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AZOLLA AND ANABAENA: THE BENEFICIAL SOULMATES

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Azolla leaves harbour, an enclosed environment for anabaena. In return, anabaena sequesters nitrogen directly from the atmosphere making it available to Azolla. Thus, making Azolla survive in a soil less environment. This unique relationship between the floating fern and the diazotrophic cyanobiont together leads to an immense and efficient nitrogen factory. While azolla production has the potential to offer several socio-environmental benefits, there are also concerns and potential negative impacts that need to be considered.

Azolla (*Azolla pinnata*) is a nature's gift which has tremendous benefits. It is a free-floating and rapidly growing aquatic fern. It floats like a small, flat, compact green mass and appears as a velvety green mat over water surface. A thick mat of Azolla supplies 30-40kg N/ha. This is a fern with a triangular stem coated in tiny hairs which gives them a hairy velvety appearance and bear roots which hang down in the water. It thrives well at low temperatures. Under ideal conditions, it grows exponentially. The lobes of azolla leaves contain cyanobacterium *Anabaena azollae*, which helps to fix nitrogen from the atmosphere. It multiplies vegetatively and is applied to the main field as a green manure crop and as a dual crop. In rice, nitrogen is the limiting factor due to which the yield gets affected. Azolla is incorporated in the rice field for better yield and for its nitrogen fixing properties.

Mechanism

Each leaf of azolla is divided into dorsal and ventral lobe. In the dorsal leaf lobe, there is an ellipsoidal cavity. The cavity largely filled with gases is lined with mucilage which contains the *Anabaena azollae*. *Azolla* provides an enclosed environment for *Anabaena* within its leaves. In return, *Anabaena* sequesters nitrogen directly from the atmosphere which then becomes available for *Azolla's* growth and after incorporation these N will enrich the soil.

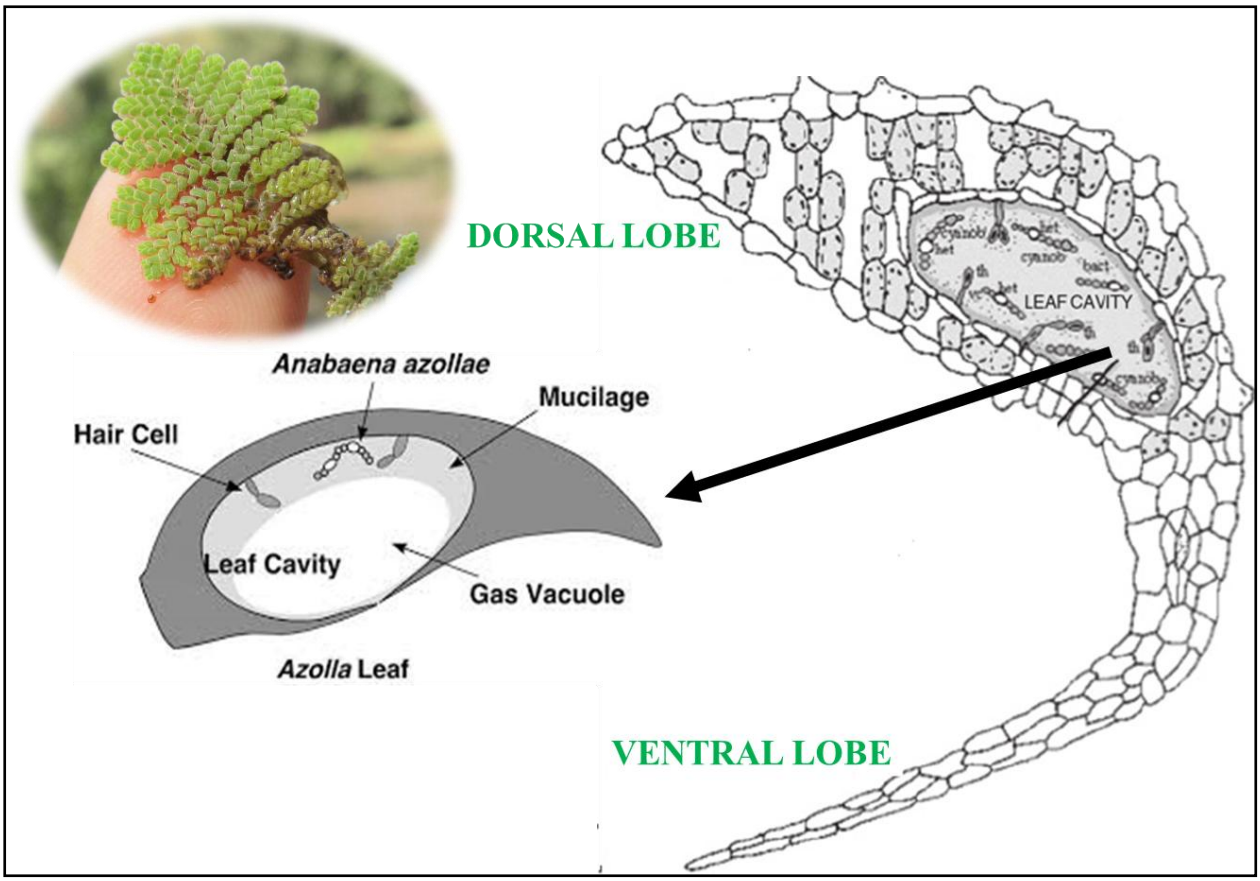

Fig. 1: Azolla – Anabaena symbiosis

Procedure

- Bed for Azolla production is prepared using bricks and concrete or any other types of artificial beds can also be used for this purpose.
- Plastic sheets are spread on the bottom to avoid leakage.
- Approximately 10-15 kg of sieved pond soil is spread over the pit.
- 3-5 kg cow dung is mixed with water and the slurry is spread over the bed.
- For nutrition 5g/sq m SSP is added.
- The tank is filled with sufficient water and the soil particles are allowed to settle down.
- Azolla is added to the pit as inoculum.
- The water level of the pit is maintained every day.
- It takes about two weeks for Azolla to get ready for the first harvest.

Exploring areas of Azolla Biofertilizer Use

Azolla is a small aquatic fern that holds significant potential for various applications due to its unique characteristics and properties. Here are some areas where Azolla has been explored and utilized:

Agriculture

Azolla is commonly used as a biofertilizer in rice paddies. It forms a symbiotic relationship with a nitrogen-fixing cyanobacterium called Anabaena azollae, which enriches the soil with nitrogen. When incorporated into rice fields, Azolla can reduce the need for synthetic nitrogen fertilizers, leading to more sustainable and eco-friendly agriculture.

Livestock Feed

Azolla can serve as a nutritious feed supplement for livestock such as poultry, pigs, and fish. It contains proteins, essential amino acids, vitamins, and minerals. When added to animal diets, Azolla can improve growth rates and overall health.

Wastewater Treatment

Azolla can be used in constructed wetlands and other water treatment systems to help remove pollutants from wastewater. Its rapid growth and ability to absorb heavy metals and nutrients make it effective in purifying water.

Bioremediation

Due to its ability to accumulate heavy metals and other pollutants, Azolla has been investigated for its potential in cleaning up contaminated water bodies and soil in polluted areas.

Bioenergy Production

Azolla can be used as a feedstock for bioenergy production, such as biogas and bioethanol. Its high growth rate and carbohydrate content make it a promising candidate for biofuel production.

Carbon Sequestration

Azolla can capture and store atmospheric carbon dioxide through photosynthesis. When it proliferates in water bodies, it can potentially contribute to mitigating climate change by removing CO2 from the atmosphere.

Limitations

It's important to note that while Azolla holds promise in these areas, there may also be challenges and limitations associated with its use. Factors such as local climate, water availability, and regulatory considerations can influence the feasibility of Azolla-based applications. Ongoing research is essential to fully understand and harness the potential benefits of Azolla in various fields.

Trust Areas

- Azolla is of interest to researchers studying plant-microbe interactions, nitrogen fixation, and sustainable agriculture practices. It is also used in educational settings to demonstrate ecological concepts and experiments.
- Azolla biomass can be used in various industries, including pharmaceuticals, cosmetics, and textiles. Extracts from Azolla have shown potential antimicrobial, antioxidant, and anti-inflammatory properties.

Precautions

- Harvesting of Azolla should be done on regular basis to avoid overcrowding.
- Temperature should be maintained at around 30-35 °C as it is an important factor for proper growth. Temperature above 35°C will lead to decrease in rate of multiplication.
- Bunds of the plot where Azolla is cultured should be lined with polythene sheet to avoid leakage.
- Nursery area should preferably be under tree and direct sunlight should be avoided.

Socio-Environmental Concerns

Here are some socio-environmental concerns associated with azolla production:

Invasive Species

Azolla has the potential to become invasive in certain ecosystems. If not properly managed, it can outcompete native plants and disrupt local biodiversity. Its rapid growth and ability to form dense mats on water bodies can alter aquatic habitats and negatively impact native species.

Water Quality

While azolla can absorb nutrients from water bodies, there is a risk of nutrient imbalances. If azolla overgrows, dies, and decomposes, it can lead to oxygen depletion in the water, which can harm aquatic life. Moreover, the release of stored nutrients from decomposing azolla can contribute to eutrophication, a process that leads to excessive nutrient enrichment and degraded water quality.

Habitat Alteration

The dense mats of azolla can alter aquatic ecosystems by shading out sunlight and reducing oxygen exchange between the water and the atmosphere. This alteration can affect the habitats and behaviors of various aquatic organisms.

Cultural Impact

Introducing azolla into traditional agricultural systems may require changes in farming practices and could impact local cultural practices and knowledge. Additionally, the introduction of non-native species like azolla could disrupt traditional ecological balances and relationships.

Genetic Contamination

The potential for genetic contamination exists when azolla is introduced into new areas. If not managed carefully, genetic mixing between cultivated and wild populations could lead to unintended consequences and impact native genetic diversity.

Disease and Pest Management

The dense growth of azolla can create favorable conditions for pests and diseases. If not managed properly, these issues could lead to the use of pesticides or other control methods that may have negative environmental consequences.

Resource Intensiveness

While azolla can reduce the need for some inputs like synthetic fertilizers, its production requires water and nutrient inputs. In areas with limited water resources, increased azolla cultivation could lead to competition for water resources with other uses or ecosystems.

Social Equity

The adoption of azolla-based practices may require changes in traditional agricultural systems and livelihoods. It's important to consider the potential impacts on local

communities, especially those who depend on existing agricultural practices for their livelihoods.

Regulatory and Policy Concerns

The introduction of non-native species, even with potential benefits, can raise regulatory concerns in some regions. Proper risk assessments and regulatory measures need to be in place to manage the introduction and cultivation of azolla.

Lack of Long-Term Research

Despite the potential benefits, there might be limited long-term research on the ecological, environmental, and socio-economic impacts of widespread azolla cultivation. This makes it important to proceed cautiously and gather comprehensive data on its effects.

Conclusion

The demand of organic agriculture is at its peak due to rising health and fitness awareness. The fact that Azolla is a Biofertilizer that possesses a rapid rate of multiplication and can be directly applied to soil in its living form is of utmost importance and usage. For small and marginal farmers, Azolla can be an economically feasible solution. The health hazards associated with chemical fertilizers can only be done away with by the use of potential biofertilizers in the fields. Rice being a major crop, Azolla can be a low input investment for farmers who are not economically strong. The positive environmental effects of the fern prove it to be a good choice.

Fig. 2: Azolla production unit

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