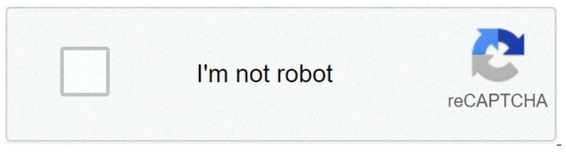

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How to cultivate azolla

Azolla is a floating water fern that has roots submerged in the water. Amusing to look at, this fodder plant has been gaining quite a lot of popularity and is quite in demand. It resembles the likes of duckweed or some type of mosses. Since Azolla is a very productive plant, let us see how they are cultivated in India. 1. Benefits/ Uses of Azolla The Azolla plant has many benefits. Azolla cultivation can be of so much use to not only famers, but consumers as well. Since the plant covers the surface of the water, it reduces the light penetration of the soil. This is good because it reduces the possibility of weed production. It helps aquatic weed from being formed whilst farming. Azolla plants uses its root system much to its advantage. It is known for fixing atmospheric nitrogen and carrying the process of photosynthesis. Like we said earlier, Azolla can be used as a fodder plant. Animals like pigs, cattle, chicken, ducks and many more consume this plant as fodder. It can be used for many vegetables and plantation crops. Another interesting use is that Azolla can be utilised as a biofertilizer for agricultural crops. It is a huge source of nutrition for soil. Azolla can be used as green manure. The azolla plant is able to purify water and is used as a medicine as well. 2. Factors Required For Growth Photo by Carnat Joel, CC BY 2.0 Let us look at some growth factors and requirements for azolla farming in India. This refers to the pH levels required in order to have the ideal azolla plantation. Azollas are known to be able to survive within the pH ranges of 3.5 to about 10. These plants are not able to grow in acidic soils with pH levels below 3.5. So, within that limit or above should be fine. Azolla is a very tolerant plant. It is known to be able to tolerate various ranges when it comes to temperature. Some species of azolla are known to even survive in temperatures as low as – 5oC which is quite impressive. Most species have the ideal temperature of 18-28. However, it can go higher for some rare species. Light affects the photosynthesis and regulates the nitrogenase activity in Azolla. Azolla plants are best known to grow under less sunlight instead of extreme sources. Under high sunlight intensities Azolla fronds turn brick red. In the case of low light intensities, these sources of light could cause the Azolla plant to suffer or die. The ideal photoperiod for azolla plants is about 20 hours. For the 20 hours photoperiod, 380E/m2/s of illumination should be fine. Just like the cultivation of any other plant, the azolla requires just as many mineral and nutrients for its growth. The nutrients required might be available to the plant in the water or it can be extracted from the soil if the water is shallow enough. Also, molybdenum and cobalt are important minerals to have. These are required for Anabaena and its nitrogen fixation. During the growth of azolla, one must be careful as to how the levels of nitrogen are maintained. This is because the levels of nitrogen play an important role in determining its nitrogen fixation rates and its growth. This is the most important nutrient for azolla production. A deficiency in phosphorus can be determined by the deep red color of the plant and the sudden lengthening of the roots. Threshold Macronutrients for Azolla growth. For Full Nitrogenase Activity. Threshold Micronutrients for Azolla growth. • P: 0.03 mmol 1-1 • K: 0.4 mmol 1-1 • Mg: 0.4 mmol 1-1 • Ca: 0.5 mmol 1-1 • P: 0.03 mmol 1-1 • K: 0.6 mmol 1-1 • Mg: 0.5 mmol 1-1 • Ca: 0.5 mmol 1-1 • Fe: 50 g1-1 • Mn: 20g1-1 • Mo: 0.3g1-1 • B: 30g1-1 3. Cultivation Process and Materials Required Photo by Kevin Thiele, CC BY 2.0 As you may know, the azolla is an aquatic plant which means that it requires a shallow pond for its cultivation. We shall be discussing the process behind the cultivation of azolla plants. A lot of care and consideration must be put when it comes to growing azolla. Firstly, choosing a location for the azolla pond is crucial. This particular location must be perfect and must abide to all the factors required. For example, having a good source of water is important. Partial sunlight and enough shade should also be present at the place of cultivation. Make sure the bottom of the pond is free from any obstructions as well. When it comes to the size of the pond, it depends on how much of azolla you're looking to cultivate. Make sure to have the pond cleaned and levelled before beginning the growing process. Line up the edges of the pond with bricks. Lastly, make sure to place a net on top so as to prevent any unwanted things from falling into the pond. The cultivation of plants in India all have different methods. The same goes for the cultivation of the azolla plant. You can start by using a mixture of fertile soil, cow dung and water. Spread this mixture across the pond. Make sure this is executed well as it is the foundation step in the cultivating process. The water should be about 5-6 inches in depth. You can use azolla culture and spread it across as well. About 1kg of this should be enough for the average sized pond. Apart from this, do not forget to check the water for alkaline levels. For its maintenance after the briefing of cultivation, use 1 kg of cow dung and about 100 grams of super phosphate to the plant once every two weeks or so. After the foundation process, the azolla plant should be ready after two or three weeks. Plastic sieves are usually used to harvest the azolla and can be done daily when fully grown. Like we said earlier, azolla acts as fodder for many livestock. So, it can be fed either directly or mixed with other nutrients. However, make sure to clean the plant well before utilising. There you have it, the A to Z of azolla cultivation in India. Azolla is a freshwater water fern that lives in ponds, lakes, swamps, and streams in both tropical and sub-tropical conditions. For many centuries, azolla has been used in southern China and northern Vietnam as green manure for rice. Why use Azolla in rice? Azolla in association with blue-green alga anabaena can fix atmospheric Nitrogen (N) into ammonia which can be utilized by rice plant when it is incorporated into soil. Azolla contains from 2−5% N, 0.3−6.0% Potassium (K) (dry weight). How do you manage Azolla in rice? Multiplication Azolla multiplies vegetatively (i.e., it does not produce seeds). Thus, live Azolla (inoculum) is maintained throughout the year by growing in small ponds or water filled ditches (e.g., areas of 4−5 m2 and depth of 0.5−1 m. You need around 250−500g (fresh weight) inoculum for such an area). Azolla grows best at a 25oC average daily temperature but dies at higher temperature. It can be utilized by rice in both wet and dry season. Azolla can be used in two ways: 1) as green manure incorporated before transplanting, and 2) as an intercrop incorporated after transplanting. In each case, about 500 kg (fresh weight) per ha is introduced into standing water in the rice field. Pre-transplanting incorporation Grow Azolla for about a month before incorporating at transplanting. Fertilize Azolla with 2.2 kg Phosphorus (P)/ha every 5 d, 4 kg K/ha every 10 d, and/or 500−1000 kg/ha farmyard manure every 5−10 d. If chemical fertilizers are unavailable, ash is substituted. Intercropped Azolla Introduce azolla into the rice field when permanent standing water is available. Intercropped azolla is usually not fertilized (but if super phosphate is available one application of 4.5 kg P/ha per crop is recommended). Under both systems, azolla can be incorporated several times during the crop cycle. Rate of growth Sixteen to twenty days after inoculation the field is covered with about 20 t of Azolla, which is then incorporated into soil. Normally, some Azolla is left after the first incorporation, which then continues to grow. Sometimes 3−4 crops of azolla are produced and incorporated in each crop of rice. This technology produces around 40 t (fresh weight) azolla/ha per rice crop equivalent to around 80 kg N/ha. It requires application of 0.5 t fresh azolla inoculum, 2−3 t farmyard manure, 20−30 kg P, and 20 kg K/ha. Limitations Azolla cannot withstand any drying – so standing water is always required. Because Azolla grows from vegetative multiplication, inoculum must be maintained in nurseries all year and multiplied for distribution before field inoculation and multiplication. High temperatures cause greater disease and insect attack on azolla. Cool weather is a key to successful Azolla utilization. Among nutrients, P is most important for azolla. Since Azolla floats, it is not able to extract P from soil, thus its growth is often constrained by insufficiency of P if P is not applied into the flood water. The economics of Azolla use is very important. The technology is labor intensive. Often farmers have little or no economic advantage in choosing azolla over chemical fertilizer because the additional costs of labor, land opportunity irrigation, seed/inoculum, phosphate, and pesticides make the use of Azolla uneconomical. Developed with input from JK Ladha Genus of aquatic plants AzollaTemporal range: Maastrichtian-Holocene Azolla caroliniana Scientific classification Kingdom: Plantae Clade: Tracheophytes Division: Polypodiophyta Class: Polypodiopsida Order: Salviniales Family: Salviniaceae Genus: AzollaLam.[1] Type species A. filiculoides[1] Species See text Azolla (mosquito fern, duckweed fern, fairy moss, water fern) is a genus of seven species of aquatic ferns in the family Salviniaceae. They are extremely reduced in form and specialized, looking nothing like other typical ferns but more resembling duckweed or some mosses. Azolla filiculoides is one of just two fern species for which a reference genome has been published.[2] Azolla taken from the Philippines Azolla is considered an invasive plant in wetlands, freshwater lakes and ditches. It can alter aquatic ecosystems and biodiversity substantially.[3] Species Section Rhizosperma Azolla cariniana Azolla imbricata Azolla nilotica Decne. ex Mett. Azolla pinnata R.Br. Section Azolla Drawing of Azolla filiculoides, about 5 mm. Upper green leaves perform photosynthesis, lower lack chlorophyll. Azolla cristata Kaulf. (this name takes priority over Azolla caroliniana Willd.) Azolla filiculoides Lam. Azolla rubra R.Br. Sources:[4][5][6][7] At least six extinct species are known from the fossil record: Azolla intertrappea Sahni & H.S. Rao, 1934 (Eocene, India)[8] Azolla berryi Brown, 1934 (Eocene, Green River Formation, Wyoming)[8] Azolla prisca Chandler & Reid, 1926 (Oligocene, London Clay, Isle of Wight)[8] Azolla tertiaria Berry, 1927 (Pliocene, Esmeralda Formation, Nevada)[8] Azolla primaeva (Penhallow) Arnold, 1955 (Eocene, Allenby Formation, British Columbia)[8] Azolla boliviensis Vajda & McLoughlin, 2005 (Maastrichtian - Paleocene, Eslaboacuten Formation and Flora Formation Bolivia)[9] Ecology Azolla covering the Canning River, Western Australia Azolla on the Canning River, Western Australia Azolla is a highly productive plant. It doubles its biomass in 1.9 days or more,[10] depending on conditions, and yield can reach 8–10 tonnes fresh matter/ha in Asian rice fields. 37.8 t fresh weight/ha (2.78 t DM/ha dry weight) has been reported for Azolla pinnata in India (Hasan et al., 2009).[11] Azolla floats on the surface of water by means of numerous small, closely overlapping scale-like leaves, with their roots hanging in the water. They form a symbiotic relationship with the cyanobacterium Anabaena azollae, which fixes atmospheric nitrogen. The plant can readily colonise areas of freshwater, and grow at great speed - doubling its biomass every two to three days. The typical limiting factor on its growth is phosphorus. An abundance of phosphorus, due for example to eutrophication or chemical runoff, often leads to Azolla blooms. Unlike all other known plants, its symbiotic microorganism transfers directly from one generation to the next. A. azollae is completely dependent on its host, as several of its genes have either been lost or transferred to the nucleus in Azolla's cells.[12] SEM image of Azolla surface The nitrogen-fixing capability of Azolla has led to widespread use as a biofertiliser, especially in parts of southeast Asia. The plant has been used to bolster agricultural productivity in China for over a thousand years. When rice paddies are flooded in the spring, they can be planted with Azolla, which then quickly multiplies to cover the water, suppressing weeds. The rotting plant material releases nitrogen into the water for the rice plants, providing up to nine tonnes of protein per hectare per year.[13] Azolla are weeds in many parts of the world, entirely covering some bodies of water. The myth that no mosquito can penetrate the coating of fern to lay its eggs in the water gives the plant its common name "mosquito fern",[14] and may deter the survival of some of the larvae. Most species can produce large amounts of deoxyanthocyanins in response to various stresses,[15] including bright sunlight and extreme temperatures,[16][17] causing the water surface to appear to be covered with an intensely red carpet. Herbivore feeding induces accumulation of deoxyanthocyanins and leads to a reduction in the proportion of polyunsaturated fatty acids in the fronds, thus lowering their palatability and nutritive value.[18] Azolla cannot survive winters with prolonged freezing, so is often grown as an ornamental plant at high latitudes where it cannot establish itself firmly enough to become a weed. It is not tolerant of salinity; normal plants cannot survive in greater than 1–1.6‰, and even conditioned organisms die given salinity above 5.5‰.[19] Azolla filiculoides Azolla filiculoides (red azolla) is the only member of this genus and of the family Azollaceae in Tasmania. It is a common native aquatic plant in Tasmania. It is common behind farm dams and other still waterbodies. The plants are small (usually only a few cm across) and float, but can be abundant and form large mats. The plants are typically red, and have small, water repellent leaves. Reproduction Scanning electron micrograph of a megaspore of the genus Azolla with adhering massulae from postal sediments of Laguna El Junco, Galápagos Island of San Cristóbal[20] Transmission electron micrograph of a megaspore of the genus Azolla from postglacial sediments of Laguna El Junco, Galápagos Island of San Cristobal[20] Azolla reproduces sexually, and asexually (by splitting). Like all ferns, sexual reproduction leads to spore formation, but unilke other members of this group Azolla produces two kinds. During the summer months, numerous spherical structures called sporocarps form on the undersides of the branches. The male sporocarp is greenish or reddish and looks like the egg mass of an insect or spider. It is two millimeters in diameter, and bears numerous male sporangia. Male spores (microspores) are extremely small and are produced inside each microsporangium. Microspores tend to adhere in clumps called massulae.[8] Female sporocarps are much smaller, containing one sporangium and one functional spore. Since an individual female spore is considerably larger than a male spore, it is termed a megaspore. Azolla has microscopic male and female gametophytes that develop inside the male and female spores. The female gametophyte protrudes from the megaspore and bears a small number of archegonia, each containing a single egg. The microspore forms a male gametophyte with a single antheridium which produces eight swimming sperm.[21] The barbed glochidia on the male spore clusters cause them to cling to the female megaspores, thus facilitating fertilization. Human use Food and animal feed In addition to its traditional cultivation as a bio-fertilizer for wetland paddy, Azolla is finding increasing use for sustainable production of livestock feed.[22] Azolla is rich in protein, essential amino acids, vitamins and minerals. Studies describe feeding Azolla to dairy cattle, pigs, ducks, and chickens, with reported increases in milk production, weight of broiler chickens and egg production of layers, as compared to conventional feed. One FAO study describes how Azolla integrates into a tropical biomass agricultural system, reducing the need for inputs.[23] Concerns about biomagnification exist because the plant may contain the neurotoxin BMAA that remains present in the bodies of animals consuming it and BMAA has been documented as passing along the food chain.[24] Azolla may contain this substance that is a possible cause of neurodegenerative diseases.[25][26][27] Azolla has been suggested as a foodstuff for human consumption, however, no long-term studies of the safety of eating Azolla have been made on humans.[28] Previous studies attributed neurotoxin production to Anabaena flos-aquae species, which is also a type of nitrogen-fixing cyanobacteria.[29] Further research may be needed to ascertain if A. azollae produces neurotoxins. Companion plant Azolla has been used for at least one thousand years in rice paddies as a companion plant, to fix nitrogen and to block out light to prevent competition from other plants. Rice is planted when tall enough to poke through the Azolla layer. Mats of mature Azolla can also be used as a weed-suppressing mulch. Rice farmers used Azolla as a rice biofertilizer 1500 years ago. The earliest known written record of this practice is in a book written by Jia Ssu Hsieh (Jia Si Xue) in 540 A.D on The Art of Feeding the People (Chih Min Tao Shu). By the end of the Ming dynasty in the early 17th century, Azolla's use as a green compost was documented in local records.[30] Larvicide The myth that no mosquito can penetrate the coating of fern to lay its eggs in the water gives the plant its common name "mosquito fern".[14] Azolla have been used to control mosquito larvae in rice fields. The plant grows in a thick mat on the surface of the water, making it more difficult for the larvae to reach the surface to breathe, effectively choking the larvae.[31] Invasive species This fern has been introduced to other parts of the world, including the United Kingdom, where it became a pest in some areas. A nominally tropical plant, it has adapted to the colder climate. It can form mats up to 30cm thick and cover 100% of a water surface, preventing local insects and amphibians from reaching the surface.[32] Importance in paleoclimatology Main article: Azolla event A study of Arctic paleoclimatology reported that Azolla may have had a significant role in reversing an increase in greenhouse effect that occurred 55 million years ago that had caused the region around the north pole to turn into a hot, tropical environment. This research was conducted by the Institute of Environmental Biology at Utrecht University. It indicates that massive patches of Azolla growing on the (then) freshwater surface of the Arctic Ocean consumed enough carbon dioxide from the atmosphere for the global greenhouse effect to decline, eventually causing the formation of Ice sheets in Antarctica and the current "icehouse period". This theory has been termed the Azolla event. Bioremediation See also: bioremediation Azolla can remove chromium, nickel, copper, zinc, and lead from effluent. It can also remove lead from solutions containing 1–1000 ppm.[33] References ^ a b In: Encyclopédie Méthodique, Botanique 1(1): 343. 1783. "Name - Azolla Lam". Tropicos. Saint Louis, Missouri: Missouri Botanical Garden. Retrieved February 19, 2010. Annotation: a sp. nov. reference for Azolla filiculoidesType Specimens HT: Azolla filiculoides ^ Li, Fay-Wei; Brouwer, Paul; Carretero-Paulet, Lorenzo; Cheng, Shifeng; de Vries, Jan; Delaux, Pierre-Marc; Eily, Ariana; Koppers, Nils; Kuo, Li-Yaung (2018-07-02). 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