Area-wide Management of the Beet Armyworm In Jamaica





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FOREWORD

Spodoptera exigua, also known as the beet armyworm is a destructive pest of onion and scallion in Jamaica. Since the 1990s, agricultural production in St. Elizabeth has suffered from several major outbreaks of the beet armyworm which have increased in pest activity, frequency and severity and so threaten the progress achieved by the initiatives for improving productivity. From 2009 to 2012, farmers in South St. Elizabeth experienced significant losses in scallion and onion crops, valued at J$140 M.

Despite several interventions from Research and Development (R&D) Division of the Ministry of Agriculture and Fisheries (MOAF) as well as the Rural and Agricultural Development Agency (RADA – the Extension arm of the MOAF), the outbreaks continue annually due to poor uptake and adaptation of the integrated pest management (IPM) technologies by many small farmers. In response to this situation, the Ministry of Agriculture and Fisheries in 2012 in collaboration with the Food and Agriculture Organisation of the United Nations (FAO) initiated a two-year project under FAO's Technical Cooperation Programme (TCP) titled 'Strengthening the National Beet Armyworm Programme'.

A key component of the project was the transfer of technology to farmers, using the farmer field school (FFS) methodology. It was anticipated that improving the farmers' understanding of IPM using a participatory 'learning by doing' approach would result in better uptake of the practices and technologies that aimed to reduce the impact of the beet armyworm. RADA and ACDI- [1]VOCA were key partners in the implementation of a training of trainers (TOT) for Extension staff, followed by the training of lead farmers in the first round of FFSs. In the second round, the trained farmers in turn led the training of other farmers in their respective communities.

This Manual is a compilation of information on the beet armyworm and its management. The preparation of the Manual was done based on input from major stakeholders (including farmers, R&D, RADA, ACDI/VOCA) and other FAO consultants as a part of the Technical Working Group. It contains detailed information on the description, biology and ecology of the beet armyworm, and the many strategies to be implemented within an IPM programme which includes monitoring, cultural, ecological, biological, nutritional and chemical control and introducing the Beet Armyworm Pest Forecasting System. It is designed in a simple format with many images to be used by farmers, extension officers and other critical stakeholders who will be involved in implementing the Beet Armyworm Area-wide Management programme.

It is anticipated that this Manual will serve as a user-friendly guide/handbook in the implementation of the outlined strategies and the Area-Wide programme and strengthen the current management programme to improve and sustain vegetable crop production by reducing the effect of beet armyworm infestation on scallion and onion.

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[1] **ACDI/VOCA - Agricultural Cooperative Development International and Volunteers in Overseas Cooperative Assistance.** This is a US based non-profit international economic development organisation Read more at http://acdivoca.org/

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ACRONYMS

ACDI VOCA	Agricultural Cooperative Development International and Volunteers in Overseas Cooperative Assistance
AIPM	Area-wide Integrated Pest Management
ALMD	Agricultural Land Management Division
BAW	Beet Armyworm
Bt	Bacillus thuringiensis
FAO	Food and Agricultural Organization of the United Nations
FFS	Farmer Field School
GIS	Geographic Information System
ICM	Integrated Crop Management
IPM	Integrated Pest Management
JAM	Jamaica
MOAF	Ministry of Agriculture and Fisheries
MRL	Maximum Residue Limits
NCU	Northern Caribbean University
ODK	Open Data Kit
PFS	Pest Forecasting System
PHI	Post-Harvest Interval
PPE	Personal Protective Equipment
PPU	Plant Protection Unit
RADA	Rural Agricultural Development Authority
R&D	Research and Development Division
SLC	Sub-Regional Office for the Caribbean
TCP	Technical Coorperation Programme
ToT	Training of Trainers
TTTI	Technology, Training and Technical Information
USAID	United States Agency for International Development
UV	Ultra Violet
UWI	University of the West Indies

INTRODUCTION

- Beet armyworm (BAW) is an economic pest on many crops across the world
- The first reported outbreak of BAW was on scallion in the 1990s in South St. Elizabeth
- Severe outbreaks of BAW were recorded on scallion and onion fields in South St. Elizabeth during 2009-2012, during the months of May/June and October/November, which coincided each time with the end of the rainy season (Plant Protection Unit, 2013)
- The pest populations flared up since 2013 but not like previous years
- Losses of over J$140M in onion and scallion fields have been recorded

In response to BAW outbreaks, several control strategies were implemented including training of farmers and research activities, however, the programme was:

  - Not properly coordinated between agencies
  - Not fully or widely adapted by farmers

- Based on a request for technical support, a two-year project under FAO's technical cooperation programme (TCP/JAM/3401), titled "Strengthening a national beet armyworm *(Spodoptera exigua)* management programme in Jamaica" was approved and implemented starting November 2013.
- Through cooperation among local agencies including Research and Development (R&D) Division, Rural and Agricultural Development Authority (RADA), ACDI /VOCA, project Consultants and farmers, an Integrated Pest Management programme was developed and transferred using the Farmer Field School learning approach (Figure 1).

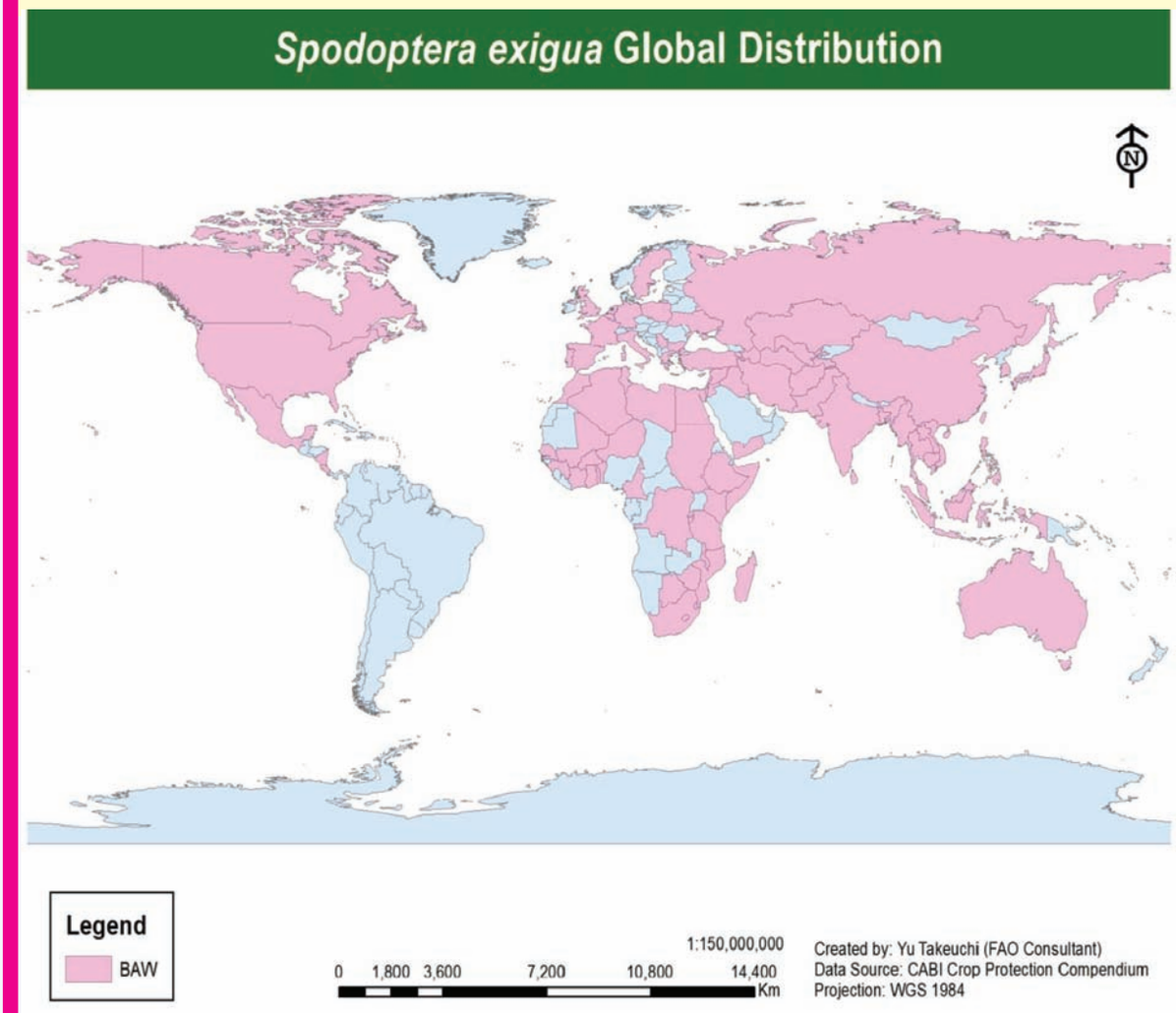
Figure 1. Weekly infield meeting of participants at FFS in South St. Elizabeth (2014), funded by the FAO Beet armyworm project and ACDI/VOCA (USAID)

CHAPTER 1: THE BEET ARMYWORM

What is the Beet Armyworm and where did it come from?

The beet armyworm (BAW) is a tropical insect pest, which originated in Southeast Asia. It is now found in many parts of the world (Figure 2), and is well-established in all parishes of Jamaica.

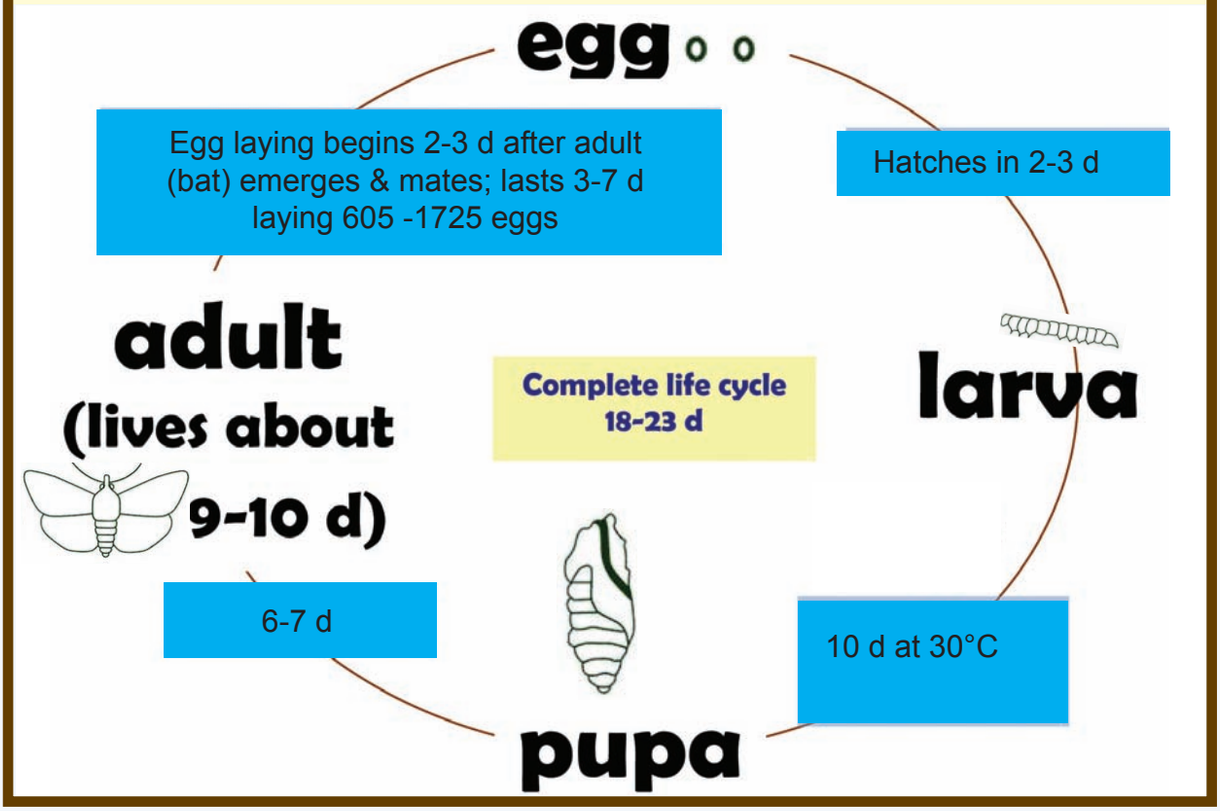
Figure 2. Global distribution of the beet armyworm



Life Cycle of BAW

- In order to manage this pest, farmers need to know what the pest looks like, as well as how it feeds and reproduces.
- The BAW has four stages of development - egg, larva ('worm'), pupa and adult ('bat') - it takes 18 to 23 days to complete its life cycle. (Figure 3)

Figure 3: Life Cycle of Beet Armyworm



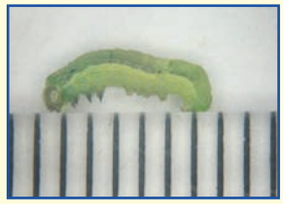
Description of Beet Armyworm

Eggs

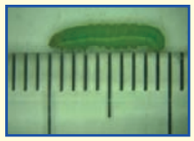
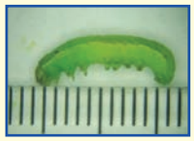
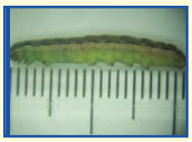
- White to greenish in colour
- Egg mass covered with fuzzy/ cottony looking whitish scales
- Laid in masses of 50-150 eggs
- Found on upper end of scallion and onion leaves


Larvae ('Worms')

- Usually 5 instars (stages)
- **1st to 2nd** instar are usually yellow to pale green in colour and 0.25 / 0.45mm in length

- **3rd to 5th** instars have different colours;
  - o light green, dark green;
  - o white stripes at the side,
  - o pink or yellow underneath;
  - o dark spot above the second front leg

Pupae

- Light or dark brown in colour, found a few cm below the soil and encased in a cocoon constructed from sand and soil particles

Adult (moths/'bats')

- Front wings mottled grey and brown; irregular banding pattern; light-coloured bean shaped spot near the centre

Life history of Beet Armyworm

- Eggs generally hatch in about 2-3 days after being laid
- Newly-emerged larvae ('worms') feed on remains of egg masses and migrate (Figure 4).
- First instars (stage) swarm onto the onion/scallion leaves and the 2nd instars enter the leaves, where they remain feeding until the 5th instars are ready to pupate in the soil.

Figure 4: Migrating first instars of the beet armyworm

- The moths fly mostly at night but may be seen flying up when disturbed or as one walks through the field
- Beet armyworm prefers dry, hot conditions and is not tolerant to cold. BAW populations tend to fall during the December-March winter season in Jamaica when the island seasonally experiences a series of cold fronts coming from the North (PPU 2013)
- At 30 °C, the larval stage is completed in 9-10 days (Wilson 1932; Fye and McAda 1972)
- Laboratory studies at R&D Bodles determined that the entire life cycle, from egg to adult, was completed in 25 days at 23.7 °C and in 15 days at 29.6°C (W Diedrick, 2013, pers. comm.).

What crops do BAW feed on?

- BAW has a very wide host range of more than 90 host species
  On scallion, BAW shows greater preference for hybrid varieties e.g. 'evergreen hardy', than local varieties e.g. white and red root (Figure 5).

Figure 5. Scallion varieties grown in Jamaica

Vegetable crops: broccoli, cabbage, callaloo, cauliflower, lettuce and tomato
Other crops: beans, beet, celery, chickpea, cowpea, eggplant, scallion, melon, onion, pea, pepper, potato, sweet potato

- **Field crops** include:
  - o corn, cotton, peanut, soybean, sugar-beet, and tobacco

- **Weeds include:** Wild callaloo (Figure 6), purslane, parthenium, guinea grass, lambsquarters, mullein, pigweed Wild callaloo), Russian thistle, and tidestromia.

Figure 6. Wild callaloo showing feeding damage by beet armyworm larvae

Economic Damage of Beet Armyworm

- The larvae eat large irregular holes in foliage, produce frass (caterpillar droppings) and may completely defoliate the plants.

- The pest in large numbers can defoliate entire fields in a short period of time if not detected and brought under control / managed early.

- Once fields with the preferred host (onion and scallion) are destroyed, they will migrate like an army to other hosts or any suitable plant to feed (Figure 7) and complete development.

BAW entry hole in scallion

Feeding damage & frass on scallion

BAW feeding damage on onion

Figure 7. Damage caused by beet armyworm (BAW) to various host crops

BAW feeding damage on eggplant leaves

BAW feeding damage on sweet pepper

BAW feeding damage on watermelon

BAW feeding damage to beetroot

What factors influence Beet Armyworm outbreaks in South St Elizabeth?

- The BAW population tends to increase due to the seasonal increase in day and night temperatures
- Major BAW outbreaks occurred during May/June in the past and had been triggered by the rains following (prolonged) drought
- The continuous cultivation of the scallion crop throughout the year serves as a reservoir for the pest to survive and provides abundant food supply for the pest population to build up and infest fields
- Eggs are protected within the cotton-like whitish scales
- Older larvae are well protected inside the hollow leaves and may develop resistance easily to insecticides
- The misuse of insecticides results in knockdown in the natural enemy populations, which take longer to recover
- BAW has a relatively short life cycle under warm field conditions, producing at least 12 generations per year
- It has a high reproductive capacity, with each female capable of producing 605 to 1725 eggs in its lifespan
- Highly mobile and is therefore capable of colonizing wide range of areas
- During prolonged droughts, natural enemy populations do not thrive so BAW populations can increase unchecked

CHAPTER 2: AREA-WIDE MANAGEMENT OF THE BEET ARMYWORM

- The current approach to managing the BAW on an individual basis using mainly the chemical approach has proven to be unsuccessful as abandoned or poorly managed fields become sources of re-infestation for other fields that are under fairly good management.

Figure 8. Farmer field school (FFS) in St Elizabeth

- In order to improve the management of beet armyworm in South St. Elizabeth, it is necessary to apply an Area-wide Integrated Pest Management Programme (AIPM), which involves implementing various strategies (= Integrated Pest Management) at the same time by all farmers in the affected areas.

- AIPM requires the involvement of all stakeholders including extension officers, researchers, input suppliers, farmers, surrounding residents growing onion, scallion or guinea grass and vendors / higglers.

- FFS conducted in St Elizabeth parish under the FAO project (Figure 8) was based on local experiences in the parish and sharing of knowledge, which provided the foundation for cooperation among stakeholders working and living in the same area to implement an AIPM of BAW.

Integrated Pest Management of Beet Armyworm

The successful management of BAW can be done by using many strategies (cultural, biological, mechanical) with reduced dependence on chemical control. This approach is called Integrated Pest Management (IPM). IPM involves the protection of the environment and human health.

For an IPM programme to be successful, it is very important to:

- Keep track of pest populations
- Know when to act (thresholds)
- Know what action/s to take (use appropriate options)

RECORD EVERYTHING

Monitoring BAW population

Damage to scallion and onion crops can be minimized by regular monitoring for early pest detection and application of appropriately-timed management strategies.

Pheromones are substances secreted by one animal that causes a specific reaction upon reception by another animal of the same species

Monitoring the BAW adult/moth

Use pheromone traps as a monitoring tool to detect the early arrival of the migrating beet armyworm adult/ moths.

Trapping should begin from early stages of plant growth and continue throughout the crop cycle.

- Prepare commercial or homemade traps (Figure 9) with one septa lure
- Fill container with soapy water up to one third level (this will drown trapped moths)
- Position traps on the outside of fields for the early detection of adult BAW
- Place traps at least 30 metres (100 ft.) apart, uniformly spaced
- Use a self-made stand or pole to suspend the traps 1-1.5 metres (3-4 ft.) above ground
- Check the traps regularly and count the number of BAW moths caught.
- Replace the soapy water if it becomes dark and smelly with excessive numbers of dead moths
- The septa should be replaced every 4 weeks (See Appendix B for construction of homemade trap)
- Trap density for monitoring – one trap per 4 ha

Figure 9. Commercial (top) and homemade (bottom) beet armyworm pheromone traps

Monitoring the BAW Egg and Larva

- Use visual monitoring of scallion and onion at least twice a week or every three days. (Figure 10)

- When monitoring plants, look for:
  - presence of white 'fluffy' egg sacs and newly hatched larvae near the leaf tips
  - small holes near the end (upper one-third) of leaves
  - bent over leaves – which can indicate that larger larvae are feeding inside

Figure 10. Visual monitoring of scallion field

- If 5 worms are found on 25 plants or less, then immediate action is required. This number (5 larvae on 25 plants) is referred to as the action threshold.

- Early detection of egg and young larvae is critical to implement control strategies in a timely manner and minimize the damage

- Older larvae are much more difficult to manage with insecticides once inside the hollow leaves

What are the options available for the IPM of BAW?

There are quite a few options available, including physical, ecological, biological and chemical control techniques.

Variety Selection

- All varieties of onion and scallion are susceptible to beet armyworm
- Narrow leaf scallion varieties such as “white root’ and ‘red root’ scallion have been observed to be fairly tolerant to BAW infestation
- Large hybrid varieties, such as the ‘evergreen hardy,’ are severely affected

All scallion and onion varieties are attacked in an outbreak

Physical Control

Handpicking

- Crush eggs and remove young worms from tips of scallion. This practice is only practical for small acreages with low populations of beet armyworm.

Mass trapping

- Use pheromone traps for mass trapping of adult BAW
  - Trap density for mass trapping – one trap every 27 m (90 ft), approximately 46 m (150 ft) from edge of field.

Changing the crop environment (Ecological Management)

- This reduces the ability of moth/’bats’ to mate, makes the physical environment and their source of food unfavourable.

Crop rotation and scheduling

- Reduce the acreages of scallion during the April to July period and cultivate alternative crops such as **hot pepper, thyme, pumpkin, melon and sweet potato** during this period.
- Schedule the planting of onions and scallion during the fall period to reduce pest pressure.
- Do not plant onion crop beyond the traditional planting season to ensure the crop is harvested before the end of April

Field sanitation

- Keep furrows and area around the crop free of weeds, as weeds serve as alternate hosts for the BAW.

- Before transplanting use clean, pest-free planting material to establish scallion fields: preferably the transplants should be treated with a targeted pesticide containing Bts (Bacillus thuringiensis) such as Xentari®, Dipel® or Agree® that preserve natural enemies of the BAW and are effective on young larvae and when pest numbers are low.

- Destroy crop residue (by composting, burying or drying in the sun) immediately after harvesting is complete. This eliminates the food source and prevents re-infestation of the crop.

- Ensure that mature onion and scallion crops are harvested and sold and not left in the field due to low prices or other marketing issues
    - Unmanaged or abandoned plants encourage the build-up of BAW populations
    - Contact an Extension Officer if you are experiencing challenges with marketing scallion

Irrigation

- This provides a cool and wet environment not suitable for BAW development.

- The use of overhead sprinklers may also mimic rainfall which helps to reduce egg-laying by female moths.

Green Much Management

- Removing or thinning grass mulch before the outbreak season provides less protection to BAW pupae in the soil. This is most suitable for farmers with adequate irrigation.

Weed Management

- Weeds surrounding and within the fields may harbour the BAW and serve as a reservoir for re-infestation and migration when the young scallion and onion leaves harden. Hence, proper weed control must be practiced.

    - Cut back on guinea grass before rainy season begins.
    - If possible, relocate scallion and onion crops away from guinea grass fields.

Nutrient Management

- This ensures that adequate nutrition is supplied to the crop by timely application of fertilizer/compost/manure.

Conserve and Protect Natural Enemies or "Farmers' friends"

- This is the use of natural enemies or "farmers' friends", to reduce pest populations and their damage.

- Examples of "farmers' friends" are wasps, plant bugs, beetles, spiders and birds (Figure 11) which feed on the BAW eggs and larvae. Other examples include some bacteria, fungi and viruses.

Figure 11. Natural enemies of the beet armyworm: paper wasp (left), ladybird beetle (centre) and cattle egrets (right)



- It has been observed in South St. Elizabeth that the paper wasp is abundant during the cooler months and has been observed cutting the scallion leaves and removing larvae.

- *Bacillus thuringiensis* (bacterium) and *Beauveria bassiana* (fungus) formulations are known to be effective against the BAW (Figure 12). These organisms are deactivated by UV light and during hot days. Therefore, they are to be applied during the cool evenings so that they will be effective against the active BAW larvae at nights.

Figure 12. Beet armyworm larvae infected with the fungus, Beauveria bassiana

Chemical Control

- Should be used as a last resort, not the first/preferred choice of action

- Use insecticides that are approved for use on onion and scallion (see Appendix C)

Use safe insecticides which manage BAW & protect "farmers' friends"

SAFE AND EFFECTIVE USE OF PESTICIDES

- Ensure applicators are trained and wear protective gear (Figure 13)
- The lowest effective amount of pesticide is applied from carefully calibrated spray equipment
- Apply treatments so that it is atomized (very fine mist) to increase contact with the pest residing within the leaves.
- Apply during the coolest, least windy time of the day - early morning or late evening (Figure 14)
- When the crop canopy is dense use high water volumes and label rates.
- Use a sticker along with the treatments, especially during the rainy season

Figure 13. Pesticide applicator in Personal Protective Equipment (PPE)

Figure 14. Pesticide applicator wrapped in paper to demonstrate drift of spray droplets during spraying of pesticide

- Rotate insecticides that have different active ingredients or are from different chemical groups.
- The effectiveness of insecticide treatments may be improved in small plots by clipping off the leaf tips prior to application, especially if the older beet armyworms have entered the leaves.
- Timing of spray application and good leaf coverage are critical
- Target older larvae by alternating Danitol® and Match®.
- Target very young larvae by alternating Bt (Bacillus thuringiensis) formulations (e.g. Xentari®, Dipel ® or Agree®) with abamectin formulations (e.g. Cure® or Newmectin®).

Agree®: 5.7 g or 2 ml / 3.8L water ; **Post-harvest interval (PHI)* None**

Cure®: 0.3 – 1.2 L / Ha. **PHI 3-7 days**

Danitol®: 5-10 ml / 3.8 L water. **PHI 14 days**

Match®: 10 ml / 3.8 L water; **PHI 20 days**

Post-harvest Management

- Farmers need to monitor the vendors to ensure that all trash/debris removed from harvested scallion/ onion are placed into plastic bags or unto tarpaulins to be sunned or destroyed after the cleaning process is finished (Figure 15).
- Any larval infestation present within the trash may migrate to adjacent fields or pupate in the soil to later emerge and migrate to nearby fields.
- Vendors as stakeholders need to play their part in managing the BAW and supporting the farmers whom they depend on as source for their livelihood.

Figure 15. Debris left on the ground after 'stripping' of scallion, where leaves damaged by beet armyworm larvae are removed

Indigenous knowledge & Innovation of Farmers to Manage Beet Armyworm

Intercropping with thyme

- Some farmers planted thyme in alternating rows with scallion and onion and reported low levels of beet armyworm (Figure 16).
- Thyme contains a chemical (thymol) which repels many moth species and can decrease/ prevent egg-laying.

Figure 16. Thyme intercropped with scallion in South St. Elizabeth

Compost drum

- Farmers were introduced to an innovation by Mr Buchannan, a farmer from Gillards, who designed a compost drum (Figure 17).
- Plant residues from scallion field were used to generate compost, which was used as fertiliser.

Figure 17. Plastic drum (left), which contained a chemical, converted into a composting bin (right)

Homemade Light Trap

- A homemade light trap, powered with mobile phone battery, was an innovation by a young farmer from Manchester (Figure 18).
- The light trap uses white light immersed in a container filled with water.
- Moths are nocturnal i.e. they are night-time creatures and use light to navigate at nights
- The light will attract the moths. White light is used because its luminous intensity is more effective than other colour lights in attracting the moths.
- The BAW moths are drawn to the light, which is submerged in water (Figure 19).
- The moths will fly to the light and drown in the water (Figure 20).
- Multiple light traps may be placed in one field

Figure 18. Homemade light trap powered with mobile phone battery (farmer innovation)

Note: Since moths and other insects will also be attracted to the light trap, it is best to use the traps when the adult moth population is high, so that mostly BAW adults caught.

Figure 19. Light trap – white light submerged in water

Figure 20. Moth caught in light trap set in scallion field

CHAPTER 3: BEET ARMYWORM PEST FORECASTING SYSTEM

In order to understand the BAW Pest Forecasting System, each stakeholder (including the public) needs to understand the following:

What is the BAW Pest Forecasting system all about?

- BAW population changes with the temperature because it needs warm conditions to develop from egg to adult.

- Using current and historical temperature information from the area, changes in the population can be predicted to develop an early warning system called the Beet Armyworm Pest Forecasting System.

- This ***Pest Forecasting System*** is a tool which can be used to:
  - o help warn farmers of increases in BAW populations
  - o advise what appropriate control measures are to be carried out to prevent damage to the crop and even prevent outbreaks.

How will this system work?

In order for the system to work properly, current information on pest and the temperature are always needed. This will require the following activities.

Area-wide surveillance and monitoring system for beet armyworm

- Information on the BAW population needs to be collected throughout the year in specific communities across South St. Elizabeth by RADA Extension Officers and cooperating FFS farmers via the ODK App on tablets or smart phones utilized by data collectors to feed to a central location.

- Temperature data will also be collected from automated or manually based Met Stations located in the area to be directly uploaded to the system through the Met Office of Jamaica and then fed to the system.

Generating BAW Forecast

- Once all the necessary information has been put into the system, a prediction is generated as to the likely change in the BAW population.

- Updates may be placed online for stakeholders to view at any time

Figure 21: Met Station used to collect environmental data (e.g. temperature) in the field

Preparation and Dissemination of Advisories

- Advisories can then be prepared by interpreting the data and can be disseminated through various media to farmers for their action
    - Display on Pest Forecast Website
    - Texting via phone
    - Print or electronic media
    - Weather report on a fortnightly or monthly basis
- The advisory should include information on the various Integrated Pest Management components to be used e.g. Monitoring, Cultural, Mechanical, Biological and Chemical.

How will this benefit the farmer?

- An early warning system will prepare farmers before BAW causes economic damage to the crop.
- There should be a reduced crop loss, thus saving thousands of dollars of farmer investments.
- Improve ability to implement management strategies in a timely manner and improve effectiveness of Area-wide management programme.

Who are the agencies involved and what are their roles?

- It will be institutionalized within the Ministry of Agriculture and Fisheries across several agencies with various roles and responsibilities, as given below.

Table 2: Agencies involved in Forecasting System and their roles

AGENCY/ INSTITUTION	ROLE/ RESPONSIBILITY
Ministry of Agriculture and Fisheries	• Hosting of PFS (Pest Forecasting System) • IT (Information Technology) support
Research & Development Division, Ministry of Agriculture and Fisheries	• Coordination and management of PFS • Research/Generation of local data
Plant Protection Division, Ministry of Agriculture and Fisheries	• Coordination and management of PFS
Food and Agricultural Organization (FAO)	• Funding of project
Rural Agricultural Development Authority (RADA), Ministry of Agriculture and Fisheries	• Electronic entry of field data • Extension support to farmers in monitoring and data collection
Agricultural Land Management Division (ALMD – **formerly RPPD)**	• Provision of GIS • Storage of ODK dataIT support
Meteorological Office of Jamaica	• Automated entry of meteorological data
Northern Caribbean University (NCU)	• Design of website • IT support
University of the West Indies (UWI)	• Research/Generation of local data
FFS farmer groups	• BAW monitoring and data collection • Electronic entry of field data
ACDI/VOCA – **USAID**	• Agro-meteorological support • FFS support • Funding

Figure 22: Roles of agencies implementing Beet Pest Forecasting System

How can the farmer participate?

- Volunteering to participate in collecting information on a regular basis on the BAW on their own farm and share with RADA.
- Listen to advisories when sent and implement IPM strategies when sent by text messaging, voice mail, radio or television or visit website weekly.
- Farmer participation is critical to prevent pockets of infestations negatively impacting on own and neighbouring farms.
- Those who have been exposed in various ways, especially those trained in BAW Farmer Field School (FFS) can share what they have learnt with others through the farmer's groups in the area or one on one in the field.
- FFS participants can, by their own examples on their own farms, demonstrate to neighbouring farms how the pest can be managed once advisories are followed.

How reliable is this system?

- This system was developed in 2014 by a international FAO Consultant under the FAO Beet Armyworm Project called: *Strengthening the National Beet Armyworm Management Programme* using local and published data incoorporated into a electronic format.
- Similar systems have been built and are being used in other countries e.g. the USA
- Local research by MOAF, Research and Development Division, NCU and UWI, continues to improve the system, supported by FAO, and ACDI/VOCA (US-AID).

- The system is currently being updated and tested (i.e. it is being validated) and is, therefore, not yet reliable enough to be actively commisioned for use.
- Once validated and shown to be reliable, the commissioning of the Pest Forecasting System will be publicly announced.
- Until then, a continuous Area-wide surveillance and monitioring programme will be done by RADA and cooperating farmers and the information used to guide management decisions and advisories to farmers.

Will this system cost the farmer to implement?

- There is no monetary cost to the farmer to implement, only time and energy for those volunteering to collect BAW data on their farms to supply to RADA.
- The only monetory cost to the farmer is the loss of revenue from crop loss and also acting as a source of infestation to neighbouring farmers managing the pest based on IPM progamme given in advisories.

FARMERS GET INVOLVED & LET US WORK TOGETHER
TO FORM OUR OWN ARMY AND BEAT
THE ATTACK OF THE BEET ARMYWORM

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APPENDIX A

Record Sheet for monitoring BAW stages

Monitoring of Beet Armyworm (Spodoptera exigua)

Name of Farmer:_____ Location:_____

Date: _____

No.	Scallion /onion variety	# Egg sac	# Larvae (instars)		# Pupae	# Adult	% Damage
			1^{st} - 2^{nd}	3^{rd} -5^{th}			# L D / T # L
1							
2							
3							
4							
5							
6							
7							
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APPENDIX B

SCHEMATIC PLAN OF THE SELF-MADE BEET ARMYWORM PHEROMONE TRAP

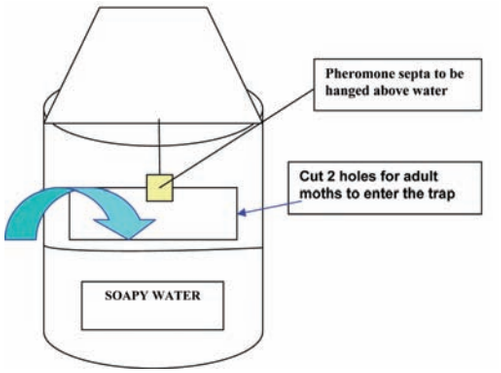

Figure 1: Schematic plan for the construction of self-made pheromone trap

Procedures:

1. Use plastic gallon container to make the trap;
2. Cut two wide holes in the container (with consideration that water will be filled in container to approximately 1/3 of volume;
3. Make the hole in the cap, insert piece of wire or large paper clip, so that pheromone lure (sachet) can be hanged above the water;
4. Fill trap with soapy water.
5. Hang the trap on self-made stand (Figure 2). Trap should be suspended about 1 m above the ground.

Figure 2: Self-made pheromone trap

- For mass trapping: Traps can placed inside the fields approximately 50 m (150 ft) from the edge and at least 30m (90 ft) apart and uniformly spaced.
- For monitoring: Place one monitoring trap per 4 hectares with a minimum of two traps per block. Place additional traps on borders that are most subject to migrations from adjacent fields or host crops.
- Refrigerate or freeze lures for longest storage Life.

For further information contact your RADA Extension Officer
Plant Health /Food Safety Unit. Rural Agricultural Development Authority (RADA)
Technology, Training and Technical Information Division (TTTI); Hope Gardens
Kingston 6, Jamaica , West Indies
Tel: 876-927-1780-1 ; Fax: 876-970-4077
September 2009.

Insecticide Products Registered in Jamaica with and Contain Active Ingredients for which Maximum Residue Limits (MRL) are Listed for ONION/ESCALLION Destined for USA, European Union & Canadian Markets

Source of information - Global MRL Database: http://www.globalmrl.com. June 2015

Trade name	Active ingredient	Chemical Group*	Mode of action	Toxicity Class	Pests controlled	Pre-harvest Interval	Dose Rates	Maximum Residue Limits (MRL)			Additional Information
								USA	UK/EU	Canada	
Trigard	*Cyromazine*	*Triazine*	*Contact*	**III**	leafminers	n.a	1/6 lb	**0.2**	0.05	0.3	Insect growth inhibitor. Selective towards Dipterous species
Cure 1.8%EC	**abamectin**	**Avermectin**	Contact & Stomach poison insecticide	III	mites , leafminers, thrips, **Beet armyworms**	3	2.5 ml/4 litres of water	**0.005**	0.1	Not given	Commencement of spraying should coincide with egg hatch and first instars larvae (very young worms) and before damage to the plant
Newmectin 1.6%EC	**abamectin**		Contact	IV	leafminers, mites, thrips, **Beet armyworm**	3-7 days	0.3-1.2 Litres/ hectare				
Confidor 70WG	*Imidacloprid*	Neonicotinoid	**Contact & systemic**	**III**	Aphids, leafhoppers, whiteflies, leaf miners	**21 days**	500 g/hectare as root drench; Or 280 g/ha; Or 1 tsp/5 US Gallons)	3.5			Distributed by Carib-Gro Distributors Ltd.
Caprid 20SL	*acetamiprid*			II	Moths, worms, whiteflies, leafminers etc	not provided**	2.5 - 5.0 ml/ 3.8 Litres (= one US gallon)	**0.02**	0.02	Not given	Insecticide can be applied at 14-21 days interval. However, when pest infestation is high apply every 7 days.
Diazinon	*diazinon*	*Organo-phosphate*	*Contact*	II	aphids, cabbage loopers, scales, leafminer, thrips, webworm, wirehorm, armyworm, cutworm and beetles.	7 days	20-30 ml in 4-8 Litres of water	**0.75**	0.05	0.75	
Malathion	*M alathion*			III	Worms, aphids, whiteflies, scales, leafhoppers, thrips, spider mites etc.	7 days	15-30 ml / 4-8 Litres of water	**8**	*0.02*	0.5	Malathion is registered in Jamaica for use on wide variety of crops including tubers.
Match 050EC	*lufenuron*	Benzoyl-urea 15	Contact	IV	**Beet armyworm**, worms, mites	14	0. 4- 0.6 Liters/ ha				For control of worms, commencement of spraying should coincide with egg hatch and first instars larvae (very young worms) and before damage to the plant
Decis 2.5 EC	*deltamethrin*	*Systemic & contact*	*Synthetic Pyrethroid*	II	Thrips, flies, moths etc.	7-10 days	6ml/4Litres water	**0.1**	0.1	Not given	
Karate Zeon	*Lambda - cyhalothrin*	*Contact & Stomach*		II	Armyworms, cutworms, worms, beetles, stinkbug, mealybugs etc.	**21 days**	8-12ml/15Litres (0.2-0.25pt/45gal)	**0.1**	*0.2*	0.1	
Caratrax 5EC							4.0-6.0 ml/3.8 Litres of water	**0.1**	*0.2*	0.1	
Flash 5 EC				II		14 days	250-350ml/ha in 400-600 Litres of water	**0.1**	*0.2*	0.1	*MRLs for use on dry bulb onion only
Obulus 5 EC	*Lambda - cyhalothrin*	*Contact & Stomach*	*Synthetic Pyrethroid*	II	Thrips *(thrips spp)*	14 days	175-250ml/ha	**0.1**	*0.2*	0.1	*MRLs for use on dry bulb onion only Spray every 3-8 days depending on the insect population and dynamics

Information on the status of pesticide registration in Jamaica can be found on the Pesticide Control Authority website: ***www.caribpesticides.net***

APPENDIX C

- Rotate chemicals with a different mode-of-action and do not use products with the same mode-of-action more than twice to help prevent and/or delay development of resistance.
- When applying insecticides and/or fungicides, use 200-250 Litres **(44.5 – 55.6 Gallons)** of water per hectare, or **17.8 – 22.3 gallons of water per acre**, to ensure good leaf coverage. When using knapsack sprayer use **hollow cone nozzle.**

Hazard Classification (According to the World Health Organization)

CLASS IA: **Extremely hazardous** – RED Colour- This class of pesticides must have the words 'very toxic', on the label.

CLASS IB: **Highly Hazardous.** RED colour - This class of pesticides must have the word 'toxic' on the label.

CLASS II: **Moderately hazardous**. YELLOW colour - The word **'harmful'** must be displayed on the label.

CLASS III: **Slightly hazardous.** BLUE colour - These pesticides must have 'caution' written on the label.

CLASS IV **Caution.** GREEN colour- These pesticides must have caution written on the label

Rural Agricultural Development Authority (RADA)
Technology, Training and Technical Information Division (TTTI),
Hope Gardens. Kingston 6, Jamaica, West Indies
Tel: 876-927-1780-1;
Fax: 876-970-4077
November 2011

APPENDIX D

Pesticide Usage Record Sheet

Farm: **Address:**

Date of applied	Crop	Pest controlled	Acreage	Name of pesticide	Volume of water used per field	How much pesticide used (dose rate)	Pre-harvest interval	Date of next spraying	Name of spray man & Remarks

Rural Agricultural Development Authority (RADA). Technology, Training and Technical Information Division. April 2010.

CONTACTS

For further information please contact,

Ministry of Agriculture and Fisheries,
Research and Development Division,
Plant Protection Unit
Phone: (876) – 983 – 2267 or 983 – 2281;
Fax: (876) – 983 – 2822;
E-mail: ppu@moa.gov.jm

OR
Visit the nearest RADA Office or
Call 1-888- -ASK-RADA (275-7232)

Please view the Beet Armyworm Video online:

Available on YouTube: https://www.youtube.com/watch?v=oTzQpzo4QBo