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Review on Aquatic Weeds and Their Management

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ABSTRACT

When aquatic weeds grow too much, they pose a threat to fish farming. An essential component of pond management is weed control. Out of approximately 160 aquatic weeds, the primary focus in India revolves around *Eichhornia crrassipes, Ipomoea aquatica, Typha angustata, Ceratophyllum demersum, Salvinia molesta, Nelumbo nucifera, Alternanthera philoxeroides, Hydrilla verticillata, Vallisneria spiralis, Chara* spp., *Nitelia* spp., and *Potamogeton* spp. Aquatic weeds are rapidly expanding in several irrigation and hydropower projects across the nation, including the Kakki and Idikki reservoirs in Kerala, the Tungabhadra project in Karnataka, the Nagarjuna Sagar project in Andhra Pradesh and the Powai Lake in Maharashtra. Biological, chemical, and physical strategies can all be used to control aquatic weeds. Aquatic weeds can be stopped from spreading or eliminated using a few common control methods. Physical remedies work best for small-scale infestations, but they are expensive and prone to regrowth when used on big water bodies. Herbicide control of tiny infestations has frequently been quite successful, but it significantly depends on trained operators who keep a close eye out for the appearance of regrowth or seedlings over a lengthy period. The amount of nutrients released into water in recent decades has significantly increased from home and industrial sources as well as from land where fertilizers are applied or where clearing has increased run off. This essay examines the problems associated with eight aquatic weeds in India and the efforts made so far to control them through a range of techniques.

Keywords Aquatic weeds, Classification, Effects, management, Role.

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INTRODUCTION

Aquatic plant assumes a significant function within aquatic ecosystems due to their provision of nourishment and shelter to fish, fauna, and aqueous lifeforms. However, some aquatic plants create a challenge since they tend to reduce water use and have a negative impact on the health and functionality of many native aquatic ecosystem. Aquatic organisms, including fish and prawns, are required to undergo maturation within aquatic habitats containing vegetation. This is essential for the conversion of solar energy into chemical energy and the continuous replenishment of oxygen in the water through the process of photosynthesis. Aquatic populations of weeds are frequently difficult to manage because of their uncontrolled growth, which interferes with water consumption, raises the risk of floods, and creates hazardous circumstances for public health (Sushil Kumar 2011).

Even though invasive aquatic vegetation negatively affects water usage and causes major environmental harm, it also results in large direct control costs and missed economic opportunities (Getsinger *et al.* 2014, Hussner *et al.* 2017). Due to anthropogenic changes in soil composition (such as the conversion of wetlands into agricultural land), water movement, water nutrient levels, and the invasion of non-indigenous species, the negative effects on the environment and economy caused by the proliferation of foreign vegetation get worse in complex estuarine ecosystems. A combination of financial and logistical support, a thorough understanding of weed invasions and their effects, and a variety of control mechanisms that are beyond the scope of any one agency or organization are all necessary for the successful control of aquatic weeds in these ecosystems (Moran *et al.* 2021).

Types of aquatic weeds

Floating weeds

Water, rather than soil, serves as the source of nutrients for aquatic plants that float atop or within the water's surface. These plants, commonly referred to as floating weeds, encompass species such as watermeal (*Wolffia* spp.) and duckweed (*Lemna minor* and *Spirodela polyrhiza*). Notably, the excessive growth of floating weeds such as Azolla, Pistia, Wolfia, and Lemna can pose a multitude of threats to fish residing within the pond, primarily due to the ensuing shading effect. Floating weeds are characterized by their foliage positioned above the water's surface, while their roots dangle freely below (Sanyal and Tanmay, 2017). Fig. 1 (a),(b), (c),(d)

Fig. 1. Floating weeds (a-d).

a) Nymphaea　　b) Myriophyllum aquticum　　c) Altemanthera philoxeroides

Fig.2. Emergent weeds (a-c)

Emergent weeds

Emerging plants that have their leaves and blossoms above the water's surface but have their roots below are examples of weeds. These specific weeds, such as Nymphaea, Myriophyllum, and Vallisneria, have roots that are securely embedded in the submerged soil, but they also have leaves, lamina, or shoots that are partially or entirely protruding above the water's surface. Emerged weeds, on the other hand, are anchored to the bottom but have stems, leaves, and blossoms that protrude above the water's surface. These kinds of plants are frequently discovered close to the beach and in waters that are shallow, usually no deeper than 10 feet. (Giri 2020). Fig. 2. (a), (b), (c).

Submerged weeds

Weeds that are submerged may or may not have roots. Aquatic weeds that are submerged develop beneath and above the water. The majority of weeds that are submerged develop seed heads and blooms that rise above the water's surface. Hydrilla (Hydrilla verticillata) and Brazilian elodea (Egeria densa) are two examples of common submerged weeds (Giri 2020). Fig 3. (a),(b),(c),(d),(e)

Marginal weeds

These weeds develop near the edges or along the shoreline of the water body. They are primarily rooted in wet areas. E.g Typha, Nymphaea, Marsilia, and Ipomoea (Giri 2020). Fig. 4 (a),(b),(c)

Effects of Aquatic Weeds

Aquatic weeds problem in lakes and reservoirs

Aquatic weeds can cause a number of significant environmental problems, including a decreased variety of species, disruptions to hydropower generation, increased flood frequency, the provision of habitat for disease-carrying insects, altered animal community interactions, difficulties with recreational navigation, obstructions to safe swimming, changes to the chemistry of sediment, disruptions to fishing operations, and decreased capacity for water storage. These weeds have been noted as a growing ecological threat in India, with examples including Kolleru lake in West Godavari, drinking water lakes in Rajasthan, Man Sagar lake in Jaipur, Sharma lake and Hirakund reservoir in Orissa, Punjab's floating, emerged, and submerged aquatic weeds, and water hyacinth in Tamil Nadu. Nearly 80% of the 39000 tanks in Tamil Nadu have an aquatic weed infestation, mostly water hyacinth. E. crassipes is the most common aquatic weed in West Bengal, and Typha is a noxious weed. Eichhornia and Lemna spp. have blocked water pipes in Palta and Baranagar water bodies, causing problems in fishing waters, drinkable waters, and lowland paddy fields. (Sushil Kumar 2011).

Aquatic weeds problem in fish ponds and lakes of India

Freshwater fish species can find food, shelter, and protection from aquatic plants. Juvenile fish eat foliage and microorganisms, whereas adult fish travel to open waterways to seek food and alter their diets. Both the growth of nests and the quantity of plants have an impact. The invasion of aquatic weeds has resulted in approximately 40% of India's 800,000 acres of freshwater becoming unsuitable for the cultivation of fish. Urban areas such as Bangalore have experienced significant damage to fishery tanks and ponds due to the presence of water hyacinth.

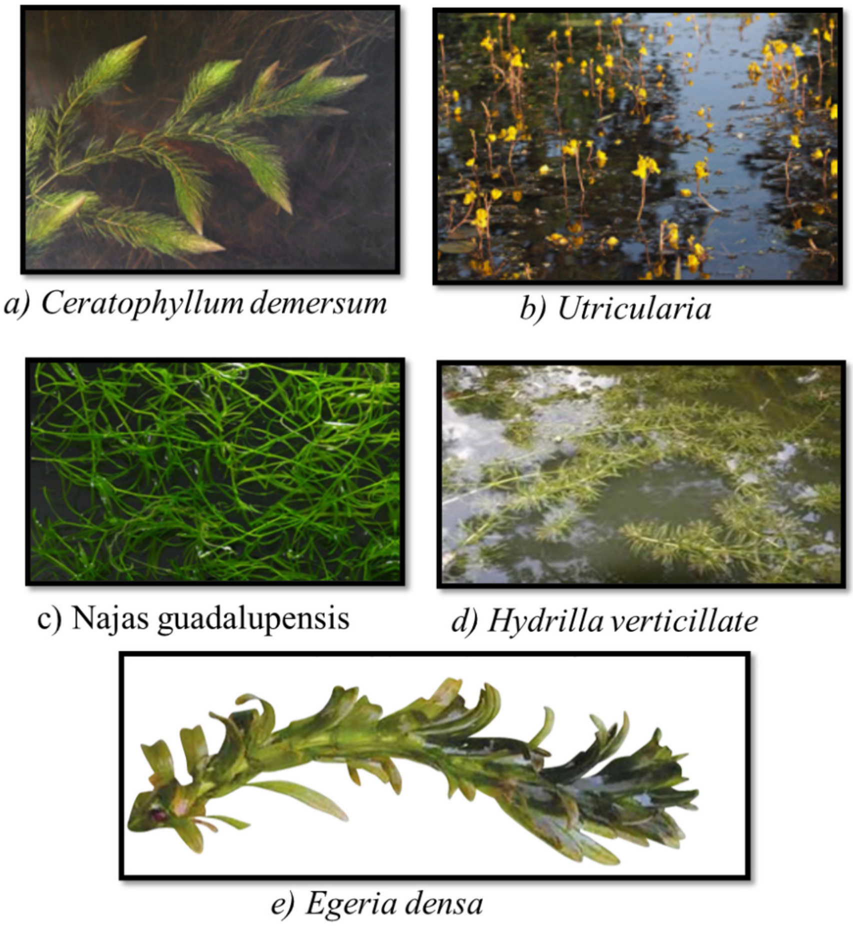

Fig. 3. Submerged weeds (a-e).

Aquatic weeds such as Eichhornia, Azolla, Nymphaea, Nelumbo, Nymphoides, Hydrilla, Vallisneria, Potamogeton, Najas, Ceratophyllum, Typha, and Utricularia spp. pose a problem in fishery lakes and tanks in various states including Andhra Pradesh, Assam, Haryana, Himachal Pradesh, Jammu & Kashmir, Maharashtra, Tamil Nadu, and Uttar Pradesh. In the beel fishery of Assam, the presence of water hyacinth poses a significant challenge that has had a noteworthy impact on the productivity of fish. The rapid proliferation of phytoplankton species results in the formation of "water blooms," which are dense aggregations that give the water its distinct hues of green, reddish brown, yellow green, or blue-green. The primary culprits behind these temporary blooms are Chlorophyceae, Bacillariophyceae, Dinophyceae, and Euglenineae, whereas persistent blooms can be attributed to Myxophyceae. Fish ponds may contain various types of aquatic weeds, including floating, emergent, submerged, rootless, marginal, and algal species. The presence of submerged aquatic weeds in Assam, Bihar, Madhya Pradesh, Orissa, Uttar Pradesh, and West Bengal leads to a significant water loss of 40-60%, making these regions unsuitable for fish farming. Moreover, the cultivation of the edible water chestnut (Trapa bispinosa) is hampered by the existence of aquatic weeds. In the regions of Nagpur, Pune, Kolhapur, Orissa, Uttar Pradesh, and Tarai, aquatic weeds represent a serious threat to drinking water supplies and horticulture. They cause financial losses in the production of rice and fisheries, with blue-green algae causing massive fish deaths in ponds

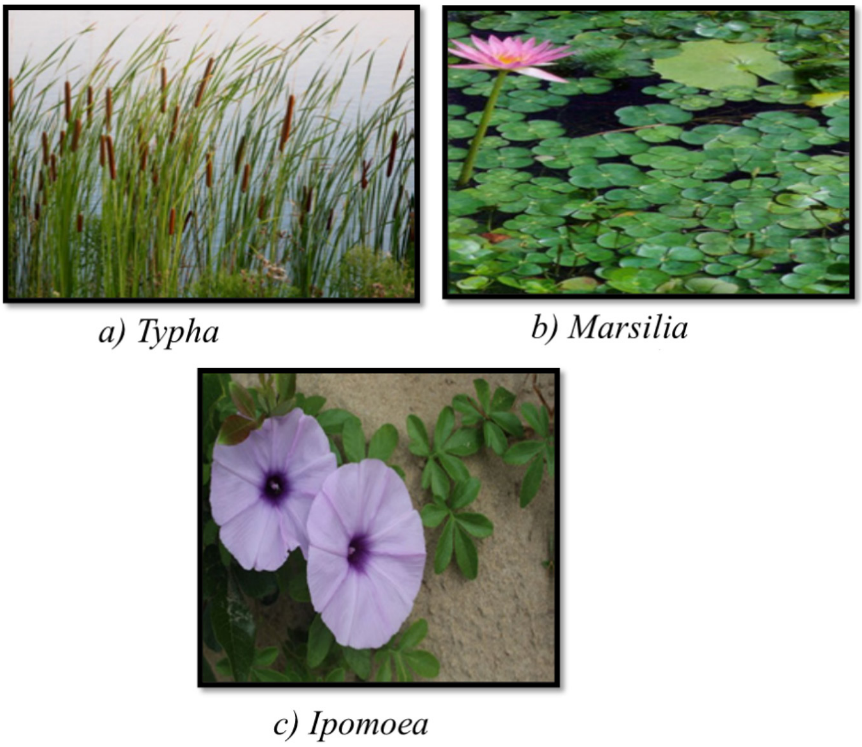

Fig. 4. Marginal weeds (a-c).

with abundant nutrients. Water hyacinth growth in Uttar Pradesh lowers the possibility for annual yield of fish. (Sushil Kumar 2011).

Effect of aquatic weeds on environment

Aquatic weeds in submerged fields and cultivable terrains threaten agricultural production, costs, and quality by competing for resources like water, nutrients, and sunlight, leading to inundation and sedimentation. Aquatic weeds encourage mosquito proliferation by offering cover and protection from predators, which helps to transmit diseases like encephalitis, yellow fever, malaria, and river blindness. Aquatic weeds have a substantial negative impact on fish output because their dense growth, which covers entire water bodies, prevents fish from getting enough oxygen, suffocates them, and finally kills them. Large amounts of organic matter are broken down by aquatic weeds, creating carbon dioxide and carbon monoxide that give off obnoxious odours and make it difficult for boats to move. They affect water bodies like lakes, dams, and tanks by slowing water flow, allowing silt to settle, and doing so. They decrease concrete construction strength, impair taste and odour, and raise biological oxygen requirement. Additionally, they restrict water movement, increasing seepage and raising the water table, which results in saline or alkaline soil conditions. Weeds that are floating and submerged spread quickly, forming dense mats that can seriously harm bridges and other structures. (Jayan and Sathyanathan 2012).

Management Measures to control aquatic weeds

Physical/mechanical method

Machines possess the capacity to eliminate aquatic vegetation. The employment of a JCB can effectively eradicate water hyacinth (Abhishek 2020). Equipment with easy handling has been developed through the use of modern technology, such as autonomous rotarywing unmanned air vehicles (Goktogan *et al*. 2010). It is possible to manually or mechanically extract aquatic vegetation, such as *Hydrilla verticillata* and

Egeria spp., which can be found in both submerged and floating forms. However, this strategy can potentially fracture the vegetation above, causing dispersal and an increase in the number of these unwanted species. (Dissanayaka *et al*. 2023). Various types of aquatic weed cutters and harvesters have been designed for the purpose of canals and large reservoirs. However, these devices are not practical for use in fish ponds. To address weed issues, an early method of physical weed removal such as raking or sieving can be employed. The harvested weeds can then be utilized for various purposes such as feed, manure, electricity, among others. In order to control weeds in aquatic environments, there are several approaches available including netting, barriers, chaining, and water weed cutters. At the Central Institute of Fisheries Technology (CIFT), a portable mechanical device has been developed that is capable of removing both floating and submerged weeds at a rate of 1-1.5 hectares per day (Sushil Kumar 2011).

Biological method

Given that many invasive species lack specialized herbivores or pathogens in their new environments, biological management is a useful strategy for managing invasive species. The introduction of biological control agents, however, might have severe effects on the ecosystem, such as the spread of new pests. Although these interactions are typically observed throughout the native ranges of the invading species, the optimal biological control product should specifically operate on the target invasive species. The leaf-mining fly, bacterial strains, and fungal isolates are a few potential biocontrol agents that could seriously harm Hydrilla but are also costly and could harm unintended native macrophyte species. The grass carp, which is native to Asia and is frequently used to reduce hydrilla, might, however, restrict the growth of local vegetation. (Sousa 2011).

Aquatic weeds make up 99% of the population, making natural biological regulating agents ineffective. Despite sluggish and inadequate benefits in some locations, specific agents must be found and transported. Fungal species like Fusarium spp., insect species like Agasicles hygrophila and Vogtia malloi, as well as fish species like Ctenopharyngodon idellus and Cyprinus carpio, are used as biological control agents to manage undesirable plant species. These organisms demonstrate the ability to successfully suppress a wide range of weed species, with a focus on the management of filamentous algae. (Dissanayaka *et al.* 2023).

Pond weed treatment is made efficient and affordable by using grass carp. The flora known as filamentous algae and duckweed, both of which have delicate, mushy leaves, are expertly handled by grass carp. Waterlily and cattail, on the other hand, are distinguished by their robust, woody foliage. Different state laws regulate the use of grass carp in various ways. (Marley *et al.* 2017). Because it necessitates (a) long-term planning (b) a variety of strategies, and (c) manipulation of the cropping system to interact with the environment, biological control is more difficult than chemical control. When managing specific aquatic weeds in multi-use streams, biological management can be a long-term, ecologically safe, economically viable solution. Biological controls work best on invasive aquatic weeds that cover large regions of water bodies in monotypic stands.

Use of insects

The world's most prominent aquatic weed is still the water hyacinth (*Eichhornia crassipes*). It is a significant issue in the Indian Subcontinent and South-East Asia and is growing at an alarming rate in Africa and Papua New Guinea. In 3 to 10 years following the installation of an agent, successful biological control can dramatically lower this weed cover, and it has produced outstanding control in a few nations. (Sanyal and Tanmay 2017).

Use of Snails

Snails Pomade canaliculata Lamer have also demonstrated potential in the management of the aquatic weeds *Anachaares alensa* in Brazil and *Marisa cornuarietis* in Florida. Additionally, successful management of aquatic weeds like *Potamogeton illinoensis, Najas guadalupesis*, and *Ceratophyllum demersum* has been noted. While *Pistia stratoites* and *Alternanthera philoxeroides* were partially restricted, *Eichhornia crassipes* growth and flowering were significantly slowed down by the snail's root trimming operation. The water plant-eating snail *Marisa cornuarietis* was once thought to have weed-controlling capability. Its capacity to consume young rice seedlings and poor tolerance for water temperatures below 10°C, however, limited its utility. On the other hand, its capacity to eradicate the bilharzia snail vector's breeding grounds would enable its introduction in locations where rice isn't the main crop. (Sanyal and Tanmay 2017).

Chemical methods

Selecting and applying appropriate herbicides for aquatic weed control is crucial for effective management without harming ecosystems. However, certain components can have harmful effects on aquatic organisms. Research shows the toxic nature of diquat, glyphosate, and glyphosate trimesium herbicides on aquatic insects such as *Eccritotarsus catarinensis* and *Neochetina eichhorniae* (Hill *et al.* 2012) and (Dissanayaka *et al.* 2023).

The initial stage of chemical weed control involves the careful identification of the weed support for the identification of the weed is provided by county Extension and Department of Natural Resources offices. Once the weed has been accurately identified, an appropriate herbicide that is authorized for usage in commercial fish ponds can be selected. Before the herbicide is applied to the pond, it is imperative for the user to thoroughly read and understand the information on the herbicide label. (Marley *et al.* 2017).

Water hyacinth, as well as smaller floating weeds including Spirodela, Lemina, and Azolla, can be effectively controlled with the herbicide 2,4-D. Using copper sulphate pellets to control Nymphaea and Nymphoides is also productive. Tap grass, water plantain, bushy pond weed, coontail, bladder wort, Hydrilla, and Nechamandra are a few examples of submerged weeds in fish ponds. Localized application of copper sulphate pellets with mud is effective. Grass, sedges, and rushes can be eliminated by spraying with 2,4-D amines and esters. (Sushil Kumar 2011).

Through utilisation

Aquatic weeds are commercially valuable. It has a wide range of applications. Aquatic weed removal is expensive and requires the employment of mechanical, chemical, and human labor. However, this expense can be balanced by making use of the weeds potential to stimulate economic growth. (Giri 2020). Aquatic weeds have shown a direct impact on the preservation of socioeconomic livelihood despite the appearance of invasive tendencies in some locations throughout the world. Some aquatic weeds exhibit a greater potential for use as a bio-fertilizer due to their innate allelopathic tendencies (Fu *et al.* 2020). This material can be used to manufacture affordable bags, paper plates, paper boards, and aesthetically beautiful paper products because to the increased amounts of cellulose, hemicellulose, and reduced lignin content (Nawaj *et al.* 2021). Aquatic weed possesses the potential to serve as unprocessed components for the production of biogas, subsequently employed for the generation of electrical energy (Bote *et al*. 2020).

Azolla spp. is considered a beneficial supplement for cattle, poultry, and aquaculture practices as a result of its exceptional nutritional composition, specifically its advantageous amino acid profile and elevated protein concentration (Brouwer *et al.* 2018, *Das et al.* 2018). *Nymphaea pubescens* extract, according to research by Aimvijarn *et al*. (2018), includes pigments that can scavenge free radicals, making them helpful for therapeutic reasons in the treatment of melanoma skin tumours. You should be aware that this extract has a pleasing aesthetic quality *Eichhornia crassipes* is a prevalent ornamental plant which is additionally employed for phytoremediation, biomass energy generation, and the production of animal feed, construction resources, handicrafts, paper, and board (Jafari *et al.* 2010). The leaves and roots of Pistia stratiotes are abundant in antioxidants, and the plant's oil extraction has been shown to be a potent remedy, specifically in treating worm infections, asthma, and various skin conditions (Wasagu *et al.* 2014). The traditional human way of life, including Ayurveda medicine, pharmaceuticals, landscaping, and human nourishment, has been greatly influenced by every component of *Nelumbo nucifera,* including its leaves, rhizomes, seeds, and flowers (Chen *et al*. 2019).

Due to limited assets, controlling aquatic weeds offers a particularly difficult problem in underdeveloped countries like Sri Lanka. As a result, a wide variety of water weed species have multiplied at an alarming rate, disrupting Sri Lanka's agriculture and ecology. This study's objective is to assess the viability of using aquatic weeds as the primary ingredient in compost production in order to satisfy regional standards for the sustainable management of plant nutrients. As a result, it is hoped that control of aquatic weeds at the level of ecosystems and agriculture will be more successful (Dissanayaka *et al*. 2023).

The roles of aquatic plants in phytoremediation of wastewater

Aquatic plants have the potential to be used in a variety of phytoremediation processes, including rhizofiltration, phytoextraction, phytovolatilization, phytodegradation, and phytotransformation, which are crucial components of biological wastewater treatment systems. The eradication of pollutants depends upon duration of exposure, concentration of pollutants, environmental factors such as pH, temperature and plant characteristics viz. species, root system etc (Irshad *et al.* 2013).

CONCLUSION

Native aquatic plants constitute a vital component of the ecosystem, despite the fact that invasive aquatic plants disrupt pond environments and hinder human utilization of the impacted water bodies. Since a large percentage of these plants have been intentionally introduced, the initial technique for protecting against aquatic weeds should involve exclusion or prevention. Regarding an excessive growth of a pond, aquatic weeds can be maintained using a variety of strategies, including cultural, mechanical, biological, and chemical control techniques. As a preventative strategy to prevent potential harm to native flora and aquatic life, pond owners should first and foremost check for the existence of invasive species. The impact that invasive aquatic weeds have on aquatic ecosystems is identified as one of the most commonly occurring hazards to the global economy, ecology, and environment. Utilizing the nutritional potential of aquatic weeds for the goal of promoting crop growth and development through composting is a very long-lasting and sustainable strategy. Their ability to create more biomass, have greater amounts of plant nutrition, have short life cycles, have the ability to produce compounds that are opposing to other species, and have the ability to clean up the environment all contribute to their suitability as composting materials. It becomes possible to protect the majority of aquatic ecosystems from the damaging effects of soil and water contamination while enhancing them by using appropriate composting techniques and parameters by conducting an analysis of the ecology and physical characteristics of various types of aquatic weeds.

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