African Rice Gall Midge:
Biology, Ecology and Control

Field Guide
and Technical Manual

F.E. Nwilene, K.F. Nwanze and O. Okhidievbie
Africa Rice Center (WARDA)

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ISBN 92 9113 236 5 (PDF)
ISBN 92 9113 255 1 (print)

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2006

Nwilene, F.E., K.F. Nwanze and O. Okhidievbie. 2006. *African Rice Gall Midge: Biology, Ecology and Control—Field Guide and Technical Manual*. Africa Rice Center (WARDA), Cotonou, Benin. 24 pp.

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ISBN 92 9113 236 5 (PDF)
ISBN 92 9113 255 1 (print)

Cover: AfRGM damage

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Printing and binding: Pragati Art Printers, Hyderabad, India

Contents

Preface

African rice gall midge is a major biotic constraint to rainfed and irrigated lowland rice production in sub-Saharan Africa. The problem is increasing with the expansion and intensification of rice production. A constraint to the development of improved control methods is a lack of understanding of the biology and ecology of gall midge.

It is hoped that this guide will help crop protection personnel (technicians, trainers, NGOs and extension workers) in the national programs in sub-Saharan Africa to gain a better understanding of AfRGM biology, ecology, and identification of factors associated with AfRGM outbreaks in affected areas. It is also hoped that it will help make farmers aware of the importance of AfRGM damage in the field and help them to manage the pest through IPM strategies incorporating indigenous knowledge.

Acknowledgements

We are grateful to the participants at the First WARDA/NARS Group Discussion and Planning Meeting on Bioecology and Management of the African Rice Gall Midge, held at WARDA/IITA, Ibadan, Nigeria, 12–16 October 1998, for providing the initial stimulus and encouragement that led to the realization of this guide. Our special thanks go to Charles Williams who coordinated production of the first African rice gall midge research guide.

We thank Guy Manners for thorough review of the final draft, Aïssata Sylla for design and desktop-publishing, Adebayo A. Omoloye and Dona Dakouo for generously providing the photos on pages 9 and 15, respectively.

The financial support provided for this publication by the UK Department for International Development (DFID) and WARDA is gratefully acknowledged.

Introduction

African rice gall midge (AfRGM), *Orseolia oryzivora* Harris & Gagné (Diptera: Cecidomyiidae), is an insect pest primarily of rainfed and irrigated lowland rice, and occurs only in sub-Saharan Africa. The larvae cause severe crop damage during the vegetative stages (seedling to panicle initiation) by producing tube-like 'silver shoot' or 'onion leaf' galls that prevent panicle production.

Severe yield losses are reported from countries where AfRGM is endemic and these vary significantly depending on the climatic zone, ecosystem and level of cropping intensification. In the face of increasing human population and rapidly growing demand for rice, the alleviation of insect-induced food-grain losses must be tackled to ensure food security of the large number of people in Africa who depend on rice. In order to effectively and economically manage this pest, it is essential to be able to identify it, and to understand its biology and host range, the nature of the damage it inflicts, and to know its natural enemies. This book provides information on integrated pest management (IPM) of AfRGM in rice-based cropping systems.

What is African rice gall midge?

African rice gall midge is a serious insect pest of rainfed and irrigated lowland rice in Africa.

It is a bud/stalk borer and larval feeding causes severe damage to rice during the vegetative stages (seedling to panicle initiation).

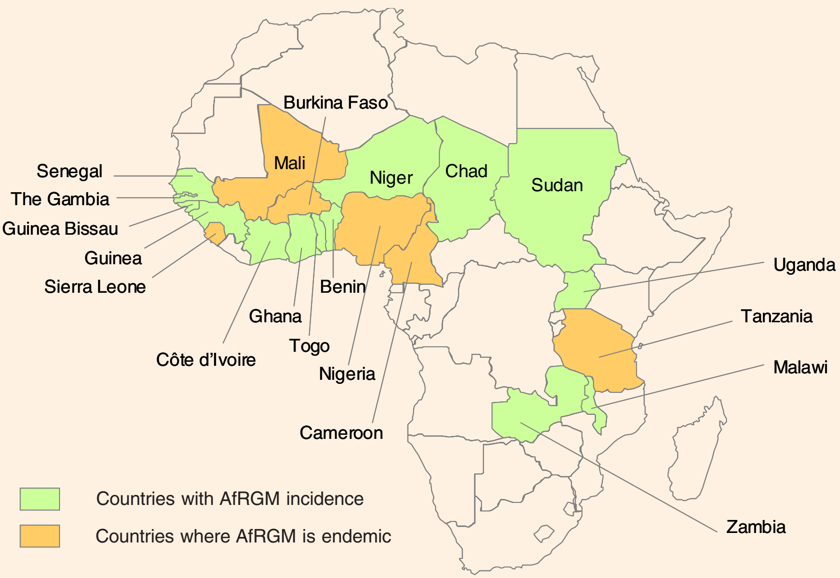
Where is AfRGM important?

African rice gall midge was first reported in Sudan in 1954.

It has become a major pest in Burkina Faso, Nigeria, Mali and Sierra Leone.

It has been recorded in a further 16 sub-Saharan African countries.

Distribution of AfRGM in Africa



How bad is the pest?

Heavy yield losses of 25–80% in farmers' rice crops have been recorded in some fields (for example, in the late 1970s, severe outbreaks occurred in Burkina Faso, and in 1988, some 50,000 ha of lowland rice were severely damaged in southeast Nigeria).

What are the causes of AfRGM outbreaks?

- Changes in weather (high rainfall, excessive cloud cover and humidity): outbreaks tend to occur in years that are wetter than usual.
- Staggered planting: wide range of planting dates increases the risk of AfRGM outbreaks. Late-planted fields are usually at higher risk.
- Planting of new high-yielding AfRGM-susceptible varieties: fertilizer-responsive improved varieties though high-yielding are generally more susceptible to AfRGM than the traditional land-races they are replacing.
- Increased use of fertilizer, which—with the adoption of improved varieties—has been a major aspect of rice intensification in West Africa, might have contributed to increased AfRGM infestation.

What are the site and field characteristics associated with higher risks of AfRGM?

- Rice ecology: rainfed lowland and hydromorphic ecologies seem to be at higher risk than upland and mangrove ecologies.
- Planting method: transplanted rice seems to be at higher risk than direct-seeded rice.
- Wet-season weather pattern: cloudy, humid weather with frequent rain or mist favors AfRGM build-up more than heavier, less frequent rainfall does.

- Presence of *Oryza longistaminata*: this weed increases the risk in areas north of the forest zones.
- Volunteer rice plants serve as alternative hosts for early population build-up in the wet season before rice crops are planted.
- Planting pattern: staggered planting is one of most important site risk factors, with the later-planted fields being at highest risk.

How can one recognize AfRGM damage in the field?

The larvae attack the growing points of rice tillers and cause the leaf sheath tissues to form a tube-like structure called a 'silver shoot gall' that resembles an onion leaf.

Early gall infestation results in stunting, bushy appearance of the rice plant, with as many as 50 small tillers per hill.

Galls cannot be pulled out of the rice tillers unlike deadhearts caused by stem borers.

How do we assess AfRGM damage in the field?

In order to estimate AfRGM infestation and damage, rice plants within a field must be selected for sampling. Sample 10 to 20 hills selected at random and estimate incidence and severity at 21, 42 and 63 days after transplanting (DAT) as follows:

Incidence

$$\% \text{ hill infestation} = \frac{\text{No. of hills with galls} \times 100}{\text{Total no. of hills}}$$

Severity

$$\% \text{ tiller infestation} = \frac{\text{No. of tillers with galls} \times 100}{\text{Total no. of tillers}}$$

Sample of AfRGM damage assessment

Field number	Sample size*	Incidence		Severity	
		Total	% hill	Total	% tiller
1	2/23, 0/17, 0/36, 0/26, 0/32, 3/22, 1/19, 1/17, 0/14, 1/19	5/10	50	8/225	3.56

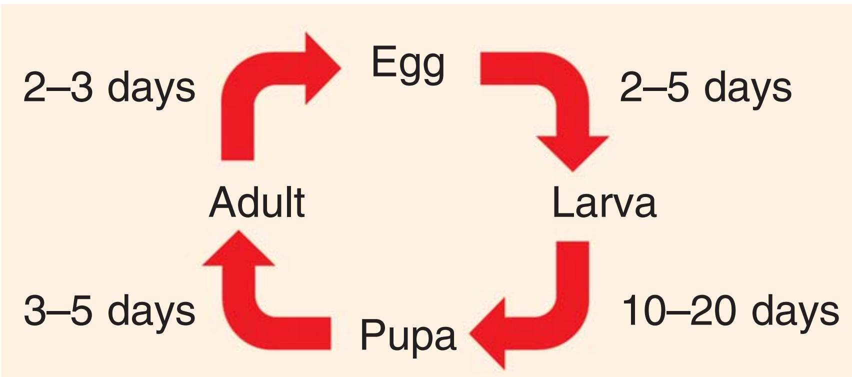
Note: * (No. infested tillers)/(Total no. tillers)

What other variables are recorded for a sampled field?

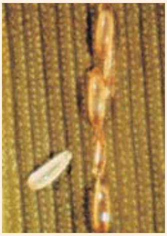
- Rice ecology (upland/hydromorphic/lowland) and field location (latitude/longitude)
- Crop growth stage (0 to 9, standard evaluation system (SES) scale)
- Surface water depth at time of survey (estimated mean, cm)
- Degree of water control on field (irrigated with poor or good water control)
- Fertilizer use (yes/no)
- Pesticide use (yes/no)
- Plant spacing (hills/m^2)
- Size and condition of neighboring fields cropped with lowland rice (appropriate scale)
- Condition of field in dry season (fallow, dryland crop/irrigated dry-season rice)
- Abundance of *Oryza longistaminata, Paspalum* and volunteer rice plants (appropriate scale)
- Percentage of tillers with galls at 21, 49 and 77 days after transplanting (DAT)
- Type of rice variety (traditional/improved)
- Planting method (transplanted/direct-seeded).

What do we know about the life cycle of AfRGM?

- Under normal conditions, AfRGM eggs hatch after 2 to 5 days.
- Larvae/maggots crawl down the leaf sheath to the growing point, where they feed and grow. The larval stage lasts 10 to 20 days.
- The pupal stage, which lasts 3 to 5 days, is mobile and moves up the gall before boring a hole near the tip through which the adult fly emerges.
- After emerging, a female lays 100 to 400 eggs either singly or in groups within 2 to 3 days.
- The entire life cycle of AfRGM takes between 21 and 28 days.



AfRGM eggs with newly hatched larva

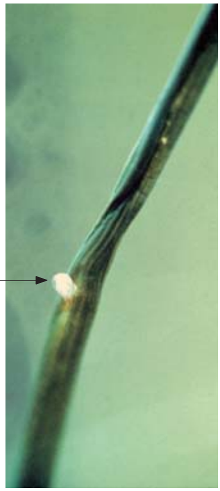


AfRGM larva in a dissected gall

AfRGM pupa

AfRGM Adult

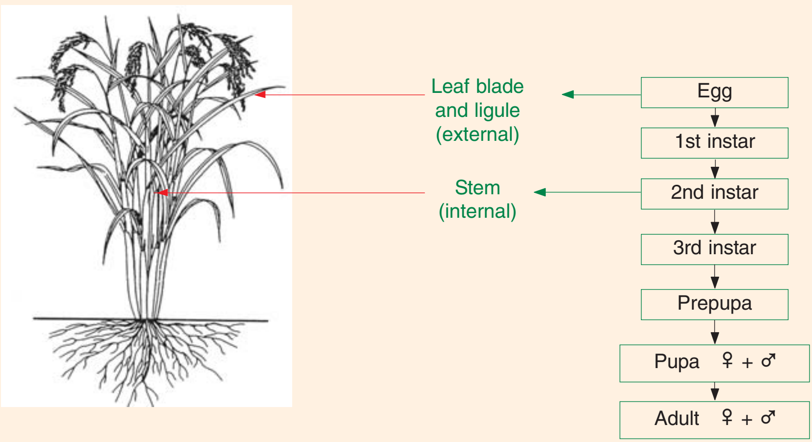
Gall showing AfRGM pupal skin in exit hole



When an adult emerges, it leaves behind an empty, transparent pupal skin protruding from the exit hole.

The skin can remain for several days before being blown away by wind or washed away by rain.

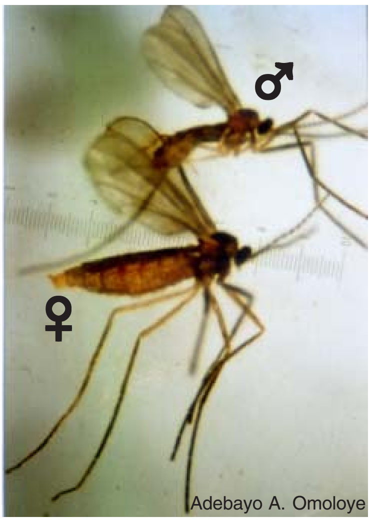
Life stages of AfRGM on rice



How can we distinguish between male and female adult midges?

- Adults are mosquito-like, cryptic and nocturnal. They can be trapped with artificial light.
- Females have robust, reddish-brown abdomens.
- Males have slender, brown abdomens and longer antennae.

N.B. *Contact a specialist if you are not sure of the sex or identity of your specimen.*



Male (top) and female (bottom) gall midges

In which agro-ecological zones and ecologies does AfRGM occur?

Infestation is common in the following agro-ecological zones:

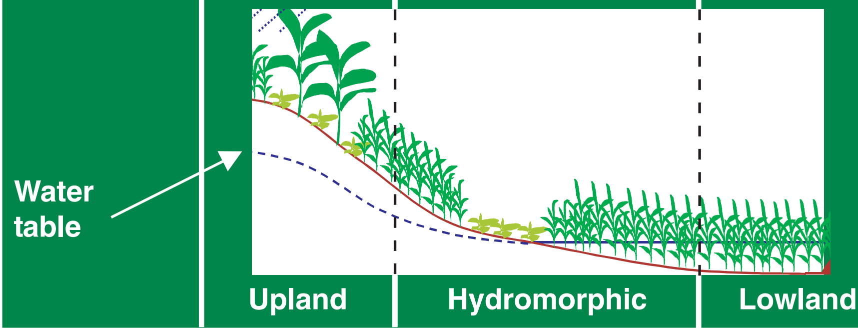
- Guinea savanna
- Derived savanna
- Humid forest

} relatively long rainy seasons

It is rarer in the Sudan savanna and Sahel.

Occurrence of AfRGM across major rice ecosystems

Ecology	Upland	Hydromorphic	Lowland
Possible infestation level	Low	Medium	High



AfRGM is rarer on tidal mangrove rice fields, but associated mangrove fields have infestation levels close to those seen in lowland ecologies.

What are the hosts of AfRGM?

Cultivated rice	*Oryza sativa*
	Oryza glaberrima
Wild rices	*Oryza longistaminata*
	O. barthii
	O. punctata
	O. stapfii

Where does AfRGM emerge from at the beginning of the wet season?

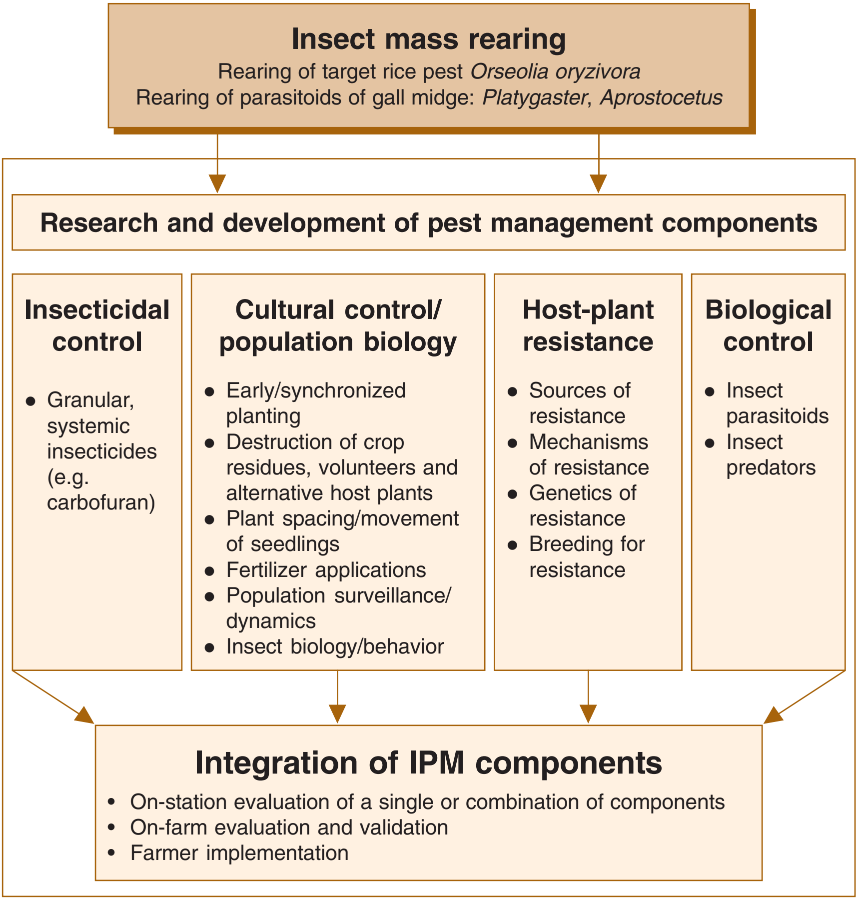
- *Oryza longistaminata*
- Volunteers (self-seeded rice plants that grow up from shed seeds)
- Ratoons (tillers that sprout from rice stubble)

Galls on rhizome of *Oryza longistaminata* during the off-season

Hibernating galls are bulbous and half buried in the soil. The outer part constitutes a fairly short tube.

Which control measures are most appropriate?

Major components in integrated pest management of AfRGM



Cultural practices

1. Early and synchronized planting: rice fields planted early are less likely to suffer serious damage than those planted late.

2. Destruction of alternative host plants such as rice ratoons, volunteers and *Oryza longistaminata*.

3. Fertilizer use: high doses of nitrogen fertilizer increase AfRGM infestation. Moderate levels of NPK fertilizer (e.g. 60 kg/ha for derived savanna) should be applied at appropriate crop growth stages.
4. Movement of seedlings (transplanting) should be discouraged as such seedlings can be infested by AfRGM in the nursery, and can spread infestation.
5. Plant spacing: close spacing should be discouraged because it provides a suitable micro-environment for the survival of the exposed life stages of AfRGM.

Natural enemies of AfRGM

Insect parasitoids

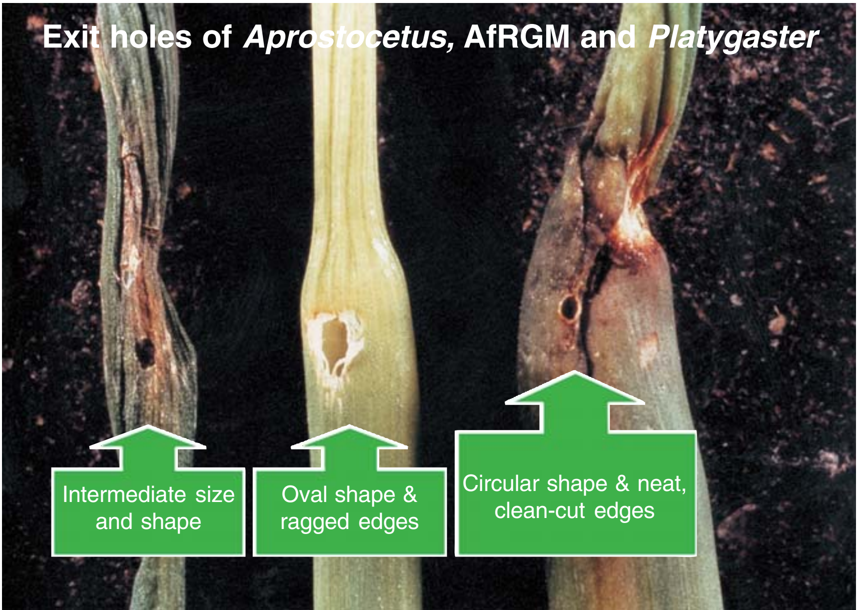
AfRGM is attacked by parasitoids. However, the level of parasitization is low because the parasitoid populations build up too late to prevent heavy AfRGM infestation. The major parasitoids are tiny wasps:

Platygaster diplosisae (Hymenoptera: Platygastridae)

Aprostocetus procerae (Hymenoptera: Eulophidae)

Dissected gall with *Platygaster* adults beside corpse of full-grown gall-midge larva

Dissected gall with *Aprostocetus* larva beside corpse of full-grown gall-midge pupa



Galls parasitized by *Aprostocetus*:

Emergence holes of *Aprostocetus* are intermediate in size and shape.

The wasp cocoons are always left inside the gall.

Unparasitized galls (AfRGM):

Unparasitized galls have pupal cases (puparia) stuck in the emergence holes, which are oval with ragged edges.

Galls parasitized by *Platygaster*:

Emergence holes smallest and roundest with neat, clean-cut edges.

There is often more than one *Platygaster* emergence hole on a single gall. Galls parasitized by *Platygaster* are often shorter and a bit thicker than unparasitized galls, and sometimes greener.

Orseolia bonzii galls on *Paspalum scrobiculatum*

- Galls found on *Paspalum* grass are produced by a related gall midge known as *Paspalum* gall midge (PGM), *Orseolia bonzii*.
- PGM cannot attack rice, but is an alternative host for the two main parasitoids of AfRGM.

PGM galls are shorter and slightly wider than those of AfRGM.

PGM galls have pointed tips.

PGM gall coloration varies from pearly-whitish, or pale green to almost dark red.


Orseolia bonzii galls on *Paspalum*

D. Dakouo

Insect predators

Cyrtorhinus viridis (Heteroptera: Miridae)

Conocephalus longipennis (Orthoptera: Tettigoniidae)

Anaxipha longipennis (Orthoptera: Gryllidae)

Ladybird beetles (Coleoptera: Coccinellidae)

Natural biological control

Habitat manipulation to increase the carry-over of parasitoids from PGM to AfRGM, such as dry-season cultivation to encourage *Paspalum scrobiculatum* abundance early in the wet season, could improve the natural biological control of AfRGM.

Varietal resistance

Cisadane is tolerant to AfRGM, released in Nigeria as FARO 51 and provides a useful component of AfRGM management.

BW 348-1 is tolerant to both AfRGM and iron toxicity, and is scheduled for release in Nigeria and Burkina Faso.

Recent advances in biotechnology increase the prospects of generating AfRGM-resistant rices from lowland-adapted *sativas* and resistant *glaberrimas*.

Chemical control

- Chemical control using foliar sprays has been unsuccessful because the larvae live within the plant and are well protected.
- A granular insecticide, such as the systemic carbofuran (Furadan), is recommended at outbreak levels.

Agronomic traits of Cisadane and BW 348-1

Trait	Cisadane	BW 348-1
Ecology	Rainfed and irrigated lowland	Rainfed lowland
Plant height (cm)	117	125
Duration (days)	145	130
Yield potential (t/ha)	6	5
Iron toxicity (1–9)[1]	5	1
1000-grain weight (g, at 14% moisture)	30	24.4
Grain length, brown rice (mm)	6.87	6.49
Grain width (mm)	2.58	2.49
Grain thickness (mm)	1.91	1.81
Grain type	Long bold	Medium bold
Brown rice (%)	78.8	77.7
Milled rice (%)	68.5	67.9
Head rice (%)	59.4	59.0
Pericarp color	Brown	Brown
Chalkiness	5	5
Alkali digestion	4.5	5
Amylose (%)	20.6	26.8
Gel consistency	85	42
Elongation ratio	1.52	1.35
Volume expansion ratio	4.33	4.05
Water uptake ratio	2.28	2.08
Cooking time (min.)	23	21

[1] 1=Resistant, 9 = highly susceptible

Conclusion

This guide provides a basic information and understanding of the biology, ecology and identification of site and field characteristics and factors associated with AfRGM outbreaks in affected areas.

It is hoped that the knowledge gained from this guide will assist all stakeholders, including technicians, trainers, NGOs, extension workers, farmers' groups and students to recognize and record pest damage on farmers' fields, facilitate survey and screening methodologies, and increase rice yields in rice-based systems using all relevant pest control methods that are both sustainable and adoptable by farming communities.

It is important to note that chemical control is not a viable control option for AfRGM because the destructive larval stages live within the plant. Farmers need to be cautioned against the use of unnecessary synthetic insecticides which increase the risk of disturbing the natural ecological balance.

Further reading

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Notes