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TECHNICAL BROCHURE

THE EGGPLANT SHOOT AND FRUIT BORER (ESFB), *LEUCINODES ORBONALIS* GUENÉE

COLEACP

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COLEACP implements two intra-ACP Fit For Market programmes. The Fit For Market SPS began in January 2019 and focuses on strengthening the sanitary and phytosanitary (SPS) systems of the ACP horticultural sector, primarily for the public sector. Both programmes form part of the intra-ACP indicative programme (2014-2020) of cooperation between the EU and the OACPS.

FIT FOR MARKET | SPS

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1. INTRODUCTION

The Eggplant Shoot and Fruit Borer is on the list of harmful organisms regulated as a quarantine pest in the European Union. During 2018 there was an increase in the number of interceptions at border controls, where imports of fruit and vegetables from Africa-Caribbean-Pacific (ACP) countries were found to contain this quarantine pest. Since 2018, the total of 39 interceptions compared to 3 in 2017 and 1 in 2016, has raised concerns, and interceptions are still high with a total of 25 in 2020 (21 in Uganda, 2 in Togo, 1 in Ghana and 1 in Sierra Leone) and already 2 interceptions in Togo in 2021. These interceptions have led to the destruction of infested consignments and potential reputational damages.

COLEACP has issued this technical brochure to facilitate identification of this pest and to suggest appropriate control strategies.

2. DESCRIPTION OF THE PEST

The Eggplant Shoot and Fruit Borer *Leucinodes orbonalis* Guenée, is a moth belonging to the Crambidae, which is the grass moth family of lepidopterans (moths and butterflies). In the remainder of this document, we will refer to the pest as ESFB.

ESFB is primarily a pest of the eggplant, *Solanum melongena*, also commonly known as aubergine or brinjal. The ESFB has also been reported on other Solanaceous crops including the African eggplant (*S. macrocarpon*), scarlet eggplant (S. gilo), potato (*S. tuberosum*), tomato (*S. lycopersicum*), black night shade (*S. nigrum*). Other hosts include the sweet potato (Ipomea batatas) and pea (*Pisum sativum*).

The moth was first described in India in 1854 but is now widely distributed in tropical and subtropical Asia and sub-Saharan Africa. The adult is 8.5 – 12 mm in length, and the females are slightly larger than the males. The moths are light to dark brown in colour. The larva varies in size depending on the instar stage (see pictures).

2.1 Life cycle

During its lifecycle (Figure 1), the ESFB develops from an egg through five larval instars, pupa, and finally emerging as an adult moth.

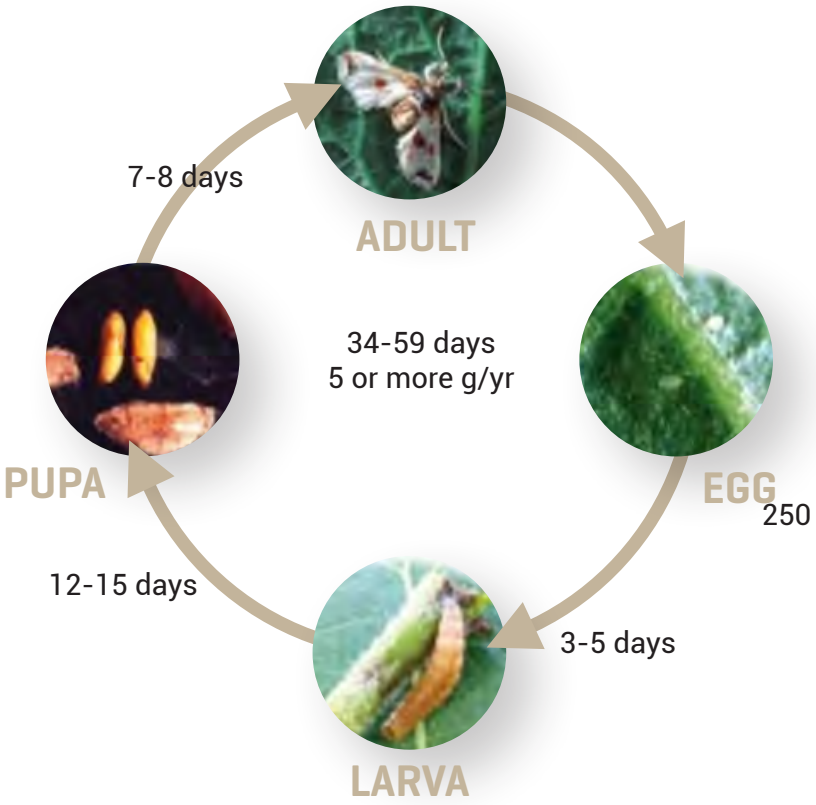

Figure 1: The life cycle of ESFB (Source: http://kb-dev.gramophone.in/page/12/?lang=en)

The adults (Figure 2) are nocturnal and do most of their feeding, mating and egg laying at night between 02:00 and 06:00 am.

Figure 2: Eggplant borer (Leucinodes orbonalis) Guenée
(Source : Kurt Ahlmark, Microlepidoptera on Solanaceae, USDA APHIS PPQ, Bugwood.org
(https://www.insectimages.org/browse/detail.cfm?imgnum=5499635))

Eggs are laid either singly or in batches, generally on the top surface of the leaves. A single female lays about 250 eggs. After hatching 3-5 days later, the larvae (caterpillars) (Figure 3) crawl to find a suitable site for penetration, and then bore into the upper shoot or tender fruits. They tend to prefer fruits if these are available. The larvae then feed and grow for the next 7-15 days. After passing through 5 larval stages, they pupate and either remain on the plant, or fall to the ground. Adults emerge from the pupa after 6-10 days. The adults then live for only 2-5 days before laying eggs, and starting a new cycle.

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Figure 3: Larva of an eggplant borer (Leucinodes orbonalis)
(Source: Syed Zahid Hasan, Sylhet Agricultural University, Bugwood.org
(https://www.insectimages.org/browse/detail.cfm?imgnum=5585591))

The whole life cycle is completed in around 28 days, though this varies depending on temperature and humidity. At higher temperatures, and with lower humidity, ESFB becomes more fertile and the length of the life cycle decreases. In India, for example, the problem of ESFB increases during the rainy season. This short life cycle means that populations of this species can build up rapidly.

3. DAMAGES & SYMPTOMS

This pest can cause serious damage to eggplants (*Solanum melongena L.*), especially during the fruiting period.

When the pest attacks young plants, the ESFB larvae bore into leaves and young shoots, sealing the entry points with their frass (excreta). They feed within the stem until, eventually, the shoot wilts and suffers from dieback. When they attack terminal shoots, the growing points are killed and the affected leaves dry and fall (Figure 4).

Figure 4: Shoot wilting due to the presence of larvae in the stem
(source: James Litsinger, CABI, https://www.cabi.org/isc/datasheet/30498)

When ESFB is present at later stages of the crop, the larvae bore into flowers buds, usually entering through the calyx (flower petals) and often leaving no signs of entry or infestation. As they feed and burrow within the fruit, they can cause severe damage. Direct damage caused by the larvae can also lead to secondary infections by fungi or bacteria, resulting in fruit rot. The larva finally exits the fruit leaving a large hole (Figure 5).

Figure 5: Eggplant infested by ESFB
(source: HOW TO CONTROL EGGPLANT FRUIT AND SHOOT BORER, AVRDC THE WORLD VEGETABLE CENTRE, http://seychellesagriculturalagency.blogspot.com/2011/09/eggplant-fruit-and-shoot-borer.html)

4. CONTROL STRATEGIES

This section outlines different methods that can be used to control ESFB. Using integrated pest management (IPM) is highly recommended; this means using several different control methods in combination in order to manage the problem more effectively and sustainably.

4.1 Planning and anticipation

If the pest has occurred on this site previously, possible new outbreaks are more likely. In this case, growers should prepare themselves to act as quickly as possible, and be very diligent with crop hygiene and cultural control.

4.2 Monitoring

Scouting and monitoring for the presence of ESFB allows early detection and prompt follow-up action, helping to prevent or minimise an outbreak. The chemical (E)-11-hexadecenyl acetate is the major component of the female sex pheromone of the ESFB. If available and permitted for use locally, this pheromone can be used in combination with a delta or sticky trap to monitor for the presence of the pest. For more info see http://www.pherobase.com/database/species/species-Leucinodes-orbonalis.php?isvalid=yes

4.3 Cultural control

Use of cultural control strategies are very important to reduce the incidence of ESFB:

- If available, grow varieties that are less susceptible
- Use crop rotations, and avoid continuous cropping or monocultures of susceptible crops. These include eggplant, African eggplant, scarlet eggplant, potato, tomato, sweet potato, and pea, among others. The pest may not have other host plants in the vicinity, so discontinuing or breaking cultivation of these susceptible crops will significantly reduce the problem.
- Do not raise eggplant seedlings near an existing or previous eggplant crop or heaps of dried eggplant stalks. If seedlings must be grown in those areas, cover the seedling beds with 30-mesh nylon net to prevent the entry of moths, which would lay eggs on the growing seedlings.
- Check seedlings for ESFB as planting infected seedlings is a major source of infestation in a newly planted crop.
- Remove or destroy old crops as soon as cropping has finished. Old plants can harbour ESFB and quickly move into new crops.
- Remove and destroy infested shoots and fruit along with larvae promptly at regular intervals until final harvest. The whole plant should be destroyed in case of heavy infestation. Even when there is no infestation, it is good practice to destroy crop waste (stalks, discarded fruit, ...) before planting a new crop of eggplant.

4.4 Physical control

There is potential for mass trapping using either light traps or pheromone traps with the pheromone indicated above.

4.5 Biological control

Commercially available natural enemies may not be available numerous in all countries. However, by adopting an IPM friendly insecticide programme natural enemies will migrate into the crop. These will have an important role in controlling levels of moths and butterflies, including ESFB. These natural enemies will reduce the populations of not only ESFB but also aphids, mealy bugs and spider mites. Different natural enemies attack different parts of the life cycle. Certain wasp parasitoids can lay their eggs in the ESFB eggs. Ladybird larvae (Figure 6), green lacewings (Figure 7), birds and spiders consume the young larvae (caterpillars) before they bore into the fruits and stems. Ground dwelling natural enemies such as beetles can eat the pupae that fall from the crop onto the ground prior to adult emergence.

Figure 6: Ladybird larvae, a predator of many caterpillars and other pests
(source: https://nature.mdc.mo.gov/discover-nature/field-guide/lady-beetles-ladybird-beetles-ladybugs)

Figure 7: An adult green lacewing, whose larvae are an important predator of caterpillars
(source: http://www.pestnet.org/fact_sheets/cucumber_moth_033.htm)

The application of neem-based bio pesticides (azadirachtin) is often used in a moth control programme. Neem can disrupt or inhibit the development of eggs, block the moulting of larvae or nymphs, disrupt mating, and repel larvae and adults. Other possibilities include the use of *Bacillus*

thuringiensis (or *Bt*), which will not interfere with the activities of beneficial insects (predators and parasitoids).

Biopesticides such as those containing *Beauveria bassiana* or *Metarhizium anisopliae* may be available for the control of various stages in the moth life cycle, including foliar applications for the control of eggs and larvae, and soil application for the control of pupae.

Biocontrol agents that are purchased and applied to a crop need to have the approval of the local regulatory authority as they are considered to be plant protection products.

4.6 Chemical control

Seedling Treatment. A seedling treatment can be done by dipping the roots of the seedlings for 3 hours in a solution of imidacloprid before transplanting (if there is a registered imidacloprid product available). Imidacloprid is a systemic insecticide that will be ingested when larvae feed on the eggplant. Note that since December 2020, imidacloprid is not anymore approved in the EU and the MRL is set at the LOD (0.01 mg/kg).

Field Treatment. During the growing season, using chemical insecticides to manage ESFB is difficult because the susceptible stage (first instar larvae) are exposed on the plant surface only very briefly before they burrow into the plant tissue. After that, they are safely protected inside the shoot or fruit from contact pesticide sprays applied to the eggplant. Consequently, applications of contact insecticides can only be successful if there is an effective monitoring system to know when the moths are laying eggs; the first few hours of the larvae immediately after hatching are their most susceptible period. Systemic pesticides could be used to target the boring stage of the caterpillar. However, the number of systemic pesticides available is limited. Also, the degree of movement within the plant, and therefore the effectiveness of systemic insecticides, is less in older fruiting plants than in young seedlings.

Plant Protection Products (PPPs). Several pesticides (Table 1) can be used against the larvae of Lepidoptera (moths and butterflies), but not all have been tested against ESFB. The choice of which product to use will be based on what is available locally, and is effective for this pest.

Note that Lepidoptera are known to become resistant to many pesticides. To avoid this, growers must rotate active substances belonging to different pesticide groups in order to prevent the emergence of resistance.

Table 1: Plant protection products used against Lepidoptera and mode of action

Active Ingredient	Group mode of action	Active Ingredient	Group mode of action
Cyantraniliprole	28	Garlic ethanolic extract (GEE)	/
Chlorantraniliprole	28	*Beauveria Bassiana*	Fungal agent of uncertain MoA
Flubendiamide	28	*Metarhizium anisopliae*	Fungal agent of uncertain MoA

Active Ingredient	Group mode of action	Active Ingredient	Group mode of action
Oxymatrine from *Sophora Flavescens*	Not included in IRAC	*Bacillus thurigiensis* var. Kurstaki	11A
Oxymatrine from *Sophora Flavescens* + *Bacillus Thurigiensis* var. Aizawai	Not included in IRAC	Azadirachtin (Neem)	Compound of unknown MoA
Spinosad	5		

For details on pesticide groups and mode of action, see: https://www.irac-online.org/modes-of-action/.

Growers should only use products that are locally registered for use on eggplant, or vegetables in general. Before spraying, the label should be read carefully, and the sprayer calibrated. The spray operator should ensure that the pesticide hits the target but without run-off. An excessively high volume will cause run-off, which means a waste of product and incur an unnecessary cost. Please see COLEACP documents on the safe use of pesticides here.

It is important to follow the recommendations for use to avoid the risk of pesticide residues on the harvested product. The permitted maximum residue levels (MRLs) may vary according to the destination market. For produce that will be exported to the European Union, the EU MRLs on eggplants apply. It is essential to follow the recommended Good Agricultural Practice (GAP) in order to ensure that the MRLs are not exceeded. The GAP recommendations include the dose rate, the maximum number of applications, the minimum interval between applications, and the pre-harvest interval (PHI). The PHI specifies the minimum number of days between the last application and harvest.

The Table 2 shows the current EU and Codex MRLs on eggplants, and the relevant GAP recommendations, where available.

Active substance	Registration Status in EU	EU MRL (mg/kg)	GAP for EU MRL				Codex MRL (mg/kg)	GAP for Codex MRL			
			Dose in g of a.s./ha	Max number of applications	Minimum interval between applications in days	Pre-harvest interval in days		Dose g of a.s./ha	Max number of applications	Minimum interval between applications in days	Pre-harvest interval in days
Cyantraniliprole	Approved	1	/	/	/	/	0.5	/	/	/	/
Chlorantraniliprole	Approved	0.6	50-75	2	7	**	0.6	/	/	/	/

Active substance	Registration Status in EU	EU MRL (mg/kg)	GAP for EU MRL				Codex MRL (mg/kg)	GAP for Codex MRL			
			Dose in g of a.s./ha	Max number of applications	Minimum interval between applications in days	Pre-harvest interval in days		Dose g of a.s./ha	Max number of applications	Minimum interval between applications in days	Pre-harvest interval in days
Flubendiamide	Approved	0.2[1]	48-72	3	7-14	3	/	/	/	/	/
Oxymatrine from *Sophora Flavescens*	Not approved	/	/	/	/	/	/	/	/	/	/
Oxymatrine from *Sophora Flavescens* + *Bacillus Thurigiensis* var. Aizawai	Not approved + Approved	/ + No MRL required	/	/	/	/	/	/	/	/	/
Spinosad	Approved in Organic production	0.7	96	3	7	/	/	/	/	/	/
Garlic ethanolic extract (GEE)	Approved in Organic production	/	/	/	/	/	/	/	/	/	/
Beauveria Bassiana	Approved	No MRL required	/	/	/	/	/	/	/	/	/
Metarhizium anisopliae	Approved	/	/	/	/	/	/	/	/	/	/
Bacillus thurigiensis var. Kurstaki	Approved	/	/	/	/	/	/	/	/	/	/
Azadirachtin (Neem)	Approved in Organic production	1	150	/	/	2	/	/	/	/	/

/ : value not available so default MRL applied 0.01 mg/kg; n.a. : not applicable; EU registration status under Regulation 1107/2009.

IMPORTANT NOTE: The information contained in this table is subject to change according to EU regulations and Codex. To check the most up-to-date information on MRLs, please check the relevant EU and CODEX websites. This information is also available on the COLEACP database, together with updates on the GAP recommendations.

1 The EU has published a Draft Regulation as regards maximum residue levels of flubendiamide. This EU MRL will be changed to the LOD 0.01* but the date of application is still unknown. Please check the EU Pesticide Database to get the last update.

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