Food Analytical Methods* **5**:890-896.

Kaur, A., Chhabra, R., Sharma, R., Sharma, V.K., Sharma, P. and Khattar, N. (2023) Botanical extracts: A step towards eco-friendly pest management strategy. *Agricultural Research Journal* **60**(2):167-176.

Khoa, N.D., Thúy, P.T.H., Thúy, T.T.T., Collinge, D. B., & Jørgensen, H. J. L. (2011) Disease-reducing effect of *Chromolaena odorata* extract on sheath blight and other rice diseases. *Phytopathology***101**:231–240.

Nguefack, J., Leth, V., Lekagne Dongmo, J.B., Torp, J., Amvam Zollo, P.H., & Nyasse, S. (2008) Use of three essential oils as seed treatments against seed-borne fungi of rice (*Oryza sativa* L.). *American-Eurasian Journal of Agriculture and Environmental Science* **4**:554–560.

Paulsamy, S. and Jeeshna, M.V. (2011) Preliminary phytochemistry and antimicrobial studies of an endangered medicinal herb *Exacum bicolor* Roxb. *Research Journal of Pharmaceutical, Biological and Chemical Sciences* **2**:447-57.

Rana, A. (2008) *Melia azedarach*:A phytopharmacological review. *Pharmacognosy Review***2**:173-79.

Reglinski, T. (2009) Disease control in crops: Biological and environmentally friendly approaches. Chapter 4 In: Walters

D, editor. *Induced resistance for plant disease control.* Wiley-Blackwell; Oxford, UK. 62-92.

Rishi, K. and Singh, R. (2003) Chemical components and insecticidal properties of Bakain (*Melia azedarach* L.) - A Review. *Agricultural Reviews* **24(2)**:101-115.

Rizk, A. and Bashir, M.A. (1980) A chemical survey of sixty plants. *Fitoterpia* **53**:35-44.

Shabana Y M, Abdalla M E, Shahin A A, El-Sawy M M, Draz I S and Youssif A W (2017) Efficacy of plant extracts in controlling wheat leaf rust disease caused by *Puccinia triticina*. *Egyptian Journal of Basic and applied Sciences* **4**:67 -73.

Singh A, Rohila R, Savary S, Willocquet L and Singh U S (2003) Infection process in sheath blight of rice caused by *Rhizoctonia solani*. *Indian Phytopathology* **56**:434-38.

Singh, P., Mazumdar, P., Harikrishna, J.A. and Babu, S. (2019) Sheath blight of rice:a review and identification of priorities for future research. *Planta* **250**:1387-407.

Srinivasachary, S., Willocquet, L. and Savary, S. (2011) Resistance to rice sheath blight (*Rhizoctonia solani* Kuhn) [Teleomorph:*Thanatephorus cucumeris* (A.B. Frank) Donk.] disease:current status and perspectives. *Euphytica***178**:1-22.

Thakur, S., Singla, A., Chhabra, R., Kaur. M., Gupta, N., Bhardwaj, U. and Sharma, J.P. (2023) GC-MS Analysis for Phytochemical Profiling of Different *Salix* Clones. *Russian Journal of Plant Physiology* **70**:122.

Tony Cisse, K. (2005) Techniques for organic paddy cultivation. *Indigenous Agriculture News* **4**: 1-4.

Willocquet, L., Noel, M., Hamilton, R.S. and Savary, S. (2012) Susceptibility of rice to sheath blight: **A**n assessment of the diversity of rice germplasm according to genetic group and morphological traits. *Euphytica* **183**:227-41.

Yoon, M.Y., Cha, B. and Kim, J.C. (2013) Recent Trends in Studies on Botanical Fungicides in Agriculture. *Plant Pathology Journal* **29**(1): 1-9.