Sustainable Management and Utilization of Aquatic Weeds

Barath Gowda, H. [1], Nihash. V. L. [2] and Spandana. B. M. [3]

[1] Ph. D scholar, Department of Agronomy, University of Agricultural Sciences, GKVK, Bengaluru-560065.

[2] Research scholar, Department of Farm Machinery and Power Engineering, College of Agricultural Engineering, GKVK, UAS Bengaluru-560065.

[3] Research scholar, Department of Processing and Food Engineering, College of Agricultural Engineering, GKVK, Bengaluru- 560065.

Corresponding Author: bharathgowdah6@gmail.com

Abstract

Aquatic weeds are unwanted plants growing in water bodies that adversely affect water quality, biodiversity, and agricultural productivity. Their rapid proliferation, mainly due to eutrophication, creates serious challenges in irrigation, fisheries, and ecosystem balance. Effective management includes mechanical, chemical, and biological methods, with integrated approaches proving more sustainable and eco-friendlier. Biological control using insects and pathogens offers long-term solutions with minimal environmental impact. Aquatic weeds can also be utilized beneficially as mulch, compost, fodder, and biostimulants, contributing to sustainable agriculture. Proper management and utilization strategies can convert these weeds from a nuisance into valuable resources for enhancing productivity and environmental sustainability.

Introduction

Aquatic weeds are undesirable plants that grow in water bodies such as ponds, lakes, rivers, reservoirs, and irrigation canals. They complete all or part of their life cycle in water and are commonly classified into floating, submerged, emerged, marginal, and dispersed weeds. Major problematic species include *Eichhornia crassipes*, *Pistia stratiotes*, *Salvinia molesta*, *Hydrilla verticillata*, and *Alternanthera philoxeroides*. The rapid growth of aquatic weeds is mainly associated with nutrient enrichment or eutrophication, which promotes excessive biomass production. These weeds adversely affect water quality, reduce dissolved oxygen, hinder irrigation and navigation, and disrupt aquatic ecosystems. In India, a significant proportion of water bodies is infested with aquatic weeds, causing serious economic and environmental concerns. Therefore, effective management through mechanical, chemical, and biological methods is essential. At the same time, utilization of aquatic weeds as compost, mulch, fodder, and biostimulants offers a sustainable approach, converting a major problem into a valuable resource.

Major problem in water bodies

Eutrophication is a general term describing a process in which nutrients accumulate in a body of water, resulting in the growth of aquatic weeds that utilize these nutrients for their growth and development. After completing their life cycle, these weeds utilize dissolved oxygen during decomposition, it directly affecting aquatic animals.

What are aquatic weeds?

Aquatic weeds, also known as plants growing in water bodies, are a common sight in or near water sources. However, their presence poses serious threats to the efficient and effective use of water. Aquatic weeds can cause tremendous water loss through evaporation and seepage, impacting water conservation efforts and agricultural practices. Additionally, these weeds can disrupt ecosystems by outcompeting native vegetation and altering water quality. Therefore, controlling and managing aquatic weeds is essential to ensure sustainable water management and protect aquatic ecosystems.

Types of aquatic weeds

A. Surface weeds
B. Submerged weeds
C. Emerged weeds
D. Marginal weeds (Shoreline weeds)
E. Dispersed weeds
F. Ditch weeds

A. Surface weeds

Free-floating weeds are plants whose leaves float on the water surface either singly or in clusters. These weeds can be classified into two types: those that are entirely free-floating and those that have roots anchored at the mud bottom of the water body. The leaves of free-floating weeds are buoyant and rise and fall with changes in water level, such as during tides or fluctuations in water depth. This adaptation allows them to thrive in varying aquatic environments and can sometimes lead to rapid colonization of water surfaces, impacting water quality and ecosystem balance.

Floating weeds

Water lily *(Nymphaea spp)*

Lotus (Nelumbo nucifera)

Anchored to bottom soil

B. Submerged weeds

Submerged aquatic weeds are complex plants that grow mostly underwater, with their flowering parts above the water surface while their foliage remains submerged. They possess true roots, stems, and leaves, making them vascular plants. However, they represent a major challenge globally as the most serious aquatic weed problem, these weeds proliferate rapidly, forming dense mats underwater that outcompete native vegetation and disrupt aquatic ecosystems.

Coontail *(Cerstophyllum demersum)*

Bladderwort *(Utricularia macrorhiza)*

Water thyme *(Hydrilla verticillata)*

Eelgrasses *(Zostera spp)*

C. Emerged weeds

These plants, rooted in bottom mud, exhibit aerial stems and leaves that extend either at or above the water surface. Their leaves can be broad, akin to many terrestrial plants, or grass-like in some species. Unlike floating weeds, their leaves do not fluctuate with water levels. These plants pose challenges in irrigation and drainage systems, often clogging canals and reducing water flow.

Cat tails (*Typha latifolia*)

Arrowhead (*Syngonium podophyllum*)

D. Marginal weeds (Shoreline weeds)

Most of these plants are emerged weeds that thrive in moist shoreline areas with water depths ranging from 60 to 90 cm. These weeds exhibit variations in size, shape, and preferred habitat, making them adaptable to a range of environmental conditions. Typically growing in shallow waters near the periphery of water bodies, these emerged weeds play a crucial role in stabilizing shorelines, preventing erosion, and providing habitat for various aquatic organisms.

E. Dispersed weeds

Weeds that grow and spread throughout the water, including both unicellular (phytoplankton) and multicellular (scum algae) types, are classified as dispersed weeds. Algae, which belong to this category, lack roots, leaves, or flowers typical of vascular plants, They reproduce vegetatively and through pores, allowing them to rapidly colonize aqua environments. Filamentous algae, for example, form strands that can attach to rocks or float in mats, contributing to the overall biomass of dispersed weeds.

F. Ditch weeds

"Ditch weeds" refers to plants that commonly grow in and around ditches, which are narrow channels or waterways used for drainage or irrigation purposes. These weeds can vary widely in species and characteristics but are typically adapted to moist or wet environments. Ditch weeds often include both terrestrial plants that grow along the edges of ditches and aquatic plants that thrive in the water itself.

Problems of aquatic weeds in India

- Major five primary aquatic weeds of the world and qualify the status of worst weeds in India.
  1. *Eichhornia crassipes*
  2. *Salvinia molesta*
  3. *Hydrilla verticillata*
  4. *Alternanthera philoxeroides*
  5. *Pistia stratiotes*
- In India 20-25 % of the total utilizable water is currently infested with water hyacinth (*Eichhornia crassipes*)
- By the end of 21th century, *A. philoxeroides* had become a growing menace in water bodies in India

Management of aquatic weeds

A. Mechanical methods

In cases where herbicide use is impractical due to water being utilized for livestock,drinking, or fish culture, employing simple implements or machines for aquatic weed control presents a viable alternative. These implements, such as weed cutters, harvesters, mechanical dredgers, or rakes, are designed to manually remove or cut weeds, aiding in the clearance of water bodies and preventing clogging. While these methods are free from pollution, their implementation can be costlier than herbicide-based approaches.

1. Dredging: A traditional method of removing aquatic weeds by uprooting them along with roots manually or mechanically from water bodies.

2. Mowing: A method of controlling aquatic weeds by cutting them to reduce height and density, though regrowth occurs quickly if not managed regularly.

3. Netting: A method of removing small floating weeds manually using a coir rope net with mesh size (about 3 cm).

4. Chaining: A method where a heavy chain dragged between tractors across a ditch uproots and removes aquatic weeds like *Hydrilla* and arrowheads.

5. Cutting: A fast and efficient method of controlling aquatic weeds using mechanical devices, though weeds may regrow quickly as roots remain intact.

6. Harvesting (cut and remove): A method combining cutting and removal of weeds to reduce biomass and prevent regrowth, though it is slower and costlier than simple cutting.

B. Chemical method

Direct sprays on foliage from boats effectively kill floating and emerged weeds, while granular formulations treat submersed weeds and algae in shallow waters. Ensuring good dispersion of chemicals is crucial for successful control, maximizing effectiveness, minimizing resistance development, and promoting sustainable weed and algae management practices. Proper application techniques, regular monitoring, and adjusting strategies as needed are essential for achieving optimal results in weed and algae control, maintaining ecological balance in aquatic ecosystems, and preserving water quality for long-term environmental health.

Chemical method advantages

- It is efficient, easier and faster method of aquatic weed control
- It is cheaper than mechanical control
- It is economical and time saving operation

Chemical method disadvantages

- Environmental impact
- Residue accumulation
- Toxicity to aquatic life

C. Biological method

Aquatic biological weed control refers to the use of living organisms, such as insects, fish, bacteria, or pathogens, to manage and control the growth of weeds. This method relies on the natural ecological interactions within aquatic ecosystems to suppress or limit the proliferation of specific weed species.

Advantages of biological weed control

- Environmentally friendly
- Selective targeting
- Reduced chemical use
- Long-term control
- Cost-effective
- Minimal resistance issues

Utilization of aquatic weeds

Mulching: Aquatic weeds can be dried and used as mulch in agricultural fields. Mulching helps retain soil moisture, suppress weed growth, and improve soil health by adding organic matter.

Fodder: Some aquatic weeds are nutritious and can be used as fodder for livestock. These weeds can supplement traditional animal feed, providing a cost-effective and sustainable source of nutrition. Common aquatic weeds used as fodder include water spinach (kangkong), water hyacinth, and duckweed.

Compost: Aquatic weeds are rich in nutrients like nitrogen, phosphorus, and potassium, making them valuable for composting. Composting aquatic weeds can help create nutrient-rich organic fertilizer for plants.

Biostimulants: Aquatic weeds contain bioactive compounds that can act as biostimulants, enhancing plant growth and stress tolerance. Extracts from these weeds can be used as natural plant growth promoters.

Challenges in Adoption

- High cost of implementation and maintenance
- Requirement of skilled labor and technical knowledge
- Environmental and health risks due to chemical use
- Slow and uncertain effectiveness of biological control
- Temporary control and quick regrowth in mechanical methods
- Regulatory restrictions on chemical usage
- Difficulty in selecting suitable method for specific conditions
- Need for integrated and continuous management practices

Future Perspectives and Opportunities

Future management of aquatic weeds lies in adopting eco-friendly and sustainable approaches that integrate mechanical, biological, and chemical methods. Greater emphasis will be placed on biological control agents for long-term and environmentally safe management. Advanced technologies such as remote sensing and GIS can

improve monitoring and early detection. Aquatic weeds also offer significant opportunities for utilization in composting, biogas production, biofertilizers, and animal feed. Their role in wastewater treatment and phytoremediation is gaining importance. Promoting value-added products and strengthening policy support and awareness programs can help transform aquatic weeds from a problem into a valuable resource.

Conclusion

Aquatic weeds pose a serious threat to water resources, agriculture, and aquatic ecosystems due to their rapid growth and spread. Effective management requires an integrated approach combining mechanical, biological, and chemical methods to ensure sustainable control. While each method has its limitations, their combined application can improve efficiency and reduce negative impacts. At the same time, the utilization of aquatic weeds for compost, biogas, fodder, and other value-added products offers promising opportunities. Therefore, with proper management strategies, awareness, and technological support, aquatic weeds can be transformed from a nuisance into a valuable resource for environmental sustainability and economic benefit.

References

Chinnusamy, C. P., Janaki, P., Murali, A., & Muthukrishnan, P. (2011). Effects of post-emergence herbicides on water hyacinth (Eichhornia crassipes): Tank culture experiment. Proceedings of the 23rd Asian-Pacific Weed Science Society Conference, 1(3), 95–100.

Effendi, H., Utomo, A. A., & Darmawangsa, G. M. (2017). Utilization of grass carp (Ctenopharyngodon idella) for inhibition of hyacinth (Eichhornia crassipes) population blooming. World Applied Sciences Journal, 35(2), 270–274.

Indulekha, V. P., & Thomas, C. G. (2018). Utilization of water hyacinth as mulch in turmeric. Journal of Tropical Agriculture, 56(1), 27–33.

Indulekha, V. P., Thomas, C. G., & Anil, K. S. (2019). Utilization of water hyacinth as livestock feed by ensiling with additives. Indian Journal of Weed Science, 51(1), 67–71.

Jimenez, M. M., & Balandra, M. A. G. (2007). Integrated control of Eichhornia crassipes using insects and plant pathogens in Mexico. Crop Protection, 26(8), 1234–1238.

Kyser, G. B., Madsen, J. D., Miskella, J., & O'Brien, J. (2021). New herbicides and tank mixes for control of water hyacinth in the Sacramento–San Joaquin Delta. Journal of Aquatic Plant Management, 59(4), 78–81.

Pathak, A., & Kannan, C. (2011). Isolation and pathogenicity of native fungal pathogens for biological management of water hyacinth. Indian Journal of Weed Science, 43(3), 178–180.

Prevost, W. J., Mudge, C. R., Fontenot, K. K., & Strahan, R. E. (2021). Evaluation of foliar and subsurface applications of metsulfuron-methyl for control of giant salvinia. Journal of Aquatic Plant Management, 59, 14–19.

Soni, S., Jaiswal, P., & Kumar, D. (2021). Effectiveness of herbicides on major aquatic weed species of Dalpatsagar reservoir, Jagdalpur. International Journal of Current Microbiology and Applied Sciences, 10(2), 1966–1976.

Tipping, P. W., Martin, M. R., Center, T. D., & Davern, T. M. (2008). Suppression of Salvinia molesta in Texas and Louisiana by Cyrtobagous salviniae. Aquatic Botany, 88(3), 196–202.

* * * * * * * * *