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Observational Study on Infestation and Management of Fall Armyworm *Spodoptera frugiperda* (Lepidoptera: Noctuidae) at Jimma, Ethiopia

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Abstract: *Spodoptera frugiperda* is an invasive and a destructive insect pest of maize and other cereals in Ethiopia. Fall armyworm infestation and different management options were assessed at Jimma agricultural research field stations. Preliminary findings show that percentage of fall armyworm infestation ranged from 3.57% to 100% with average infestation of 54.73% in main growing season. Severe infestation due to fall armyworm is expected to decrease yield. To reduce its infestation, massive larvae collection, phermonal control and insecticides were used. Within a month a total of 601 fall armyworm moths were captured by a single sex pheromone trap. Per week 77 to 211 *Spodoptera frugiperda* was captured. In addition, handpicking is the most effective cultural practice for fall armyworm management. During assessment, earwig predator was abundantly found both during wet and dry season that could play a role in reducing the fall armyworm population as biological control agent. This study highlights the importance of using phermonal control, hand picking, early planting and biological agent can manage fall armyworm, and used as component of integrated pest management. Further studies are recommended to strengthen more the findings of the current study especially on the massive rearing of indigenous natural enemies and yield loss due to fall armyworm.

Keywords: Biological Control, Hand Picking, Infestation, Predator

1. Introduction

Maize is the most widely cultivated crop in Ethiopia. Thus, in the Jimma area, maize ranks first in production and productivity since the release of these hybrid varieties [1]. The crop is prone to a number of diseases and insect pests'. The main challenging pests of maize production currently in Ethiopia due to disease especially maize lethal necrotic disease and newly emerging insect pest fall armyworm *Spodoptera frugiperda.*

In Africa, fall armyworm was first reported in 2016 [2-4], and in Ethiopia it was reported in 2017 in southwestern part of the country by Mizan-Tepi plant health clinic. FAW is a highly polyphagous insect pest that attacks more than 80 plant species [5] and maize is the main crop affected by FAW in Africa and also in Jimma areas. In infected maize plants, the larvae of FAW can be observed on the different maize growth stages (i.e., from seedling up to cob stage), and its infestation depending on the growth stages of the plant [2]. When there is 25-50% damage of leaf, silk and tassel results in 58% of yield reduction [6], but crop infestation due to the pest depends on the number of pest, time of infestation, natural enemies of the pest available at that time and health status of the plant [7]. The larger larvae in the whorls can feed on maize cob or kernels, reducing yield and quality [3, 8]. At Jimma (southwestern Ethiopia), 4.35% to 100% crop loss had been observed on rain fed maze trials planted in 2017 due to fall armyworm [9].

Moreover, in a push to increase yield by controlling the insect pest, farmers have applied various cultural management options such as hand picking to reduce the pest infestation. In addition botanicals are important qualities of pest control products for smallholder farmers in Africa including fall armyworm [10], and chemical control are the most powerful tools and an important component of fall armyworm management practices. However, effective management of fall armyworm is mandatory to reduce the loss caused by insect. Therefore, the objective of this study

was to assess the fall armyworm infestation on maize and its management options carried out in the areas. For this, we conducted a field assessment on maize trials (cereal breeding, agronomy, natural resource management (acidity and fertility) and irrigation and water harvesting- maize based research activities), and management methods used to tackle this pest below economic threshold level.

2. Materials and Method

2.1. Study Area

The assessment was done at Jimma Agricultural Research Center (JARC) (7°40'37"N and 36°49' 47"E, at 1753 altitude) in southwestern Ethiopia. JARC is found in Jimma zone, in Oromiya regional state, about 360 km southwest of Addis Ababa. The area receives mean annual rainfall of 1531 mm, with the main rainy season between June and September. Mean daily minimum and maximum temperatures are 11.5°C and 26.2°C, respectively [11].

2.2. Fall Armyworm Infestation Assessment and Its Management

The infestation of fall armyworm was assessed on various maize trials at Jimma agricultural research experimental stations. A total of ten maize farms (experimental plots) were assessed. Within each maize plots five stops were used and 18 maize plants were selected for fall armyworm infestation assessment. The percent infestation was determined as proportion of infested maize to total number of maize plant counted per plot.

2.3. Pheromone Trap

Only one sex pheromone trap was placed inside the maize field at Jimma agricultural research compound for fall armyworm moth detection and control (Figure 1). The source of pheromone trap was obtained from Bako national maize coordinating research center. The trap was hanged from a suspended stick about 1.4 m above the ground (Figure 1). The fall armyworm monitoring kit also contained nylon cloths moisten with diazinon insecticide which immobilized the moths once attracted to the device. The pheromone lure was replaced after 15 days as the trap was hanged for detection for a month. The trap was checked daily (June 20 - July 19, 2017), and trapped moths were then sorted to identify fall armyworm in JARC entomology laboratory.

Figure 1. *The fall armyworm monitoring kit hanged in maize plot and captured adult moths.*

In addition to pheromone trap, massive larvae collection was done on different maize growth stages i.e. from seedling up to tasseling stage on some maize experimental plots.

3. Results and Discussion

3.1. Fall Armyworm Infestation

Assessments done on different maize experimental plots (cereal breeding, agronomy, soil acidity, soil fertility and irrigation agronomy) indicated the percentage of fall armyworm ranged from 3.57% to 100% with average infestation of 54.73%, in 2017 growing season. In 2019/20 on late grown maize up to 100 percent crop loss was observed. Similarly, on irrigated maize trial up to 100% crop damage was recorded at same area in 2021 (Figure 1a). Severe infestation due to fall armyworm is expected to decrease yield. In addition to maize crop fall armyworm *S. frugiperda* infesting sorghum crop in the area (Figure 2b), for this same management option should be implemented as that of maize.

Figure 2. *Damaged maize (A) and infested sorghum (B) by fall armyworm. JARC, 2021.*

3.2. Phermonal Control

Six hundred one (601) total number of fall armyworm adult moths was captured within a month (Figure 3). The minimum and maximum number of fall armyworm moths trapped was 3 and 62 per night, respectively. Per week 77 to 211 fall armyworm *S. frugiperda* was captured at Jimma agricultural research center maize experimental plots (Figure 3). As the male fall armyworm moths captured massively the fall armyworm second generation and life stage can be reduced.

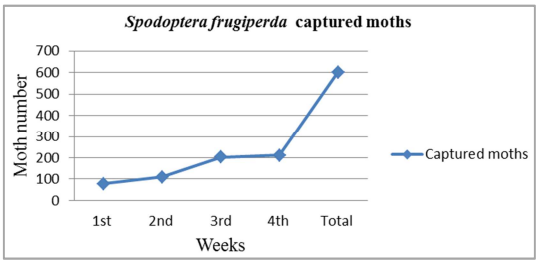

Figure 3. *Fall armyworm moths captured by sex pheromone trap at Jimma (Melko, 2017).*

3.3. Handpicking of Fall Armyworm Larvae

Handpicking is the most effective cultural practice for fall armyworm larvae reduction (Figure 4). The hand picking efficiency for the control of fall armyworm are based up on the crop growth stage i.e. easy to pick the larvae during

early-whorl, mid-whorl and late whorl stage than tasseling and silking stage. Another method used was to adjust time of planting, late planted maize was highly infested than early planted maize in the areas. Besides, effective filed inspection of the fall armyworm damage symptom and sign (egg and larvae) on different maize growth stages are important to determine the need, time and type of control measures used.

Figure 4. *Hand picking of fall armyworm larvae.*

3.4. Biological Control of Fall Armyworm

Different natural enemies were reported as parasitoids and predator of fall armyworm in different countries. Among the natural enemies, earwig (regardless of species name) predator was abundantly found on assessed experimental maize trials at Jimma (Figure 5). From the assessment, we observed that earwig predator was found both during main growing season and on irrigated maize fields, and can be reduced the population of fall armyworm (observed during preying egg masses in maize field at Melko-but need further investigation and identification). For example, in Argentina, the earwig *Doru lineare* has been observed preying on *S. frugiperda* egg masses in corn crops [12]. Similarly in Central America, *Doru taeniatum* has been reported as an effective predator of *S. frugiperda* [13, 14]. Conserving fall armyworm natural enemies like earwig (Figure 5) and other associated parasitoids is very important. In addition to reduce the pesticide resistance due to frequent application of insecticide, biological control is very crucial. As, an example fall armyworm has developed resistance to several synthetic insecticides [3, 15]. Therefore, it is essential to conserve the already available natural enemies through plant diversification that may allow for the sustainable maize production in the country.

Figure 5. *A) Earwig at field and B) in laboratory. JARC, 2021 (Photo credits Tamiru S.).*

4. Conclusion and Recommendation

Severe infestation due to fall armyworm is expected to decrease yield. This study highlights the importance of using phermonal control, hand picking, early planting and biological control agent can manage fall armyworm, and used as component of integrated pest management. Future emphasis should be given due concern for the development of appropriate fall armyworm insect pest management through conservation and mass rearing of indigenous natural enemies.

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