Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(6): 315-318
Received: 13-09-2019
Accepted: 15-10-2019

Bal Manohar
Department of Agronomy, Bihar Agricultural College, B.A.U Sabour, Bhagalpur, Bihar, India

Sushmita
Department of Seed Science and Technology, Bihar Agricultural College, B.A.U Sabour, Bhagalpur, Bihar, India

Corresponding Author:
Sushmita
Department of Seed Science and Technology, Bihar Agricultural College, B.A.U Sabour, Bhagalpur, Bihar, India

Gorgon nut and its associated weeds

Bal Manohar and Sushmita

Abstract
Makhana (*Eurale ferox* Salsib.) is an important aquatic plant growing in mostly in northern part of Bihar & West Bengal. It is mostly grown in streams waterhole, lakes, land depression trenches and marshland, etc. The infestation of weed takes place rapidly in the initial stage of development of Makhana crop. Therefore, regular weeding is essentially required during the initial stage of establishment of the seeding. On account of luxurious vegetative growth of Makhana leaves. i.e., after 30-40 days of transplantation, the infestation level of weeds, however, starts getting reduced. Herbicide like paraquat and glyphosate are effectively used in aquatic weeds control. *Cyperus difformis* and *Aeschynomene aspera* were remarkably controlled by the application of organic cakes like neem (*Azadiracta indica* L.) and arandi (*Ricinus communis* L) in equal proportion and @2-3 ton ha-1after pulverized the soil with rotavator. Makhana is an important aquatic crop, has tremendous potential to support the livelihood of resource poor farmers of eastern region of country.

Keywords: Herbicide, marshland, glyphosate, paraquat, rotavator

Introduction
Euryale ferox Salisb is an important crop, belonging to family Nympheaceae. It is commonly known as Makhana, Gorgon nut or Foxnut and grown in stagnant perennial water bodies like ponds, Oxbow lakes, and swamps. Makhana plant is considered as a native of South-East Asia and China, but distributed to almost every parts of the world. In general, its distribution is extremely limited to tropical and sub-tropical regions of South-East Asia and known to exist in Japan, Korea, Russia, North America, Nepal, Bangladesh and some parts of India. In India, it is distributed in West Bengal, Bihar, Manipur, Tripura, Assam, Jammu & Kashmir, Eastern Odisha, Madhya Pradesh, Rajasthan and Uttar Pradesh. However, its commercial cultivation is limited to North Bihar, Manipur, parts of West Bengal and Madhya Pradesh. In the state of Bihar, major Makhana producing districts include Darbhanga, Sitamarhi, Madhubani, Saharsa, Supaul, Araria, Kishanganj, Purnia and Katihar. Approximately, 80% of the total production of processed Makhana comes from Darbangha, Madhubani, Purnia, and Katihar districts alone. Area under Makhana cultivation is about 13,000 ha. Bihar is the leading producer of makhana (90%). It has also been noticed that not only in India but also in the world the North Bihar ranked first. Wetlands of North Bihar accounted for the maximum makhana production due having lot of ponds, lakes and stagnant water bodies. The distribution of Euryale ferox is limited to tropical and sub-tropical regions of South East and East Asia while, it occurs in wild form in Japan, Korea, Bangladesh, China and Russia etc. In India, it grows as a natural crop and is distributed sparsely in parts of Manipur, Orissa, Jammu and Kashmir, etc. It is cultivated as a cash crop in Bihar and parts of West Bengal and Assam. Makhana plant requires shallow water depth having thick layer of mucky bottom that is rich in organic nutrients.

Climatic Requirement
Makhana thrives best when range of air temperature is (20-35 ^{O}C), relative humidity is 50-90 per cent and annual rainfall is about 100-250cm reported that cultivation of makhana is possible in general agricultural field with clay soil for better water holding capacity.

Botany
Makhana is a floating leaf emergent macrophyte. It does not bear stem but the rootstalks are short, thick and fibrous comprising 3 to 5 clusters, each consisting of about 15 rootlets. The plant roots make their way into the fine clay bottom soil while the plant shows very fast vegetative growth. The leaves are orbicular, floating and glabrous, green and corrugated above and pink or deep purple beneath, supported by stout, porous and prickly ribs.

The full-grown leaves are of 1.2 - 1.5 m in diameter. Petioles are prickly and deep green or pink. The flowers are about 5-6 m in diameter and are violet-blue or dark pink in color. Each plant produces 15-20 fruits, which are round, spongy and prickly outside. Each fruit consists of 20-25 seeds, which are small (0.75 cm in diameter), black and encrusted with a thick sheath around the white edible part.

Flower characteristics and pollination

The floweris cleistogamous and predominantly self pollinated. Peak pollination was observed between 60-70 days after transplanting. The weather of August and September were ideal for pollination and fruit set. The temperature and humidity of this period were 29-30 degree celcius, and relative humidity pf this period is 79%-81%, respectively. Besides cleistogamy chasmogamy is also observed after july flowering, when crop gets matured. The complete flower development is noticed within 72-96 hrs from floral initiation.

Flower characteristics and pollination

Table 1: Parameters of cultivation

Parameter(s)	Traditional Method of Cultivation	Cropping System Mode
Water requirement	15000-20000 m3	3000-4000 m3
Seed requirement	80-90 kg/ha	20 kg/ha
Source of water	Perennial water bodies	Irrigation water
Fertilizers and manure	Not applied	Applied before and after transplanting of seedlings
Weed management	Tedious and time consuming	Easy and faster
Plant population/ha	5000-5500 nos.	6000-6400 nos.
Seed yield	1.6-2.0 t/ha	2.8-3.0 t/ha
Cultivation of other crops	Not practiced except fish rearing in some fox nut growing water bodies	After harvest of fox nut, water chest nut, green fodder and/or pulses (lentil) is grown.
Harvesting	Very tedious. Carried out only by trained manpower	Easy. Carried out even by unskilled manpower.
Scope of horizontal expansion of Makhana cultivation	Limited. It would depend upon the availability of natural water bodies.	Wide scope with scope of expansion in an area of 1.0 m ha.

Weed problem in makhana cultivation

An assured supply of irrigation is a pre requisite for Makhana cultivation. The transplanted Makhana seedling take 4 month period for gaining its full maturity. Since transplanting is done in the month of April, The main growing period (April to August) could make use of monsoon rains. Nevertheless, farmers need to apply 4-5 irrigation depending on the requirement, particularly when rainfall is erratic The infestation of weed takes place rapidly in the initial stage of development of Makhana crop. Therefore, regular weeding is essentially required during the initia lstage of establishment of the seeding. On account of luxurious vegetative growth of Makhana leaves. i.e., after 30-40 days of transplantation, the infestation level of weeds, however, starts getting reduced. In integrated farming system, combining Makhana with fish and water chestnut, weed menace is reduced due to netting during harvesting of the fishes in the month of December-January.

Hydrilla verticillata, spp. and *Sagittaria guayanesis* are the major aquatic weeds in India during rainy season. Herbicide like paraquat and glyphosate are effectively used in aquatic weeds control.

Weed *Marsilea* spp. only found in shallow depth of pond. *Cyperus defformis* was the most obnoxious weed for makhana cultivation but it's presence was observed in the water depth up to 30 cm. But *Cyperus rotundus* instead of *Cyperus defformis* was present at water depth of 40-50 cm *i.e.* shallow depth of water in Rice field. They also confirmed that *Cyperus rotundus* was the major weed in rice field. Occurrence of *Hydrilla* and *Algal bloom* were most common features in the field having more than 40 cm water depth.

Weed problem in makhana cultivation

Table 2: Appearance of different kinds of weed species

Mostly Found	Moderately Found	Sparsely Found
Cyperus defformis L.	*Sagittaria guayanesis*	*Marsilea quadrifolia* L.
Cyperus defformis L.	*Cyperus rotundus* L.	*Marsilea quadrifolia* L.
Aeschynomere asoera L.	*Algal bloom*	----------
Hydrilla vertisillata Royle	----------	----------

Population density, biomass yield and protein content of certain aquatic weeds growing in association with makhana crop

The population density of different weed species was recorded from makhana fields. The highest number of plants was recorded with *Marsilea quadrifolia* (132 plants/m2) while the lowest with *Eichhornia crassipes* (2 plants/m2). The number of plants recorded with *Ceratophyllum demersum* and

Ipomoea aquatica were 5 and 10, respectively. Fig: - Heavy infestation of *I. aquatica* weed the highest protein content was recorded in the biomass of *I. aquatica* (25.00%) followed by *Azolla pinnata* (22.50%). The other three weed species had recorded almost similar protein content in vegetative phase of growth. On account of having a large vegetative body, *E. crassipes* recorded maximum biomass (200 kg/ ha) on dry weight basis (Table 22). Thus, it adds an appreciable amount of organic matter to the soil which would certainly be beneficial in sustaining the fertility of the soil among the studied weed species. The *I. aquatica* was observed to be the second largest contributor of organic matter (130 kg/ha) to the soil whereas the lowest biomass wasadded by *C. demersum* (7 kg/ha). Population density, biomass yield and crude protein content of certain aquatic weeds growing in association with makhana crop.

Weeds growing in association with makhana crop

Table 3: Population density, biomass yield and crude protein content of certain aquatic weeds growing in association with makhana crop

Weed	No. of plant/m2	Crude protein (% dry weight)	Standing weed biomass dry weight (Kg/ha)
Marsilea quadrifolia	132	14.06	62
Eichornia crassipes	2	15.35	200
Ceratophyllum dermersum	5	18.20	7
Ipomea aquatica	10	25	130
Azolla pinnata	-	22.50	120

Macronutrient content of weed species

Many weeds had nitrogen content above 2.20 per cent. Plant materials with a N content above 2.5 per cent when added to the soil induce an initial release of nitrogen. Besides being rich in N, and K, these weeds may be a good source of calcium, magnesium, sodium and sulphur to the plants (Table 23).

Table 4: Chemical analysis of inorganic elements (percent) of certain aquatic weed species

Weed species	Organic carbon	Total N	Total P_2O_5	Total K_2O	C:N	C:P
Azolla pinnata	29	3.6	0.08	0.67	8:1	362:1
E. crassipes	42	2.40	0.13	2.85	17:1	323:1
C. dermersum	30	2.78	0.30	2.52	10:1	100:1
I. aqatica	45	2.54	0.20	2.65	17:1	225:1

The C:N and C:P ratios varied from 10.80 to 17.70 and 100 to 362.50. Plant residues having a C:N ratio above this when added to the soil will cause an initial immobilization of soil nitrogen.

Below this, net release of inorganic nitrogen takes place. The majority of the weeds analysed had a C:N ratio below 20, and the C:P ratio for all the weeds was slightly above 200 except *C. demersum*. This study of the biological constants indicated that the addition of these weeds is likely to result in the microbial release of nitrogen, phosphorus and other plant nutrients.

Micro nutrient content in certain aquatic weed species

The aquatic plants growing in the study area exhibited different trace elements depending on the plant organ. Iron, manganese, zinc and copper contents of the weeds varied from 2225 to 2405, 492 to 1245 mg/kg, 90 to 195 mg/kg and 5.4 to 38 mg/kg, respectively (Table 24).

The present study revealed that *M. quadrifolia* and *C. demersum* possess greater accumulation ability for selected heavy metals. The maximum accumulation of Fe, Mn, Zn and Cu was made by *M. quadrifolia* followed by *C. demersum*. In present study very high accumulation of Cu was found in shoot system of *Marsilea quadrifolia* (38 mg/kg) which indicates that this species can be effectively used as phytoremediant for Cu contaminated water bodies.

Table 5: Micro-nutrient content in certain aquatic weed species

Weeds species	Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)	Cu (mg/kg)
Marsilea quadrifolia	2400	840	195	38
Eichchornia crassipes	2225	1245	170	5.4
Ceratophyllum demersum	2405	492	182	28
Ipomea aquatic	2300	700	90	27
Azolla pinnata	-	-	-	-

Management of Problamatic Weeds

Herbicide like paraquat and glyphosate are effectively used in aquatic weeds control. *Cyperus defformis* and *Aeschynomene aspera* were remarkably controlled by the application of organic cakes like neem (*Azadiracta indica* L.) and arandi (*Ricinus communis* L) in equal proportion and @2-3 ton ha-1 after pulverized the soil with rotavator (Fig.2). Chaffy and immature seeds of *Sagittaria guayanesis* and other weeds are also controlled by the application of organic cakes but bold and mature seed are mostly germinated while less number of seeds was destroyed by soil pulverization. Makhana and *Sagittaria guayanesis* are closely related genus and aquatic crops in nature, therefore absolute removal of *Sagittaria guayanesis* from the plot is impossible. When we applied

organic cakes for growth of Makhana crop the maximum weed seeds were get affected. Although some weeds get germinated their growth was suppressed by the rapid growth of makhna crop, which covered whole field within the one month. Mainley these aqatic weed grow in winter and complete life cycle, at least a part in water. A number of aqatic herbicides and algicides are marketed and used. In India herbicide control in aquatic ecosystem is very much limited. Some of the herbicide used are as follows:-

1) Acrolein & Aromatic solvent
2) Anhydrous ammonia
3) Dalapon
4) 2,4-D
5) Paraquat and diquat
6) Diuron
7) Endolhall (Na &K salts)

A major limitations of physical control of aquatic weed is that the harvested weed grows fast, making it essentially a continuous, manual or machine intensive process.

Fig 1: *Saggiteria guanensis* L.

Fig 2: *Marselia quadrifolia* L.

Conclusion

Makhana is an important aquatic crop, has tremendous potential to support the livelihood of resource poor farmers of eastern region of country. However the crop is still neglected, probably because of lack of awareness among the progressive farmers and policy planners. In India, there are a lot of fallow wetlands, which remain unutilized round the year. In such case, Makhana cultivation offers a unique opportunity to earn more revenue. Sincere efforts are needed for dissemination of the knowledge related to its cultivation, processing, packaging and marketing. Post harvest and processing of makhana is, however, still a challenging task ahead which need to be addressed sincerely. Investigations on development of value added, convenient and ready to eat products from makhana and their packaging techniques is essentially required for its promotion and marketing.

Reference

1. Gupta OP. Aquatic weed management weed management principles and practices. 219-242.
2. JANA BR. Impact of water depth on growth of gorgon nut and associated weed under wetland ecosystem of North Bihar province in India Journal of Crop and Weed. 2017; 13(1):77-82.
3. Ahmad SH, Singh AK. Prospects of integration of Makhana (*Euryale ferox*) with fish culture in north Bihar-Fishing Chimes. 1997; 16:45-50.
4. Banerjee SR. Infestation of *Euryale ferox* Salisb. By larvae of *Nymphula crisonalis* Walker and trials on its control- J Bombay Nat. Hist. Soc. 1972; 69:79-90.
5. Dahlin Irish, Ninkovic Vladimir. Aphid performance and population development on their host plant is affected by weed crop interaction. J Applied Ecol. 2013; 50:1281-88.
6. Das S, Der P, Roychoudhury U, Maulik N, Das DK. The effect of *Euryale ferox* (Makhana), an herb of aquatic origin, on myocardial ischemic reperfusion injury. Mol. Cell Biochem. 2006; 289(1-2):55-63.
7. Dwivedi AK, Shekhar R, Sharma SC. Ultrastructural studies of Euryale ferox leaf infected by Alternaria alternate. Indian Phytopath. 1995; 48:61-65.
8. Ramkumar J, Singh RD. Management of rice leaf folder pest-The Hindu (News Paper). TNAU, Ramanathapuram. Updated. 2013; 16(23):50. IST
9. Rao AN, Lodha JK. Economic weed management approaches for Rice in Asia, 2013, 500-509.
10. In: Baki Hj; Baker, Dkurniadie and Tjitrosoedirdj (eds.). Proc. 24th Asia Pacific Weed Sci. Soc. Conf. Bandung, Indonesia, 22-25 Oct, 2013.
11. Saraswati KC, Mishra RK, Kumar R, Jha V. *Rhopalosiphum nymphaeae* Linn. Infestation on the leaves of Euryale ferox in Darbhanga. J Aphidol. 1990; 4:89-92.
12. Singh IS, Kumar Lokendra Singh AK, Bhatt BP, Singh SP. Impact of makhana (*Euryale ferox* Salisb) based cropping system on nutrient dynamics of inceptisols of North Bihar, Int. J Agricult. Stat. Sci. 2014; 10(1):125-29.