Aquatic Weeds And Their Management In India

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Introduction

Among the many developing nations, India with its more than 547 million people is by far the second most populous nation of the world. With a land frontier of 15,200 km and a coastline of 6,083 km, it covers a land area of 3,267,500 sq km. This area, although only about one third that of the United States, supports a population three times as great. Progress in India is hindered by many basic problems. One of paramount importance is the need for greater development of irrigation resources to increase food-crop production to meet the rapidly growing needs of the people. Since independence, the total land area under irrigation has increased from 22.6 million to over 37.5 million ha. The increase was made possible by development of river valley projects such as Chambal Irrigation Project, Kota and Bhakra Nagal Canal System, Punjab. With the longest canal system in the world, the irrigation potential of the major and medium irrigation projects of India has more than doubled. Today, a large part of the 1.0 million ha of inland water-area in this country is threatened by the invasion of noxious aquatic weeds. Nearly 2,800 km of the Bhakra Canal in the Hissar District itself is so badly infested with weeds that it has to be cleaned six times a year.

The total water potential of India, determined by mean annual river flows, is estimated to be 1,672,590 million m^3. Of this resource, the estimated volume for irrigation is 666,000 million m^3 (9). As the irrigation facilities are expanded, the infestations of aquatic weeds multiply rapidly and today they are often the greatest cause of inefficient use and loss of water. Some of the main canals, and the network of drainage and seepage channels, are so badly infested with these weeds that they reduce the capacity of water flow from 50 to 80%. Aquatic weeds are a potential danger to the entire water system because they clog grates, siphones, valves, and sprinkler heads. Because of the diverse climatic conditions and the wide range of rainfall (from little or nothing in the western deserts to over 1,000 cm annually in the Khasi Hills of Assam), some species of aquatic weeds persist in many areas and pose critical and continuous problems. Temperatures vary from freezing during most of the year in the North to 49 C or more in the deserts of Rajasthan during the summer. However, year-round favorable temperatures in most of the country promote a luxurient growth of aquatic flora.

THE PROBLEM WEED SPECIES

Dense colonies of aquatic weeds are observed in the North, East, and Central parts of the country as well as along the coastal regions comprised mainly of U.P. Punjab, Hissar, Rajasthan, Madhya Pradesh, W. Bengal, Bihar, Kerala, Andhra Pradesh, and Orissa. These regions are by far the most seriously effected and many beautiful lakes and ponds have been devastated by weed growth and are now abandoned. Waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) has spread up through the plains of India, infesting thousands of bodies of water. On the other hand, the flow of water in canals is reduced drastically (40 to 90%) by submersed weeds such as pondweeds (*Potamogeton* spp.) and southern naiad (*Najas guadalupensis* (Spreng.) Magnus). Vast swampy areas, ditchbanks, drainage channels, and flood-control channels are becoming infested with cattails (*Typha* spp.) which are often designated as India's worst weed (3, 11, 20). In addition to problems caused by emersed weeds such as cattails, the semi-aquatic weeds such as canarygrass (*Phalaris arundinacea* L.), and the submersed weed hydrilla (*Hydrilla verticillata* Royle) are rapidly infesting large bodies of water. Waterhyacinth spreads readily by water currents, strong winds, and passing boats. Sometimes, it also spreads by seeds. When the water is shallow and the temperature is high enough for germination, seeds become a potent source for reinfestation of cleared areas. The potential for growth of alligatorweed (*Alternanthera philoxeroides* (Mart.) Griseb) is staggering. A plant may produce 17 m of lateral growth in one season. Upwards of 10 metric tons of root growth per ha is possible in the top 10.16 cm of soil. The depth of fleshy roots in the soil may be 90 cm or more (19).

Although an intensive survey of the infestation of the waterways in North and South India has not been completed, in the West an attempt was made to determine the most prevelant types of weeds in the Chambal Canal. Gupta (7) has published a list prepared by Brezny and Mehta reporting the following aquatic weeds to be most prominent in this region (Table 1). It is estimated that about 1,500 ha of the Chambal Irrigation System is infested with submersed weeds, whereas there are 10,000 ha of emersed weeds. The ponds in the Western region are full of eelgrass, waterhyacinth, waterferns (*Salvinia* spp.) naiads, hydrilla, pondweeds, duckweeds, (*Lemna* sp.) *Wolfia* spp.), and many others.

Weeds such as johnsongrass (*Sorghum halepense* (L.) Pers.), bullrushes (*Scirpus* spp.), quackgrass (*Agropyron repens* (L.) Beauv), reeds, cattails, and puncture vine (*Tribulus terrestris* L.) on ditchbanks are major obstacles in irrigating crops like sugarcane, rice (*Oryza sativa* L.), vegetables, and many fruit trees. The use of sprinkler irrigation is not yet common in India due to its high cost. Consequently, water is distributed largely by systems of

TABLE 1. AQUATIC WEEDS IN THE CHAMBAL CANAL.

Common Name	Scientific name
Waterhyacinth	*Eichhornia crassipes* (Mart.) Solms.
Eelgrass	*Vallisneria americana* (Michx.)
Cattails	*Typha* spp.
Duckweed	*Lemna minor* L.
Giant duckweed	*Spirodela polyrhiza* (L.) Schleid.
Curley leaf pondweed	*Potamogeton crispus* L.
Sago pondweed	*Potamogeton pectinatus* L.
Redheadgrass	*Potamogeton pusillus* L.
Swamp morningglory	*Ipomoea aquatica* Forsk.
Waterfern	*Azolla pinnata* R. Br.
Watersmartweed	*Polygonum glabrum* (serrulatum Lag.)
Coontail	*Ceratophyllum demersum* L.
Hydrilla	*Hydrilla verticillata* Royle
Arrowhead	*Sagittaria guayanensis* H.B.K.
Waterclover	*Marsilea uncinata* A. Br.
Waterclover	*Marsilea quadrifolia* L.
Reeds	*Phragmites* spp.

ditches and furrows. No effort has been made to determine accurately the extent of water loss due to these weeds in India, but it is generally believed to vary between 20 and 40%. Studies on water losses reported as early as 1958 by Timmons and Klingman[1] may be cause for alarm and recognition of the gravity of the problem. Ditchbank weeds are not only potential sources of invasion into croplands from seed or other viable structures (1), but they also cause flooding, seepage, evapo-transpiration loss (13), decreased water delivery, and silting in irrigation channels. A recent study made in India (14) of the evapotranspiration losses of six dominant emersed and floating weeds revealed that waterchestnut (*Trapa natans* L. var. *bispinosa* Roxb.), waterlettuce (*Pistia stratiotes* L.), and swamp morningglory did not increase water loss significantly, but loss of water due to waterhyacinth was 30 to 40% higher, that due to narrowleaf cattail (*Typha angustifolia* L.) was 60 to 70% higher, and that due to nutsedge (*Cyperus rotundus* L.) was 130 to 150% higher than from a free-water surface. Apart from the staggering water losses caused by these weeds, they are also a great menace to fish culture (17). Very frequently fish are killed and their culture prevented by decomposition of masses of aquatic weeds which deplete the dissolved oxygen in the water.

Since rice (*Oryza sativa* L.) is a major cultivated crop in India, weed problems in rice culture are of great concern. Nearly 40,000 ha of rice land around Vembanad Lake and large areas along the canal systems of Kottayam, Alleppey, and Ernakulum in Kerala State are severely infested with waterfern, spikerush (*Eleocharis* sp.), waterlily (*Nymphaea stellata* Willd.), waterhyacinth, and waterlettuce (18.). The rice crop suffers severely from competition when infested by aquatic weeds during the initial stages of growth. The losses may range from 30 to 60%. The prevelant method of flooding the field for rice cultivation magnifies the threat of aquatic weed infestation by way of the incoming waters.

AQUATIC WEED CONTROL IN INDIA

The diverse habitat and the varied growth forms of aquatic weeds make it difficult to find an effective approach to their control. Some control of aquatic weeds can be accomplished by chemical, biological, mechanical, or physical methods; or by combinations of these. No one method seems to be a panacea due to the complex nature of the aquatic environment. Herbicides are by far the most modern and effective method of aquatic weed control, but they are too costly in the Indian economy. Chaining, dredging, and cutting are still the most common methods used in India even though they are less effective and more time consuming. Many herbicides are used to control submersed, emersed, and floating aquatic weeds (5). Their economical and safe use has yet to be determined under the largely tropical conditions of India. Biological control offers a means of coping with aquatic weeds over extensive areas where the cost of chemical or mechanical methods are prohibitive, or where hazards make the use of chemicals impractical. Biocontrol agents such as fish, snails, insects, birds, and mammals; as well as pathogens and competetive plants, are being employed to control weeds in different situations in the United States as well as in India (2, 3, 4, 6, 7, 8, 10, 15, 16). Tests conducted in India at the Central Inland Fisheries Research Sub-Station in Cuttack, India and the United Nations Development Programme at Kota, India are encouraging. The white amur (*Ctenopharyngodon idella* Val.) was used to eliminate hydrilla, naiad (two of the worst submersed weeds), coontail, and species of *Ottelia*, *Nechamandra*, and *Unicularia*.

SOLUTION OF INDIA'S AQUATIC WEED PROBLEM

The rapidly growing problem of weeds in the aquatic ecosystem of India demands more serious attention. Extensive research to develop suitable techniques that are effective, economical, and environmentally acceptable are critically needed. The following steps should be taken to satisfy this need:

1. Conduct an extensive and intensive survey to establish the distribution, prevalence, and economic impact of noxious aquatic weeds in India.

2. Establish a strong National Research Project for research on management of problem aquatic vegetation. Areas of research should include ecological studies: biological, chemical, and mechanical methods of control; and methods for economic utilization of aquatic plants.

3. Create an aquatic weed control awareness among the population by means of films, posters, and news items.

4. Make herbicides and herbicide application equipment more readily available to research workers and other people who are intimately affected by the encroachment of aquatic weeds in irrigation systems and other habitats suitable for their growth.

5. Expand aquatic research with the assistance of funds and technical aid through the PL 480 Program.

6. Establish a coordinating committee consisting of members from agencies concerned with agriculture, engineering, irrigation, health, fisheries, and economic development.

This committee would be instrumental in establishing and directing research on problems and goals common to all agencies.

[1]Timmons, F.L. and D.L. Klingman. 1958. Control of aquatic and vegetation and phreatophytes. Presented at the AAAS Meeting, Sect. O — Water in Agriculture. December 29-30.

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Water Level Manipulation: A Tool For Aquatic Weed Control

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INTRODUCTION

Louisiana has 6.4 million acres of fresh water wetlands with 1.5 million acres in lakes and reservoirs over 1.0 square mile in size (12). The fresh water to land ratio is 1:12 on a statewide basis. There are at least 40 reservoirs 1,000 to 32,000 acres in size excluding Toledo Bend, a joint Louisiana-Texas reservoir of 180,000 acres on the Sabine River. These reservoirs average in depth from 4 to 8 ft (12).

Carver (1) said, "Louisiana's streams are the target of several agencies which propose "work of improvement" for flood control, water storage, and navigation. Approximately 64 new reservoirs on Louisiana streams are planned for construction in the future. The Soil Conservation Service, acting under the authority of PL-566 has watershed projects under construction or in planning stages for most of the major watersheds in the State." With 1.5 million acres presently in lakes and reservoirs over 1.0 square mile in size and 64 new reservoirs in the planning stage, it becomes obvious the importance these waterways have in Louisiana's economy. The shallow water depth of these areas and long growing seasons in Louisiana are conducive to lush growths of aquatic vegetation.

The following information has been garnered from field experience and general observations in managing Louisiana's reservoirs where water level manipulation is an accepted tool for fishery management and aquatic weed control.

PLANT PROBLEMS

Louisiana has a severe aquatic weed problem, primarily submersed and emersed species, in 35 of its reservoirs. Twenty-five reservoirs have management plans designed for improvement of the fisheries, lake renovation, and control of aquatic weeds. Aquatic weed problems in our natural lakes are generally minor, however there are some exceptions. These exceptions are usually traceable to a man-made barrier which tends to stabilize the water body.

Due to the severity of the aquatic weed problems in Louisiana's reservoirs, some type of control practice has