Africa Rice Center (WARDA)

# Rice Stem Borers: Biology, Ecology and Control

## Field Guide and Technical Manual

Nwilene F.E., Sanyang S., Traore A.K. , Togola A.,
Goergen G. and Agunbiade T.A.

**2008**

## About Africa Rice Center (WARDA)

Africa Rice Center (WARDA) is an autonomous intergovernmental research association of African member states. WARDA is also one of the 15 international agricultural research Centers supported by the Consultative Group on International Agricultural Research (CGIAR).

WARDA's mission is to contribute to poverty alleviation and food security in Africa through research, development and partnership activities aimed at increasing the productivity and profitability of the rice sector in ways that ensure the sustainability of the farming environment.

The *modus operandi* of WARDA is partnership at all levels. WARDA's research and development activities are conducted in collaboration with various stakeholders—primarily the national agricultural research systems (NARS), academic institutions, advanced research institutions, farmers' organizations, non-governmental organizations and donors—for the benefit of African farmers, mostly small-scale producers, as well as the millions of African families for whom rice means food.

The *New Rice for Africa* (NERICA), which is bringing hope to millions of poor people in Africa, was developed by WARDA and its partners. The success of the NERICAs has helped shape the Center's future direction, extending its horizon beyond West Africa into Eastern, Central and Southern Africa.

WARDA hosts the African Rice Initiative (ARI), the West and Central Africa Rice Research and Development Network (ROCARIZ) and the Inland Valley Consortium (IVC). It also supports the Coordination Unit of the Eastern and Central African Rice Research Network (ECARRN) based in Tanzania.

Since January 2005, WARDA has been working out of the International Institute of Tropical Agriculture (IITA) Benin station in Cotonou, having relocated from its headquarters in Bouaké, Côte d'Ivoire, because of the Ivorian crisis. WARDA has regional research stations near St Louis, Senegal and at IITA in Ibadan, Nigeria.

For more information, visit www.warda.org


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# Contents

# Preface

The WARDA-NARS Task Forces on Integrated Pest Management (IPM) of the Rice Research Network for West and Central Africa (ROCARIZ) recognize rice stem borers as major biotic constraints limiting rice production in West and Central Africa. However, there is no field guide or technical manual available which provide technical information on different aspects of the biology, ecology and control of these pests. Much of the information available remains obscured in unpublished reports and articles.

This guide provides a basic knowledge and understanding of the biology, ecology and recognition of the pests, a prerequisite for successful control intervention. It is intended for agricultural researchers, technicians, trainers, extension specialists, non-governmental organizations and entomologists involved in managing stem borers of rice. It is also intended to provide a reference source for research and training of M.Sc and Ph. D students. The intension is to make existing information more easily accessible and to present it in a simple and understandable way. Thus, technical terms have been kept to a minimum, and those used have been explained.

The references provided at the end of the book are not intended to be exhaustive, but rather represent suggested reading for more technical detailed information on the subject. WARDA permits reproduction of this guide for non-profit purposes.

Dr Papa A. Seck

Director General

# Acknowledgements

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# Introduction

Dipterous and Lepidopterous stem borers are among the economically most important pests of rainfed upland/lowland and irrigated rice in Sub-Saharan Africa. The larvae of stem borers cause significantly yield loss during the vegetative and reproductive stages by producing deadhearts and whiteheads, respectively, which prevent panicle development.

The most important species reported on rice include:

- the stalk-eyed flies, *Diopsis* spp (Diptera: Diopsidae)
- the African white borer, *Maliarpha separatella* Ragonot (Lepidoptera: Pyralidae)
- the yellow stem borers, *Scirpophaga* spp. (Lepidoptera: Pyralidae)
- the striped stem borer, *Chilo zacconius* Bleszynski (Lepidoptera: Pyralidae)
- the pink stem borers, *Sesamia* spp. (Lepidoptera: Noctuidae).

All are indigenous to Africa except *Maliarpha separatella* that can be found in Asia.

Heavy yield losses of 10-90% in farmer' rice crops have been reported from some West African countries. Thus, attempts to help rice farmers reduce the damage caused by these pests is a major challenge to entomologists, agricultural researchers, trainers and technicians in West and Central Africa. This requires an understanding of the identity, biology, host range, nature of damage of pests and knowledge of their natural enemies, in order to design appropriate integrated pest management (IPM) strategies. This book highlights key elements of management practices.

# Production potential and major constraints across major rice ecosystems

| Ecology | Total area (%) | Yield | | Constraints |
|---|---|---|---|---|
| | | Current | Potential | |
| Upland | 57 | 1.0 | 1.5–4.5 | Drought, weeds, blast, N deficiency, acidity, stem borers, termites, nematodes |
| Rainfed lowland | 20 | 1.4 | 2.5–5.0 | Weeds, AfRGM, blast, N deficiency, Fe toxicity, stem borers, nematodes |
| Irrigated lowland | 5 | 2.8 | 5.0–7.0 | N deficiency, Fe toxicity, RYMV, AfRGM |
| Sahel (irrigated) | 5 | 3.5 | 5.0–8.0 | RYMV, extreme temperature, salinity, N deficiency |
| Mangrove | 7 | 2.0 | 2.5–6.0 | Salinity, crabs, N deficiency, acidity |
| Deep water | 6 | 1.2 | 1.5–3.0 | No water control, low fertilizer use efficiency |

# What are rice stem borers?

- Stem borers belonging to the orders Diptera and Lepidoptera are the most serious pests of rice in sub-Saharan Africa.

- They are internal stem feeders and larval feeding causes damage to rice tillers during the vegetative and reproductive stages. Stem borer attack is most damaging when it occurs after tillering is completed.

# Where are rice stem borers important?

| Common name | Species | Order: Family | Distribution | Host range |
|---|---|---|---|---|
| Pink stalk borer | *Sesamia calamistis* Hampson | Lepidoptera: Noctuidae | Cameroon, The Gambia, Ghana, Côte d'Ivoire, Niger, Nigeria | Rice, maize, sorghum, wheat, millet, sugarcane, wild grasses |
| Pink stalk borer | *Sesamia nonagriodes botanephaga* Tams & Bowden | Lepidoptera: Noctuidae | Ghana, Côte d'Ivoire, Nigeria | Rice, maize, sorghum, wheat, millet, sugarcane, wild grasses |
| Pink stalk borer | *Sesamia n. penniseti* Tams and Bowden | Lepidoptera: Noctuidae | Ghana, Côte d'Ivoire, Nigeria | Rice, maize, sorghum, wheat, millet, sugarcane, wild grasses |
| Pink stalk borer | *Sesamia poephaga* Tams and Bowden | Lepidoptera: Noctuidae | Nigeria | Rice, maize, sorghum, wheat, millet, sugarcane, wild grasses |
| Striped stem borer | *Chilo zacconius* Bleszynski | Lepidoptera: Crambidae | Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Mali, Niger, Nigeria, Senegal, Sierra Leone | Rice, sorghum, *Echinochloa crus-galli*, *Pennisetum* spp. |
| Yellow stem borer | *Scirpophaga melanoclista* Meyrick | Lepidoptera: Crambidae | Cameroon, Côte d'Ivoire, Mali, Nigeria, Senegal | Rice |

| | | | | |
|---|---|---|---|---|
| Yellow stem borer | *Scirpophaga subumbrosa* Meyrick | Lepidoptera: Crambidae | Ghana, Mali | Rice |
| African white borer | *Maliarpha separatella* Ragonot | Lepidoptera: Pyralidae | Côte d'Ivoire, Mali, Nigeria | Cultivated and wild rices (*Oryza barthii, O. longistaminata, O. punctata*) |
| Stalk-eyed flies | *Diopsis longicornis* Macquart, *Diopsis apicalis* Dalman, *Diopsis collaris* Westwood | Diptera: Diopsidae | Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo | Rice, sorghum, millet, *Cynodon dactylon*, *Cyperus difformis*, *Paspalum orbiculaire* |

It is hoped that the knowledge gained from this guide will assist researchers, trainers, technicians, extensionists, farmers' groups and students in recognizing the most important stem borers associated with rice, assessing the damage they cause in the field, and to take good crop protection measures against losses. The use of synthetic insecticides for rice stem borer control is not attractive to most small scale farmers.

It is also recognized that this manual can serve as a starting point for others who plan to develop a training curriculum or an IPM farmer field school for rice-based cropping systems in West and Central Africa.

## How bad are rice stem borers?

- Yield losses due to stem borers vary greatly among seasons, ecological zones and regions.
- For instance, yield losses caused by rice stem borers in farmers' fields in Ghana and Nigeria have been estimated to range from 10 to 90%.
- The severity and nature of stem borer damage depend upon deadhearts and whiteheads production.

## What puts a rice field at risk from stem borer attack?

- Crop residues (what's left after harvest), ratoons (tillers that sprout from rice stubble) and volunteers (self-seeded rice plants that grow up from shed or spilt seeds) are ideal places for borers to survive and multiply.
- Presence of alternative host plants in and around rice fields.
- Planting with high-yielding varieties – varieties that are unfortunately susceptible to attack.
- Favourable climate
- Wide range of planting dates

# How do we assess stem borer damage in the field?

To assess stem borer damage, visual method is used to sample 20 to 30 hills selected at random. Estimate deadhearts at 21 and 49 DAT and whiteheads before harvest as follows:

$$\% \text{ deadhearts} = \frac{\text{No. of tillers with deadhearts} \times 100}{\text{Total No. of tillers}}$$

Scale (deadhearts):

0 No damage
1 1–10%
3 11–20%
5 21–30%
7 31–60%
9 61% and above

$$\% \text{ whiteheads} = \frac{\text{No. of tillers with whiteheads} \times 100}{\text{Total No. of tillers}}$$

Scale (whiteheads):

0 No damage
1 1–5%
3 6–10%
5 11–15%
7 16–25%
9 26% and above

Deadhearts and whiteheads in the susceptible check should average more than 20 and 10%, respectively, of infested tillers for the test to be considered valid.

*Deadheart due to rice stem borer attack*

*Whiteheads due to rice stem borer attack*

## How do we monitor stem borer populations?

To monitor populations of stem borer in the field, light traps are the most widely used technique.

In areas without electricity, kerosene light traps are commonly used because they are easy to operate and are less expensive.

## What are the symptoms caused by stem borer attack?

**Early symptoms**

- Deadhearts: attack of young plants at the vegetative stages (seedlings to panicle initiation) results in the destruction of the growing point, typically referred to as “deadhearts” caused by the drying up of the central shoots (dead inner leaves).
- Larval damage by Maliarpha separatella within the stem results in reduced plant vigour, fewer tillers and many unfilled grains. The larva does not produce deadhearts because the growing apical portion of the plant is not cut from the base. Thus, panicles can be initiated at the last node.

**Late symptoms**

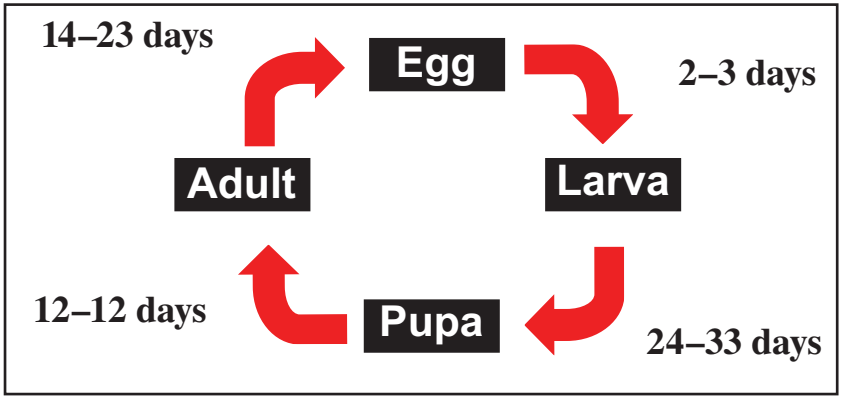
- Whiteheads: attack of plant bearing panicles at the flowering stage results in a white or dry empty panicle called ‘whitehead’.

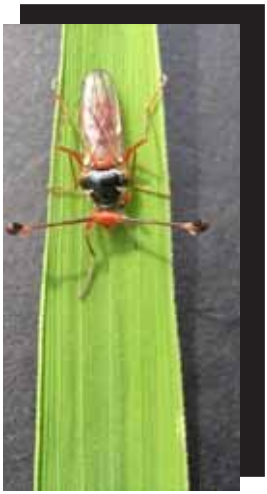
## What do we know about the life cycle of rice stem borers?

- Nocturnal adults lay eggs in masses on rice leaves or between the leaf sheath and the stem.
- Newly hatched larvae move on the leaf surface and to neighbouring plants by means of a silk thread, which they attach to leaf tips.
- Larvae feed first on the leaf but shortly penetrate through the leaf sheaths into the rice stems.
- Pupation occurs inside the stem after an exit hole for adult emergence has been cut.
- Stem borers generally produce several generations a year, but the number of generations depends on crop availability and environmental factors, mainly temperature.
- At the end of rice season, the sixth instar larva of M. separatella hibernates at the base of dried stubble for up to 20 weeks

## Life cycle of *Diopsis* spp.

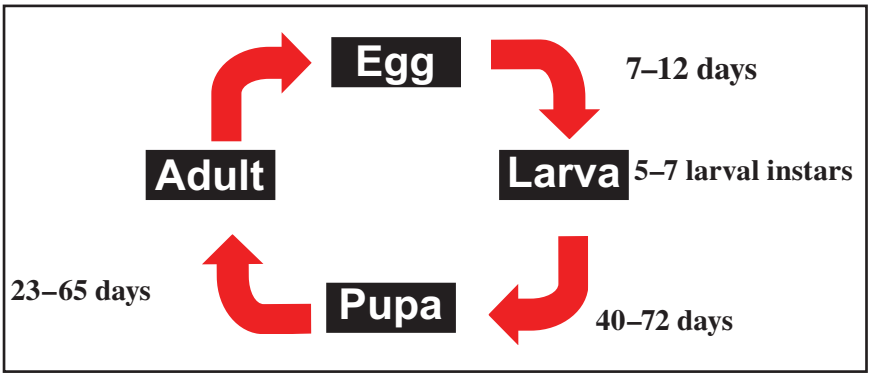
- Adult diopsids are easily recognized by their characteristic eyes located at the tip of stalks – hence they are called stalk-eyed flies. The head is orange in color and the thorax shiny black with two spines and a pair of transparent wings.
- Eggs are creamy-white in color and boat-shaped. A female lays about 20 eggs over a 10-day oviposition period


14–23 days
Egg
2–3 days
Adult
Larva
12–12 days
Pupa
24–33 days



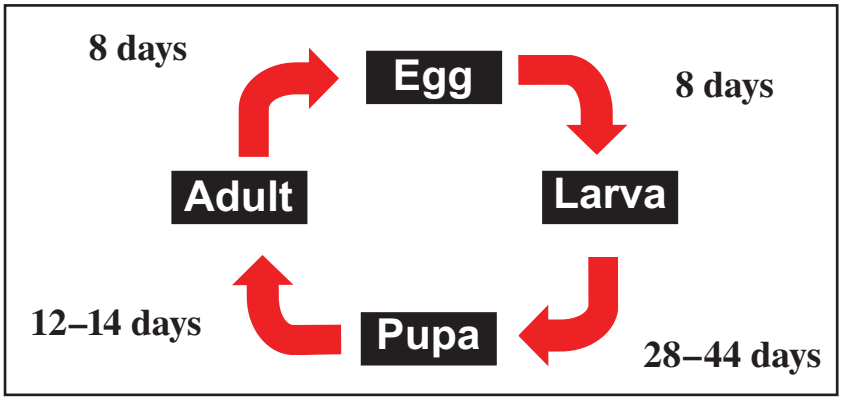
# Life cycle of *Maliarpha separatella*

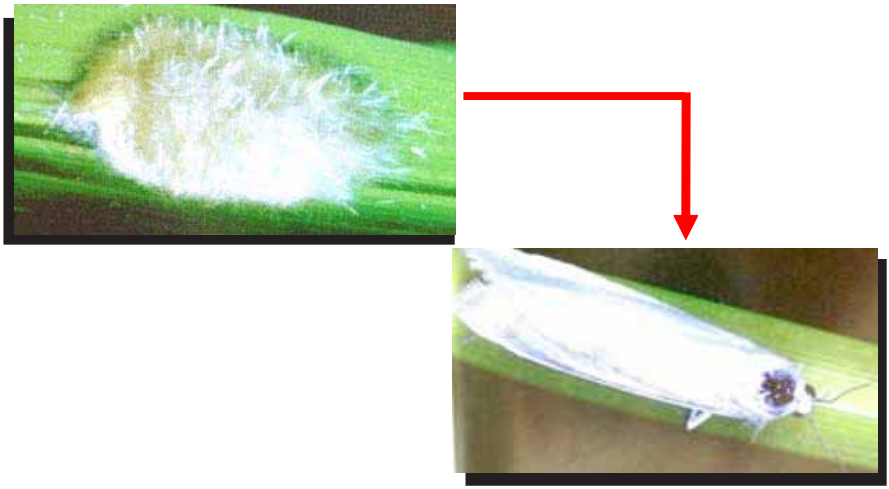
- Adult forewings are yellowish or straw-colored with a conspicuous brown line on the anterior edge.
- Eggs are laid in parallel rows and each female can lay between 30–100 eggs.
- Emerging larvae are white to pale yellow with dark brown heads, but later turns yellow.




# Life cycle of *Scirpophaga* spp.

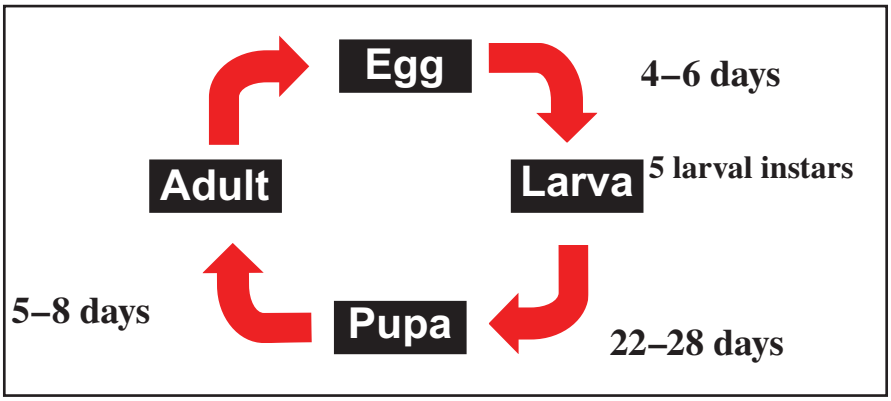
- Adult female has satin-like white wings and black thorax covered with white scales and white legs.
- Eggs are laid in two or three layers and are covered with a light brown downy mass composed of sacles.
- The emerged larvae are light brown in colour with brown hairs.

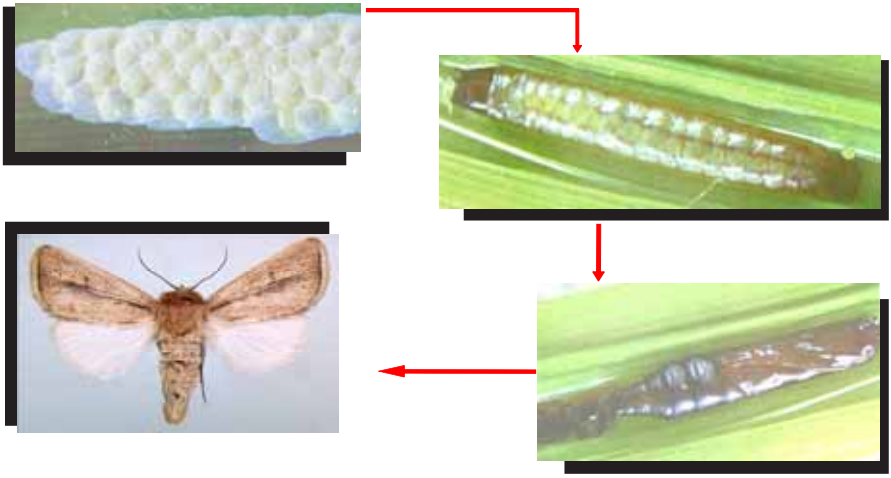


# Life cycle of *Chilo zacconius*

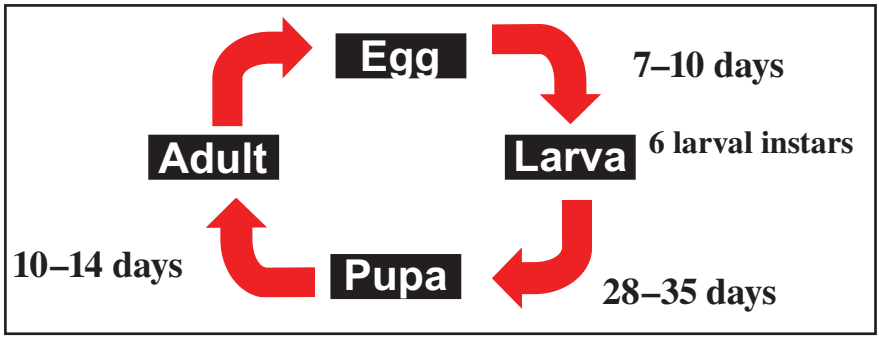
- The fore-and hindwings of adults are covered with black spots.
- Eggs are laid in overlapping rows resembling fish scales and pale yellow in color.
- The emerged larvae bear two protrusions in front of the eyes with seven longitudinal stripes on the body.

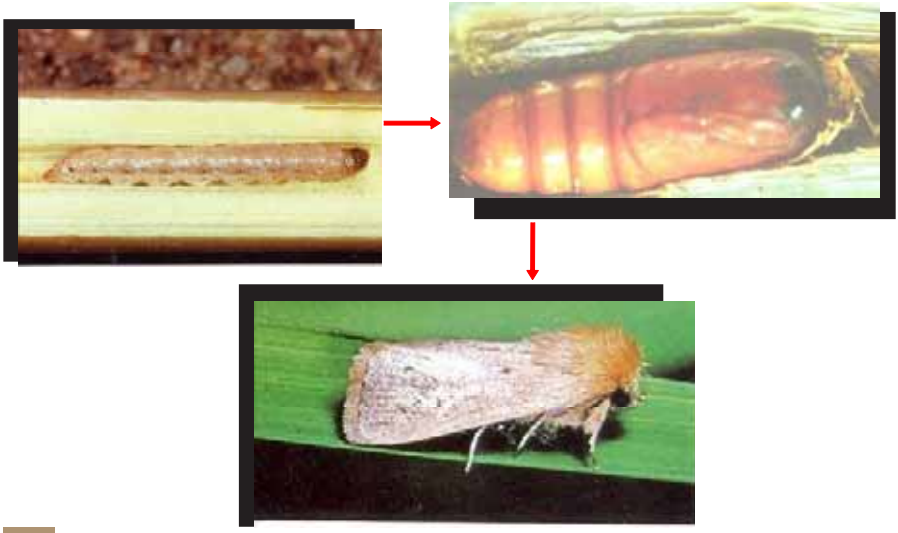


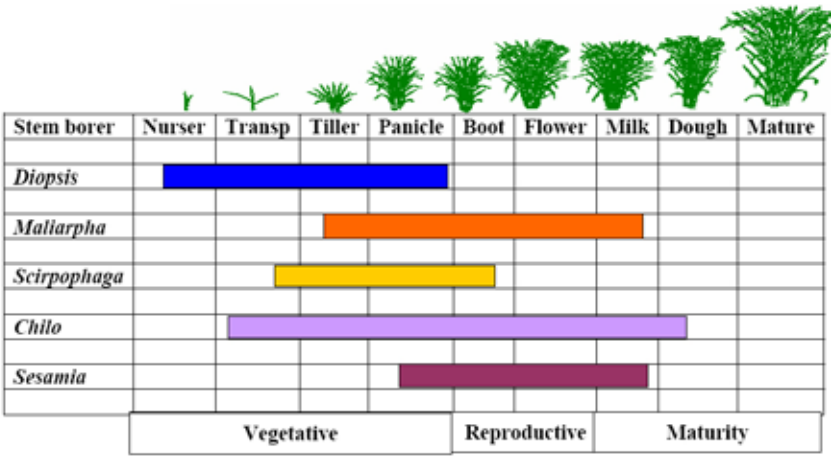
# Life cycle of *Sesamia* spp.

- Adult light brown in color with brown stripes. The forewings margin is wide, whitish and partly smoky.
- Eggs are laid side by side, flat-shaped with numerous longitudinal striation. A female lays upto 300 eggs.
- The emerged larva is yellowish pink in color with a dark brown head and greyish lateral and dorsal stripes.



## What crop growth stages does the stem borer attack?




## In which climatic zone does the stem borer occur in West Africa?

- *Diopsis* species are abundant in all agroecological zones of West Africa: the humid forest, Guinea savanna and Sudan savanna.
- *Maliarpha separatella* is abundant in the humid forest and Guinea savanna than in the Sudan savanna.
- Scirpophaga spp. are abundant in the humid forest and Guinea savanna.
- *Chilo zacconius* is most abundant in both the Guinea and Sudan savanna.
- *Sesamia* species occur only in the humid forest zo ne and Guinea savanna.

# Which rice ecology does the stem borer occur in West Africa?

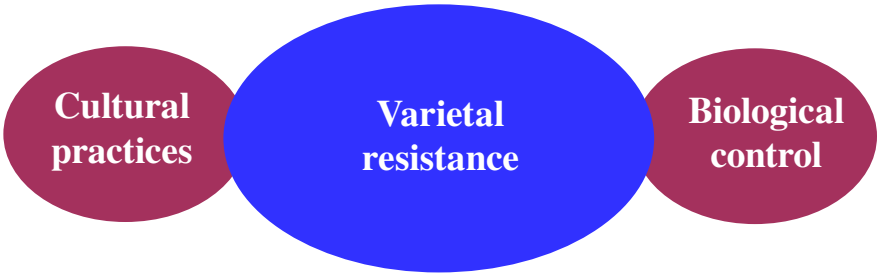
| Stem borer species | Upland | Hyromorphic | lowland |
|---|---|---|---|
| *Diopsis* spp. | Low | Medium | High |
| *Maliarpha separatella* | Medium | Low | High |
| *Scirpophaga* spp. | Low | Medium | High |
| *Chilo zacconius* | High | Medium | Low |
| *Sesamia* spp. | High | Medium | Low |

# What are the hosts of rice stem borers?

| Stem borer | Host range | |
|---|---|---|
| | **Main** | ***Alternative*** |
| *Diopsis* spp. (Stalk-eyed flies) | Rice and sorghum | *Millet, Cynodon dactylon, Cyperus difformis, Paspalum orbiculaire* |
| *Maliarpha separatella* (African white borer) | Rice | *Wild rices (O. longistaminata, O. punctata, O. barthii)* |
| *Scirpophaga* spp. (Yellow stem borers) | Rice | |
| *Chilo zacconius* (Striped stem borer) | Rice | *Sorghum, Echinocloa crus-galli, Pennisetum* spp. |
| *Sesamia* spp. (Pink stalk borers) | Rice, maize, sorghum, wheat, millet, sugarcane | Wild rices and grassy weeds - elephant grass, *Paspalum* sp., Guinea grass |

# Which insect control methods are most appropriate?

**Major components in IPM of rice stem borers**




## Cultural practices

- Cultural practices such as early sowing, narrow spacing of plants and maintaining weed-free fields have been observed to minimize diopsid infestation
- Synchronized planting over a large area has been used to allow the most susceptible stage of rice to escape from *Chilo zacconius* damage.
- Destruction of alternative host plants eliminates breeding sites, and harvesting by cutting the stalk at ground level helps eliminate larvae and pupae lodged within dried stalks
- Strip- and inter-cropping of maize with NERICA was found to be effective in reducing stem borer damage on rice because maize and rice share some common stemborer species
- Management of stubble by burning, plowing and flooding after harvest destroys diapausing larvae of *Maliarpha separatella*.

## Varietal resistance

- Several *Oryza glaberrima* lines showed appreciable levels of resistance to rice stem borers.
- An *Oryza sativa* ITA 121 showed resistance to *Diopsis* species in Nigeria.
- LAC 23, IR 4625-132-1-2, IR 2035-120-3, TOS 4153 have been reported to be resistant to *Chilo zacconius* in Central Nigeria.
- Use of NERICA 1, NERICA 2, NERICA 5, and NERICA 7 in Nigeria
- NERICA 4 has stronger level of resistance to rice stem borers in Côte d'Ivoire
- WAB 1159-2-12-11-6-9-1-2 has been reported in Uganda to trap *Diopsis thoracica* larvae with their hairy leaves.

## Biological control

- A variety of predators such as earwigs (*Diaperasticus* sp.), dragonflies (*Pseudagrion* and *Trithemis* spp.), spiders, nymphs of gryllids and tettigoniids, feed on first-instar larvae and adults of *Maliarpha separatella* and *Sesamia* spp.
- Carabids, reduviids, dragonflies and spiders are known predators of *Chilo zacconius*.
- The braconids *Rhaconotus scirpophagae* Wilk. and *Bracon antennatus* Granger are gregarious endoparasitoids of *Maliarpha separatella* in Nigeria.
- The braconid *Cotesia* (=*Apanteles*) *sesamiae* Cameron and the eulophid *Pediobus furvus* Gahan are the most important wasps attacking *Sesamia* spp. Both have been successfully introduced from Africa into Madagascar and Mauritius.
- Eggs of *Scirpophaga* spp. are often parasitized by *Telenomus thestor* Nixon (Hymenoptera: Scelionidae) with parasitism reaching up to 50% in Côte d'Ivoire.

# Conclusions

It is hoped that the knowledge gained from this guide will assist researchers, trainers, technicians, extensionists, farmers' groups and students in recognizing the most important stem borers associated with rice, assessing the damage they cause in the field, and to take good crop protection measures against losses. The use of synthetic insecticides for rice stem borer control is not attractive to most small scale farmers.

It is also recognized that this manual can serve as a starting point for others who plan to develop a training curriculum or an IPM farmer field school for rice-based cropping systems in West and Central Africa.

# Further Reading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## About the Consultative Group on International Agricultural Research (CGIAR)

The Consultative Group on International Agricultural Research (CGIAR) was founded in 1971 as a global endeavor of cooperation and goodwill. The CGIAR's mission is to contribute to food security and poverty eradication in developing countries through research, partnership, capacity building and policy support, promoting sustainable agricultural development based on the environmentally sound management of natural resources. The CGIAR works to help ensure food security for the twenty-first century through its network of 15 international and autonomous research centers, including WARDA. Together, the centers conduct research on crops, livestock, fisheries and forests, develop policy initiatives, strengthen national agricultural organizations, and promote sustainable resource management practices that help provide people world-wide with better livelihoods.

The CGIAR works in partnership with national governmental and non-governmental organizations, universities and private industry. The United Nations Development Programme, the United Nations Environment Programme, the World Bank, and the Food and Agriculture Organization of the United Nations sponsor the CGIAR. The CGIAR's 58 members include developing and developed countries, private foundations, and international and regional organizations. Developing world participation has doubled in recent years. All members of the OECD (Organisation for Economic Co-operation and Development) Development Assistance Committee belong to the CGIAR.

The CGIAR is actively planning for the world's food needs well into the twenty-first century. It will continue to do so with its mission always in mind and with its constant allegiance to scientific excellence.

www.cgiar.org

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| | |
|---|---|
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| CIFOR | Center for International Forestry Research (Bogor, Indonesia) |
| CIMMYT | Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico, DF, Mexico) |
| CIP | Centro Internaçional de la Papa (Lima, Peru) |
| ICARDA | International Center for Agricultural Research in the Dry Areas (Aleppo, Syria) |
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