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.

Introduction
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 into 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
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
**Azolla Hybrids**

Several *Azolla* hybrids have been enveloped by crossing megasporocarps and microsporocarps. The following hybrids are developed at Chinese Academy of Science, Fuzhou, China,

1. AH-C1 [Azollamicrophylla 4018 x 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**


**Morphology of 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 colour and coated in tiny hairs, giving them a velvety appearance. The hairs make the top surface of leaves water-
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, *Anabaenazollae* 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.

**Uses of Azolla**

*Azolla* is used

1. As green manure
2. As dual crop in rice
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**

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<thead>
<tr>
<th>Order</th>
<th>Family</th>
<th>Pests</th>
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<tr>
<td>Diptera</td>
<td>Chironomidae</td>
<td>1. Chironomids,</td>
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<td>• Two banded chironomid, <em>Polypedilumjuinoense</em></td>
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<td>• Yellow chironomid, <em>Cricotopuspp</em>.</td>
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<td>• Brown chironomid, <em>Tendipes attenuates</em></td>
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<td>• Green chironomid, <em>Tendipes riparius</em></td>
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<td>• <em>Chironomuscassiforceps</em></td>
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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 Ameuromarphaacceptamatethoracica feed the eggs,
6. larvae or pupa 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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<tbody>
<tr>
<td><strong>Coleoptera</strong></td>
<td><strong>Curculionidae</strong></td>
<td>1. Snout beetle, Bagousaffinis</td>
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<td>2. Weevils</td>
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<td>• Stenopelmusrufinasus</td>
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<td>• Nanophyesinsularis</td>
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<td>• Apionspp.</td>
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<td><strong>Lepidoptera</strong></td>
<td><strong>Pyralidae</strong></td>
<td>1. Caseworm,Elophilaresponsalis</td>
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<td>2. Leaf Webber, Cryptoblabes gnidiella</td>
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<td>4. Brown nymphula, Nymphula tarbata</td>
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<td>5. Black nymphula, Nymphula swinhoe</td>
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<td>6. Ephesiopsisvishnou</td>
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<td>7. Elophilaenixalis</td>
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<td>8. Elophilanigrabalasis</td>
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Conclusion

Among aquatic pteridophytes, *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.

References


