National regulatory control systems
Systèmes de lutte nationaux réglementaires

Eichhornia crassipes

Specific scope

This standard describes the procedures for control of *Eichhornia crassipes*.

Specific approval and amendment

First approved in 2009–09.

Introduction

Details on the biology, distribution and economic importance of *Eichhornia crassipes* (Pontederiaceae) can be found in OEPP/EPPO, 2008.

Eichhornia crassipes is an introduced exotic pest of the EPPO region originating from South America. This species is considered one of the most invasive aquatic plants worldwide and is on the EPPO A2 list of pests recommended for regulation. The plant has detrimental economic impacts: it is a threat to agriculture, plant health, the environment, public safety, recreation activities, water quality and quantity and human health.

Eichhornia crassipes has impacts on agricultural production worldwide. The most important impacts of the plant on crop yield are caused by water loss and increasing irrigation costs.

While *E. crassipes* is already present in Israel, Italy, Portugal and Spain, it is still absent in other parts of the EPPO region. The main pathway of introduction is as an ornamental plant for ponds and for aquaria.

This plant is well adapted to survive the existing procedures usually used for aquatic weed management such as the killing and removal of plants, and draw down. *Eichhornia crassipes* is a free-floating and mobile macrophyte on variable water levels. It tolerates desiccation, its flowers and seeds can be produced within 12 weeks after germination. Reproduction is both vegetative, via daughter plant production, and by seeds. Daughter plants are spread through wind and wave action. In the Guadiana river in Spain, doubling time varied between 10 and 60 days (Téllez *et al.*, 2008a). Seeds are produced in very large numbers, and persist in the seed bank for up to 20 years.

Countries with areas at risk may wish to regulate this plant at the national level to prevent introduction into non-invaded areas and to manage infested areas. This EPPO Standard includes general recommendations on the surveillance and control of *E. crassipes*.

EPPO member countries at risk are advised to prepare a contingency plan for the surveillance, eradication and containment of this pest.

This standard presents the basis of a national regulatory control system for the monitoring, eradication and containment of *E. crassipes* and describes:

- Elements of the monitoring programme that should be conducted to detect a new infestation or to delimit an infested area
- Measures aiming at eradicating recently detected populations (including an incursion)
- Containment measures: to prevent further spread in a country or to neighbouring countries, in areas where the pest is present and eradication is no longer considered feasible.

Regional cooperation is important and it is recommended that countries should communicate with their neighbours to exchange views on the best programme to implement, in order to achieve the regional goal of preventing further spread of the pest.

For the efficient implementation of monitoring and control at a national level, cooperation between the relevant public bodies (e.g. NPPOs, Ministries of Environment, Ministries in charge of water management, etc.), as well as with other interested bodies (private sector, associations) should be established.

Monitoring of *E. crassipes*

An annual delimiting survey (according to the ISPM no. 6 *Guidelines for surveillance*, IPPC, 1997) is necessary to determine the geographical distribution of the plant and its prevalence. Such information is necessary to determine control measures. Control strategies need to be adjusted on a case-by-case basis according to the density and occurrence of the plant within a country.

Priority areas to survey are ponds, lakes, rivers, canals, water tanks, etc., with a focus on waters rich in nutrients. The whole

water surface should be monitored, but particular attention should be paid along the shoreline and amongst vegetation.

Eradication of *E. crassipes*

The eradication programme for *E. crassipes* in the case of recently detected populations (including an incursion) is based on the delimitation of an area within the country and the application of measures to both eradicate and prevent further spread of the pest. The feasibility of eradication for *E. crassipes* depends on the size of the area infested and the density of the plants. These measures are described in Appendix 1.

Containment of *E. crassipes*

The containment programme for *E. crassipes* in the case of established populations is based on the application of measures to prevent further spread of the pest in the country or to neighbouring countries. These measures are described in Appendix 2.

Communication

This species is very easily recognizable, and professionals (administration, managers of water reserves, etc.) as well as the public (e.g. in schools, public places, etc.) should be informed about its threats. A wide public could take part in monitoring the species (see Nang'alelwa, 2008).

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Appendix 1 – Eradication programme

The eradication process involves four main activities:

- Surveillance to fully investigate the distribution of the pest
- Containment to prevent the spread of the pest
- Treatment and/or control measures to eradicate the pest when it is found
- Verification of pest eradication.

Surveillance

A delimitation survey should be conducted to determine the extent of the pest distribution (see monitoring). Infested areas and adjacent areas, especially downstream, that might receive seed or vegetative reproductive parts, should be monitored.

Containment

Preventive measures include the prohibition of planting of *E. crassipes* and prohibition of its release into the wild. Unintentional transport of seeds or reproductive vegetative parts through water currents, fishing equipment, machinery and boats should be avoided. Equipment and machinery should be cleaned to remove mud before moving to an uninfested area. In water, fences (that extend into the substrate under shallow water) could be placed to prevent the spread downstream of the plant. Booms and cables can be used to prevent *E. crassipes* from entering hydro-power coolant intakes, fishing areas, drinking water intake areas, etc. The weight of mobile mats of aquatic plants, when pushed by wind or flow, or through growth expansion, can break booms and fences.

Treatment and control programme

Treatment should start early in the growing season and continue as long as regrowth is noted. Chemical and mechanical controls are the two most effective treatment measures for eradication.

Control

Eradication is only possible if there are few and accessible populations of *E. crassipes*. A combination of mechanical and chemical control may give better results (see Appendix 2).

Mechanical control Mechanical control aims at removing biomass of the plant and shall be used in conjunction with the use of fences or barriers to prevent the plant from spreading. It is also used to prevent the plant from entering some areas, e.g. to prevent *E. crassipes* clogging water supplies and hydroelectricity turbines. The remoteness and difficult accessibility of many infestations makes mechanical control unfeasible.

In Spain, crane trucks equipped with a grapple, backhoes with buckets, and 35 meter boom cranes are used (Téllez *et al.*, 2008b).

See EPPO Website on the Workshop on *Eichhornia crassipes* for illustrations.

Manual control can be done through hand-pulling or using pitch forks. This is widely used in developing countries, it is very labour intensive and can be an employment creation exercise. Operators should be warned not to spread the plant by leaving some parts in the water, and to remove mud from their footwear.

Mechanical control includes a wide range of equipment to collect and remove the plant: bulldozers, grapple buckets swung from shore or from boats, self propelled collecting machines that pick the plant up then dump their load on shore via conveyors, dump trucks, etc.

The management cost to remove nearly 200 000 tonnes of the plant was 14 680 000 EUR for 2005 to 2008 in the Guadiana river (for around 75 km of river) (Cifuentes *et al.*, 2007). It represented 65 723 working days and necessitated the use of crane trucks equipped with a grapple, backhoes with bucket, and 35 m boom cranes (Téllez *et al.*, 2008b).

In Portugal, the management in the Municipality of Agueda cost 278 000 EUR from December 2006 to May 2008, including the purchase of the mechanical harvester and its monthly running costs, as well as almost 1800 labour hours. Three persons were employed for this purpose in 2006 and 2007, and one during 2008 (Laranjeira & Nadais, 2008). A water harvester and a truck were used.

Eichhornia crassipes' biomass is high since the plant contains around 95% water. Calculations must be made to determine how much wet weight of material can be removed per unit of time, since collecting boats have already sunk (e.g. in Lake Victoria in East Africa). Plants pulled out should be put in waste disposal, or dried and then burnt (requirements for the treatment of biowaste of plant origin to ensure its phytosanitary safety are presented in PM 3/66 *Guidelines for the management of plant health risks of biowaste of plant origin.* OEPP/EPPO, 2006).

Chemical control Herbicides have been widely used to control small to medium size populations of *E. crassipes* that are accessible. The remoteness and difficult accessibility of many infestations makes chemical control unfeasible. Chemical control has the advantage of being quick and temporarily effective, but must be regularly and frequently reapplied (Center *et al.*, 1999). *Eichhornia crassipes* is very susceptible to 2,4-dichlorophenoxyacetic acid (2,4-D), diquat, and glyphosate (Gopal, 1987). These herbicides have resulted in successful control in small, single purpose water systems such as irrigation canals and dams of around 1 ha in size (Wright & Purcell, 1995).

It should be noted that all products should be used following the label instructions and in line with the relevant plant protection product regulations. For applying glyphosate in aquatic systems for example, it is important to assess the impact on non target species. The use of glyphosate in enclosed waters is generally prohibited, and such products should not be used in sites infested by *E. crassipes* used for drinking water and fishing.

In the European Union (EU), glyphosate and 2,4-D presently have registered aquatic uses. Availability varies significantly from country to country and the current product approvals are subject to change under the EU review process for plant protection products. There are presently no known registered aquatic uses for diquat in the EU.

Glyphosate has proven successful while used in Spain (Grupo de Investigación en Biología de la Conservación de la Universidad de Extremadura, 2006). After the use of herbicides, the mats of *E. crassipes* collapse (nearly 6 weeks after application) and should ideally be removed. The use of herbicide is often not appropriate in developing countries as it is expensive. Chemical control often involves treating areas that can be reached from land or by boat, since the cost of using hovercraft, fixed-wing planes or helicopters is prohibitive. In the USA, ongoing waterway weed control program including *E. crassipes,* using herbicides costs around 3 million USD per year in Florida, and 2 million USD in Louisiana. They have been going on for decades (Schmitz *et al.*, 1993), and will likely continue *ad infinitum*.

Verification of pest eradication

Chemical or mechanical measures should be conducted until there is no sign of *E. crassipes*. Since the seeds can survive for many years in the soil, follow-up monitoring should be undertaken for approximately 20 years.

Appendix 2 – Containment programme

In the case of an established population, eradication is difficult to achieve and often, the objective is the suppression of the plant. Containment measures aiming to prevent further spread of the pest to endangered areas or to neighbouring countries should be applied.

As for eradication, measures to prevent spread from an infested area should be applied (see Appendix 1, Eradication programme). Chemical and mechanical control (as described in Appendix 1) may be implemented to suppress populations of *E. crassipes.* Applying a combination of different measures may prove more effective, as was the case in Mexico, using the herbicide 2,4-D and machinery for removal (Gutierrez *et al.*, 1996), where reasonably successful results were obtained.

Hydrological control

Reducing the water level of impoundments to desiccate *E. crassipes* is generally limited in effectiveness. In most situations, it is not possible to remove the large volume of water needed to cause the plant to desiccate. Then, plants must be collected as they survive well on mud. In addition, seed-bank germination can occur with re-filling (Barrett, 1989).

Biological control

In tropical countries biological control is considered to be the only method that offers economical and sustainable control of the weed (Harley *et al.*, 1996). In temperate areas (e.g. Southern Africa, the USA and China) acceptable levels of control have not been achieved through this method, or biological control is perceived to be too slow acting. In tropical areas establishment of an efficient biological control of *E. crassipes* under ideal conditions can last three to five years (Julien *et al.*, 1999). To date, biological control agents have been released in at least 33 countries (Julien & Griffiths, 1998). The most successful agents used throughout the world being the weevils *Neochetina bruchi* Hustache (Coleoptera: Curculionidae) and *N. eichhorniae* Warner, and the pyralid moth *Niphograpta albiguttalis* (Warren) (= *Sameodes albguttalis* (Warren)) (Lepidoptera: Pyralidae) (Julien *et al.*, 2001).

When population density is high, *Orthogalumna terebrantis* (Acarina: Galumnidae) can produce large number of feeding galleries on *E. crassipes* leaves and damage the plant (Hill & Cilliers, 1999). This agent has been released in many countries, and a post release evaluation is currently underway in South Africa.

Although many of the control agents have been successful in controlling populations of *E. crassipes* in many tropical areas, herbivore pressure on *E. crassipes* could be further increased by the introduction of additional control agents (Stanley & Julien, 1999). Research and development of useful agents to add to the list is being undertaken (see Coetzee & Hill, 2008).

It should be stressed that the release of biological control agents may be subjected to specific procedures nationally.

Integrated control

In areas where frost can cause high mortality of the biological control agents but the plant is able to survive during winter, an integrated management approach is followed. This includes a combination of biological control, herbicide applications, manual removal and possibly most importantly, the management of nutrients entering the aquatic ecosystem (Hill & Olckers, 2001). Jones & Cilliers (1999) and Jones (2001) developed an integrated

management programme for the Nseleni River system in the more tropical region of South Africa. The key elements of this approach were primarily the appointment of one individual or organisation to drive the control programme, the involvement of all interested and affected parties on the river system, the division of the river system into management units and the implementation of appropriate control methods for each of these management units. Using this integrated approach, some 19 km of river that was previously 100% covered by water hyacinth was initially cleared using mainly herbicide application and is maintained at 5% weed cover through biological control with occasional follow-up herbicide application around sensitive sites (water extraction localities) when necessary. This control operation occurred between 1995 and 2000 (Jones, 2001) and represents an example where a river has been returned from being heavily impacted by water hyacinth to a fully functioning aquatic ecosystem through appropriate management (Hill & Coetzee, 2008). Nevertheless, the use of herbicide may have deleterious effects on biological control agents such as *Neochetina bruchi* (Sushilkumar & Pandey, 2008).