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## Fight against water hyacinth *Eichhornia crassipes* (Mart.) Solms, 1833. A review Lutte contre la jacinthe d'eau *Eichhornia crassipes* (Mart.) Solms, 1833. Revue de littérature

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### KEY WORDS

Water hyacinth, Biological-  
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**Abstract** Water hyacinth originating from South America was introduced into several regions of the world as an ornamental plant. Its biological characteristics, including capacities of sexual and asexual reproduction ways very effective, its high growth rate and productivity, allowed it to colonize freshwater communities and be very competitive to other plant species. *E. crassipes* shows the most significant growth rate in comparison with other terrestrial or aquatical species. Because of its ecological and socio-economic impacts, it belongs to the "100 most harmful invasive species in the world". Documentary research has been done without taking into account the results obtained over the last decades concerning various techniques used to eradicate its proliferation. This study shows that methods of physical, chemical and biological control have been adopted and given the limitations of use of these different methods, studies are still being carried out to remedy its expansion.

### MOTS CLES

Jacinthe d'eau, Lutte  
physique - chimique et  
biologique.

**Résumé** La jacinthe d'eau originaire d'Amérique du Sud a été introduite dans plusieurs régions du monde comme plante ornementale. Ses caractéristiques biologiques, notamment ses capacités de reproduction par voies sexuée et asexuée très efficaces, son fort taux de croissance et sa productivité élevée, lui ont permis de coloniser rapidement les milieux d'eau douce et d'être très compétitive vis-à-vis des autres espèces végétales. *E. crassipes* est l'espèce végétale, par comparaison avec d'autres espèces terrestres ou aquatiques, qui présente le taux de croissance le plus important. En raison de ses impacts écologiques et socio-économiques, elle fait partie des «100 espèces



envahissantes parmi les plus néfastes au monde. Une recherche documentaire a été réalisée sans partie pris des résultats obtenus au cours de ces dernières décennies concernant des différentes techniques utilisées en vue d'éradiquer à sa prolifération. Il ressort de cette étude que des méthodes de lutte tant physique, chimique que biologique ont été adoptées et compte tenu des limites d'utilisation que présentent ces différentes méthodes, des études continuent d'être menées afin de pallier à remédier contre son expansion.

## 1. Introduction

Aquatic plants are of vital importance to humans and animals. They are also ecological important through the processes of oxygenation and purification of water. Thus maintaining the balance of the aquatic ecosystem. Some aquatic, submerged or surface, plants only become invasive under certain conditions. These invasive plants are one of the most important threats to biodiversity of native species [37] *Eichhornia crassipes* is among these invasive aquatic plants because of its excellent reproductive power. It has invaded many areas around the world and it is adapted to tropical and subtropical climates [33].

Water hyacinth is a perennial herbaceous monocotyledon belonging to Pontederiaceae family, genus *Eichhornia*, a specific epithet: *Crassipes* (Martius) Solms-Laubach [45]. It favors calm or low-flow water, and supports seasonal variations in current speed [42]; [9]. Its growth rate varies with the density of the developed vegetation mat and some environmental conditions such as water temperature and nutrient concentration [46]. It has two modes of reproduction: sexual and asexual reproduction. Sexual reproduction is minority reproductive mode. The optimum climatic conditions for the sexual reproduction of the species are close to 90% humidity of the air. The vegetative growth of *E. crassipes* occurs mainly in the spring and is manifested by the emission of stolons and buds and by the growth of existing plants [9].

Having become a real plague in fresh water around the world, this invasive species alter the functioning of aquatic ecosystems, threatening fisheries, docking, tourism and even human health because it offers a supportive environment to snails and carrying mosquitoes vectors of schistosomiasis, malaria and other diseases [24].

Infestation of water bodies by *Eichhornia crassipes* causes a significant or even total reduction of indigenous aquatic plants; the installation of a herbaceous carpet dense blockage of the penetration of light and navigation. This is followed by a release of foul-smelling odors due to their putrefaction [25]; [11].

Several methods of struggle against this plant have been adopted but none of them has produced a satisfactory result. This article summarizes the work carried out in the past in order to eradicate its proliferation.

## 2. Materials and methods

As part of this study, the documentation has led us to the libraries, documentation centers of Abomey-calavi University, the Food Agriculture Organization, the Ministry of the Environment, Habitat and Urban Planning, the Directorate of Fisheries of the International Institute of Tropical Agriculture A etc., websites were also explored.

Several documents (reports, books, articles, books, theses and dissertations) have also been exploited. This study lasted a total of four (4) months and it emerged that methods of physical, chemical and biological control have been adopted and studies continue to be carried out in order to remedy the proliferation of water hyacinth.

It should be noted that the major difficulty encountered during this study is the free access to the results of the work recently carried out.

## 3. Results and discussion

### 3.1. Physical control

Manual or automatic plants, harvesting is the first technique used in the control of *E. crassipes*, and has long been privileged over other methods in poor countries [21].

Despite the disadvantages of this technique (mainly its high cost and low efficiency), it has often been used to control water hyacinth invasion and has yielded satisfactory results in various areas. However this method of control would contribute to the dispersion of water hyacinth through the fragments of plant left in the water after collection. Moreover, it is difficult to use these devices in deep water [37].

### 3.2. Biological control

This control method is based on the use of natural enemies (insects, aquatic herbivores, phytoherbicides) of the plant in order to put a permanent pressure on it [17].



### 3.2.1. The biological basis of insect control

Although the weevils *N. eichhorniae*, *N. bruchi* and lepidopteran *N. albiguttalis* are the insects that are commonly most in biological control against *E. crassipes*, other arthropods have been tested, mainly the Heteroptere *Eccritotarsus catarinensis*, lepidopteran

*Xubida infusellus* and the mite *Orthogalumna terebrantis* [34]. Table 1 summarizes the agents used in this method of struggle and the countries in which these agents were introduced.

Tab. 1: Biocontrol agents against *E. crassipes* used, with countries and years of introduction

Species Countries	<i>Neochetina bruchi</i>	<i>Neochetina eichhorniae</i>	<i>Niphograta albiguttalis</i>	<i>Eccritotarsus catarinensis</i>	<i>Xubida infusellus</i>
Australia	1990	1975	1977		
Benin	1992	1991	1993	1999	
China	1996	1996		2000	
Congo	1999	1999			
Cuba	1995				
Egypt	2000	2000			
Fiji		1977			
Ghana	1994	1994	1996		
Honduras	1989	1990			
India	1984	1983			1986
Indonesia	1996	1979			
Kenya	1995	1993			
Malawi	1995	1995	1996	1996	
Malasia	1992	1983	1996		
Mexico	1995	1972			
Mosambiqua	1972	1972			
Myanmar		1980			
Nigeria	1995	1993			
Panama	1977		1977		
Philippines	1992	1992			
PNG	1993	1986	1994		
Rwanda	2000	2000			
Solomon Islands		1988			

Source: [34]



It follows that *Neochetina eichhorniae* is the most widely used species and continues to be used in all parts of the world because it makes it possible to fight effectively against water hyacinth and permanently.

Following the host status study in thirteen different countries, this species of weevil showed a very strong restriction on eating, laying and survival only on the water hyacinth. [15] reported a 53% reduction in plant density, 67% plant height, 29% leaf per plant, 41% leaf diameter, and 65% plant leaf biomass seedlings with the application of *Neochetina* spp in China.

[2] observed a reduction in the biomass of water hyacinth with *Neochetina* spp from 1991 to 1993 on the rivers Ouémé and Zou in Benin. However, although they are highly effective control agents against *E. crassipes*, the limitations of this method of control include the short life cycle of insects and their inability to destroy plants, especially adult plants. Moreover, the weevil effect is proven after several years and is closely dependent on environmental conditions such as climate, hydrology, phytosanitary status of the plant and the number of insects released [34].

### 3.2.2. Fighting with mycoherbicides

Several studies showed the effectiveness of several mycoherbicides as means of fight against water hyacinth but three species of fungus *Acremonium zonatum*, *Eichhorniae Alternaria* and *Cercospora piaropi* revealed in the laboratory of interesting features for combating biological *E. crassipes*. Indeed, these pathogens can cause significant damage on the leaves of *e. crassipes*, causing a decrease in the biomass of the plant, without reaching his mortality.

The use of these pathogens is mainly oriented to application coupled with other control techniques, biological or chemical. For example, the use of *Acremonium zonatum* has often been associated with the mite *Orthogalumna terebrantis*; and the fungus *Cercospora piaropi* is mainly designed to be used as a bioherbicide applied in complementarity with weevil *Neochetina* spp [14].

However, promising, the use of pathogens as agents of biological control against *E. crassipes* is still at an experimental stage (Cf. Table 2).

**Tab. 2 : Promising mycoherbicides for water hyacinth in worldwide**

Target weeds	Potential biocontrol agent	Countries where the mycoherbicide is developed	Stage of development
<i>Eichhornia crassipes</i>	<i>Alternaria eichhorniae</i>	Egypt	Field tests
	<i>Alternaria alternata</i>	India, Egypt	Field tests
	<i>Fusarium pallidoroseum</i>	India	Field tests
	<i>Fusarium chlamydosporum</i>	Egypt, India	Field tests
	<i>Cercospora piaropi</i>	USA, Mexico	Greenhouse tests
	<i>Myrothecium</i>	USA, India, Indonesia, Malaysia	Greenhouse tests
	<i>Uredo eichhorniae</i>	Egypt, Brazil, Argentina, Uruguay	Greenhouse tests
	<i>Acremonium zonatum</i>	USA, Egypt, Asia, Mexico	Greenhouse tests
	<i>Drechslera sp.</i>	Egypt	Greenhouse tests
	<i>Phoma sp.</i>	Egypt	Greenhouse tests
	<i>Alternaria jacinthicola</i>	Mali	Field tests
	<i>Cadophora malorum</i>	Mali	Field tests

Source : [19]

### 3.2.3 Fighting with Herbivorous Aquatic Animals

Some species of fish such as Chinese carp, *Ctenopharyngo idella*, as well as carp *Tilapia melanopleura* and *T. mossambica* feed on water hyacinth. Chinese carp is used across the USA to reduce the density of the aquatic plants in water courses devoted to the sport of fishing. However, the species is not specific to hyacinth [37]. The manatee *Trichechus manatus*, a large, exclusively herbivorous mammal, consumes floating or submerged herbs such as seedlings and water hyacinth, and can consume an average of 50 kilograms of plants per day.



Its introduction into the waters invaded by water hyacinth would be an adequate solution to combat the proliferation of this species.

### 3.3. Chemical control

2,4-Dichlorophenoxyacetic acid (2,4-D) generally sprayed on water hyacinth plants at concentrations between 1 and 12 kg of 2,4-D / ha is one of the most used. This product in its various forms can be used based on the type of environment to deal with and corresponding to varying levels of toxicity to the animal species [9]; [19].

Moreover, the Rodeo, composed of glyphosates and used at a rate of 2 kg/ha is a non-selective herbicide and presenting no toxicity to aquatic organisms [37].

Other products such as paraquat; highly toxic but one of the most widely used herbicides in the world is marketed to control water hyacinth. Copper sulfate or copper chelates used at 3.5 mg/l concentration act as inhibitors of the growth of the plant and are lethal at rates of 103 mg/kg of dry weight, but are toxic for fish, some mammals and aquatic invertebrates [9].

KWHO2 at 1.5kg / ha doses reduces the number of new twigs produced by the plant and it's not present any ecological risk [16].

As water hyacinth is associated with freshwater, the use of sodium chloride to combat its expansion gave indisputable results, notably in Ivory Coast where the opening of the Comoe river pass in Grand Bassam Was an undeniable success [20].

The main purpose, the evacuation of most of the water hyacinth has been reached. But, this method of control resulted in hydrological, sedimentary and ecological changes in the lagoon area near the pass, creating a new estuarine zone [7]. The limit of use of this technique is based on the efficacy and toxicity levels of the different products developed.

### 3.4. Valorisation of water hyacinth as a means control

Many trials of valorization of the plant are being studied especially in the developing countries because the presence and the fight against this invasive plant is economically costly. But, none of these activities has actually led to industrial development [17]. It's also important to point out that developing countries should not encourage the spread of hyacinth for use. The interests of their people will be saved by seeking rather an effective and control the plant as long-term by its valuation [28].

## 4. Conclusion

Infestation of water by hyacinth is one of the causes of the disappearance of floristic and faunal diversity of the ecosystems invaded by this species. Moreover, this plant is inedible for most species of fish or snails; only some herbivorous mammals can contribute to the fight against this hydrophyte. FAO has led numerous initiatives in Africa to control invasive aquatic plants. Despite numerous attempts to upgrade the plant, which unfortunately did not develop industrially, water hyacinth remains the most important aquatic weed in Africa. In addition to various techniques used against its expansion, additional means based on other natural enemies of water hyacinth would be desirable in order to obtain a lasting and effective control.

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