

Euryale ferox Salisb (also known as fox nut, foxnut, makhana, or gorgon plant) is one of the most valuable cash aquatic fruit grown in thousands of fresh water stagnant pools (both natural and man-made) of

Northern and Eastern Asia, Europe, America, etc. and is very common in the freshwater habitats of Northern, Eastern and Western India.

In India, it is grown in the various tracts of N.E. Assam, Tripura, West Bengal, Orissa, Bihar, and Meghalay, different parts in MP and UP and in Alwar (Rajasthan). North Bihar and lower Assam are probably the only states in India where the plant is cultivated for commercial purpose along with *Nelumbium*, *Trapa* species and fish (Ahmad and Singh,

1991, 1997; Datta Munshi, et al., 1991; Dehadrai, 1994; Jha, 2000).

For geographical and climatic reasons Bihar is the heaven for Makhana Production. The cultivation of the crop is confined to Dharbhanga, Motihari, Madhubani, Samastipur, Sitamarhi, Saharsa, Supaul, Araria, Kishanganj, Katihar and Purnea districts of Bihar. Makhana is cultivated in more than 2000 ha in Darbhanga and Madhubani districts. Around 75% of the total Makhana production comes from Bihar Swetlands.

Approximately 2000 tons of popped makhana worth Rs. 100 million are exported outside north Bihar (Thakur, 2005). Makhana is valued for its nutritional, medicinal and ritualistic significance also. In north Bihar, the seed is consumed in popped form, but in Manipur, other parts (leaves and stalks) are consumed as vegetables. Seeds are also used in many dishes of India.

Leaf blight caused by *Alternaria alternata*, is a most serious fungal disease of makhana (Haidar and Nath, 1987; Dwivedi et al., 1995). Symptoms of *Alternaria* leaf blight appear on the upper surface of leaves, which include leaf spots, and blighting. Leaf spots are light tan to brown and usually have a concentric ring or target pattern with a yellow halo. As leaf spotting increases, blighting and premature defoliation occur (Haider and Mahto, 2003).

Remove infected leaves foliage, and destroy it safely, will prevent their spread. In pool, where there are no fish, foliar sprays with copper oxychloride or dithane M-45 @ 0.3% twice or thrice at fortnightly interval have been found very effective to check the disease.

There are two species of leaf spot disease that damage makhana leaves. One causes random spotting and dark patches on the surface of the leaves, which eventually enlarge or merge together, and may be reddish to grayish brown; the other tends to start at the outer edges of the leaves, causing them to turn brown and crumble. Both are debilitating and disfiguring, but they are not very serious problems. Their incidence will vary considerably from year to year, depending upon the prevailing conditions.

The more recent strain of root rot disease is believed to be caused by a number of pathogens, which have not yet been fully identified. One has

FIGURE 17.1 Symptoms of leaf spot in makhana leaves.

Diseases of Makhana and Their Management 341

been known over the years as crown or root rot which is believed to be caused by *Phytophthora* species. Apparently, healthy plants suddenly showing wilting and yellowing. The roots appear dark brown or black, which become soft and rotten. The outer layer of cells easily strips off the roots leaving only the central strand of water conducting tissue.

At present, there is no cure, so it is vital to remove and destroy any infected

plants. Then the pool should be cleaned thoroughly and sterilized with a solution of sodium hypochlorite or swirling a muslin bag filled with copper sulfate crystals through the water before being flushed out with fresh water. Once clear water has been run back in, new plants can be safely introduced. All fish must be removed before any such treatment begins, and not returned until the pool has been emptied, swilled out and refilled with fresh water.

Botrytis blight or “gray mold” is a widely distributed disease caused by the fungus *Botrytis* species. *Botrytis* are ubiquitous and opportunistic; they attack only physiologically-weakened plants. *Botrytis*, gray mold is common on seeds and seedlings. *Botrytis* at first appears as a white growth on the plant but very soon darkens to a gray color. Smoky-gray “dusty” spores form and are spread by the wind or in water. Buds or small leaves with gray mold on them may influence growth and photosynthesis. The risk of disease and plant loss can be minimized by reducing pathogen populations and increasing plant vigor.

Sanitation is the first important step in controlling this disease. Remove dead or dying tissue from the plants and from the soil surface. Sanitation alone is not sufficient to control this fungus.

Seeds should be soaked in Hydrogen peroxide and water at a ratio of 1:10. Fresh solution should be added every day until the seed has swollen and is ready to split its skin and extend stems and roots. This is a time

7.6 DEVELOPMENT OF TUMORS

The crop suffered a heavy damage to its leaves and other parts including the petiole, pedicel, etc., from a smut fungus known as *Doassansiopsis euryaleae* (Verma and Jha, 1999). The infection usually extended from leaf lamina to petiole and from pedicel to the basal part of flower causing great distortion in shape due to hypertrophy. At the beginning the hypertrophy was small but later attained a major dimension. Infection to the basal part of the flower including the ovary greatly reduced the number of viable seeds and caused an economic loss to the farmers (Verma et al., 2003). Sometimes it affects fruits and causes fruit galls. There is no control measure reported for this disease (Figure 17.2).

Other diseases like chlorosis, nutrient deficiencies and poor growth of plants is normally due to fertilization, CO₂ or lighting conditions.

These can lead to other problems like bacterial rots, etc. because the plants are weak for extreme patience. Scarification or cutting the shell of the seed hurries things along. Just don't cut too deep. It can still take 20 days.