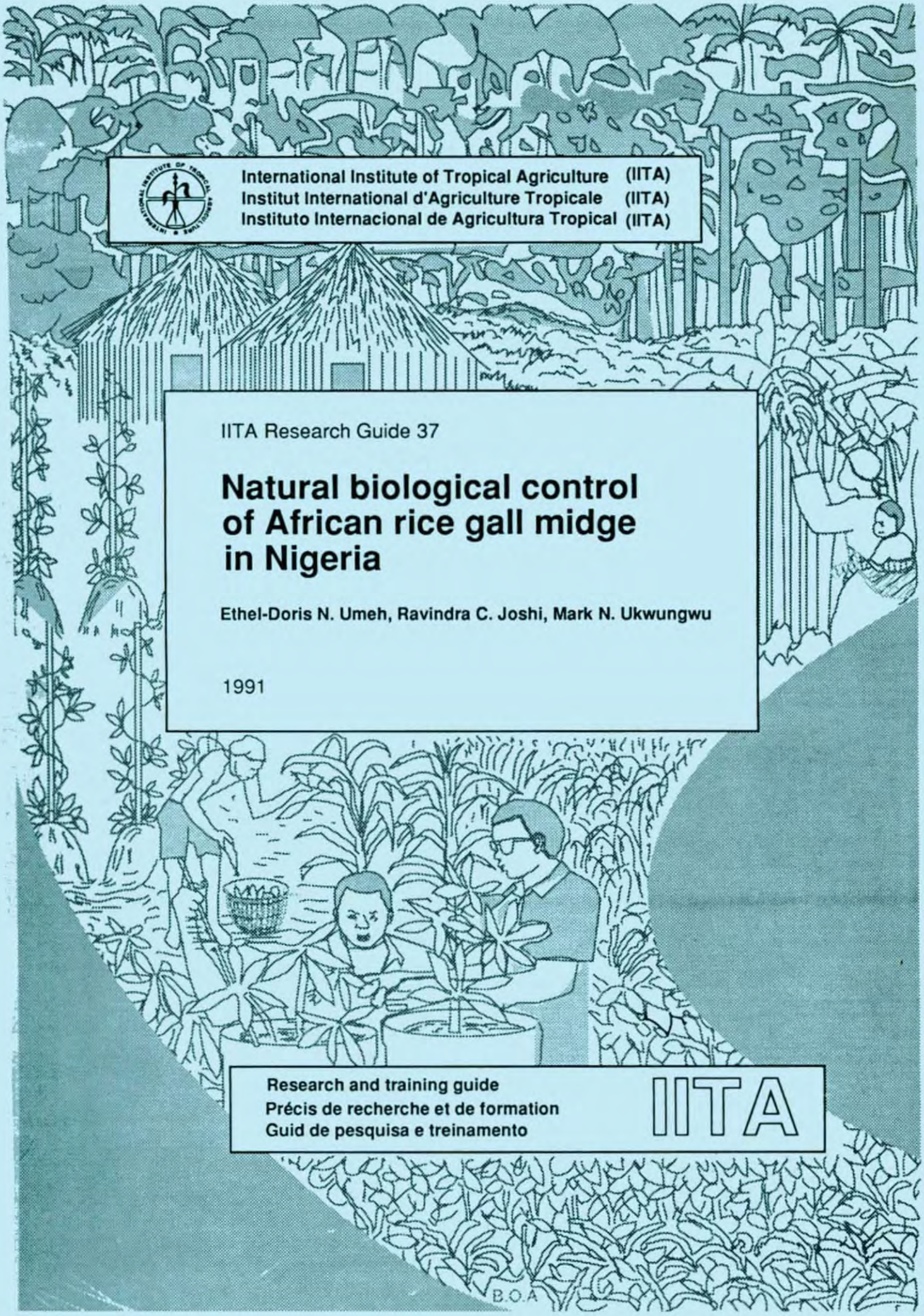

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IITA Research Guide 37

Natural biological control of African rice gall midge in Nigeria

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E.D.N. Umeh is applied entomologist at Anambra State University of Technology, PMB 5025, Awka campus, Anambra State, Nigeria; R.C. Joshi is rice entomologist at IITA, Ibadan; and M.N. Ukwungwu is rice entomologist, at the National Cereals Research Institute (NCRI), Badeggi, PMB 8, Bida, Niger State, Nigeria.

International Institute of Tropical Agriculture
PMB 5320
Ibadan, Nigeria

Tel.: 400300 - 318
Cable: TROPFOUND Ikeja
Tlx: 31417 + 31159 TROPIB NG

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Natural biological control of African rice gall midge in Nigeria

Objectives. This guide is intended to enable you to:

- describe the importance of the African rice gall midge (ARGM);
- discuss the principles of biological control;
- describe two biological control agents;
- differentiate parasitized from non-parasitized galls.

Study materials

- Infested rice plants.
- ARGM larvae, pupae, and adults.
- Samples of parasitized and non-parasitized galls.
- Samples of naturally occurring biological control agents.

Practicals

- Survey farmer's fields for infestation with ARGM and presence of naturally occurring biological control agents.
- Collect parasitized and non-parasitized galls.
- Rear naturally occurring biological control agents.
- Determine the type of naturally occurring biological control agent involved.
- Determine the extent of parasitism/predation.

Questionnaire

1 What is the African rice gall midge (ARGM)?
2 What is the damage of ARGM in your region?
3 What does larval feeding of ARGM cause?
4 How does an ARGM gall look like?
5 What other symptoms does gall formation cause?
6 What is the degree of parasitized galls in your region?
7 What does biological control comprise?
8 What is natural biological control?
9 What are the reasons for increasing interest in naturally occurring biological control agents?
10 Why is chemical pest control not desirable?
11 What is *target pest resurgence* ?
12 What are *secondary pests* ?
13 What is the cause of insecticide resistance?
14 Why is natural biological control especially useful in developing countries?
15 What are two types of biological control agents?
16 What are *parasitoids* ?
17 What are *predators* ?
18 What are additional natural enemies found in Asia?
19 Describe the life cycle of *Platygaster diplosisae.*
20 What does *polyembryony* mean?
21 To what percentage can *Platygaster diplosisae* parasitize ARGM eggs?
22 Where do ARGM and *Platygaster diplosisae* survive?
23 What key characters indicate parasitization by *Platygaster diplosisae* ?
24 How can you distinguish parasitization by *Aprostocetus pachydiplosisae* ?
25 Why should you **not** burn rice stubbles and **not** use insecticides indiscriminately?

Natural biological control of African rice gall midge in Nigeria

Abstract. The African rice gall midge (ARGM), *Orseolia oryzivora* Harris & Gagné, has recently emerged as an important insect pest of rice in many African countries. Infestation can result in total crop failure. Naturally occurring biological control agents have been identified in Nigeria that can reduce ARGM to tolerable levels. Researchers observed a large percentage of parasitized galls in unsprayed rice fields. Naturally occurring biological control agents attack ARGM population, thus reducing the severity and frequency of attack. Control agents reduce ARGM populations free of charge to the farmers. Natural enemies of ARGM in Nigeria so far discovered are parasitoids.

1 African rice gall midge (ARGM)

In the later years of the 1980s, the status of some rice insect pests in Nigeria changed. Among these insects is the African rice gall midge (ARGM), *Orseolia oryzivora* Harris and Gagné, which caused destruction of about 50 000 hectares of rice farms in the guinea savannah zones of Nigeria in 1988, and also invaded new areas in the forest zones of Nigeria in 1989 and 1990.

Larval feeding destroys the growing point (bud) causing the surrounding tissues to elongate and form a tube-like structure which is called the gall. The gall is silvery in color and resembles an onion leaf, hence it is referred to as *silver shoot* or *onion leaf*, respectively. The gall is 10 - 30 cm long and has various forms (bent, twisted, or spiral).

Once a gall is formed, growth stops and the tiller does not produce panicle. Thus, each gall represents a tiller lost. When the primary tiller is destroyed, the rice plant is stimulated to tiller profusely to compensate for the damage, especially in young transplants.

Presently, ARGM ranks among the most important insect pests of rice in Nigeria.

Because of the economic importance of the insect and the difficulty of controlling it with insecticides, ARGM collaborators in various institutions in Nigeria during 1989-1990, started searching for naturally occurring biological control agents of ARGM. They observed a large percentage of parasitized galls in unsprayed rice fields. Interest on the identification of naturally occurring biological control agents increased.

2 Biological control

There are two types of biological control: *applied biological control* and *natural biological control*.

Applied biological control comprises the use of living organisms (whether introduced or otherwise manipulated) to reduce pest populations to tolerable levels where they no longer cause economic damage. Hence, applied biological control is a deliberate use of beneficial organisms (agents) against harmful organisms (targets).

Natural biological control is the regulation of an organism's population density by its natural enemies in the field or wild without man's intervention. Natural enemies contribute constantly to suppression of insect populations, and are of great value in pest management. This fact is often not recognized.

Several reasons exist for the increasing interest in naturally occurring biological control agents. Chemical pest control is a non-desirable management strategy because of the following reasons:

- Target pest resurgence occurs with the application of insecticide which kills a relatively greater number of natural enemies than the pest population. Killing of natural enemies enables the pest to multiply unrestrained in the sprayed area. Eventually, pest populations explode. This phenomenon is called target pest resurgence.

- Secondary pest outbreaks is also a result of insecticide abuse. Some organisms that normally are not pests may become pests after insecticide application. Destruction of the natural enemies eventually converts innocuous organisms into major pests.

- Insecticide resistance is another problem. When an insecticide is sprayed against a pest population, natural enemies have been killed, and a tiny proportion of the pest population is usually able to survive its toxic effects. These surviving individuals multiply to produce progeny that can also resist the toxic effects of the insecticide. Thus higher doses and often more frequent application are required to control the pest. With time, pest generations are produced that can no longer be killed by the insecticide even at higher doses. This phenomenon is called insecticide resistance.

The increasing dissatisfaction with the dependence on insecticides for crop protection has led to more serious consideration of the potential role of naturally occurring biological control agents. In developing countries, where the cost of insecticides is prohibitively high and where inappropriate or excessive use of insecticides has resulted in pest resistance, natural biological control is especially useful.

3 Biological control agents of ARGM

Entomologists refer to beneficial organisms / natural enemies as entomophages that include *parasitoids* and *predators.*

Parasitoids are those insects that initiate their life cycle on tissues of arthropods and kill the host at the end of their larval period. Individual parasitoids only consume one host during their developmental period. Adult parasitoids are generally free living, mobile, and are able to search actively for hosts in which to lay eggs. Efficient parasitoids are host specific. Parasitoids belonging to the Order *Hymenoptera* are called wasps.

Predators attack and kill a number of prey during their lifetime. Unlike parasitoids, predators require many preys to complete development. Examples of common insect predators are spiders, ladybird beetles, dragonflies, and predacious mites.

The inventory of naturally occurring biological control agents of ARGM in Nigeria is still in progress in collaboration with scientists from the International Institute of Entomology, London. A key natural enemy so far identified is the parasitoid *Platygaster diplosisae* Risbec. The wasp is just visible to an unaided eye.

Another wasp attacking and killing ARGM larva or pupa in Nigeria is *Aprostocetus* (=*Tetrastichus*) *pachydiplosisae* (Risbec).

Additional natural enemies of rice gall midge *in Asia* are predatory mites that attack and feed on eggs, and spiders that feed on adults.

Platygaster diplosisae. The wasp, *Platygaster diplosisae* Risbec, lays a single egg inside the egg of ARGM. The ARGM egg hatches into a larva, carrying the wasp egg inside. As the larva develops, the wasp egg hatches and begins to feed on the tissues of the ARGM host. It is therefore an *endoparasitoid.*

The wasp larva divides many times (*polyembryony*) giving rise to 25-30 larvae within a single host. By this time, the wasp larvae have killed the ARGM host larva. When wasp larvae have consumed all the host tissues, each larva makes a cocoon where it pupates. Adult wasps emerge from their cocoons and cut tiny emergence holes in the gall through which they escape.

Parasitized ARGM larvae are filled with wasp cocoons and are much bigger than healthy (unparasitized) ARGM larvae. *P. diplosisae* is capable of parasitizing up to 80 % of ARGM eggs in unsprayed rice ecosystems.

During the off-season, small populations of both ARGM and the wasp survive on galls of ratoons and wild rice.

Aprostocetus pachydiplosisae. The wasp *Aprostocetus* (*Tetrastichus*) *pachydiplosisae* (Risbec) develops outside its host (*ectoparasitoid*) and obtains nutrition by sucking the host's body fluid (larva and pupa). Wasp larvae pupate near the dead host pupae inside the gall. Parasitized ARGM pupae turn brownish black, and lose their shape. Larvae of the parasitoid can be seen lying next to the live or dead larvae or pupae of ARGM. Before pupation, the parasitoid moves to the apical part of the gall. Only one adult parasitoid develops in each host (solitary parasitoid).

4 Parasitization of ARGM

Some key characters indicate what parasitoid is responsible for killing the ARGM. The following external characters of galls reveal that ARGM is parasitized by *P. diplosisae* :

- Parasitized galls are generally short and thick, whereas unparasitized galls are long and slender.

- The apical end of the gall presents a single emergence hole in unparasitized galls, whereas many and smaller emergence holes characterize parasitized galls.

- Unparasitized galls have pupal cases (puparium) stuck in the emergence hole, unless blown or washed away by wind or rain. Parasitized galls never have pupal cases stuck in the emergence holes. They are always left inside the gall.

- A parasitized gall held against the light shows the black image of wasp cocoons. Cocoons are absent in unparasitized galls.

Galls parasitized by the larval/pupal parasitoid *A. pachydiplosisae* can only be distinguished by dissecting the galls. If parasitized, galls have parasitoid larvae feeding externally on the ARGM larva/pupa.

It is important to recognize that in every rice farm, naturally occurring biological control agents are working relentlessly to reduce the ARGM numbers to the benefit of farmers by reducing economic loss.

It is also important **not** to burn rice stubbles and **not** to use insecticides indiscriminately. These practices kill or drastically reduce naturally occurring biological control agents. Providing nectar plants and modifying cropping practices promote natural control agents.

In future, research emphasis will increase on naturally occurring biological control agents to conform with the concept and philosophy of integrated pest management.

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