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Insect Pests of Makhana Crops and Their Management Strategies

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Makhana (*Euryale ferox* Salib) is an important aquatic cash crop and about 80-90 percent of the world's total production comes from Bihar, especially Mithilanchal and Simanchal Koshi regions in Bihar. The average productivity of Makhana crop in Bihar is 11-15 q/ha. At present 40-45 percent of Makhana crop is cultivated in low land rice field condition and rest are traditionally grown in the pond systems. Due to changing pattern of cropping systems and intensification of the crop, number of abiotic and biotic factors acting upon, reducing the crop yield, of which insect pests and gastropods especially Mollusca's pose threats and emerges as potential major pests of the crop. Though, there are meagre reports on the occurrence and status of pests, the four dozen insect pests and eight gastropod species were found associated with Makhana crop (Mishra et al., 1992) that can reduce crop yield by 10 percent or more. Considering the medicinal properties and nutritional values of makhana, its global demand is increasing rapidly, creating a good opportunity to enhance the income of makhana farmers in Bihar. In recent years, due to modern research and favorable government policies, farmers' interest in makhana cultivation has increased significantly. Traditionally, makhana has been considered a hardycrop, though in recent times most of the insect pests were emerging / potential pests but due to the adoption and intensification of Makhana crop from pond to low land rice field, number of insect pests pose threats and emerges as major and minor pests. Therefore, through this extension literature, an attempt has been made to provide farmers with brief information about the major insect pests affecting Makhana crops, alongwith their management strategies.

Insect pests of Makhana crops

Like other crops, the makhana crops is also affected by the various insect pests, which cause considerable damage to its cultivation. The major insect pests that damage to Makhana crops are as follows :

Table : Insect pests and Gastropods Associated with Makhana crops :

S. No.	Common name	Scientific name	Family	Order	Damaging stage	Effected plant parts	Pest statues
1	Aphid	*Rhopalosiphum nymhaeae Linn*	Aphididae	Homoptera	Nymphs and Adults	Leaves	Major pest
2	Case worm	*Elophila depuntalis G. Elophila crisonalis E.*	Pyralidae	Lepidoptera	Larvae	Leaves	Major pest
3	Leaf Midge/Rib Borer	*Chironomous spp.*	Cheronomidae	Diptera	Larvae	Leaves and fruits	Major pest

S. No.	Common name	Scientific name	Family	Order	Damaging stage	Effected plant parts	Pest statues
4	Leaf Sucking Bug	*Plea litruata F.*	Pleidae	Homoptera	Nymphs and Adults	Leaves	Minoj pest
5	Root Borer	*Donacia delesserti*	Chrysomelidae	Coleoptera	Grubs and Adults	Flower, Leaves and Root	Minoj pest
6	Singhara Beetle	*Galerecella birmanica jacoby*	Chrysomelidae	Coleoptera	Grubs and Adults	Leaves	Minoj pest
7	Gastropods (Snails) May be 3-5 spicies were found	*Pila globosa Lymnaea spp. Indoppleanorbis spp.*	-	-	Adults	Leaves and petioles	Minoj pest

(1) Aphids (*Rhopalosiphum nymphaeae*)

The peak period of makhana aphid occurs from February to March during the early vegetative stage and transplanting stage. The infestation then sharply declined and disappeared in the month of April. Mild cloudy weather combined with western winds severely enhance aphid infestation and population growth. Both nymphs and adults suck the sap from upper surface of leaves. Under heavy infestation, the affected parts of the leaves turn yellow / rust red, fast decay and results for yield losses ranging between 17–23.6 percent.

(2) Case worms (*Elophila depunctalis* G. and *Elophila crisonalis* E.)

The case worm appeared in February on the makhana crop with peak activity from March to June and their population declined in July. Case worms are notorious emerging pests in makhana. The young larvae feed by scraping the leaf surface either in middle or at the margin. The larva makes on oval case out of the portion on the leaf cut out from it and remains inside it, moving with the case on the leaves. The larva of case worms were observed as one of the major pests of makhana as it causes heavy damage and significant reduction in yield of makhana crop.

(3) Leaf Midge / Rib Borer (*Chironomous* spp.)

The Rib Borer / Leaf Midge (*Chironomous* spp.) appeared in February and showed increasing trend during the summer months of May, June and july. The pest incidence was found till the harvest of makhana crop in the month of August. The incidence of chironomid larvae was observed minimum in February, but it showed increasing trends from March onwards and continued till July. However the population goes down from August onwards. The larvae of chironomid were observed in the developed ribs under the leaf surface. The larvae easily move inside the aerenchymatous cavities of ribs under leaf surface and causes rapid destruction. The colour of affected leaves changes to yellow, decay fast. While emerging in the early stages of crop growth, their population rapidly build-up during peak flowering and fruiting stages which causing significant yield reduction. Rib borers (chironomids), when combined with the other pests like aphids and case worms can cause a combined yield losses ranging from 17.40 percent to 33.66 percent.

(4) Leaf Sucking bug (Plealitruata Flab.)

The population of the leaf sucking bug appeared in the month of January in nursery bed and showed increasing trends from mid-February with the maximum population in March and April. The pest showed in declining trends and disappeared in May. The population of bug observed on leaves, tender shoots and roots of makhana plants. Commonly spotted on tender seedlings, both the nymphs and adults suck the cell sap from the under surface of the tender leaves, shoots and roots of the crop.

(5) Singhara beetle (*Galerucella birmanica* Jacoby)

The Singhara beetle is a notorious and major pest that severely damages both water chestnut (Singhara crop) and the floating leaves of foxnut (Makhana crop). The pest population appeared in last week of March and showed increasing trends in April with the maximum

population in May. The pest showed declining trends from May end and disappeared in June. Grubs and adults damage the younger and mature leaves, even sometimes petiole and integument of makhana fruits. The adult beetles scraping away the green tissues of the makhana and singhara leaves. Grubs were more destructive than adults, and cause significant damage to leaves and young fruits, which ultimately stunts the growth and yield of the seeds.

(6) Root borer (*Donacia delesserti*)

The root borer appeared in March–April on the crop with peak activity from May to July and the insect continues its incidence until harvest of the crop (August to September). The makhana root borer is notorious pest whose larvae feed on fibrous roots and the base of stems, causing fast decay and significantly yield reduction.

(7) Gastropods

Gastropods (Snails) are the major menace in the Mithila and Koshi regions of Bihar. Several snail species naturally inhabit these stagnant wetlands. They serve a dual role, acting as a vital pond cleaners that eat detritus, but also as destructive agricultural pests that scrap roots, shoots and under-surface of the floating leaves, which reduced the crop yield.

Common Gastropod Species in Makhana Ponds

Several specific gastropod species are closely associated with makhana crops, particularly in the Mithila and Koshi regions of Bihar.

(a) Pond Snails (*Lymnaea* spp.) : These are air-breathing fresh-water snails. While they clean the water by grazing on dead plant matter and algae, their populations can explode. During outbreaks, they mainly damage the delicate leaves of the makhana plant.

(b) Apple Snails (*Pila globosa*) : A large, widely distributed fresh water snail found abundantly in Bihar's makhana and singhara fields. They are highly adaptable detritivores but can cause significant tissue damage to aquatic macrophytes.

(c) Ramshorn Snails (*Indoplanorbis* spp.) : Typically found in stagnant, vegetation-rich waters. They feed on plant tissues and periphyton, occasionally nibbling on submerged makhana shoots and roots.

(d) Orb Snails (*Gyraulus* spp.) : Small, flattened aquatic snails that primarily feed on algae but contribute to the grazing pressure of makhana crops' aquatic vegetation.

(e) Other Associated Snails : Includes ***Indoplanorbis exustus, Gyraulus convexius, Gabbia orcula,*** and ***Bellamya bengalensis.***

Peak Period : Gastropods, especially different species of Mollusca, were found throughout the crop growth season with an increasing trend from February to April, maximum in May–July, and their incidence was found till the harvest of the crop in the month of August-September.

Consequence on the Makhana Crops : Gastropods pose a significant threat to makhana cultivation in Bihar, especially during the main growing season from February to July.

Impact of Damage : This is one of the most notorious emerging pests of the makhana crop and outnumber the other pests. They lay eggs on fibrous root and leaves. The adult remains attached with under surface of the leaves, shoots and fibrous roots. It feed on the plant tissues of the makhana plant and caused fast decay of the afflicted plants. This is a menace of makhana crop as it is found in entire crop growth period and led to significant yield reduction.

Natural Enemies of Aphid in Makhana Crop

A total of four coccinellids beetle was found feeding on aphid in makhana crops. The maximum population of these Coccinellids beetle was found in March. Among these coccinellids beetle, *Scymnus spp*. was observed more in number than *Coccinella septumpunctata*, *Menochilus sexmaculatus*, and *Brumus spp*. The *Scymnus* spp. was also found more effective predator of aphid compared to the other species.

Management Strategies of Insect Pests

Effective insect pest management strategies for the makhana crop relies on an integrated approach to utilize a combination of preventive and curative measures treatments, natural

enemies and need-based eco-friendly chemicals. Because makhana is grown in sensitive aquatic wetland, the excessive use of synthetic chemical insecticides is generally avoided to prevent makhana crop ecosystem damage. Thus controlling insect pests requires careful and environment-friendly measures should be adopted.

Crop monitoring and Cultural practices: Consists of regular monitoring to the water body, and physical manually collected, destroyed / removal of infested plant parts (leaf, shoots and other parts) and egg masses in the early stages of infestation.

Plant nutrition : Maintain balanced plant nutrition to ensure the crop has the vigor to withstand the pest stress.

- **Seed treatements :** Treat seeds with Imidacloprid 70 WS or Thiomethoxam 70 WS (5 gm / kg of seed) before sowing.
- **Root dip treatements :** Dip plant roots in a solution of Thiomethoxam 25 WG / Imidacloprid 17.8 S. (4 ml of water) for 30 minutes at the time of transplanting.

Organic or Botanical Foliar Spray

- In three rounds of Neem Seed Kernel Extract (NSKE) @ 0.5% to keep emerging pest populations under check.
- Apply Neem Cake (25 kg/hectare) at the time of final preparation of makhana field for controlling the root borer.
- Foliar spray of Neem leaf / Karanj leaf extract solution 5 percent (5 ml/1 litre of water) for effective against aphids and other sucking pests.
- Foliar spray of Neem oil 0.3 percent (3 ml/1 litre of water) is effective for sucking insects like aphid and leaf sucking bug.
- **Use of Light Traps :** Installation of light traps (2-3 traps/hectare) for attraction and killing adult insects.
- **Biological Control Measure :** Natural predators such as Ladybird beetle / Coccinellid beetles (*Scymnus* spp. and *Coccinella septampunctata*) and lacewings, which actively feed on aphid colonies.
- **Botanical Repellents :** Spraying of 3 percent neem oil solution is recommended to naturally repel aphids and other pests without contaminating the aquatic ecosystem of makhana ponds/fields.
- **Resistant Varieties:** Consider cultivating makhana varieties with moderate field resistance to insect pests, such as Swarn Vaidehi and Sabour Makhana-1.
- **Manual Picking:** Regularly sweep the ponds/fields and manually remove infested leaves and other infested parts of the plants.
- **Fish Integration:** Integrating makhana with compatible fish farming (e.g., air-breathing fish) helps regulate the insect population.
- **Predatory Fish:** Many farmers introduce predatory fish-such as Mangur (Catfish)-into the ponds, which act as a natural eco-friendly way to keep the Singhara beetle population in check.
- **Egg Mass Removal:** Collecting and destroying infested leaves to remove the beetle egg masses.
- **Organic Treatments:** Applying neem-based products or organic ash to check the infestation of Singhara beetle.

Chemical Interventions

These control measures should be followed under the direction of a plant protection specialist of an Agricultural Institution. If the pest damage exceeds economic thresholds, farmers sometimes use very light and safe application of synthetic insecticides as follows:

- **Foliar application of Emamectin Benzoate 5 SG** (0.4 to 0.5 gm / litre of water) at a 15-day interval for three sprays has been successful for the control of root borer.
- **Foliar spraying of Imidacloprid 17.8 SL** (0.3 ml / litre of water) **or Thio`methoxam 25 WG** (1 gm / litre of water) against aphids, leaf sucking bug, and other sucking pests.

- **Granular application of Fipronil 0.3 GR or Carbofuran 3G** (20–25 kg / hectare) should be applied before transplanting of the crops for the management of root borer, Singhara beetle, rib borer, and snail.

Management and Control Strategies of Gastropods

1. Biological Control

Introduce Bottom-Feeding Fish: Integrating air-breathing fishes like *Clarias batrachus* (Mangur) and *Heteropneustes fossilis* (Singhi), or bottom-dwellers like *Cyprinus carpio* (Common Carp) and *Cirrhinus mrigala* (Mrigal) is the most effective and eco-friendly control method.

- **Natural Population Check:** These fish naturally feed on gastropods, keeping their population in check while producing beneficial organic detritus for the makhana crop.

2. Mechanical and Physical Control

- **Manual Removal:** Snails can be handpicked or scooped out using traditional sieves (like the *polo* or *gaanj*) alongside regular leaf and debris removal.
- **Pond Drying (Summer Exposure):** Allowing makhana fields or ponds to completely dry up for several weeks during the peak hot summer months (May–June) helps break the life-cycle of the gastropods and their eggs.

Cultural Control

- **Debris Clearing:** Dead makhana leaves and excessive rotting vegetation provide ideal breeding and feeding grounds for snails. Clearing excess organic matter and utilizing the field system (where water levels can be regulated, typically 1 to 2 feet) helps sanitize the growing environment.

Conclusion

It may be inferred that aphids, case worms, rib borers and gastropods under the changing cropping patterns and intensification of makhana crop emerge as major constraints in getting maximum yield. Further leaf sucking bug and sighara beetle appeared as minor pest and in future augmentation and changing cropping pattern may aggravate their population and infestation. Effective insect pest management strategies for makhana crops relies on an integrated pest management (IPM) approaches that combines seed and root dip treatment, cultural practices and biological control measures to minimize insecticide use to aquatic environment in Makhana ponds/fields modern management modern strategies include using imidacloprid / Thiamethoxam for seed and root dip treatments, adopting transplanting method techniques and promoting natural predators viz., Coccinellid beetle to manage sucking and borer pests. Paucity of information, as no detailed work was reported pest status in Makhana crops. However, occurrence and associated pests were reported by different works (Banerjee, 1972, and Mishra et al., 1992, 2003).

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