Black Sea Journal of Agriculture
Open Access Journal
e-ISSN: 2618 - 6578

BS Publishers

Review
Volume 2 - Issue 1: 58-62 / January 2019

WATER HYACINTH: UTILIZATION AND IMPACT ON BIODIVERSITY

Muhammad FAWAD[1], Aftab JAMAL[2]*

[1]*Department of Weed Sciences, the University of Agriculture Peshawar, Pakistan*

[2]*Department of Soil and Environmental Sciences, the University of Agriculture Peshawar, Pakistan*

Received: *October 30, 2018;* ***Accepted:*** *November 09, 2018;* ***Published:*** *January 01, 2019*

Abstract

Water hyacinth (Eichhornia crassipas) has got considerable attention as the world worst alien invasive weed. It is an aquatic plant and its rapid growth and colonization is a serious threat to the aquatic biodiversity and a major challenge for water utilization in power generation, navigation, irrigation, recreational activities and the utmost economic threat. Its control and management is laborious and very expensive, however the actual application of water hyacinth is potentially beneficial and useful in a number of the sector. This review was under taken to highlight the possible utilization of Water Hyacinth as well as its adverse effect on the environment.

Keywords: Water hyacinth, Invasive, threat to biodiversity, aquatic ecosystem

***Corresponding author:** Department of Soil and Environmental Sciences, the University of Agriculture Peshawar, Pakistan
E mail: aftabses98@gmail.com (A. JAMAL)
Muhammad FAWAD https://orcid.org/0000-0002-3518-2399
Aftab JAMAL https://orcid.org/0000-0001-8518-3130
Cite as: Fawad M, Jamal A. 2019. Water hyacinth: utilization and impact on biodiversity. BSJ Agri, 2(1): 58-62.

1. Introduction

Water hyacinth technically known as *Eichhornia crassipas* belongs to the family Pontederaceae. It is a free floating aquatic weed, although in water deficit condition its root attached to the hydro soil and exhibit like emerged plants. Water hyacinth belongs to the monocot class of angiosperm and can be easily distinguished form other aquatic plants. Identification features includes round rosettes like structure having inflated petioles with bulb like structure in the middle having aerenchyma, help the plant floating on the surface of water. It is found in a number of differing morphological growth forms, and the morphology and architecture of leaves, petioles, and clonal groups can be highly plastic. However, two forms dominates one, typically found in open water or at the edges of plant mats, is characterized by short bulbous and very buoyant petioles containing air-filled aerenchyma, whereas another form occurs in crowded areas, such as in the middle of plant mats, with slender, tall, non bulbous petioles. The short bulbous form can develop into the tall non bulbous form if crowding occurs and sufficient nutrients are available. Petioles can therefore grow to over a meter (over 3 ft) in length, although 50 cm (20 inches) is usually more typical. Center and Spencer found that in mature plants, between 6 and 8 leaves or lamina are present on each plant and that in equilibrium establishes between new leaves appearing and old leaves senescing (Gopal 1987). Water hyacinth roots are feathery, with dark violet, pinkish or bluish look and some time whitish appearance in shady habitats. The roots are protected from the herbivores because of the presence of

soluble pigment anthocyanins (Gopal 1987). Inflorescence is spike that bears flower on an elongated peduncle subtended by two bracts (Figure 1). The lower bract consists of separate blade. Each spike bears about 4 to 25 flowers with maximum of 35 flowers. Each flower contains about six stamens with curved filaments in which three are small and adjacent to periath tube. The stamen numbers may be varied from 5 to 7. Anthers are violet and about 2 mm long Fruits consist of thin walled capsule developed form the perianth tube. Fruits are enclosed in a thick hypanthium. The capsule contains about 450 ripened and mature seeds. (Gopal 1987; Batcher 2000).

Figure 1. Water hyacinth flower

Water hyacinth is fresh water weed in the free frost zone of the world it cannot tolerate low temperature, minimum temperature for its survival is 12 ^{o}C. It is susceptible to low temperatures. The optimum temperature for its growth is 25 to 30 ^{o}C and maximum temperature for its prolific growth is 33 ^{o}C (Kasselmann, 1995; Holm *et al*. 1997). After when the temperature is favorable the damaged part of the water hyacinth which is affected by frost during low temperature regenerate from the underwater rosette base. (Langeland and Burks 1998).

Water hyacinth is perennial and herbaceous weed reproduce both sexually (seeds) and asexually (vegetative parts). Sexual reproduction of water hyacinth was first time reported by Muller (1883). Seeds are important for their existence and are the inherited ability of flowering plants. Seeds are to be dormant for one or more years in the hydro soil and germinate upon favorable condition. Seeds are more important than vegetative reproduction for maintaining population whereas in seasonal environment the vegetative parts sometimes damaged by desiccation and other stress conditions. (Barrett 1977, Barrett 1979). Moreover, the seeds are produced at the base of each flower in capsules while the daughter plant resulting from the asexual reproduction attached to the mother plant until they are broken through water movement, wind or other physical force.

Keeping in mind all the above facts the present review was undertaken with the main aim to highlight not only the proper utilization of Water hyacinth but also its adverse effect on aquatic biodiversity.

2. Origin and Ecological Distribution

Water hyacinth is one of the most problematic alien invasive aquatic weed in Pakistan and probably throughout the world especially in tropical areas native to tropical America and Brazil. It was first time discovered by a German naturalist Von Martius in 1823 and named it *Pontedria crassipes* during his study of the flora of Brazil. After that it was then described in the genus *Eichhornia* by Solms reported by Kuntz in 1829. It was recorded in Egypt in 1870's and was then invaded to Africa during the year 1879 to 1882 (Friend, 1989). It was recorded in 1880s, in the United States. During the 1890's it was found most abundantly in Southern American Countires, Caribean, Africa, and in 1890s it was recorded in Australia and Asia, while in China and the Pacific by the early 1900s, South Africa by the 1910 (Mailu, 2001; Thomson et *al*., 2002; Mironga, 2004; Plummer, 2005). During the early 19th century it was spread from its native range to the whole word. Hutchinson and Dalziel (1968) also reported that water hyacinth was native to Amazonian basin and because of its beautiful flower it was than exported as ornamental to tropical and subtropical regions of the world (Julien *et al*., 1999). It is now present in more than 50 countries further more Lei and Bo (2004) reported that water hyacinth is spread to about 62 countries in the world. At present water hyacinth is distributed with huge infestation across the tropics and subtropical zones (Rezene, 2005). It was first reported by Marwat *et al*. 2000 in Pakistan, it was then spread in 2010 flood throughout the country (Fawad *et al., 2013*).

3. Rapid Growth and Colonization

In optimum growth conditions, water hyacinth makes its biomass double within two weeks and rapidly colonizes the entire water body (Figure 2.) Water hyacinth can produce about 1200 daughter plants in four months (Yan et al., 2017). It has massive growth potential, one meter square of water hyacinth increase its biomass up to 500 g each day, subsequently during normal climatic conditions 1800 tons fresh biomass can be produced in one hectare. Gopal (1987) reported that it can increase 12% of its biomass every day, while the time required doubling its number or biomass is variously reported from 6 to 15 days keeping in view the suitable environmental condition. In temperate climatic zone asexual reproduction is rapid and formed dense thick rafts within short period of time. Water hyacinth formed thick tightly packed mats on the surface of water that consequently lowering oxygen concentration and greatly suffer under water creatures (Rommens et al., 2003; Mangas-Ramirez and Elias-Gutierrez, 2004; Perna and Burrows, 2005).

Figure 2. Picture of a and b shows rapid colonization of water hyacinth in a period of two weeks.

4. Adverse Impact on Aquatic Ecosystem and Biodiversity

Water hyacinth alter oxygen level in water suffocate fisheries and other marine creatures consequently disturb both the flora and fauna. Water hyacinth is adapted to wide variety of water bodies includes, running stream water, drainage ditches, stagnant water ponds and irrigation canal. Dense mats of Water hyacinth also harbor insect pest and snakes; disturb the ecosystem and food web (Toft et al., 2003). Rapid growth and colonization makes water hyacinth very aggressive forming a huge thick impenetrable mat on water surface that seriously damage the biodiversity and eliminates the native aquatic plants and marine life due to restrictive light penetration to water. (Green field et al. 2007). Water hyacinth infestation alters the aquatic ecosystem and hydrology (Galatowitsch et al. 1999, in Toft 2000; Fawad et al., 2015). Natural diversity with balance ecological communities greatly affected due to invasion of water hyacinth. Water hyacinth greatly alters the ecosystem competes with the natural biodiversity for nutrients, sunlight and space consequently the survival of many plants and animals may threaten up to a great extent. Masifwa et al. (2001) reported that massive floating mats of water hyacinth decrease oxygen concentration for the underwater creatures and a major threat to the phytoplanktons, zooplanktons and other marine creatures. Unlike phytoplankons and submerged fresh water vegetation water hyacinth does not release oxygen under the water and creates O_2 deficit condition for aquatic life. Invasion of water hyacinth is a huge threat to the biodiversity and ecosystem of Pakistan. Water hyacinth provide highly restricted habitat by altering the natural aquatic habitat at the surface of water and restrict the growth of native aquatic flora and fauna and other invertebrate's habitat (Meerhoff et al., 2003). The structure of a macrophyte community plays a large role in determining community composition of phytoplankton, zooplankton and fish in fresh water ecosystems (Meerhoff et al., 2007).

Native aquatic macrophytes are a natural part of fresh water ecosystem plays an important role in maintaining a healthy aquatic ecosystem and provide a key role in food chain for the marine life. Native flora protects the shorelines from erosion and plays a major role as phytoremediation extract heavy metals and pollutants from the water like *Lemna* spp. (Bennicelli, et al., 2004). There are many more native aquatic plants that act as a contaminant filter for waste water treatment. Water hyacinth is one of the world worst aquatic weed in the world (Holm et al. 1977; Stroud, 1991; Room and Fernando 1992). In District Swabi (Pakistan) during the last five years water hyacinth colonized so rapidly that it endangered about eight native or unproblematic aquatic plants including submerged, floating and emerged plant communities (Fawad et al.,2013). Water hyacinth can adopt itself to wide range of aquatic habitats that is more competitive than any other aquatic weed and is a major threat to biodiversity (Fawad et al., 2015)

5. Socio-economic Impact of Water Hyacinth

Water scarcity and water pollution are the important issue of the 21st century. Therefore, water conservation is necessary for sustainable agriculture, drinking, fisheries, industrial and domestic use. Water hyacinth cause large amount of water losses through transpiration, blocking water ways during rainfall and monsoon rains, interferes with human recreational activities like swimming, boating and fishing and cause substantial economic losses (Ramlan, 1991; Charudattan, 2001; Rezene, 2005). Water hyacinth can greatly affect fish catch rates because mats of water hyacinth can block access to fishing grounds blockage and damaging eye of net, and increasing costs of fishing interfere with recreational activities like swimming and boating (Barret 1989; toft 2000). Water hyacinth has adopted itself to wide range of aquatic habitats including, fresh water streams, drainage ditches and stagnant water ponds and cause huge economic losses (Li et al., 2004). It obstructs the use of water for irrigation and many other intended water use for various purposes. Pakistan has one of the best canal systems in the world, with fascinating water streams and dams. Water hyacinth covers almost all water bodies in the plain areas of Pakistan. During the monsoon season in Pakistan maximum rainfall in most of the regions results in flood water resulting hindrance and blocking water ways due to dense thick mats of water hyacinth cause severe destruction to the nearby area and troublesome to the inhabitant. (Rezene, 2005; Fawad et al., 2015).

6. Utilization

Water hyacinth management is very costly laborious and temporary while unintentional import or single daughter plant remains can occupy the entire water body. Considerable research work has been carried out on this

noxious weed to unlock its value otherwise it is problematic. Major potential use of water hyacinth as pulp material for producing greaseproof paper, fibre boards, indoor partitioning and low cost home shelter material and its formulation can also be used in Indian medicine for various diseases treatment (Goswami and Saikia, 1994; Oudhia, 1999a, b). It can be utilize for best compost as organic fertilizer (Szczeck, 1999). In Kenya it is used as organic fertilizer (The Nation Nairobi 2004). It is an efficient plant for biogas production (Ali et al., 2004), other possible way of water hyacinth utilization as a phytoremediator and a biosorbent of toxic metals (Sajn et al., 2005; Malik 2007). It can be also utilize as fodder for livestock (Aboud et al., 2005). In China it was widely used as cattle feed during the year 1950s to 1970s, since than 1980s it was used for feeding ducks (Jianqing et al., 2001). Water hyacinth utilization is an important technique rather than costly control practices to better cope with the menace. Water hyacinth plays a promising role in water reclamation it eliminates heavy metals from sewage sludge of ponds and drainage ditches (Vietmeyer 1975). In China it was used as a test plant for waste water treatment (Jianqing et al., 2001). Unlike its overwhelming economic losses and a great threat to biodiversity the same plant has adopted enormous ability of absorbing toxic heavy metals from the water (Mohamadi, 2011). Water hyacinth has greater ability than any other aquatic water plant to absorb wide range of heavy metals, pollutants and nutrients. Sidek et al. (2018) reported that within a period of 28 days water hyacinth is the most efficient weed in removing 96 % iron 50 % turbidity and 97.3 % of phosphorus from the water as compared to water lettuce. Biogas production from water hyacinth is an economical control method of its noxious presence.

7. Conclusions

It was concluded that the threat of water hyacinth to aquatic environment is genuine. It invaded our water bodies as so vigorous speed that must be handled with all measure of reality. However complete eradication of this weed may not be the most prominent option, for the reason of high cost and more laborious work, furthermore some eradication methods may do further harm to the environment. However an alternative approach of its utilization can be focused to cope the menace. It may be utilized as phytoremediation for heavy metal absorbent, as fodder for livestock, biogas production and for making papers in paper making industry which in turn could create employment and reduced poverty.

Conflict of Interest

The authors declare that there is no conflict of interest.

References

Aboud AAO, Kidunda RS, Osarya J. 2005. Potential of water hyacinth (*Eicchornia crassipes*) in ruminant nutrition in Tanzania. Livest ResRural Dev, 5: 17.

Ali N, Chaudhary BL, Khandelwal SK. 2004. Better use of water hyacinth for fuel, manure and pollution free environment. Indian J Environ Prot, 24: 297–303.

Barrett SC. 1977. Tristyly in *Eichhornia crassipes* (Mart.) Solms (water hyacinth). Biotropica, 230-238.

Barrett SC. 1979. The evolutionary breakdown of tristyly in *Eichhornia crassipes* (Mart.) Solms (Water Hyacinth). Evolution, 33(2): 499-510.

Batcher MS. 2000. Element Stewardship Abstract for Eichhornia crassipes (Martius) Solms water hyacinth. Prepared for The Nature Conservancy, Arlington Virginia. 10pp.

Bennicelli R, Stępniewska Z, Banach A, Szajnocha K, Ostrowski J. 2004. The ability of Azolla caroliniana to remove heavy metals (Hg (II), Cr (III), Cr (VI)) from municipal waste water. Chemosphere, 55(1): 141-146.

Charudattan R. 2001. Are we on top of aquatic weeds? Weed problems, control options and challenges. A talk presented at an international symposium on the world's Worse Weeds, Organized by the British Crop Protection Council, Brighton, UK.

Fawad M, Gul B, Khan H, Khan Z. 2013. Study and collection of hydrophytes of the district Swabi, Pakistan. Pakistan J Weed Sci Res, 19(4).

Fawad M, Khan H, Gul B, Khan MA, Marwat KB. 2015. Comparative effect of herbicidal and non-chemical control methods against water hyacinth. Pakistan J Weed Sci Res, 21(4).

Gopal B. 1987. Water hyacinth. Elsevier, Amsterdam.

Goswami T, Saikia CN. 1994. Water hyacinth—a potential source of raw material for greaseproof paper. Bioresour Technol, 50: 235-238.

Holm L, Doll J, Holm E, Pancho J, Herberger J. 1997. World weeds. Natural histories and distribution. New York, USA: John Wiley and Sons, Inc.

Hutchinson J, Dalziel JM. 1968. Flora of West Tropical Africa. 2nd Edition, 3 (1): 108-110.

Jianqing D, Ren W, Weidong F, Guoliang Z. 2001. Water hyacinth in China: Its distribution, problems and control status. In: Julien MH, Hill MP, Center TD, Jianquig D (eds.). biological and integrated control of water Hyacinth eichhornia crassipes (Proceedings PR102 2001).

Julien, M. H, Griffiths MW, Wright AD. 1999. Biological control of water hyacinth. The weevils Neochetina bruchi and N. eichhorniae: biologies, host ranges, and rearing, releasing and monitoring techniques for biological control of Eichhorniacrassipes. ACIAR Monograph No. 60, 87 pp.

Kasselmann C. 1995. Aquarienpflanzen. Egen Ulmer GMBH and Co., Stuttgart. 472. (In German).

Langeland, K. A and K. C. Burks (Eds.). 1998. Identification and Biology of Non-Native Plants in Florida's Natural Areas. UF/IFAS.165 p.

Mailu, A. M 2001. Preliminary assessment of the social, economic and environmental impacts of water hyacinth in the Lake Victoria basin and the status of control, biological and integrated control of water hyacinth, *Eichhornia crassipes*, ACIAR Proceedings No. 102.

Malik A. 2007. Environmental challenge vis a vis opportunity: The case of water hyacinth. Environ Int, 33: 122-138.

Mangas-Ramirez E, Elias-Gutierrez M. 2004. Effect of mechanical removal of water hyacinth (Eichhorniacrassipes) on the water quality and biological commu-nities in a Mexican reservoir. J Aquatic Healthand Manage, 7: 161–168.

Masifwa WF, Twongo T, Denny P. 2001. The impact of water hyacinth, Eichhornia crassipes (Mart) Solms on the abundance and diversity of aquatic macroinvertebrates along the shores of

northern Lake Victoria, Uganda. Hydrobiologia, 452(1-3): 79-88.

Meerhoff M, Mazzeo N, Moss B, Rodriguez-Gallego L. 2003. The structuring role of free floating versus submerged plants in a subtropical shallow lake. Aquat Ecol, 37: 377–391.

Meerhoff M, Iglesias C, De Mello FT, Clemente JM, Jensen E, Lauridsen TL, Jeppesen E. 2007. Effects of habitat complexity on community structure and predator avoidance behavior of littoral zooplanktonin temperate versus subtropical shallow lakes. Fresh-water Biol, 52: 1009–1021.

Mironga JM. 2004. Geographic information systems (GIS) and remote sensing in the management of shallow tropical lakes. Appl Ecol Environ Res, 2: 83–103.

Muller H. 1883. The fertilisation of flowers. Macmillan.

Oudhia P. 1999a. Medicinal weeds in rice fields of Chhattisgarh (India). Int Rice Res Notes, 24: 40.

Oudhia P. 1999b. Studies on allelopathy and medicinal weeds in chickpea fields. Int Chickpea Pigeonpea Newsl, 6: 29–33.

Perna C, Burrows D. 2005. Improved dissolvedoxygen status following removal of exotic weed matsin important fish habitat lagoons of the tropica lBurdekin River floodplain, Australia. Marine Pollut Bullet, 51: 138–148.

Plummer ML. 2005. Impact of invasive water hyacinth (*Eichhornia crassipes*) on snail hosts of schistosomiasis in Lake Victoria. East Africa Eco Health, 2:81–86.

Ramlan MF. 1991. The status of aquatic weeds in Malaysia. Proc. Of the aquatic weed management. Conference. Bogor (Indonesia), 15-17 May 1990. Seameo Biotrop, 39-45.

Rezene F. 2005. Water hyacinth (*Eichhornia crassipes*): A Review of its weed status in Ethiopia. In: Rezene Fessehaie (eds.), Arem, 6: 105 –111.

Rommens W, Maes J, Dekeza N, Inghelbrecht P, Nhiwatiwa T, Holsters E, Ollevier F, Marshall B, Brendonck L. 2003. The impact of water hyacinth (*Eichhornia crassipes*) in a eutrophic subtropicalimpoundment (Lake Chivero, Zimbabwe) I. Waterquality. Archiv Fur Hydrobiologie, 158, 373–388.

Room PM, Fernando IVS. 1992. Weed Invasions Countered by Biological Control: Salvinia molesta and Eichhornia crassipes in Sri Lanka. Aquatic Botany, 42: 99-107.

Sajn SA, Bulc TG, Vrhovsek D. 2005. Comparison of nutrient cycling in a surface flow constructed wetland and in a facultative pond treating secondary effluent. Water Sci Technol, 51: 291–298.

Sidek NM, Abdullah SRS, Ahmad NU, Draman SFS, Rosli MMM, Sanusi MF. 2018. Phytoremediation of abandoned mining lake by water hyacinth and water lettuces in constructed wetlands. J Teknol, 80(5): 87-93.

Stroud A. 1991. Water hyacinth (Eichhornia crassipes [Mart.] Solms) in Ethiopia. In: Proceedings of the 9th Annual Conference of the Ethiopian Weed Science Committee, EWSC, pp. 7–16, (Rezene Fessehaie, ed.), EARO, Addis Ababa, Ethiopia.

Szczeck MM 1999. Suppressiveness of vermicompost against fusarium wilt of tomato. J. Phytopathol. Phytopathologische Zeitschrift. 47: 155–161.

The Nation (Nairobi) March 25 2004. Local Scientist Patents Hyacinth Processing Machine. Dan Teng'o Nairobi.

Thomson S, Enala TM, Mick M. 2002. Control of aquatic weeds through pollutant reduction and weed utilization: a weed management approach in the lower Kafue River of Zambia. Physics Chem Earth, Parts A/B/C, 27: 983–991.

Toft JD, Simenstad CA, Cordell JR, Grimaldo LF. 2003. The effects of introduced water hyacinth on habitat structure, invertebrate assemblages, and fish diets. Estuaries, 26(3), 746-758.

Toft JD. 2000. Community Effects of the Non-Indigenous Aquatic Plant Water Hyacinth (Eichhornia crassipes) in the Sacramento/San Joaquin Delta, California. Thesis (MSc). University of Washington).

Yan SH, Song W, Guo JY. 2017. Advances in management and utilization of invasive water hyacinth (Eichhornia crassipes) in aquatic ecosystems–a review. Critical Rev Biotechnol, 37(2): 218-228.