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Azolla - An Amazing Aquatic Mosquito Fern

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Abstract

Azolla is a small, rapidly growing, free floating, nitrogen fixing aquatic fern. It is widely distributed in the water bodies in floating conditions by means of hanging roots. The plant is very popular due to its nitrogen fixing ability. The plant is used as bio-fertilizer. Beside this, the plant has bio-remediation potential and used as feed for animals and food for human beings *etc*. The plant is also considered as weed when it grows rapidly in aquatic ecosystem.

Introdction

Azolla is a small, rapidly growing, free floating aquatic fern native to Japan, Asia, Australia and tropical Africa (Adhikari and Babu, 2018).It floats on water surface by means of hanging roots in pond, pool, reservoirs and lakes. The young plant is green or bluish green in colour. Towards maturity, it turns in to red which can be easily recognized and claims its presence. With drying in water bodies plants dies. The plant is associated with symbiotic nitrogen fixing cyanobacterium *Anabaena azollae* which can fix atmospheric nitrogen and helps it to grow in nitrogen deficient condition. *Azolla–Anabaena* symbiosis is the only plant-cyanobacterial symbiosis used as bio-fertilizer in agriculture.

Fig 1. *Azolla* propagules

Fig 2. *Azolla* cultivation

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Different Species of *Azolla*

1. *Azolla pinnata*
2. *Azolla microphylla*
3. *Azolla fuliculoides*
4. *Azolla rubra*
5. *Azolla caroliniana*

Fig 3. *Azolla pinnata*

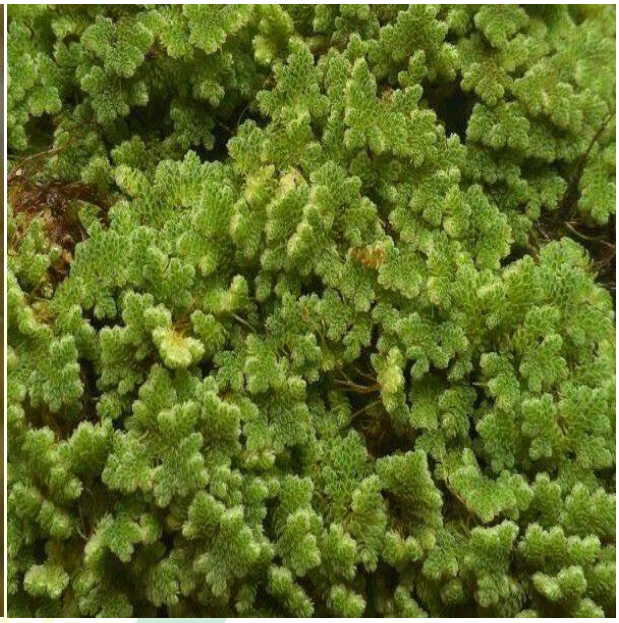

Fig 4. *Azolla microphylla*

Fig 5. *Azolla fuliculoides*

Fig 6. *Azolla rubra*

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Fig 7. *Azolla caroliniana* (Red)

Fig 8. *Azolla caroliniana* (Green)

***Azolla* Hybrids**

Several *Azolla* hybrids have been enveloped by crossing megas porocar and microsporocarps.The following hybrid sare developed at Chinese Academy of Science, Fuzhou,China,

1. AH-C1[*Azollamicrophylla*4018x*Azollamicrophylla*4028(V3)]
2. AH-C2 [*Azolla microphylla* 4018 x *Azolla microphylla* 4018 (V4)]
3. AH-C3 (A strain of *Azolla microphylla* from China)
4. AH–C4 (A strain of *Azolla pinnata var. imbricata* from China)
5. RongPing

Taxonomy of *Azolla*

The genus *Azolla* is represented by seven species belongs to the family Salviniaceae, Order Salviniales and Class Polypodiopsida. Now, the plant is placed in monotypic family Azollaceae (Konar and Kapoor, 1972).

Scientific Classification

Kingdom: Plantae, **Clade**: Tracheophytes, **Division**: Polypodiophyta, **Class**: Polypodiopsida, **Order**: Salviniales, **Family**: Azollaceae, **Genus**: *Azolla*, **Species**: *A. pinnata*

Morphologyof *Azolla*

The plant is triangular in shape. It is dichotomously branched. Stem is short and branched called rhizome.Roots are very small arises from the frond. The leaves are rounded and angularly overlapped which are green, blue green or dark red in colourand coated in tiny hairs, giving them a velvety appearance. The hairs make the top surface of leaves water-

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repellent keeping the plant afloat even after being pushed under. A water body may be coated in a dense layer of the plants, which form a velvety mat that crowds out other plants. The leaves contain the cyanobacterium, *Anabaenaazollae* which is a symbiont and fixes atmospheric nitrogen that the fern can use. This gives the fern the ability to grow in habitats that are nitrogen deficient.

Usesof *Azolla*

Azolla is used

1. As green manure
2. Asdualcropinrice
3. To increase crop yield
4. To increase soil fertility
5. To decrease salt content of Saline soil
6. In remediation of environmental pollutants
7. In phytoremediation of industrial waste water
8. For treating waste water of poultry farms
9. For the production of hydrogen fuel the production of biogas
10. In preparation of mosquito repellent
11. As weed control agent
12. In production of Biogas
13. As Bioenergy
14. As human food
15. As Space Diet
16. As animal food (Raja *et al*. 2012)

Pests infesting *Azolla*

Order	Family	Pests
Diptera	Chironomidae	1. Chironomids, • Two banded chironomid, *Polypedilumjuinoense* • Yellow chironomid, *Cricotopusspp*. • Brown chironomid, *Tendipes attenuates* • Green chironomid, *Tendipes riparius* • *Chironomuscrassiforceps*

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		• *Chironomusjavanus* • *Chironomuskiiensis* • *Polypedilumanticum*
Coleoptera	Curculionidae	1. Snout beetle, *Bagousaffinis* 2. Weevils • *Stenopelmusrufinasus* • *Nanophyesinsularis* • *Apionspp*.
Lepidoptera	Pyralidae	*1.* Caseworm,*Elophilaresponsalis* *2.* Leaf Webber, *Cryptoblabes gnidiella* *3.* Gray Pyralid, *Pyralis spp.* *4.* Brown nymphula, *Nymphula tarbata* *5.* Black nymphula, *Nymphula swinhoe* *6. Ephestiopsisvishnou* *7. Elophilaenixalis* *8. Elophilanigrabalis*

Management of Pests Infesting *Azolla*

1. Use healthy *Azolla* inoculums. Avoid pest in fested *Azolla* inoculum.
2. Use *Azolla* species that are resistant to pests.
3. Avoid overcrowding of *Azolla* mat.
4. Grow mixed culture of *Azolla* species / varieties in the same field.
5. Parasites such as *Apantelesspp* .and *Ameuromarphaacceptametathoracica* feed the eggs,
6. larvae orpupa of the insects.
7. *Diplonynchusrusticus* (Giant water bugs), *Limnogonusfossarum* (Water striders), *Microvelliadoughlasiatrolineata* (Ripple bugs), *Cybistertripunctatusorientalis* (Beetle), *Lacophilusinsularis* (Beetle), *Hydrophilusaffinis* (Beetle), *Berosusspp*. (Beetle), *Sternolophusspp*.(Beetle) and *Lycosapseudoannulata* (Spider) used to manage pests.
8. Apply Carbofuran, Phorate, Aldicarb and Quinolphos that control the pests of rice as well as that of *Azolla*.

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Conclusion

Among aquatic pterid ophytes, *Azolla* is very popular because of its nitrogen fixing ability. Beside this, the plant has nutritional value, phyto remediation property and other uses. Due to the shrinkage of water bodies the plant is gradually declining in wild. Its conservation is very urgent by taking different steps so as to maintain the sustainable agriculture and improve the degrading environment.

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