

Evaluation of Fungal Pathogens for the Biological Management of Water Hyacinth (*Eichhornia crassipes*)

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Abstract:

A survey of different water bodies in Raipur revealed that water hyacinth (*Eichhornia crassipes*) was affected by several fungal diseases, including petiole rot, root rot, dieback, leaf blight, and leaf spot. Ten fungal isolates representing different genera were obtained from infected plant parts. The highest level of infection was recorded on the leaf lamina, though only mild symptoms were expressed. Among the isolated fungi, *Colletotrichum dematium* occurred with the greatest frequency and thus appears to be a promising fungal candidate for the biological control of water hyacinth.

Key Words: Lamina, *Eichhornia crassipes*, fungal pathogens, *Colletotrichum dematium*.

Introduction:

Water hyacinth (*Eichhornia crassipes*) is a highly destructive aquatic weed that occurs in floating, submerged, and emergent forms, creating serious ecological and management problems. It has spread across thousands of water bodies in India, leading to the decline and loss of several species of aquatic flora and fauna. Severe infestations are commonly observed in ponds, reservoirs, irrigation and drainage systems, as well as in the river, particularly in areas with low water flow. This noxious weed spreads rapidly through vegetative reproduction, contributing to its aggressive expansion (Sculthorpe, 1971).

Due to its role in deteriorating water quality in affected water bodies, effective eradication and management strategies are urgently required. Consequently, extensive surveys have been undertaken to identify potential pathogens suitable for the biological management of water hyacinth. The successful use of the host-specific fungus *Cercospora rodmanii* in controlling water hyacinth has greatly stimulated interest in employing fungal pathogens for weed management (Conway and Freeman, 1977). Charudattan (2005) provided an in-depth perspective on the selection of suitable weed targets for effective biological control programmes.

In the present study, isolation and identification of fungi associated with infected water hyacinth were carried out, and their frequency of occurrence in infected samples was recorded. The study focuses on the isolation, identification, and screening of the most prevalent fungal pathogens associated with water hyacinth in Raipur, along with the determination of their frequency across different water bodies.

Material and Methods

Survey and Collection: Water hyacinth plant parts with disease symptoms were collected by Periodical survey, from various pools, ditches, ponds, etc., from the Raipur. The main water bodies surveyed were from Naya Raipur region. The plant specimens were collected and stored in polythene bags and brought to the laboratory where isolation and purification of the fungi was attempted.

Isolation of Fungi:

Small tissue pieces (approximately 2 mm in size) were excised from the margins of necrotic or chlorotic lesions present on the lamina and petiole. These segments were surface sterilized using 1% sodium hypochlorite solution for about three minutes and subsequently rinsed with sterile distilled water to eliminate surface contaminants (Hawker, 1950; Chopada et al., 2014). The sterilized tissue pieces were then aseptically placed on pre-prepared Petri plates containing potato dextrose agar (PDA) medium amended with streptomycin (75 mg L^{-1}) and a pinhead amount of rose bengal. The plates were incubated at $26 \text{ }^\circ\text{C}$ for 3–4 days in a BOD incubator (Agrawal and Hasija, 1986). Emerging fungal colonies were subcultured to obtain pure cultures (Johnston and Booth, 1983; Marak et al., 2014).

Purification and maintenance of Fungal culture:

The fungal species isolated earlier were purified using the streak-plate subculturing technique (Agrawal and Hasija, 1986). A total of fifteen purified isolates were multiplied on potato dextrose agar (PDA) plates. Stock cultures of the isolates were maintained on PDA slants, while working cultures were incubated in a BOD incubator at $25 \pm 1 \text{ }^\circ\text{C}$ and routinely transferred to fresh slants to ensure viability for experimental use.

Identification of the Fungi:

Identification of the isolated fungi was carried out by studying their cultural and morphological characteristics using standard manuals, monographs, and research papers. The fungi were identified

primarily on the basis of morphological features with the help of available literature, including Subramanian (1971), Ellis (1971), Barnett and Hunter (1972, 1976), and Sutton (1980).

Frequency of Fungi:

The distribution of fungi isolated from the various samples was studied, and the percentage frequency of each species was determined. Frequency, as defined by Raunkiaer (1934), refers to the number of sampling units in which a particular species occurs and thus represents the distribution or dispersion of species within a community. Based on this concept, the percentage frequency of each fungal species was calculated as follows:

$$\text{Percentage frequency} = \frac{\text{Number of sampling units in which the species occurred frequency}}{\text{Total number of units studied}} \times 100$$

Results and Discussion:

During a periodical survey of various water bodies in Raipur, water hyacinth was found to be associated with several fungal diseases, including petiole rot, root rot, dieback, leaf blight, and leaf spot. A total of fifteen fungal species were isolated from different parts of the infected water hyacinth plants. These included *Aspergillus niger*, *Alternaria* sp., *Cephalosporium* sp., *Cladosporium* sp., *Colletotrichum dematium*, *Curvularia lunata*, *Drechslera indica*, *Epicoccum nigrum*, *Fusarium oxysporum*, *Fusarium solani*, *Helminthosporium* sp., *Phoma* sp., *Rhizoctonia solani*, *Sclerotium* sp., and *Alternaria alternata*. The highest level of infection was recorded on the leaf lamina, although the disease symptoms expressed were minimal.

In the initial stage of screening, fifteen fungal isolates were evaluated, out of which four highly virulent isolates were selected for further studies. Based on their frequency of occurrence and the severity of symptoms produced, *Alternaria alternata*, *Colletotrichum dematium*, *Fusarium oxysporum*, and *Aspergillus niger* were found to be the most prevalent in infected parts of water hyacinth.

In subsequent screening, these pathogens were re-evaluated, and *Colletotrichum dematium* was identified as the most pathogenic isolate. This fungus is known to cause several important foliar diseases, with symptoms ranging from small leaf spots to severe blight, occasionally resulting in complete foliar death. In the present investigation, *Colletotrichum dematium* caused severe blight

on water hyacinth. Infection initially appeared on the lamina and petiole as small circular to irregular dark spots measuring 1–5 mm in diameter. These lesions gradually enlarged and coalesced, covering the entire leaf surface and ultimately leading to plant death. The culture of *Colletotrichum dematium* isolated in this study proved to be mildly pathogenic under growth chamber conditions.

Discussion:

Pathogens belonging to the genera *Alternaria*, *Fusarium*, and *Aspergillus* are facultative parasites and generally lack highly specialized mechanisms for host penetration (Aneja et al., 1993). Leaf spot or early blight diseases of water hyacinth have been reported to be caused by several fungal pathogens, including *Colletotrichum dematium* (FCWH#05), *Fusarium oxysporum* (FCWH#09), and *Alternaria* spp. (Marak et al., 2014). Similarly, pathogens of the genera *Fusarium*, *Alternaria*, and *Curvularia* have been described as facultative parasites with limited specialization for host entry (Aneja et al., 1993).

Several highly virulent fungal pathogens capable of infecting water hyacinth have been reported earlier. These include *Acremonium zonatum*, *Alternaria alternata*, *Alternaria eichhorniae*, *Bipolaris* spp., *Fusarium chlamydosporum*, *Helminthosporium* spp., *Cercospora rodmanii*, *Myrothecium roridum*, *Rhizoctonia solani*, and *Uredo eichhorniae*, all of which have been shown to cause significant damage to water hyacinth (Charudattan, 1982). An isolate of *Colletotrichum* sp. collected from China was reported to be highly virulent, producing a disease index of 65.28% after 30 days of inoculation, while an *Alternaria* isolate from the same region caused a 67% disease index within just 7 days of inoculation (Ding et al., 2008). These findings highlight the strong pathogenic potential of *Alternaria* species and their suitability as biological control agents.

Biological control of water hyacinth using plant pathogens has demonstrated substantial effectiveness in weed management. In the present study, a periodic survey of various aquatic bodies in Jabalpur was conducted, during which diseased water hyacinth plants and leaves were collected. All emergent fungi were isolated, resulting in the recovery of fifteen fungal isolates associated with this weed. Among these, *Alternaria alternata* (FCWH#15) caused the maximum damage to test plants under experimental conditions. These observations differ from several

earlier reports that identified other pathogens as more effective biocontrol agents (Nagraj and Ponappa, 1967; Charudattan and Rao, 1982; Shabana et al., 1995a, 1995b, 2000a, 2000b; Molo et al., 2001; Hubballi et al., 2010; Pathak and Kannan, 2011).

Table 1: Percentage Frequency of various Fungi associated with infected water hyacinth

S.No.	Name of Fungi	Infected plant part	Frequency (in %)
1.	<i>Aspergillus niger</i>	Lamina, Petiole and Root	45.1
2.	<i>Alternaria sp.</i>	Lamina, Petiole	30.4
3.	<i>Cephalosporium sp.</i>	Leaf	20.0
4.	<i>Cladosporium sp.</i>	Petiole	31.0
5.	<i>Colletotricum dematium</i>	Lamina	68.1
6.	<i>Curvularia lunata</i>	Lamina	30.0
7.	<i>Dreschlera indica</i>	Lamina, Petiole	22.0
8.	<i>Epicoccum nigrum</i>	Lamina, Petiole	25.0
9.	<i>Fusarium oxysporum</i>	Lamina, Petiole	48.2
10.	<i>Fusarium solani</i>	Lamina, Petiole	41.6
11.	<i>Helminthosporium sp.</i>	Lamina	28.2
12.	<i>Phoma sp.</i>	Lamina	12.1
13.	<i>Rhizoctonia solani</i>	Lamina, Petiole	30.0
14.	<i>Sclerotium sp.</i>	Petiole	18.0
15.	<i>Alternaria alternata</i>	Lamina	56.6

Conclusion:

The results of the present study and related observations indicate that *Colletotrichum dematium* exhibited the highest frequency and phytotoxicity among the tested isolates and was therefore selected as the most virulent strain and a potential biological control agent for the management of the noxious weed water hyacinth.

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