Semester - II
Paper Code - MBOTCC - 5 : Biofertilizer Technology
Unit - III
***Azolla* - mass cultivation and application in rice field.**

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1. Introduction to *Azolla*

Systematic Position

Division - Filicophyta
Class - Leptosporangiate
Order - Salviniales
Family - *Azolla*ceae
Genus - *Azolla*

Occurrence

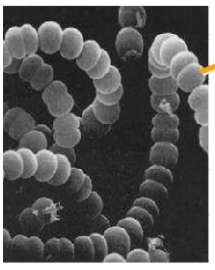
- It is a hydrophytic fern, very small plant, grows free living in free floating condition on the surface of ponds, lakes and ditches.
- It has 6 species which are found in tropical and temperate regions.
- *Azolla pinnata* is common species.

Morphological features

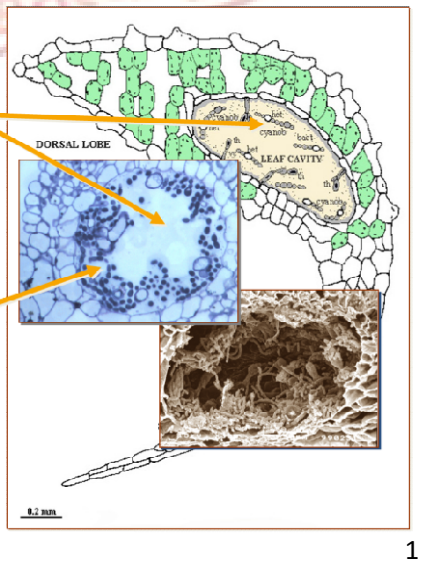
Azolla plants are triangular or polygonal in shape, and float on the surface of the water, individually or in mats. They give the appearance of a dark green carpet.

i. **Roots** - Long, slender and green roots with large number of root hairs arise from beneath of stem.
ii. **Stem** - Profusly branched floating stems.
iii. **Leaves** - Minute, overlapping, bilobbed, alternately arranged in two dorsal rows.
The upper lobe is chlorophyllous and floating .
The lower or ventral lobe is achorophyllous and submerged.
The upper or dorsal lobe contains cavities in which symbiont cyanobacteria *Anabaena azollae* resides.
The fern provides nutrients and a protective cavity in each leaf to *Anabaena* colonies in exchange for fixed atmospheric nitrogen and possibly other growth-promoting substances. It is believed that water absorption takes place through submerged lobe rather than through roots.

***Azolla* leaf**



Anabaena



Anatomical features
of leaves

Advantages of *Azolla*

1. It easily grows in wild as well as under controlled conditions.
2. It can easily be produced in large quantity required as green manure in both the seasons – Kharif and Rabi.
3. It can fix atmospheric CO_2 and nitrogen to form carbohydrates and ammonia respectively and after decomposition it adds available nitrogen for crop uptake and organic carbon content to the soil.
4. The oxygen released due to oxygenic photosynthesis, helps the respiration of root system of the crops as well as other soil microorganisms.
5. It solubilises Zn, Fe and Mn and makes them available to the rice.
6. It suppresses tender weeds such as *Chara* and *Nitella* in a paddy field.
7. It releases plant growth regulators and vitamins which enhance the growth of the rice plant.
8. It can be a substitute for chemical nitrogenous fertilizers to a certain extent (20 kg/ha) and it increases the crop yield and quality.
9. It increases the utilization efficiency of chemical fertilizers.
10. It reduces evaporation rate from the irrigated rice field.

2. *Azolla* as biofertilizer

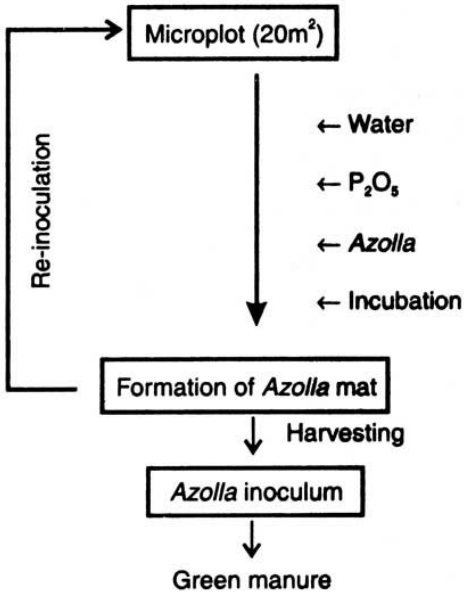
History

- *Azolla* has a historical role in agriculture as it has been used as a biofertilizer and green manure for the rice crop due to its N_2 fixing abilities (Van Hove et al., 1996). *Azolla* was also mentioned as poultry feed.
- It attracted international attention in the 1970s as a result of the oil crisis and the rising prices of fossil fuel-dependent N fertilizers. *Azolla* became a potential replacement for these as it was believed that it could bolster rice production in many tropical countries.
- However, *Azolla* does have several unquestionable agronomic qualities: the capacity to fix atmospheric nitrogen, a very high productivity in the right environment, a high protein content, an herbicide effect and the capacity to decrease N-fertilizer volatilization.
- For those reasons, *Azolla* started to attract attention again in the late 1990s, notably as a component of integrated farming such as rice-fish-*Azolla*, rice-duck-*Azolla*, rice-duck-fish-*Azolla* or pig-fish-*Azolla* systems (Van Hove et al., 1996).
- Adoption of *Azolla* by livestock farmers still faces important hurdles. In India, for example, in spite of being promoted by non-government organizations, cooperatives and government agencies, adoption has been slow and sporadic due to poor yields, pests, handling and storage difficulties, and labour requirements (Chander, 2011; Tamizhkumaran et al., 2012).
- Research and promotion of *Azolla* as a livestock feed has been increasing. Because *Azolla* has a higher protein content (19-30%) than most green forage crops and aquatic macrophytes, and an essential amino acid composition (notably lysine) favourable for animal nutrition, *Azolla* can be a valuable protein supplement for many species, including ruminants, poultry, pigs and fish (Hasan et al., 2009).

Cultivation process

- The biomass production under natural condition i.e. in rice field is only 50 g/ sq.m/day as against optimum production of 400 g/sq.m/day.
- The production efficiency can be increased by reducing contamination and competition with other algae. This can be achieved by growing *Azolla* in pits, lined with synthetic polythene sheet in courtyard /back yard preferably in open space or on terrace, where adequate sunlight is available.

- A polythene sheet is spread over the bed in such a way that 10 cm of standing water can be maintained. Width of the bed is maintained at 1.5 m to enable the cultural operation from both sides. Length of the unit may be varied depending upon the requirement.
- Once the bed of size 2.5 m x 1.5 m is ready, about 15 kg of fine sieved soil is spread over the bed, which will provide nutrient to the azolla plant.
- About 5 kg of pre-decomposed (2 days) cow dung is mixed with the water, which provides carbon source for the *Azolla*. About 40 g of nutrient mix (made by mixing 10 kg Rock phosphate, 1.5 kg Magnesium salt and 500 g of Murate of potash) is added to the *Azolla* bed.
- The solution is fortified with micronutrient of desired quantity. This not only takes care of the micronutrient requirement of *Azolla* but also the cattle when it is fed with the *Azolla*.
- Sufficient water is added to make the water level of the bed to 10 cm.
- Production of *Azolla* scientifically and on a continuous basis requires cement concrete tanks of size 2 m long, 1 m wide and 0.5 m deep.
- Due care should be taken so that water can stand in the tank. Ten or more tanks can be constructed in one place covering an area of 25 sq. m. Arrangements for water to each tank should be made by laying pipe and tap from the over head tank.
- Soil is distributed evenly across the bottom of the tank. The depth of soil layer should be about 10 cm.
- Cow dung is to be added at the rate of 1 to 1.5 kg per sq m of the tank area (2 to 3 kg of cow dung per tank).
- Single Super Phosphate (SSP) is to be added at the rate of 5 g per sq m of the tank area every week. (10 g SSP per tank).
- Fill the tank with water till the water collects to a height of 10 to 15 cm above the soil. Allow the soil particle to settle down.
- Prepare the fresh *Azolla* inoculum by adding 2 g of carbofuran to prevent pest infestation.



- Remove the layer of foam and scum that forms on the surface of the water. The foam impedes the growth and root penetration of azolla. Allow the tank to stand overnight.
- On the following day, spread around 200 g of fresh *Azolla* inoculum over the surface of the water. It takes about seven days for *Azolla* to form a mat over the water surface. Water level in the tank should be maintained especially during summer months.
- To reduce excessive ambient light, a shade made out of coconut leaves may be laid above the tank. This also prevents dew formation on the growing *Azolla* during winter.
- Ideally it will give 10 kg of *Azolla* within seven days. During the initial seven days azolla is not harvested.
- Water level is maintained by applying water everyday.
- After the seventh day, 1.5 kg of *Azolla* can be harvested every day. *Azolla* should be harvested in plastic trays with sieve.
- Harvested *Azolla* should be washed in fresh water before it is fed to the cattle. Washing is necessary to remove the smell of cow dung.
- The *Azolla* wash can be used as bio-manure for plants grown nearby. *Azolla* harvested can be mixed with the commercial feed in 1:1 ratio.

- Cow dung and mineral mixture removed by *Azolla* mass has to be supplemented at least once in seven days after harvest. A mixture made of cow dung, mineral mixture, soil and water should be added once in seven days.
- After every 60 days, soil is removed from the bed and another 15 kg of fresh fertile soil is added into the bed to avoid nitrogen build up and also provide nutrient to the *Azolla*.
- Fresh inoculation of *Azolla* after removing soil and water should be made at least once in six months repeating the whole process afresh.

Precautions to be adopted:

1. Maintenance of pure culture free from contamination is essential for good yield.
2. *Azolla* should be harvested regularly to avoid overcrowding.
3. Temperature is an important factor for good growth. It should be around 35°C. The fodder plot is to be covered with a plastic sheet in cold regions so as to reduce the impact of cold weather. 4.
4. Places with direct and adequate sunlight should be preferred. A shady place yields less.
5. pH of the medium should be between 5.5 to 7.
6. Suitable nutrients such as cow dung slurry, micronutrients should be supplemented as and when required.