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Damage Evaluation Of Two Major Pests Of Maize (Zea Mays) At The Ferkéssédougou Research Station, Côte d'Ivoire.

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Abstract
Spodoptera frugiperda and Eldana saccharina are two pests that attack maize. The larvae of these two insects cause considerable damage to this crop in Côte d'Ivoire. To establish an alternative control method, this study aims to assess the damage to evaluate the loss rates in future studies. To conduct this study, weekly observations were made on a sample of 40 plants selected according to a W-shaped layout, and the infestation rate was then determined. Observation of the damage to maize showed that S. frugiperda and E. saccharina attack all parts of the plant above the soil. Their effects can destroy an entire crop if no treatment is applied. The study also showed that the blocks surrounded by the host plants of these insects were the most severely affected.
Keywords : *Insects , Maize, Daloa, Pests*

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I. Introduction

Maize (*Zea mays*, L.) belongs to the grass family, like rice, millet and sorghum. This plant is one of the world's main cereal crops, forming the pillar of global food security (Faostat, 2020). It is cultivated for its grains or silage. Its annual global production is estimated at 1,162,352,997 tonnes. In Côte d'Ivoire, maize is cropped in various agro-ecological zones, either alone or in association with most other crops, on an area of 558,406 ha, with an estimated average annual production of 1,175,715 tonnes (Faostat, 2020). It is the most important cereal crop after rice and is the basic foodstuff for many Ivorian families. Maize is also used in animal feed (poultry, pigs and cattle) and as a raw material in certain industries (brewing, soap and oil production) (Yapi *et al*., 2017).

Several biotic factors contribute to substantial losses in maize production, both during the growing season and post-harvest. The primary pests include insects, rodents, granivorous birds, and pathogens, mainly fungi, viruses, and weeds. Among these, insects are responsible for most of the damage, particularly the Fall Armyworm (*Spodoptera frugiperda*) and the Stem Borer (*Eldana saccharina*). These highly phytophagous species feed on over 80 host plants, with a marked preference for young maize. Severe infestations at early growth stages can result in yield losses of up to 100% (Fontaine *et al*., 2018 ; Sikirou *et al*., 2020). This study aims to characterize the damage caused by these two major pests, identify the most vulnerable phenological stages, and assess their impact on maize productivity.

II. Materials And Methods

Study Site Description

The research was conducted at the CNRA Research Station in Ferkessédougou, the administrative capital of the Tchologo Region in northern Côte d'Ivoire. Geographically, the city is located approximately 650 km from Abidjan and 360 km from Yamoussoukro, at coordinates 9°32′ N latitude and 6°29′ W longitude. The natural vegetation is characterized by wooded savannah. The climate is typically hot and dry during December and January, followed by a long dry season that precedes the rainy season. Rainfall is bimodal, with two distinct peaks occurring in June and September. The soils are predominantly ferralitic, featuring a shallow arable layer (40 to 60 cm) constrained by hardened subsoil layers (RGPH, 2014) (Figure 1).

Figure 1 : CNRA-Ferkessédougou study site

III. Material

Plant Material

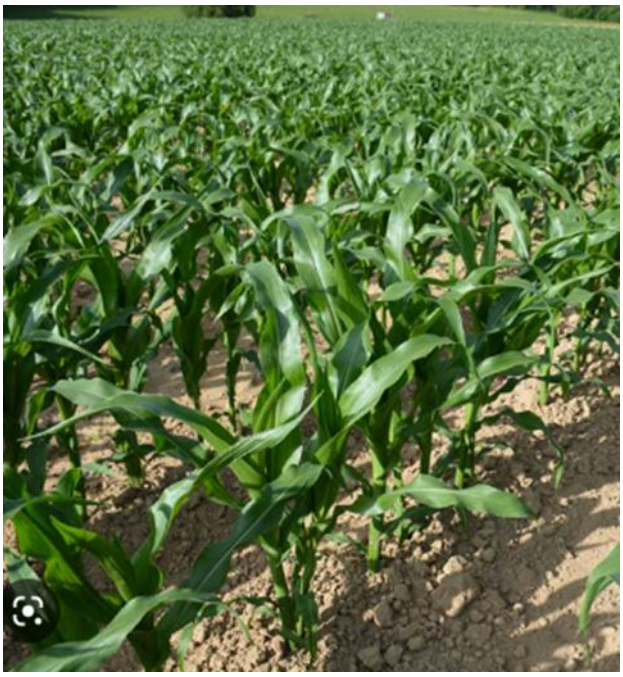

FIG 2

The plant material used in this study consists of a maize variety sourced from the National Agronomic Research Centre (CNRA), specifically from the Ferkessédougou research station (Figure 2).

Animal Material

The animal material used in this study consisted of larvae of Spodoptera frugiperda (Fall Armyworm) and Eldana saccharina (Stem Borer), collected directly from maize plants at various phenological stages. (Figures 3 & 4)

Figure 3 : Larva of *S. frugiperda*

Figure 4 : Larva of *E. saccharina*

Technical material

The technical equipment used consisted of plot maintenance tools, plot demarcation tools, field data collection instruments, and observation equipment (Figure 5).

Figure 5 : hand lens

IV. Method

Method for Collecting Fall Armyworm (*Spodoptera frugiperda*) Abundance

S. frugiperda were collected and counted weekly across the experimental plots. Observations were conducted weekly on a sample of 40 maize plants selected using a W-shaped sampling layout. Caterpillars were collected from plant organs (leaves, whorl, and ears) according to the phenological stages of maize.

Damage data were also collected weekly on a sample of 40 plants, following the phenological stages listed below:

- Stage 1: 2-3 leaves (approximately 15 cm in height)
- Stage 2: 6-8 leaves (70-90 cm in height)
- Stage 3: Flowering-silking
- Stage 4: Mature grain ears

For the first two stages (vegetative phase), the Guthrie et al. (1960) scale was used. This nine-class rating scale assesses insect damage on leaves during plant development. Damage classes are interpreted as follows:

- Classes 1-3: Low damage → plant considered resistant
- Classes 4-6: Moderate damage → plant considered moderately resistant
- Classes 7-9: Severe damage → plant considered highly susceptible

Classification into resistant, intermediate, or susceptible categories depends on the size and shape of leaf lesions. A general description of the damage classes is provided below:

- Class 1: No visible damage or very small holes on a few leaves
- Class 2: Small puncture holes resembling lesions on a few leaves
- Class 3: Regularly spaced holes on several leaves
- Class 4: Several leaves with small holes and long lesions
- Class 5: Several leaves with long lesions
- Class 6: Several leaves with long lesions approximately 2.5 cm
- Class 7: Long lesions regularly present on approximately half of the leaves
- Class 8: Long lesions regularly present on approximately two-thirds of the leaves
- Class 9: Most leaves show long lesions, for the last two stages (reproduction, grain development and maturation), the whorl of young panicles, panicles and developing grains are examined.

The infestation rate of maize plants, leaves, panicles, and/or ears was calculated using the following formula :

$$Infestation\ rate\ per\ organ = \left(\frac{Number\ of\ organs\ attacked}{Total\ number\ of\ organs}\right) * 100$$

Method for Collecting Stem Borer (*Eldana saccharina)*

Damage caused by the stem borer was observed and recorded weekly on maize stems during the maturation stage. Observations were conducted on a sample of 40 plants selected using a W-shaped sampling layout.

The infestation rate of maize stems attacked by *Eldana saccharina* was calculated using the following formula :

$$Infestation\ rate\ (\%) = \left(\frac{Number\ of\ stems\ attacked}{Total\ number\ of\ stems}\right) * 100$$

The data obtained were analysed using R Studio software (version 4.1.1). The Newman-Keuls test was applied to rank the means in cases of equal variance, allowing the identification of statistically homogeneous groups at a 5% significance level. Graphical representations were produced using Microsoft Excel.

V. Results

Study of the damage caused by a few maize pest

Autumn Armyworm Caterpillar

The results indicate that the Fall Armyworm (*Spodoptera frugiperda*) was more abundant in Block A3 (0.64 ± 0.48) compared to Block A2 (0.32 ± 0.62) and Block A1 (0.02 ± 0.15), as illustrated in Figure 6

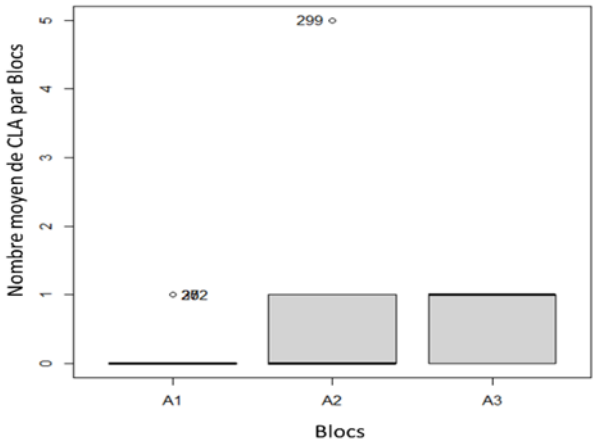

Figure 6 : Average Number of Fall Armyworm Caterpillars per Block

Abundance of Caterpillar Attacks According to Blocks

The initial attack rate across all blocks was very low. However, Blocks 2 and 3 experienced a marked increase in caterpillar attacks, reaching peak values of 60 and 80, respectively, during the third harvest, before dropping to zero by the fifth. In contrast, Block 1 showed a slight increase in attack rate from the second day onward, followed by a sharp decline to zero at the third harvest (Figure 7).

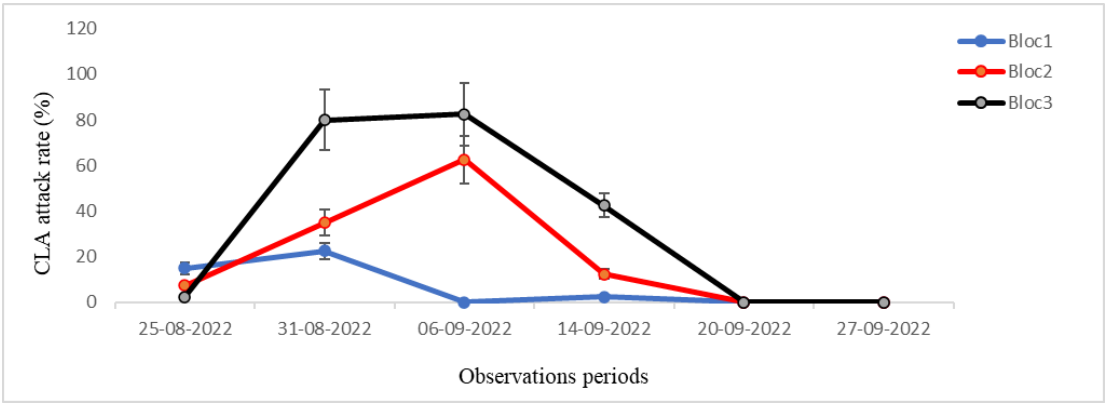

Figure 7: Abundance of caterpillar attacks by block

Severity of Caterpillar Attacks According to Blocks

The results indicate that the average severity rate of caterpillar attacks is higher in Block 3 and Block 1 than in Block 2. Notably, Block 1 shows a high severity of weak attacks compared to Blocks 2 and 3. In contrast, the severity of strong attacks is most pronounced in Block 2, followed by Block 3. Block 1, however, recorded a very low severity of strong attacks by the Fall Armyworm (*Spodoptera frugiperda*) (Figure 8).

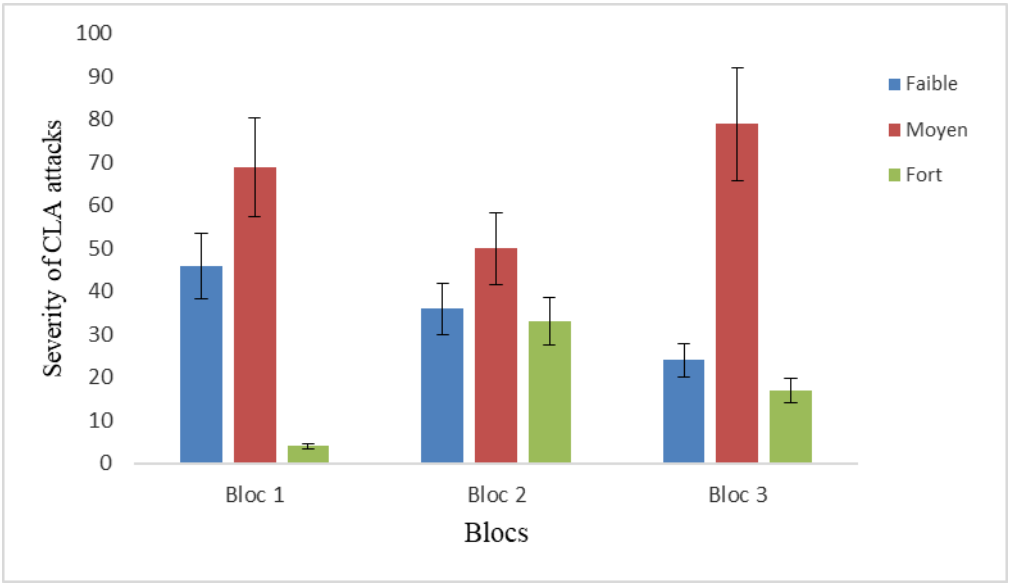

Figure 8 Severity of attacks by the autumn armyworm

Foreur de Tige

Nombre Moyen de Tiges Attaquées

The results show that the number of maize stems attacked by the stem borer (*Eldana saccharina*) is significantly higher in Block 3 (1.451613 ± 0.765692) compared to Block 1 (0.419355 ± 0.068887) and Block 2 (0.068887 ± 0.113287), as illustrated in Figure 9.

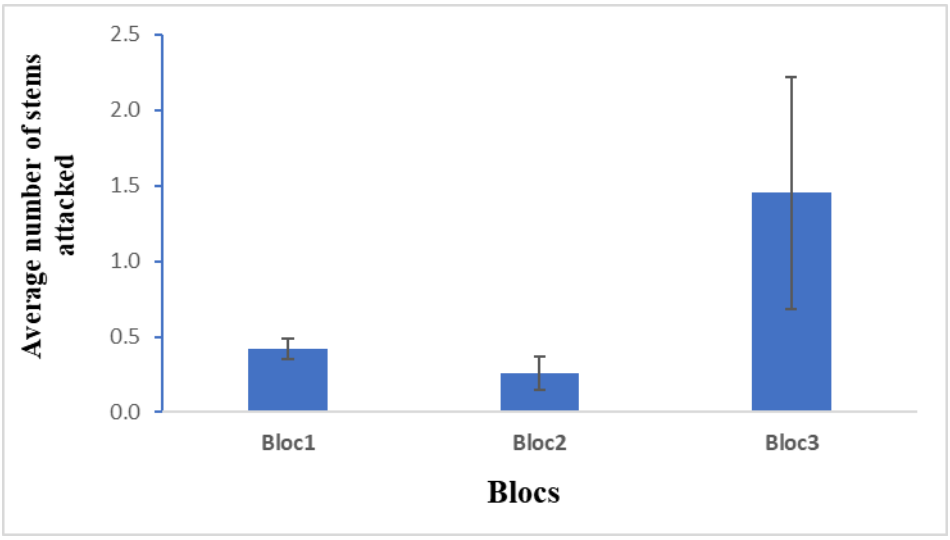

Figure 9 : Average number of stems attacked

Average Rate of Internodes Attacked

The results reveal that maize stems with 9, 11, 12, 13, and 15 internodes are more severely attacked by stem borers compared to those with 10, 14, and 16 internodes, as illustrated in Figure 10.

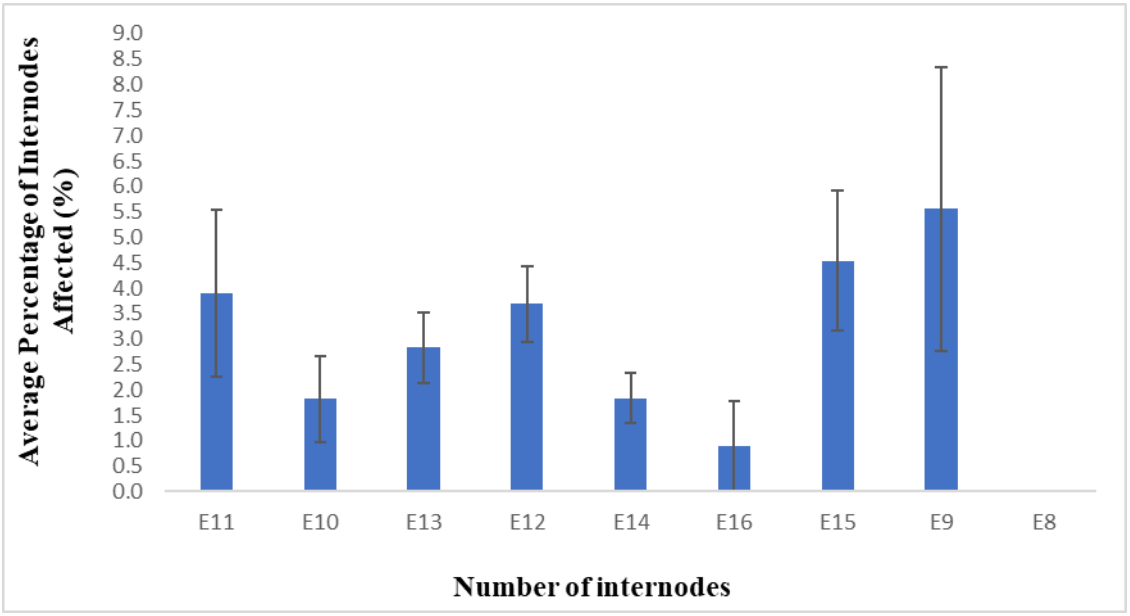

Figure 10 : Average Rate of Internodes Attacked

VI. Discussion

Significant infestations of fall armyworms (*Spodoptera frugiperda*) have been recorded in maize fields, primarily due to the overlap between the maize growing season and the rainy season a period highly conducive to armyworm proliferation, especially during the vegetative stage. This pest remains active throughout the entire maize development cycle, posing a persistent threat to crop productivity. The larvae exhibit destructive feeding behavior: they gnaw on leaves and bind leaf edges with silk threads to create a protective gutter in which they lodge. In severe cases, they can sever young seedlings, compromising early stand establishment. Field observations confirm that *S. frugiperda* attacks all aerial parts of the maize plant, from leaves to panicles and ears. These findings corroborate those of Sikirou *et al*. (2020), who documented continuous pest pressure throughout the vegetative phase of maize. Their study noted that young caterpillars tend to cluster and feed on leaf surfaces, causing superficial perforations. As they mature, the caterpillars penetrate the whorl, consume emerging leaves, and contaminate the plant with frass. They also damage the developing panicle and eventually migrate to the ears, rendering them unsuitable for fresh consumption and significantly reducing marketable yield. This pattern of damage highlights the need for early detection and integrated pest management strategies, particularly during the

critical vegetative window when maize is most vulnerable. The fall armyworm (*Spodoptera frugiperda*) and the stalk borer (*Eldana saccharina*) pose a severe threat to maize production, with infestations capable of causing up to 100% yield loss. These pests are particularly prevalent during the rainy season, which coincides with the maize vegetative stage, a period of high vulnerability. Field observations confirm that *S. frugiperda* damages all aerial parts of the maize plant. The larvae feed on leaves, bind leaf edges with silk to form protective shelters, and may sever young seedlings. As they mature, caterpillars penetrate the whorl, consume emerging leaves, and contaminate the plant with frass. They also attack the developing panicle and migrate to the ears, rendering them unsuitable for the fresh produce market. These findings are consistent with those of N'Goran (2022), who noted that egg-laying occurs under favorable conditions, moderate rainfall and low temperatures. The most severe damage begins at the second larval stage, when older caterpillars burrow into the cob (heart) and destroy internal leaves. The presence of these pests is often indicated by frass deposits on the upper leaf surfaces. Our results also align with Azonkpin *et al*. (2019), who reported that maize is highly susceptible to *S. frugiperda* attacks during the "6-8 leaf" stage (0-40 days after sowing). This confirms that the vegetative phase is a critical window of vulnerability requiring targeted monitoring and control strategies. The high infestation levels observed in Blocks A2 and A3 may be attributed to the presence of multiple host plants surrounding these plots, unlike Block A1, which is relatively isolated. The elevated abundance of stem borers (*Eldana saccharina*) in maize fields appears to be closely linked to the ripening stage of the crop. During this phase, maize plants begin to dry out and accumulate carbohydrate reserves, creating favorable conditions for larval development. This increased presence of stem borers is also commonly observed at the end of the rainy season, when food sources become scarce. In response, caterpillars burrow into maize stems to survive the dry season. Our findings corroborate those of Mauchamp (1988) and Bensouiki & Soudani (2019), who reported that larvae enter diapause at the end of the growing season. The insect overwinters within the stem as diapausing larvae, ensuring its persistence until the next cycle. The particularly high abundance of stem borers in Block 3 compared to other blocks is further explained by the proximity of host plants, which serve as reservoirs and facilitate pest migration and establishment.

VII. Conclusion

Studies on the damage caused by *Spodoptera frugiperda* (fall armyworm) and *Eldana saccharina* (stalk borer) in maize production have demonstrated that these two pests are extremely voracious. Their caterpillars feed on leaves, stems, and ears, leading to severe defoliation and ear damage. Yield losses can be substantial, particularly when infestations occur during critical growth stages such as the vegetative and reproductive phases. To effectively manage these pests, an integrated pest management (IPM) approach is recommended. This includes regular field monitoring to detect early signs of infestation, pheromone traps for population tracking and early warning, use of resistant maize varieties adapted to local conditions, balanced fertilisation to strengthen plant resilience, targeted insecticide application only as a last resort, using approved products, it is essential to rotate active ingredients to prevent the development of resistance and ensure long-term efficacy of control measures.

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