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SURVEILLANCE OF POTENTIAL PATHOGENIC FUNGI ASSOCIATED WITH WATER HYACINTH IN LAKE KAINJI, NIGERIA

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ABSTRACT

The entire Kainji Lake and the riverine areas upstream of Yauri were surveyed monthly between February and May 2002 with a motorboat to make full inspection of fungi-infested water hyacinth plants. Various parts of water hyacinth plant showing symptoms of fungal infection were collected, dried between paper towels, labeled, treated and planted onto growth agar media in petri dishes sealed with parafilm. All isolates were characterised for identification. On some older plants with larger leaves were found sporulating *Myrothecium roridum*. On the smaller plants with purple flecking lesions were isolates of *Alternaria eichhorniae* of, which were necrotic patches surrounded by chlorotic halos. The presence of *A. eichhorniae* in Nigeria indicates a great promise as its choice in most African environment by the International Mycoherbicide Programme for *Eichhornia crassipes* Control in Africa (IMPECCA) for development into a mycoherbicide. Other fungal pathogens isolated included *Rhizoctonia solani, Acremonium zonatum* and *Cercospora piaropi.*

Key words: Bio-control, pathogenic fungi, Kainji Lake, water hyacinth, identification

INTRODUCTION

The choice of the technique in handling the problem of aquatic weed may depend upon several factors such as ease of application, site accessibility, time scale, labour availability, economics, personal preference and legislative control. Employing a number of management techniques that reduce their growth and spread can abate the menace of water hyacinth and other aquatic weeds. Methods of control that have been successfully used include manual, mechanical, biological and chemical measures (Wunderlich, 1964; Misra and Das, 1969; Scott *et al.* 1979; Thyagarajan, 1984; Marytn, 1985; Charudattan, 1986; Schmidt, 1987; Jayanth, 1988; Joyce and Haller, 1984; Thielen *et al.* 1994).

Among these methods, biological control is considered the best, being environmentally friendly for solving aquatic weed problem. This method has been successfully used in USA, Australia, Argentina, India and Sudan to control water hyacinth (Goyer and Stark, 1984; Bashir, 1984; Jayanth, 1988). Large numbers of biotic agents have been investigated for their potential to control water hyacinth. However, only a few have been tested, cleared and released based on their effectiveness in field studies. Biotic agents that have been tried include pathogen, *Acremonium zonatum* (Cephalosponium), mammals (manatee), fishes (white amur) and weevils (*Neochetina* sp.).

The most successful agents are the weevils- *Neochetina eichhorniae* and *N bruchi*, the mite- *Orthogaluma tetrabrantis* and stem borer- *Sameodes albiguttalis*. However, DeLoach and Cordo (1976) in Argentina reported that the degree of suppression of water hyacinth by the weevils was about 10 – 35%, which was considered less than desired. Thus the need to use other agents to increase the effects of insect activities.

It was only recently that the incorporation of fungi pathogens in water hyacinth biological control programme received considerable interest and support. In 1971, the association of a fungus, *Cercospora rodmanni*, with a widespread decline of watel hyacinth in the Rodman Reservoir, a large impoundment of water near Orange Springs, Florida, was discovered (Conway, 1976). The fungus in its natural form is host specific to hyacinth and causes root rot and small spots on the margin of the leaf. *Cercospora piaropi* isolates when used to inoculate healthy water hyacinth leaves had been found to cause large scale, severe damage and a significant reduction in plant density (Martyn, 1985). Other fungus species used and found successful in USA was *Acremonium zonatum* (Harley, 1990). Other several fungi species have been known as effective pathogens in many places in USA, Argentina, India and Australia, but almost nothing is known of the fungi infesting water hyacinth in Nigeria including their host specificity and virulence.

This study was aimed at establishing baseline information on the Lake Kainji pathogenic fungi that are associated with diseased or decaying water hyacinth plants based on the criteria established by International Mycoherbicide Programme for *Eichhornia crassipes* Control in Africa (IMPECCA). And also to identify most promising pathogens, indigenous to Nigeria, which exhibit host specificity and virulence for water hyacinth.

MATERIALS AND METHODS

The entire Kainji Lake and the riverine areas upstream of Yauri were surveyed monthly between February and May 2002 with a motorboat to make full inspection of fungi-infested water hyacinth plants. During the surveys, sites with observed fungi-infested water hyacinth plants were located with the

aid of Geo-Positioning System (GPS) and recorded for subsequent revisits (Fig. 1). All leaf samples showing symptoms of fungal infection were collected, labeled, dried between paper towels that were replaced daily, and stored in a plant press. Particular caution was made by slicing only infected areas when collecting petiole samples due to high water content, which favours the growth of opportunistic fungal saprophytes and the degradation of samples. This was overcome by dissecting and storing only small sections. For sporulating symptoms such as *Myrothecium roridum*, spores were transferred with a flame-sterilised dissecting needle directly onto water agar. For other leaf samples, sections from each symptom type per site were surface sterilised by immersing in 5% Sodium hypochloride (NaOCl) for 2 to 3 minutes, followed by washing in sterile distilled water and planted onto water agar in petri dishes. Following labeling the dishes were sealed with parafilm. All samples were incubated and noticeable growth of fungi mycelia was observed after the third day that continued till the eighth day. These cultures were characterized and identified based on fungus colony growth and morphology, conidial measurements, ability to produce pigmentation on growth media (Reeder, 2001)

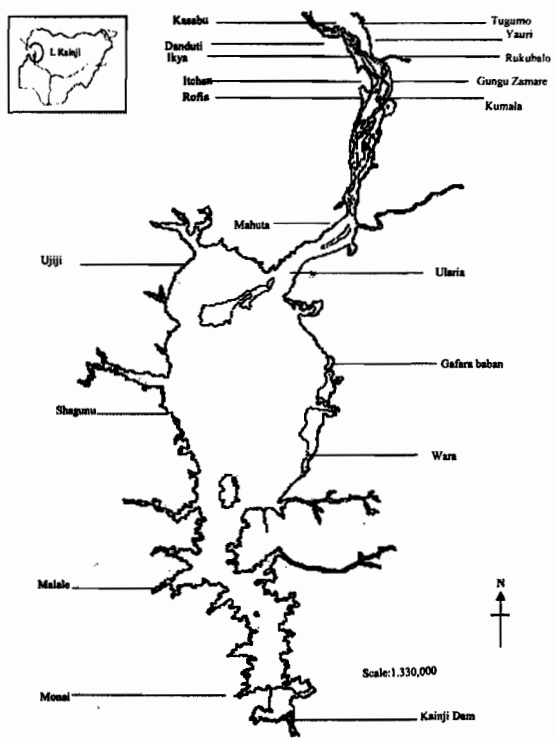

Fig 1: Map of Kainji lake and river Niger showing sampling sites

RESULTS

Not much water hyacinth was present on the Lake except around the northern edge and on the River Niger during the survey trips. On the infrequent, elongated, older water hyacinth plants there was extensive growth of saprophytic and patches of pathogenic fungi. Isolates of pathogenic fungi associated with water hyacinth occurring on Lake Kainji were identified and shown on Table1. One of the pathogenic fungi isolated from the leaves and petioles was *Alternaria eichhorniae,* usually on the smaller plants with purple flecks. In the field *A. eichhorniae* symptoms manifested in the form of leaf spots and leaf blotches usually on older leaves. Lesions were variable in size, ranging from minute brown, necrotic flecks to well developed spots, 5 x 6 cm in size. Several leaf spots were found occurring on a single leaf blade or as irregular blotches covering the entire leaf blade and also found on the petioles. On some smaller plants purple flecking lesions were present which appeared to be a physiological response or possibly a hypersensitive defense reaction to fungal attack. It was found that, severe infection in the form of several large spots or innumerable small spots culminated in the premature death of the leaf. Also, *A. eichhorniae* was surprisingly isolated from many such symptoms. However, at one site, leaves on such plants exhibited sporulating *Myrothecium roridum* lesions and at two other sites non-viable lesions were evident on dead leaves. This pathogen was more commonly found on older plants with larger leaves and it was speculated that symptoms would become scarce as these plants died and the less suitable prostrate plants predominated. More characteristic *A. eichhorniae* symptoms, of necrotic patches surrounded by chlorotic halos, were observed at a single site, Danduti, from which the pathogen was not isolated. The pathogen isolated from these symptoms was *Cercospora piaropi.* The Danduti site differed from the other locations visited because of an increased level of human activity, for instance, boat transport, washing of clothes and children playing which resulted in stress to the plants via damage to petioles.

Another pathogenic fungus isolated and identified was *Acremonium zonatum* around Kasabu area. In its natural form it has a very distinct necrotic zonate lesions with dark and light concentric bands. Lesions observed were small to large, merging to cover most of the leaf surface. Other pathogenic fungi isolated and identified included *Rhizoctonia solani,* a fungus that favours conditions of high rainfall.

DISCUSSION

The relatively low water hyacinth population during the surveys between February and May 2002 was attributed partly to the presence of the boom, but the most important factor is the previous integrated control efforts of NIFFR (Daddy *et al. 2000*; Ayeni

et al. 2002). It was interesting to note that all populations of water hyacinth observed showed at least minimal damage due to weevil attack (Daddy *et al.* 2002). However, results of studies carried out to date clearly shown that *N. eichhorniae* and *N. bruchi* are effective biological control agents but their impacts are too gradual compared to the aggressive proliferation of water hyacinth (DeLoach and Cordo, 1976). Thus, the recent increased interest in the incorporation of fungi pathogens in water hyacinth control programme (Conway, 1976) to boost efficacy of pathogenic control agents. Despite the fact that fungi pathogens have been present in the country ever since the weed first appeared, their record, symptomology, pathogen description, spread and impact on water hyacinth are few and scanty. Among the 18 world acclaimed fungi pathogens (Caunter, 1982) in the control of water hyacinth five species were recorded in this study (Table 2). Considering the diverse ecological differences of Nigeria aquatic systems more of these fungi pathogens are expected. *A. eichhorniae* was first reported as a potential biocontrol agent for water hyacinth in 1970 in India (Nag Raj and Ponnappa, 1970). Subsequently the fungus was recorded on this host from various other regions in India (Charudattan, 1973), Bangladesh (Badur-ud-Din, 1978), and in 1987 in Egypt (Shabana, 1992; Shabana *et al.*, 1995). Shabana *et al.* (1994, 1995) have demonstrated the safety, efficacy and feasibility of using an isolate of *A. eichhorniae* (Ae5) as a mycoherbicide for water hyacinth in Egypt. They reported that none of the 97 economically important, non-target plant species and cultivars evaluated in host range trials was susceptible to Ae5 and found that its efficacy for controlling water hyacinth increased with the number of applications and type of the formulations. Although records have affirmed *A. eichhorniae* to be an aggressive, safe and desirable pathogen for the control of water hyacinth but the genus is composed of about 50 species (Shabana *et al.* 1995) including many highly host specific and nonspecific pathogens. With adequate funding and collaborations with other relevant institutions the existing naturalized genus *Alternaria* sp. can be developed to boost the efficacy of the obligate weevils for the control of water hyacinth that is vastly taking over the intricate inland water systems.

Another pathogenic fungus isolated from a typical *A. eichhorniae* necrotic patch was *Cercospora piaropi.* Although they show distinct features it is possible that the symptoms represent early stages of infection. But because of the large number of flecks covering whole leaf areas it seems unlikely that a sufficient number of spores were contained in the air to achieve this, particularly as no actively sporulating lesions were observed. It is possible that the symptoms represent early stages of infection. In the field *C. piaropi* causes numerous brown spots, discrete on young leaves and petioles, but spreading and leading to chlorosis and necrosis on older plants. These are usually dark in colour and have grey centre. However, these symptoms are also similar to *C. rodmanii,* yet to be identified on Lake Kainji. *Acremonium zonatum* has been extensively used as a biological agent in America (Harley, 1990). In its natural form it shows very distinct necrotic zonate lesions with dark and light concentric bands. Although *Myrothecium roridum* and *Rhizoctonia solani* have not been extensively used as *A. eichhorniae* and *A. zonatum* but their presence on Lake Kainji is an indication that the environment is suitable and under adequate technique, for integration in the management of water hyacinth.

Although there are some difficulties associated with the use of plant pathogens in the biological control of water hyacinth, new research initiatives, such as the International Mycoherbicide Programme for *Eichhornia crassipes* Control in Africa (IMPECCA) project, are in progress to ensure its successful bio-control in Nigeria.

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Table 1: Sites visited during survey of Lake Kainji, symptom type and fungal pathogens isolated.

Site Name	GPS Coordinates	Water Hyacinth Growth Condition	Foliar Symptom	Fungal Pathogen Isolated
Gungu Zamare	10°45.25N 004°42.23E	Prostrate type. Taller, older plants infrequent	Purple flecks: Non viable, *Myrothecium roridum*, old symptoms on large, dead or drying leaves.	*Alternaria eichhorniae*
Ikya	10°47.92N 004°42.36E	Prostrate type	Purple flecks:	*A. eichhorniae*
Rukubalo	10°47.97N 004°43.18E	Prostrate type. Taller, older plants infrequent and producing ramets of the prostrate type	Purple flecks:	*A. eichhorniae*
Rofia	10°45.93N 004°42.40E	Prostrate type	Purple flecks:	*A. eichhorniae*
Itchan	10°48.48N 004°43.03E	Prostrate type	Brown patch with dark margin:	*Myrotheium roridum*
Yauri	10°49.40N 004°43.58E	Prostrate type. Taller, older plants infrequent	Purple flecks: Teardrop lesion, sporodochia on upper surface:	*A. eichhorniae* *M. roridum*
Kasabu	10°50.49N 004°44.26E	Prostrate type	Purple flecks: Brown pat h with dark margin:	*A. eichhorniae* *Rhizoctonia solani*
Danduti	10°50.49N 004°44.26E	Prostrate and damaged by human activity	Necrotic dots surrounded by chlorotic halo:	*Cercospora piaropi*
Kumala East	10°51.72N 004°44.30E	Prostrate type	Purple flecks:	*A. eichhorniae*
Kumala	10°52.05N 004°43.76E	Prostrate type	Purple flecks:	*M. roridum*
Kumala North	10°53.10N 004°43.33E	Prostrate type	Purple flecks:	*A. eichhorniae*
Kasabu	10°49.36N 004°42.41E	Robust petioles and tall plants	Purple red flecks on leaf surface	*Acremonium zonatum*
Tugumo	10°55.36N 004°42.20E	Prostrate type. Taller, older plants infrequent	Purple flecks: Non viable, *M. roridum*, old symptoms on large, dead or drying leaves.	*M. roridum*

Table 2: Main Potential Fungi Species as Biological Agents for Water Hyacinth

Species	Remarks
Alternania eichhorniae	Found on Kainji Lake
U. eichhorniae	
Acremonium zonatum	Found on Kainji Lake
Bipolaris stenospila	
Cercospora piaropi	Found on Kainji Lake
C. rodmanni	
Curvularia lunata	
Aspergillus niger	
Fusarium sp.	
Helminthosporum sp.	
Myrothecium roridum	Found on Kainji Lake
Mucor sp.	
Rhizoctonia solani	Found on Kainji Lake
Phaeotrichoconis crotalariae	
Curvularia tuberculate	
Septofusidium elegantulum	
Penicilluim oxalicium	
Trichoderma virede	

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