

Review Article

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Agronomic Management of Water Chestnut (*Trapa natans* L.): A Review

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ABSTRACT

Water chestnut is an important high value aquatic crop grown in India. Of late the importance of this crop has been increasing due to the presence of appreciable amount of nutritional contents therein like protein, carbohydrates, fiber and minerals. This paper explores the recent agronomic management techniques and post-harvest utilization of water chestnut crop. Being a short duration annual crop, it can be introduced in low-input cropping systems as a viable alternative crop for sustainable horticulture. Water chestnut production is mainly constrained by lack of knowledge on agronomic practices, deficiency of technical know-how about its processing and lack of mass awareness about its high nutritional values. These days, field cultivation of this crop is also proving to be profitable. Hence, attempts are being undertaken to integrate it with field crops. Improved genotypes namely Bihar Large Red, Green Spineless and Balasore Green have been found to perform the best under field cultivation. Planting distance of 1m x 2m with application of NPK @ 60:40:30 kg/ha in split applications have witnessed a yield of as much as 12.0 t/ha. Being a high value cash crop, it can be sold as the fresh produce; better income however can be secured by selling value added products of water chestnut like dry nut and flour. Cultivated with right agronomic techniques and processed appropriately after harvest, water chestnut crop can significantly improve the livelihood of farmers living in water surplus regions of rural India.

Keywords

Water chestnut, horticulture, Bihar large red, Green spineless and Balasore green

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Introduction

Water chestnut (*Trapa natans* L.) is one of the most important aquatic nuts grown in India. It is an important nut in terms of protein, carbohydrates, mineral and vitamin content along with important amino acids (Faruk *et al.*, 2012). Nutritional and medicinal qualities of *Trapa natans* have been recognized in India, China, Thailand, Russia and many other countries (Hummel and Kiviat, 2004).

In India, *Trapa natans*, *T. bispinosa*, *T. quadrispinosa* and *T. bicornis* are very popular. Fresh nut is well known for its high water content (80.0%) (Puste, 2004) protein (1.87%) and TSS (7.0-8.0%) (Singh *et al.*, 2010). According to Adkar *et al.*, (2014) and Alfasane *et al.*, (2011) protein and carbohydrate content of fresh water chestnut are 4.40% and 22.3%, respectively. Water chestnut is an excellent source of crude fiber (2.13% in green variety and 2.27 % in red

variety). It is also a fair source of Vitamin B along with Ca, K, Fe and Zn (Singh *et al.*, 2009 and Gopalan *et al.*, 2004). Water chestnut is an eco-friendly crop and is utilized for prevention of cyano-bacterial bloom and addition of nutrients to the soil after decomposition of its residue. *Trapa natans* usually decreases dissolved inorganic nitrogen in water thereby potentially reducing eutrophication process in water bodies (Tsuchiya and Iwakuma, 1993). From aquatic environment, it absorbs heavy metals such as cadmium, nickel, and cobalt (USEPA, 1989) which are deposited mainly in hulls. According to Block and Morris (2002) one seed gives rise to 10-12 rosettes and each rosette produces as much as 20 fruits. It requires 4.0 months after transplanting for producing economic yield. It is very hardy crop requiring only 1-2 sprays of insecticides and fungicides for disease and pest free plant growth.

Agronomic management techniques

Genotype

Four types of water chestnut are mainly cultivated in India *viz.* spine and spineless with red and green color. The prominent genotypes of water chestnut are Spineless Red, Spineless Green (Jana *et al.*, 2019). Red Spine, Bihar Large Red, Green Spine, Balia Red, Lucknow Green, Jaunpuri and Balasore Green (Jana, 2016a) which are common in all parts of India. However Balasore Green of Odisha gives relatively a better yield of 16.84 t/ha (Choudhary *et al.*, 2003).

Climate

Water chestnut needs rather cool climate for its seed germination (12-15 °C). For plant growth and development it needs little higher temperature 25-30°C. However, fruit is generally harvested during cool winter

October-November (Block and Morris, 2002 and Kundu and Joshi, 2012).

Soil and nutrient management

It thrives in soft nutrient rich waters of lakes, ponds and streams with a neutral to slightly alkaline pH. For commercial cultivation soil should be heavy, muddy and rich in organic matter. Organic manures in form of oil cakes, poultry manure and compost/FYM @ 8 t/ha are recommended for growth and development of water chestnut crop (Choudhary *et al.*, 2003). Significant amount of phosphorus and potassium is needed for optimum growth of the crop. In West Bengal, application of 30-40 kg urea/ha during transplantation and another 20 kg/ha is recommended after 25-30 days of transplanting (Jana, 2016a). Soils rich in Zn and B result in increased number of fruits and fruit weight. For newly cultivated field, the fertilizer dose can be modified from NPK @ 60:20:20 kg/ha to NPK @ 60:40:30 kg/ha (Jana *et al.*, 2019).

Nursery raising and transplanting

The seed rate for nursery preparation is 80-100 kg dry nut/ha. It is recommended that plants are first grown in a low nutrient plot/nursery and transplanted into main plot when stems are about 1.0-1.5 m tall. Care should be taken at the time of transplanting to keep the seedlings moist but not submerged. According to Jana *et al.*, (2019) planting distance should be maintained at 1m x 2m to give an optimum plant population of 4500-5000 plants/ha.

Water level

Throughout the growth period of the crop 1-2 m water depth should be maintained for proper growth and development (Jana, 2016a) (Fig. 1). A greater depth of water is tolerated

by the plants but they do not prosper if water shortage occurs at early period of growth. Prior to harvesting of the crop water depth may be reduced gradually.

Reproductive stage

Spineless Red cultivar flowers first at wetland ecosystem of North Bihar during 2nd week of August. Blooming period continues to 1st week of September. But Spineless Green cultivar has longer blooming period from August to October. Harvesting of the nuts is usually performed during October to December (Fig. 2). A well maintained local genotype gives the maximum yield of 2.5-3.5 t/ha (Jana, 2016). Bihar Large Red (Spine), the commercial variety of Mithila region, Darbhanga, India, gives a higher yield of 7.0 t/ha (Jana *et al.*, 2019). The maximum yield of 12.0 t/ha can be achieved by cultivation of Green Spineless genotype (Jana *et al.*, 2019). Regular eradication of aquatic weeds, especially *Hydrilla* and *Sagittaria*, common in makhana and water chestnut crop, is utmost important during the cropping season to avoid the crop-weed competition (Jana, 2016b)

Fig.1 Water chestnut plant



Pest and disease management

Beetle (*Galerucella birmanica* Jacoby) and aphid are the main pests under wetland ecosystem of Darbhanga, North Bihar. Two to three sprays of *Carbaryl* @ 0.05% at an interval of 7-10 days can control beetle (*Galerucella birmanica* Jacoby), aphid and mealy bug. Spray of *Bavistin* (0.1%) is required to control fungal diseases (Yadav and Gargav, 1988).

Value addition

Traditionally water chestnut is consumed after boiling. This is high value nut from which sweets and precious chapatti may be made. Sun drying or artificial drying in oven is common in India. It's a medium to low calorie food with maximum nutrients which is gaining importance for making snacks for every class of people throughout the world. Nut is free from gluten and cholesterol and rich in K, Mg and fiber, which renders it an ideal snack. Low cost mixed food can be made by mixing this nut flour with wheat and pulse flour to fortify its nutritional value (Sha *et al.*, 2016; and Baba *et al.*, 2016).

Fig.2 Harvesting of water chestnut



Fig.3 Green Spineless fresh nut



Fig.4 Green Spineless dry nut



Water chestnut for enhancing rural livelihood sustainability

Water chestnut is a high value aquatic horticultural cash crop. High farmers' income can be secured by increasing production of water chestnut by cultivating high yielding genotypes, value addition and efficient marketing management. The net profit from water chestnut (fresh product) is about INR 1.87 lakh/ha/year (Jana, 2019) with production cost of about INR 0.6 lakh/ha/year. From the cultivation of superior genotype 'Green Spineless', a harvest of more than 2.0 t/ha dry nut (Fig. 3 and 4) is possible which is worth INR 4.0 lakh/ha/year.

Limitations and future prospects

Necessary actions should be undertaken to keep ecosystem vibrant and get the maximum benefit from water chestnut crop. Crop residues are easily decomposed and add various plant nutrients to soil including organic matter for sustainable horticultural production system. Water chestnut cultivation is also a kind of bio-remediation by natural means. It is difficult to maintain its quality during processing which is essential for export, which merits particular attention. Water chestnut is a lucrative crop which requires mass awareness about nutritional qualities and consumption techniques for the

health conscious people. Water chestnut crop can significantly improve the livelihood of farmers living in water surplus regions of rural India if cultivated with right agronomic techniques and processed appropriately after harvest.

Conflicts of interests

There is no conflict of interests.

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