

Aquatic weeds problems in India

— Challenge for management

Sushil Kumar¹ and Adikant Pradhan²

Directorate of Weed Science Research, Jabalpur (Madhya Pradesh) 482 004

Aquatic plants are important in an aquatic ecosystem because they provide food and habitat to many aquatic fauna besides to fishes. When these aquatic plants lose their utility and cause nuisance become unwanted vegetation are called aquatic weeds. Aquatic weeds are also responsible to reduce the available water resources of India by way of high evapotranspiration through weeds in general and water hyacinth in particular. Water hyacinth has become a notorious weed to deplete water rapidly because it can cause 4- to 5-fold evapotranspiration than other aquatic vegetation. Heavy expenditures are required to control aquatic weeds due of their fast growth. In India, the per caput average annual freshwater availability has reduced from 5,177 cubic meters from 1951 to about 1,869 m³ in 2001 and is estimated to further come down to 1,140 m³ in 2050. The developing countries as a whole are expected to expand their irrigated area from 202 million ha in 1997 to 242 million ha by 2030. According to World Bank, agricultural irrigated land (% of total agricultural land) in India was 35.12 million ha in 2009, which has increased about 47.7% in 2013-14. This increase could be possible due to various completed and ongoing river valley projects. Today, a large part of inland water-area in this country is threatened by the invasion of noxious aquatic weeds. Irrigation canals in Haryana and Punjab are badly infested with weeds, which has to be cleaned many times in a year to sustain the flow of water. Therefore, it has become essential to manage aquatic weeds to save water for irrigation purpose and human use.

Key words: Aquatic, Challenge, Management, Weeds

According to habitat, weeds can be classified as submerged weeds, emerged weeds, dispersed weeds, shoreline weeds, ditch weeds, bank weeds, marshland weeds etc. There are situations where vast areas of land- remain inundated with water for long periods of time, and may only dry out in severe drought conditions. Such lands are known as marshes or swampy and may be infested with amphibious species like *Alternanthera philoxeroides* (alligator weed), *Marsilea minuta* (pepper weed), *Monochoria vaginalis* (carpet weed) and *Paspalum fluitans* (water paspalum) etc. Emergent weeds grow in shallow waters and situations existing near the water-bodies where water recedes and rises with the

seasons or regular releases from a large water body or reservoir. These weeds may be called semi-aquatic but more appropriately referred to as emergent aquatic weeds e.g. *Typha angustata* (narrow-leaved cattail), *Phragmites communis* (common reed) and *Ipomea carnea*. Some of the weeds freely float and move long distances e.g. *Eichhornia crassipes* (water hyacinth), *Pistia stratiotes* (water fern) and *Lemna minor* (duck weed). Some weeds float on the water surface but their root anchor down to soil at the bottom of the water body e.g. *Sagittaria guayanensis* (arrow head), *Nelumbo nucifera* (lotus) and *Nymphaea alba* (white water lily). Those weeds, which germinate, grow and reproduce

below the water surface, are called submerged weeds. The roots of such weeds remain in soil at the bottom of the water body. These weeds may be further divided as shallow water submerged weeds e.g. algae like *Chara zeylanica* (musk grass), *Nitella hyaline* (stone wart), higher plant like *Najas minor* (naiad), *Vallisneria spiralis* (eel weed), *Potamogeton crispus* (curly leaf pond weed) and deep water submerged weeds like *Myriophyllum spicatum* (eurasion water milfoil), *Hydrilla verticillata* (hydrilla) and *Utricularia flexuosa* (bladderwort)

Detrimental effect of aquatic weeds in India

There are about 160 aquatic weeds in India, of which 10 species namely,



Fig. 1. Ponds infested with water hyacinth and lotus

Eichhornia crassipes, *Salvinia molesta*, *Nymphaea stellata*, *Nelumbo nucifera*, *Hydrilla verticillata*, *Vallisneria spiralis*, *Typha angustata*, *Chara* spp., *Nitella* spp., and *Ipomoea* spp. are of primary concern. Among these, *Eichhornia crassipes* (water hyacinth), *Salvinia molesta* (water fern), *Hydrilla verticillata* (hydrilla), *Alternanthera philoxeroides* (alligator weed) and *Pistia stratiotes* (water lettuce) are five primary aquatic weeds of the world and qualify the status of worst weeds in India also. It has been estimated that in Assam, West Bengal, Odisha and Bihar, water hyacinth invaded about 40% water surface, however, about 20 to 25% of the total utilizable water in India is currently infested with water hyacinth.

Aquatic weed problems in lakes and reservoirs

In Punjab, three wetlands namely Harike, Kanjili Kehhopur-Miani lake and Mand Bharthala were threatened by aquatic weeds like water hyacinth, *Potamogeton pectinatus*, *Hydrilla verticillata* etc. The famous Kolleru lake in the West Godavari often succumbed to invasion of *Eichhornia crassipes*, *Ipomoea aquatica*, *Typha*, *Vallisneria*, *Nymphaea*, and *Ulothrix* spp. In Tamil Nadu, almost 80% of 39,000 tanks are infested with aquatic weeds mainly water hyacinth and *Hydrilla verticillata* etc. The world famous Ootumund lake was ruined due to infestation of water hyacinth during 1990s and Government of Tamil Nadu had to incur huge expenditure to clean the lake because it was a major tourist attraction.

It is estimated that out of 8 lakh ha of freshwater available in India for pisciculture, about 40% is rendered unsuitable for fish production

because of invasion by aquatic weeds. Some of the well-known fishery lakes like Barwar, Ramgarh and Gujar lake in Uttar Pradesh, Ansupa lake in Odisha, Kollern lake in Andhra Pradesh, Loktak lake in Manipur and the world famous Dal, Nigeen and Walur lakes in Jammu and Kashmir were largely invaded by the aquatic weeds. In the coastal areas of Odisha, aquatic weeds inflict huge economic losses in rice production and fisheries. In the nutrient-rich fish ponds, blue-green algae (mainly *Microcystis* spp.) often cause mass mortality of fish.

Aquatic weed problem in rivers and irrigating canals

Bheema river in Maharashtra annually become badly infested with luxurious growth of *Pistia stratiotes*. Nearly 2,100 km of the Bhakra Canal System is badly infested along the bank regions. Vast swampy areas, ditch banks, drainage channels and flood-control channels are infested with cattails (*Typha* spp.) and *Ipomoea carnea* throughout India and are often designated as India's worst weed. *E. crassipes* (free floating), *Nymphaea stellata* (rooted floating), *N. nucifera* (rooted floating), *Hydrilla verticillata* (rooted submerged), *T. angustata* (emergent), *Sagittaria* sp., *Potamogeton* sp. (rooted submerged), *P. stratiotes* (free floating), *S. molesta* (free floating) are the major weeds which choke the rivers and irrigating canals in India. (Fig. 1.)

Damage in crop fields: Vast low land paddy area in India, particularly in north-eastern states of India, West Bengal, Bihar and Kerala become severely infested with aquatic weeds during rainy season. In the coastal Kerala, *Salvinia* spp., particularly *S. molesta* plays havoc, while in the north-east, *E. crassipes* *Chara* spp.

Nitella spp. and algal scums are nuisance. Cultivation of water chestnut (*Trapa bispinosa*) was also reduced in many region of India due to heavy growth of water hyacinth and other aquatic weeds in water-bodies. Alligator weed was reported to infest maize in Himachal Pradesh while water lettuce infested large area in Karnataka.

Problems in hydroelectric projects: Many steel producing plants and hydroelectric generating plants in country are regularly facing problem of water infestation by massive growth of aquatic weeds. For instance, Bhilai Steel Plant and Sarni Thermal power plant in Madhya Pradesh; Bokaro Steel Plant and Tata Iron and Steel Company in Jharkhand, Tungabhadra project in Karnataka, Nagarjuna Sagar project in Andhra Pradesh, and Kakki and Idikki reservoirs in Kerala are facing problems of aquatic weeds. The weeds became a problem to Blower and Pump House Department due to impeding flow of water in the pumps and making machinery non-functional by reaching through water supply system.

Problems in tourist lakes of India: The world famous lakes of Kashmir, namely the Dal, Nigeen and Wular are sick with aquatic weeds. Main Dal lake in Srinagar is infested with submerged weed hydrilla and water lily and often witnesses frequent algal blooms. This compelled Kashmir Government to spend huge expenditure for their frequent interval.

Management of aquatic weeds

The management of aquatic weeds is challenging job in comparison to weeds management in terrestrial situations. There is rarely a situation

when weeds can be 'eradicated' but often can be 'prevented' from infesting other areas. Once prevention fails the next step is to treating them in a way that they do not emerge again. Management of aquatic weeds can be done by following methods:

Preventive measures: In India, water hyacinth moves from one state to another through canal systems and rivers. The effective quarantine laws can be enacted and implemented by states to check the flow of water hyacinth from one state or city to another state or city. Yamuna river in Delhi and many other rivers in India become severely infested by water hyacinth during summer due to slow flow of water. In rainy season all moves to river course due to heavy water flow and rivers become clean after rains. But such rivers again become infested from the left remains of weeds or seeds. State government may prevent future infestation effectively at very low cost by prevention of new emergence of weeds through proper monitoring system.

Manual and mechanical methods: Manual removal of *Hydrilla* is regularly done in Dal lake and other lakes. There are several techniques like (a) netting, (b) barriers, (c) chaining, (d) water, weed cutters to control weeds in aquatic situations. Machine that cut and picks up the weeds from water body and convey these to shore simultaneously are called harvester and which are important machineries to manage aquatic weeds. In Dal lake, big harvester are in operation regularly to cut and remove various weeds. These are costly machine, hence are not in reach of the authorities of all water-bodies. To reduce the cost, at present, removal of water floating weed is generally being done with the help of JCB and Pokland machines. Water hyacinth mats are cut from mid of water-bodies and directed towards bank side, where biomass are lifted with the help of JCB and loaded on tractor trolley to unload elsewhere. To further reduce the cost of water hyacinth removal from infested water body, Mr Godasu Narasimha, a member of the fishing community

from Muktapur, Andhra Pradesh, has developed a machine that could easily remove this noxious weed at lesser cost. The interwoven mats of water hyacinth are cut and directed towards the conveyer belt of machine, which is fixed at shore that pulls the plants into a rotating shaft that moves into a chute provided with eight cutters positioned diametrically. The hyacinths are then cut into pieces. A tractor with trolley is positioned under the cutter and the cut pieces drop directly into the vehicle. Four men use this machine to remove the weeds for 5 days, which otherwise requires nearly 50 people to do manually for 2-3 months. The machine can be operated with the help of diesel engine.

Chemical method: Registered herbicides and algacides are widely used throughout the world to manage aquatic weeds; however, all aquatic weeds cannot be controlled by a single herbicide. In India, herbicides yet to be registered exclusively for aquatic weed control, nevertheless, these are being used to manage different types of aquatic vegetation. In the case of emerged and floating weeds, the herbicides are applied as a normal post-emergence as done on the crops. However, for control of submerged weeds, chemicals have to be applied on the total volume of water. The herbicide 2,4-D is most effective for control of water hyacinth. The smaller floating weeds like *Spirodela*, *Lemna* and *Azolla* can be fully controlled with 0.1 kg/ha of paraquat. *Nymphaea* can be controlled with 2,4-D ethyl ester while *Nelumbo* and *Euryale* with 2,4-D sodium salt. Five times less expenditure in chemical control than the manual control of water hyacinth has been estimated. But the use of herbicides is limited in India due to fear of causing harm to water quality and non-target organisms. The Directorate of Weed Research, Jabalpur, revealed that 2,4-D and glyphosate as the most effective herbicides against water hyacinth without causing significant detrimental effect of water quality and non-target organisms. Metsulfuron-methyl at 20 and 24 g/ha was found most effective to

control aquatic and terrestrial form of alligator weed, respectively without affecting fish and water quality parameters. No fish mortality was observed in ponds at Jabalpur when treated in large area with recommended doses of glyphosate, 2,4-D and metsulfuron-methyl to control lotus infestation. The effect of chemical and biological integration reduced the time of control, which would otherwise were done by using bioagents alone. Contrary to above observations, several researchers are of the opinion that herbicides are not totally safe, and inside the herbicide formulation may affect aquatic fauna like fishes besides, affecting water quality. Use of herbicides should always be done with the advice of experts.

Biological control: Exploitation of living organisms or their products to reduce or prevent the growth and reproduction of weeds is called biological control. It is one of the safest approaches keeping in view increasing awareness about the ill effects of chemicals. Any plant feeding organism may be used to control aquatic weeds, providing it does not harm plants of economic value or create undesirable imbalances in the plant community. It is estimated that biocontrol programme can yield enormously favorable returns on investment. By chemical methods, return is smaller (1:4), while it may be 1:1,000 in case of biological control. Biological control agents may be insect, pathogens, fishes, rodents, snails etc.

In India, spectacular success by bio-agents was achieved in many aquatic-bodies representing different states against water hyacinth by *Neochetina* spp. In Kerala, successful control of water fern (*Salvinia molesta*) was done by another bioagent *Cyrtobagous salviniae*. The success of biological control was found to depend on many factors like number of weevils released in the water-bodies and type of water body. For example, bioagents work fast in perennial type of water-bodies like ponds and lakes, while they hardly work effectively in running water. In stagnated water-body like ponds and



Fig. 2. A large pond heavily infested by water hyacinth (left photo) was controlled completely (right photo). In the middle photo, dry water hyacinth is indication of heavy damage by bioagent.

lakes, bioagents are able to multiply their population fast, while in running water it remains low. These bioagents are also not very effective against such water-bodies which dry fast during summer. In such cases, population buildup process is hampered as roots of water hyacinth or water fern anchored on the soil, which affect pupation process. This is reason that in some water-bodies, biological control is ineffective. Bioagent take longer time and effect may be visible after 16 to 30 months depending upon the type of water-bodies.

Not all weeds are likely to be easy targets for biocontrol. Likewise, the fungal pathogens tested so far have not proven consistently effective in controlling weed in field trials in India. It was estimated that degree of success is about 55.5% in biological control of aquatic weeds followed by homopterous pests (46.7%) against crop pests and terrestrial weeds (23.8%). In world scenario, at least three aquatic weeds were successfully brought under the banner of biocontrol, using specific insect bioagents. Among these water hyacinth and water fern have also been successfully controlled in India.

Use of fish grass carp, native to the large river systems of Eastern Asia (China, Siberia) and has been distributed worldwide for use as a food fish and for biological control of aquatic weeds. Natural reproduction of this fish is limited on a world-wide basis due to river modification and reservoir construction, but grass carp are easily produced in aquaculture

using artificial means. Among the several species of herbivorous fishes which feed on aquatic weeds, grass carp, *Ctenopharyngodon idella*, *Tilapia melanoplaura*, *T. zilli*, *T. nilotica* are used. Among these, *C. idella* is more effective. Grass carp feed voraciously on *Hydrilla*, *Azolla*, *Nechamandra*, and *Lemna* spp. in India. This fish is being used against submerged weeds in India.

Utilization of aquatic weeds

Aquatic weeds can be used for making paper, fiber board, files, bags, methane (CH_4) gas formation, mulching and compost. In India, in Kerala and north-east, several NGOs are using water hyacinth for purse, files, bags making. Water hyacinth was demonstrated to use as a effective mulch in many crops. Water hyacinth mulching helps to check the growth of weeds besides increase in yield. Good vermicompost may easily be prepared from water hyacinth. Use in mulching and compost making is most easiest way to utilize this noxious weed. In spite of many useful attributes, the use of aquatic weeds has not got popularity among the users. This aspect needs more research input for easy use of aquatic weeds.

SUMMARY

In India, floating aquatic weeds like water hyacinth, water fern, alligator weed and water lettuce; emergent weeds like lotus, cattail and water lily; submerged weeds like *Hydrilla*, bladderwort and eurasian water milfoil have become most

problematic weeds and causing many detrimental effects to men and environment. Several irrigation, steel plant and hydroelectric projects in the country are suffering with massive growth of aquatic weeds besides impeding flow of water and deteriorating water quality. Weed like water hyacinth enhances rates of evaporation many folds through evapotranspiration than that of open surface, hence is responsible for great loss of water. Aquatic weeds can be controlled by using several methods like prevention, manual, mechanical, ecological, biological, chemical and through utilization. Each method has its merits and demerits. In spite of costly methods, manual and mechanical approaches are being employed frequently in India due to quick relief. In big aquatic bodies, weeds harvesters are employed. Chemical control is also being done at small scale, but its use is limited owing to lack of many registered herbicides. Use of bioagents was demonstrated successfully for control of water hyacinth and water fern by using exotic weevil *Neochetina* spp. and *Cyrtobagaus salviniae* in different parts India but for several other aquatic weeds, suitable bioagents are not available. Use of grass carp fish is increasing in India for control of submerged weeds like *Hydrilla* with varying degree of success.

¹Principal Scientist (Entomology), Directorate of Weed Research, Jabalpur, Madhya Pradesh and ²Associate Professor (Agronomy), College of Agriculture, IGKV, Jagdalpur, Chhattisgarh. Corresponding author's e mail: sknrvs@gmail.com

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