Fall armyworm Identification, Monitoring, and Management Options for Maize in Kenya
Foreword

This technical brief was reviewed by a group of Fall armyworm experts drawn from the Ministry of Agriculture, Livestock, Fisheries and Irrigation (MoALFI), CAB International (CABI), Kenya Agricultural and Livestock Research Organization (KALRO), Kenya Plant Health Inspectorate Service (KEPHIS), University of Nairobi (UoN), Precision Agriculture for Development (PAD), International Centre of insect Physiology and Ecology (icipe) and the International Maize and Wheat Improvement Centre (CIMMYT). The review write shop was funded and facilitated by CABI in April 2019. The brief contains the latest, agreed advice for Fall armyworm (FAW) management in Kenya and will be used to support the development of a range of information materials and activities for use by extension workers, agro-dealers and farmers. The brief has been reviewed by all parties and is hereby authorized for use on 20th May, 2019.

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INTRODUCTION

Fall Armyworm (FAW) scientifically called Spodoptera frugiperda is an insect pest native to tropical and subtropical regions of the Americas. It was first detected in Central and Western Africa in early 2016 and has now spread across Sub-Saharan Africa. Kenya officially reported the presence of FAW in March 2017. FAW caterpillar is capable of feeding on more than 80 plant species with maize and sorghum being the most preferred hosts. The pest has been confirmed to feed to a lesser extent on sugarcane, rice, millet, cotton, napier grass, capsicum and Rhodes grass (Chloris gayana). The moth can fly up to 100 km per night and the female moth can lay between 1000-2000 eggs in her lifetime.
Fall armyworm: Life cycle and damage to maize

The fall armyworm life cycle includes egg, 6 growth stages of caterpillar development, pupa and moth.

**LARVAL GROWTH STAGES 4-6**
By stage 4 the caterpillar will be bigger and have reached the whorl, where it does the most damage, resulting in ragged holes in the leaves. Feeding on young plants can kill the growing point, resulting in no new leaves or cobs developing.

If the plant is older and has already developed cobs, then the caterpillar will eat its way through the protective leaf bracts into the side of the cob, where it begins to feed on the developing kernels (seeds).

**LARVAL GROWTH STAGES 1-3**
After hatching, the young caterpillars begin feeding, which creates patches on the leaves called ‘windows’. Young caterpillars can spin silken threads that catch the wind and transport the caterpillars to a new plant.

**DAY 1-3**
Batches of 50-200 eggs are laid on the leaves.

*After around 8-9 days the adult moth emerges to restart the cycle.*

The caterpillar will then burrow 2-8 cm into the soil before pupating. The loose silk oval shape cocoon is 2-3 cm in length. If the soil is too hard then the caterpillar will cover itself in leaf debris before pupating.

**DAY 6-14**
After approximately 14 days the fully grown caterpillar will drop to the ground.
FALL ARMYWORM IDENTIFICATION

Fall armyworm has four stages of development, eggs, caterpillar, pupae and adults. Look out for the following identification features

1. Adult females lay 100-200 eggs on the lower leaves. They change from green to light brown before hatching.

2. Eggs are covered in protective scales rubbed off from the moth’s abdomen.

3. After hatching, the young caterpillars begin feeding on the leaves.

4. As they grow, caterpillars change from light green to brown.

5. Fall armyworms have four dark spots forming a square on the second-to-last body segment.

6. Fall armyworms have a dark head with a pale, upside-down Y-shape on the front.

7. They are at their most damaging when they are 3-4 cm long.

8. The pupa is shiny brown and usually found 2-8 cm into the soil.

9. Adult moths (top: female, bottom: male). The females are slightly bigger than the males.

CABI, 2019
INTERGRATED PEST MANAGEMENT OPTIONS FOR FALL ARMYWORM

1. Management During Farm Preparation

Early land preparation to expose the pupa to solar heat

2. Good Agricultural Practices

Effective management of agricultural pests starts with growing healthy crops in healthy soils. Add manure or compost to your fields and/or fertilize your crops to maintain high soil fertility. This will make your crops grow well and make them withstand and recover from FAW damage. Observe field hygiene and destroy old infested crop residues. Practice timely Weeding

3. Planting

a) Timing

- Plant your maize early at the start of the rains. Early planting avoids the peak migration of FAW adult moths to maize fields.
- Use certified maize seed suitable for your agro-ecological zone.
- Avoid late or staggered planting (plots of different ages).
- It is good to plant early but also important to adhere to a regional planting schedule. The table below shows the main maize planting schedule for difference regions in the country:

<table>
<thead>
<tr>
<th>Region</th>
<th>Main maize planting season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nyanza</td>
<td>February</td>
</tr>
<tr>
<td>Western</td>
<td>February</td>
</tr>
<tr>
<td>North Rift</td>
<td>March</td>
</tr>
<tr>
<td>South and Central Rift</td>
<td>March</td>
</tr>
<tr>
<td>Central Kenya</td>
<td>March</td>
</tr>
<tr>
<td>Upper and Lower Eastern Region</td>
<td>October</td>
</tr>
<tr>
<td>Coastal region</td>
<td>March</td>
</tr>
</tbody>
</table>

*Table 1: Maize planting schedule in Kenya*
b) Additional recommended practices during planting

i. Adopt Intercropping

Intercropping maize with legumes like beans, groundnut, pigeon peas and soy beans which can help reduce the spread of the FAW by repelling them. Other crops which can be used for intercropping includes Irish potato, sunflower, shallots, fodder shrubs like caliandra and other non-host species which will help reduce incidence of FAW.

ii. Encourage Natural enemies of the FAW

- Natural enemies of FAW are found in the natural environment and these include birds and insects (parasitoids, predators).
- Conserve natural hedges around the farm to encourage and build up population of certain birds and insects (ants, earwigs, wasps) which eat FAW eggs and caterpillars. Growing a variety of crops in your fields helps increase the number of these natural enemies (farmers’ friends), which will help limit the impact of FAW damage on your maize.
- FAW parasitoids lay their eggs inside the eggs, caterpillar or pupa slowing down the development, maturity or causing the death of the FAW. Winthemia trinitatis and Chelonus insularis are examples of natural enemies found in Kenya that lay eggs in the FAW caterpillar and eggs respectively.

*Cotesia icipe* – The wasp feeds on the FAW caterpillar this helps to reduce population and future generations of FAW in the field.

*Winthemia trinitatis* - The female fly places its eggs in older FAW larvae near the head. Once the fly larvae hatch, the FAW caterpillar becomes swollen and dies. This helps to reduce population and future generations of FAW in the field.

Image source: FAO

Image source: icipe
• **Predators** on the other hand kill and feeds on FAW eggs and caterpillars. Predators may actively hunt for FAW or sit and wait for it. Ants and earwigs are examples of natural enemies found in Kenya that feed on FAW eggs and caterpillar as shown in the images below.

![Ants are a general predator that attacks FAW larvae on the plants. They may be attracted to fields by a fish soup mixture.](image-source: FAO)

![Earwigs can penetrate the hiding places of FAW such as the maize whorl or the ears. They are usually found in many numbers on a plant.](image-source: FAO)

iii. **Use Push-Pull technology**

- Farmers can use the “push-pull” technology for management of FAW. Two companion crops are used in push-pull technology. Silver leaf or Greenleaf desmodium is used to push (repel) FAW away from maize and Brachiaria grass or Napier grass to “pull” (attract) FAW to lay eggs.
- To enhance the effectiveness of push-pull, farmers are advised to plant desmodium and Brachiaria grass before planting maize.
- Brachiaria grass is planted as a border crop along the edges of your farm while desmodium is intercropped with maize. **NOTE** farmers are advised that desmodium if not properly monitored can potentially become a weed that affects maize growth, and should be well managed well.
4. **Management of FAW During Plant Growth**

   a) **Monitoring and scouting**

   It is important to monitor your crop frequently after germination for signs of the FAW because early detection may inform early management, which may help to keep yield losses low unlike when high pest infestations occur.

   - Check your maize at least twice per week after germination until maturity. Checking should be done early in the morning or at sunset because this is when the FAW caterpillars are most active.
   - Walk through your maize farm in an ‘X’ or ‘zig-zag’ direction checking for signs of the pest (eggs and larvae) and the larvae windowing damage.
   - As you walk through the field in the ‘X’ or ‘zig-zag’ direction check 50 maize plants (5 groups of 10 plants) across the field for the signs. Note down how many are affected by FAW.
• If FAW is present then we recommend taking control measures immediately. FAW can cause more damage to crops at the early growth stage, which is why the threshold for the use of chemicals is lower than in older crops.

• If any egg masses are encountered during monitoring, these should be removed and crushed to prevent them from hatching into the damaging stage of larvae. A quick response while the caterpillars are few gives the best results in managing a FAW outbreak. The different measures to be undertaken are outlined in the table below (page 9).

b) Community scouting and response

• Community action (an area-wide approach) is required for effective control of FAW. Scouting collectively together and applying control measures for FAW as a community is better than individual farmer interventions. Inform your local extension service provider and local administration if you find FAW on your farm.

c) Pheromone traps

• Pheromone traps can complement field scouting to check for presence of FAW especially on large farms where manual scouting may be difficult. Up to four (4) pheromone traps can be used per acre. If you notice FAW moths in the trap, check your crop thoroughly to determine the presence of FAW and take necessary control measures accordingly.

d) Decision making based on scouting records

• After monitoring your crop, record the number of plants that have FAW or show signs of FAW damage. The table below can help you decide on the most appropriate option to use based on extent of infestation.

<table>
<thead>
<tr>
<th>Extent of infestation</th>
<th>growth Stage of plants</th>
<th>Control measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 or less plants infested with eggs, have caterpillars or show signs of damage (out of 50)</td>
<td>Early growth (1-1.5 feet)</td>
<td>Handpick and crush eggs and caterpillars</td>
</tr>
<tr>
<td>10 or more plants infested with eggs, have caterpillars or show signs of damage (out of 50)</td>
<td>Early growth (1-1.5 feet)</td>
<td>Handpick and crush eggs and caterpillars, and apply approved biopesticides or insecticides.</td>
</tr>
<tr>
<td>19 or less plants infested with eggs, have caterpillars or show signs of damage (out of 50)</td>
<td>Late growth (1.5 feet and above)</td>
<td>Handpick and crush eggs and caterpillars</td>
</tr>
</tbody>
</table>
5. **Non-chemical control options**

   a) **Mechanical control**

   - Crush all egg masses and caterpillars you find. Killing one caterpillar potentially prevents more than 1000 caterpillars that would form within a one-month period.
   - Hand pick and crush or drown all caterpillars in soapy water derived from bar soap.
   - Hand pick caterpillars and feed them to chicken.

   b) **Indigenous management options**

   **NOTE** These options have not been scientifically verified for their efficacy, but are being used by farmers.

   - Application of Crushed or ground chilies mixed with wood ash or soil into the maize funnel may help reduce FAW populations, and soil in.
   - Application or spraying solution made from crushed neem leaves/seeds, garlic and other botanical plants when mixed with soapy water derived from bar soap (with potassium hydroxide) to maize plant may also help reduce FAW populations.
   - Pouring fish soup or smearing cooking fat randomly on selected maize plants in a farm helps to attract ants which feed on the FAW caterpillars.

6. **Chemical control options**

   a) **Registered Products**

   At present, the following five products have complied with the registration process as set by the regulatory law of the Government of Kenya. Farmers are encouraged to use these products and observe the dose rate. Although there are other several products available in Kenya with the same active ingredient, the public should note efficacy trials have not been conducted to establish their application rates under Kenyan conditions.
Table 3: Registered pesticide Active Ingredients against FAW

<table>
<thead>
<tr>
<th>Pesticide(s)</th>
<th>Active Ingredient (AI)</th>
<th>Spraying rate</th>
<th>WHO classification</th>
<th>Mode of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lotus 75% SP</td>
<td>Acephate</td>
<td>20ml in 20l of water</td>
<td>III</td>
<td>contact / systemic</td>
</tr>
<tr>
<td>Radiant 120 SC</td>
<td>Spinetoram</td>
<td>20ml in 20l of water</td>
<td>U</td>
<td>contact</td>
</tr>
<tr>
<td>Ampligo 150 ZC</td>
<td>Lambda-cyhalothrin &amp; Chlorantraniliprole</td>
<td>10ml in 20l of water</td>
<td>II</td>
<td>contact / systemic</td>
</tr>
<tr>
<td>Escort 19 EC</td>
<td>Emamectin benzoate</td>
<td>8ml in 20l of water</td>
<td>Not Listed</td>
<td>contact</td>
</tr>
<tr>
<td>Belt 480 C</td>
<td>Flubendiamide</td>
<td>10ml in 20l of water</td>
<td>III</td>
<td>systemic - broad spectrum</td>
</tr>
</tbody>
</table>

b) Guidelines for spraying chemicals on fall armyworm

1. Timely application of pesticides (when caterpillars are small) is very important in controlling FAW.
2. Apply pesticides very early in the morning or late in the evening to maximize their effectiveness.
3. When applying pesticides use a sprayer if possible and target the maize funnel.
4. Chemicals take time to work on the FAW caterpillars, do not expect instant results. Be patient and check for fresh signs of FAW infestation after 2 weeks before deciding on the need to spray again.
5. It may take up to three sprays to control the FAW on your crop to a level where the infestation is manageable and not too damaging for your crop.
6. Don’t use the same chemicals to manage FAW on your crop within one season. Instead alternate different active ingredients to avoid FAW pesticides resistance. Ask your extension service provider for advice on active ingredients.

c) Other good practices when using pesticides

- Do not exceed the dose rate indicated on pesticide label. Read instructions on the label.
- It is more economical, more effective and safer to apply chemicals using a knapsack sprayer. Ensure you use proper personal protective equipment.
- Keep farm records like records of maize varieties planted, the pesticides used, when they were applied, and the dosage used.
- Pesticides stay on crops for some time, make sure you wait for the advised re-entry period (check the product label)
• Only use recommended/registered chemicals from authorized agro-dealers. When unsure check with your local agricultural extension service provider.

• Buy chemicals from registered Agro-dealers. Check the expiry date.

• Do not use paraffin, tobacco, battery acid or detergents to control FAW. This will harm your crops and poses a health risk to humans and livestock.

• Do not mix different insecticides. Instead of making the product more effective against FAW, the mixture may harm your crops. This practice may also lead to rapid build-up of FAW resistance against available pesticide products. This practice is also dangerous to your health and environment.

• More general advice on safe use of pesticides can be found on the product label and also at the end of this document

• Effective control of FAW requires an area wide approach. Where appropriate all farmers within an area should collectively work together to control FAW in all their farms. When using a knapsack sprayer, use the correct nozzle to ensure effective delivery. Refer to your local extension service provider for advice

NOTE: Farmers are encouraged to seek support of trained spray service providers when applying pesticides to their crops.

7. Messages to address fall armyworm myths

The following messages are aimed at addressing common myths about FAW: -

• Fall Armyworm does not come with seeds or fertilizer. FAW is not normally transmitted or transported through seed or fertilizers, but through the movement of moths, which lay eggs in new areas.

• Fall Armyworm caterpillars are not poisonous to humans or animals when they are handpicked or when infested maize is harvested. You can feed FAW infested maize stover to animals after drying the materials appropriately. However, do not feed livestock with crop materials that have been sprayed with pesticides.

• Fall Armyworm do not cause yellowing of the maize leaves. If you notice leaf discoloration, it may be due to disease or a nutrient deficiency. Spraying with a wrong dosage or with a pesticide that is not recommended might also cause phytotoxicity to the crop

• Heavy rainfall can help wash FAW caterpillars away but this will not necessarily control the infestation and doesn’t eliminate the need for management. When you don’t get an infestation of FAW, it does not mean the pest has gone away. When conditions become conducive, the pest will resurge. Therefore, always do scouting to confirm the presence of FAW.

• Rouging, uprooting or burning FAW affected plants is not an effective way of controlling this pest.
• Chemical control should be the last resort. Pesticides will not provide a “silver bullet” to controlling FAW. This pest is best managed by deploying varied and timely integrated pest management options.

8. General messages

• Crop pests and diseases when not properly managed will cause huge crop losses. Farmers are advised to save and set aside some funds for use in undertaking FAW control operations to minimize crop damage from this pest.
• If you practice early monitoring and apply appropriate control measures, the damage due to FAW can be minimized. Seek professional advice and do not panic.

9. Additional Notes on Responsible Use of Pesticides

<table>
<thead>
<tr>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals are poisonous. If you accidentally consume any, call toll free line 0800720021 for help</td>
</tr>
<tr>
<td>If you feel unwell during spraying - (nausea, headache, weakness), you should stop the application immediately and seek medical advice.</td>
</tr>
<tr>
<td>Put on the appropriate protective clothing (head gear (cap etc), goggles, mask, gloves, overall and boots) at all steps when handling, mixing and applying pesticides; always follow the instruction on the label</td>
</tr>
<tr>
<td>Use clean, well calibrated pumps (in good condition) and clean water for mixing the pesticides</td>
</tr>
<tr>
<td>Strictly use knapsacks and not basins/buckets for mixing &amp; application of Pesticides</td>
</tr>
<tr>
<td>Use the correct quantity/dose during mixing (always follow the instructions on the label)</td>
</tr>
<tr>
<td>Open pesticide containers with extreme care to avoid spillage</td>
</tr>
<tr>
<td>Always mix pesticides in an open place to avoid accumulation of pesticide fumes</td>
</tr>
<tr>
<td>Have plenty of clean water and soap at the application site for emergency cleaning</td>
</tr>
<tr>
<td>Mix pesticides using a long stick or stirrer and not bare hands</td>
</tr>
<tr>
<td>Don’t spray during windy conditions or possibly when it’s about to rain</td>
</tr>
<tr>
<td>Never eat, smoke, drink or breast feed during application</td>
</tr>
<tr>
<td>Elderly persons, children and the sick should never apply pesticides</td>
</tr>
<tr>
<td>Don’t use your phone while spraying to avoid contamination</td>
</tr>
</tbody>
</table>
Don't apply pesticides close to, during or after harvesting. Always check the pre-harvest interval (PHI)

Do not apply pesticides with long Pre-harvest interval when maize plants are at cobs stage because poisonous residues will be left on the grains

When taking off the protective gear, gloves should be removed last and after rinsing them

If you have an open wound – do not spray unless you have protectively dressed the wound

Mix only the required amount of chemicals to be used

Don't leave empty pesticide containers in the field to avoid contamination of the environment

Do not burn empty pesticide containers or throw them into pit latrines as they produce poisonous gas harmful to humans and environment

Do not rinse empty pesticide containers near a water source or throw them into water bodies to avoid contaminating the water source. The empty pesticide container should be rinsed three times, punctured, crushed and flattened or returned to the agro-input dealers for onward disposal/incineration.

Don't reuse your empty pesticide containers

References


