BIOLOGICAL CONTROL OF AQUATIC WEEDS IN RESERVOIRS

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ABSTRACT

The free floating weeds (Eichhornia crassipes, Lemna minor, etc.) and submerged aquatic weeds like Hydrilla verticillata, Vallisneria zennichelia, Chara sp., Algae, Potamogeton natans, etc. are problematic aquatic weeds in the water bodies of India. The spread of these aquatic weeds through reservoirs, canals and drains after construction of high dams exemplifies the need for concern. These water systems have slowly been infested with the aquatic vegetation which has caused many problems; they hamper the water flow which results in reduced carrying capacity, increase water loses by evapotranspiration, interfere with water distribution, etc. The control of aquatic weeds due to their high reproduction rate and perennial growth has become a global problem.

This paper discusses the management of some aquatic weeds in reservoirs biologically. The studies include the control of Eichhornia crassipes (Water Hyacinth) with the use of two host specific weevils i.e. Neochetina eichhorniea and Neochetina bruchi and submerged weeds with Ctenopharyngoden idella fish (Grass carp). The studies undertaken at Irrigation & Power Research Institute have shown that the Ctenopharyngoden idella readily consumes the aquatic weeds like Chara sp, Hydrilla verticillata, Vallisneria zannichelia, Potamogeton crispes, algae, etc. in its preference order. Biological control by using the host-specific insects and other organism is an alternative method that offers long term potential for control of aquatic weeds in water bodies. It is relatively inexpensive and free from harmful environmental impact.

INTRODUCTION

The aquatic environment is an essential habitat to many life forms, including various insects genera and genera of aquatic or amphibious snails that play the role in the transmission of human disease. These diseases are closely associated with water resource development projects (Irrigation development, hydro-power dam and reservoirs for drinking water supply) and the impact on the local human health status is substantially compounded by aquatic weed infestation of such projects.

Large number of aquatic plants growing in India is of exotic origin (Gupta, 1976). Eichhornia crassipes (Water hyacinth) belongs to the family of Pontederiaceae, which is entirely aquatic group. Water hyacinth has spread within 100 years from its home base in South America to all over the world (Vietmeyer, 1975). It has created problems in about 50 countries including India. It made its entry into Bengal about 1896 (Biswas & Calder 1954), now occurs throughout India in fresh water ponds, pools, tanks, ponds, lakes, reservoirs, streams, rivers, irrigation channels and drains. Water hyacinth is considered to be the most problematic aquatic weed worldwide.

In India it is estimated that 2 lacs hectare of surface water is covered with Water hyacinth. In Punjab, Water hyacinth has infested all the seepage-cum-anti flood drains, village ponds, barrages (Harike) etc. The removal of this weed mechanically can not overtakes its propagation because even one plant or seed escapes removal double its number in 10 days. The seed of this weed sink to the bottom mud where they can remain viable for as long 20 years (Gopal & Sharma, 1981).

Water hyacinth can be controlled using chemicals and mechanical removal. However, the only sustainable solution to Water hyacinth is biological control. Biological control, especially with the aid of insects used in classical biological control strategy, has been successful in reducing water hyacinth infestation in several countries. Biological control with the use of host-specific natural enemies to reduce the population density of pest. These enemies can be parasites, predators or pathogens and even competitors. Weevils are most appropriate for the control of water hyacinth as they usually come from the native habitat of the weed and are amongst the natural control agents that keep the species at reasonable population "at home". Being host specific, they rarely affect other plants within the ecosystem.

The *grass carp* also known as white amur (Ctenopharyngodon idella) is the largest member of the minnow family is indigenous to large coastal rivers in Siberia (Amur River) and China that flows into Pacific Ocean. The herbivorous fish have proven both effective and relatively easy for aquatic weed control. A genetically modified triploid grass carp has been produced that is sterile, there is no danger if these fish escape as they are incapable of reproduction. The biological control with Triploid grass carp became widely used method of aquatic weed control. Grass carp feed largely on soft, stemmed submerged weeds such as hydrilla, potamogeton, ceretoplyllum, chara, filamentous algae, vallisneria, etc.

The biological control work undertaken at Irrigation & Power Research Institute, Amritsar for water hyacinth with two insects Neochetina eichhornea and Neochetina bruchi has been presented in this paper. The studies have explored the potential of herbivorous fish to control the submerged aquatic weeds.

MATERIALS AND METHOD

Water Hyacinth

Irrigation and Power Research Institute, Punjab, Amritsar got these insects i.e Neochetina eichhorniea and Neochetina bruchi from Indian Institute of Biological Control, Banglore in 1986. The multiplication of weevils was taken up in the premises of I.P.R.I. in pucca pits measuring lm x lm x 80cm. The weevils were released with fresh Eichhornia plants brought from the field. The tank was filled with fresh water, 25 gm. of superphosphate and 10 gm urea to get healthy plants and for quick multiplication of insects. These adult weevils were allowed to lay eggs on Eichhornia plants for 15 days. After egg laying weevils were handpicked and again used for exposing the fresh water plants in the tanks and the process was repeated many times. The plants with laid eggs were stocked in the different channels. Harvesting of adults from these channels was started for 90 days after the start of the process. The channels and tanks were examined daily for feeding spots and symptoms of weevil activity. The harvested weevils were kept in plastic container covered with cloth mesh or tissue paper with water hyacinth leaves.

Some 2000 adults of both Neochetina species were released in pond situated in Harike wild life sanctuary in Distt. Ferozepur. And similar number of weevils was released at the Gobindgarh Forte pond outside the walled city of Amritsar in 1995. The weevils were released all along the periphery of about 5-acre area pond with 1 m water depth. The process of releasing the weevils was repeated during the ensuing years. About 46000 weevils were released in the Harike wild life sanctuary.

Submerged Aquatic Weed

The experiments to study the feeding behaviour of grass carp were carried out in the semi field conditions. Study was initiated in the ponds to know the preference of various weeds by grass carp when all the varieties of aquatic vegetation were present in the same vicinity.

Table 1: Common submerged aquatic plants and preference by grass carp

Common Name	Scientific Name	Preference
Hydrilla	Hydrilla verticellata	High
Pondweed	Potamogeton natans	Moderate
Coontail	Certophyllum sp	.High
Duckweed	Lamna minor	Moderate
Eelgrass	Vallisneria zennichelia	Moderate
Stonewort	Chara sp.	High
Water hyacinth	Eichhornia crassipes	Low
Cattail	Typha angustata	Low
Filanentous algae	Sprirogyra sp	High

Experimental pond was filled with water and six grass carps of 30 cm size were released in it. Different aquatic weed species were tied in bundle of 1 kg each and placed in pond. After every 24 hours weed bundles were recovered from the pond, drained and dried. The balance weed was weighed to determine the consumption by the grass carp. Experiment was conducted fore a month . The consumption of each weed species (Table 1) by Ctenopharyngodon idella. was correlated with the growth of the fish

RESULTS & DISCUSSION

N. eichhorniae and N. bruchi established readily under the field condition at all release sites with in 3 months. Weekly visits to the release sites in each pond were conducted to determine the establishment and spread of weevils. Many feeding scars were observed on water hyacinth leaves, suggesting the establishment of Neochetina weevils at the release sites. It was observed that most of water hyacinth plants in the lake has come under the impact of biotic agents.

Both N. eichorniae and N. bruchi were found to be effective in controlling water hyacinth. The results are better in land locked ponds where there is least disturbance and places where ponds do not dry up during summer season. From the perusal of table 2 & 3, it is clear that during initial 2 years of weevil infestation the impact on water hyacinth is not very significant. After the third year when the number of weevils per plant reaches 3, there is marked decrease in vegetative parameters of weed plant. When the number of insects per plant increased to 5 or

more per plant a rapid deterioration of weed colonies was observed. In Harike wild life sanctuary entire area was cleared in the 6th year. Almost same condition was observed in Gobindgarh Fort pond. Biological control by using host-specific insects and other organisms is an alternative method that offer long term potential for control of water hyacinth. The suppression of water hyacinth by Neochhetina eichhornae has been reported from USA (Center and Balciunas, 1982), Australia (Wright, 1984), Sudan (Irwing and Beshir, 1982) and Egypt (Fayad et.al; 2001). Control of water hyacinth by release of N. bruchi has been reported from Argentina (Deloach and Cordo, 1983). Most recently control of water hyacinth has been achieved using two beetle agents (Neochetina sp.) (Mukiibi, 1999).

Table 2. Effect of Neochetina sp. on *Eichhornia crassipes* in Harike wild life sanctuary pond

Date	Vegetative Parameters of the Water hyacinth plants				
	Average Weight (gm)	Average Height (cm)	Average width of leaf (cm)	No. of Leaves	Average No. of weevils
09/1995	1.4	120	12	15	-----
09/1996	1.2	105	13	10	1
09/1997	1.0	85	12	8	3
09/1998	0.55	50	10	6	3.5
09/1999	0.20	32	4	3	5
09/2000	0.10	20	3	2	6
09/2001	---	----	----	----	----
09/2002	---	----	----	----	---

Under the climatic conditions of Punjab where aerial portion of Eichhornia plants dry up during winter season, the build up of Neochetina species stops during this period. Due to the cold winter in Punjab, more than 4 years are required for the biological control methods to be effective.

Table 3 : Effect of Neochetina sp. on *Eichhornia crassipes* in Gobindgarh Forte pond

Date	Vegetative Parameters of the Water hyacinth plants				
	Average Weight (gm)	Average Height (cm)	Average width of leaf (cm)	No. of Leaves	Average No. of weevils
09/1995	1.7	120	18	15	-----
09/1996	1.5	102	16.5	13	1
09/1997	1.2	85	15	10	3
09/1998	0.8	57	9.5	7	4
09/1999	0.4	25	6.3	4	5
09/2000	0.25	12	2.4	3	6
09/2001	---	----	----	----	----
09/2002	---	----	----	----	---

Results of the experiments performed with *Triploid grass carp* indicate that it began feeding on microscopic animals called zooplankton untill they are about 2 inch long. They become dedicated vegetarians after they reach a length of about 4 inches. The amount of weed consumed bt the grass carp depends upon several environmental conditions such as water temperature, water chemistry and the kind of plants available. The observation reveals that soon after stocking, fish become associated with aquatic vegetation. Grass carp has been found to consume the aquatic weed given in Table 1. Those plants that grass carp do not consistently control are rated as "low" in preference (Table 1). Grass carp exhibit definite food preference and some aquatic plant species will be consumed more readily than others. The plants that are not preferred will be consumed only after the favorites are finished. The relative preference of the available aquatic weeds in Irrigation system of Punjab was as follows.
Hydrilla > Chara > Spirogyra > Vallisneria > Potamogeton > Lemna minor.
Hydrilla verticillata and similar soft stemmed species are always most preferred and their elimination is very effective. The consumption of various aquatic weeds with size and weight of fish is reported in table 4.

Table 4. Average Consumption of aquatic weed swith size and weight of grass carp.

Average length (cm)	Average weight (gm)	Consumption of Aquatic weeds (gm)				
		Hydrilla	Vallesnwria	Lamina	Potamogeton	Sprirogyra
5	6	8.5	6.0	--	4.5	8.0
10	10	25.3	22.0	32.1	607	---
15	38	32.0	26.5	---	---	50.8
17	51	56.4	48.1	46.8	---	78.0
19	70	---	52.5	---	16.4	107.5
20	96	94.0	65.5	50.7	18.1	115.2

Consumption rate of the aquatic weed vary with the size of grass carp (Table 4). Triploid grass carp can consume more than their own body weight of fresh vegetation in a single day.

CONCLUSIONS:

Both Neochetina species were found to be effective in controlling Eichhonia crassipes. The results are better in land locked ponds and ponds do not dry up during summer season. Under the climatic conditions of Punjab where the area portion of water Hyacinth plants dry up during winter season, more than 4 years are required for biological control method.

Most of the submerged aquatic weeds are readily consumed by the Grass carp.Grass carp can effectively be used for the submerged aquatic weeds.

10-15 grass carps of 25-30 cm size are sufficient to clear an acre area of infested reservoir or canal.

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