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Fluctuation of larvea population of shoot and fruit borer, *Leucinodes orbonalis* Guenée, in brinjal cultivation

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Abstract
African brinjal (*Solanum aethiopicum*), that is one of the vegetable crops grown in Côte d'Ivoire, is severely affected by the shoot and fruit borer *Leucinodes orbonalis.* This study was conducted to determine the fluctuation of larvea population of *L. orbonalis* in brinjal cultivation. An experimental field comprising four sub-plots was established. It contained 192 plants, with 48 plants per sub-plot. Sampling involved searching for and counting larvae on 20 central plants in each sub-plot, within the shoots and fruits. The average number of larvae increased gradually from 0.52 ± 0.11 larvae per plant to 12.6 ± 1.86 larvae per plant, then decreased gradually to reach 2.13 ± 0.8 larvae per plant by the end of the fruits harvest. Average number of larvae was significantly positively correlated with the average temperature and negatively correlated with relative humidity.

Keywords: *Leucinodes orbonalis*, larvea population, brinjal, borer, fluctuation.

Introduction
African brinjal (*Solanum aethiopicum*) is one of the most widely grown fruit vegetables in Côte d'Ivoire (MINAGRI, 2014) [15]. Production in Côte d'Ivoire in 2010, 2020 and 2021 was 83,983, 109,052 and 107,512 tons respectively (FAO 2022). It ranks third in terms of consumption volume after tomatoes and okra (Lester and Seck, 2004) [12]. Brinjal have significant nutritional value as they are rich in iron, calcium, phosphorus, potassium and B vitamins (Fategbe *et al.*, 2013; Scorsatto *et al.*, 2017) [8,18]. Brinjal form the basis of many dishes in Côte d'Ivoire and are among the crops essential for food security (Lester *et al.*,1986; Daunya *et al.*,1997; N'Tamon, 2007) [11,4,16]. Several insect pests attack brinjal crops. Among these pests, brinjal of shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenée (Lepidoptera: Crambidae), causes significant damage that severely affects the plant (Mazumder and Khalequzzaman, 2010; Kaur *et al.*, 2014; Obodji *et al.*, 2016) [14,10,17]. In order to control this pest effectively, it is urgent to study fluctuations its population within brinjal crops to determine periods of high abundance and to implement appropriate control measures.

Materials and methods
The study was conducted in Azaguié Ahoua, located in the south of Côte d'Ivoire. The biological material consisted of african brinjal plants of the species *Solanum aethiopicum*, of the Kotobi variety, and the animal material was comprising larvae of *L. orbonalis*.
The experimental field consisted of four plots. The plots were spaced 2.5 metres apart. Each plot contained 48 plants arranged in four rows, with 12 plants per row. The total number of plants in the experimental field was 192. No insecticide treatment was applied to the plants in the experimental field.
Observations for the search for larvae on brinjal plants were carried out regularly, at weekly intervals, from 25 days after transplanting (DAT) the plants until the end of the fruits harvest.
Larvae were searched for on 20 central plants selected from each plot. Before the fruiting stage, the plants were carefully examined to search for and count larvae in the shoots. During the fruiting stage, larvae were searched and counted in both the shoots and fruits. The fruits were harvested and cut open with a knife and larvae present inside the fruits were counted. The average number of larvae per plant was calculated and correlated with certain abiotic factors that are average temperature, relative humidity and rainfall.
All recorded data were subjected to Analysis of Variance using Statistica version 7.1 software. Multiple comparisons of means were performed using Fisher's LSD tests. The Pearson correlation test was used to demonstrate the relationship between average numbers of larvae and abiotic factors.

Results and discussion
Evolution of number of the larvae during phase before fruiting
before to fruiting, larvae were recorded exclusively in the shoots.
In the first week of observation (25 days after transplanting: DAT), no larvae were recorded on the brinjal plants. In the second week of observation (32 DAT), the average number of larvae was
0.52 ± 0.11 larva per plant. This average number increased gradually to reach 3.8 ± 1.2 larvae per plant on the 109 th DAT (Figure: A).
Absence of larvae in the first week of observation would be due to the fact that the plants were not developed and did not have shoots that could contain the larvae.
A similar observation was made by Douan *et al.*, 2013, [6] in their study comparing the population dynamics of *Spodoptera littoralis* with those of two other Lepidoptera. Indeed, these authors did not observe larvae of three species of cabbage pest at the start of the plant cycle at 21 and 28th DAT during one of the trials.
Low number of larvae recorded in the second week of observation could be explained by the fact that this low number of larvae originated from the first eggs laid, which hatched on plants that were not yet well developed. These larvae penetrated the few shoots that had developed on the

plants, where they would feed. A low number of individuals was also recorded by Djieto-Lordon *et al.,* 2014 [5], during their work on the assessment of insect pests of chili pepper in Cameroon. These authors noted a low number of aphids and whiteflies in the third week after transplanting the plants. These authors attributed this low number to the plants not being well developed and lacking sufficient nutritional resources for these pests. The gradual increase in the number of larvae to 3.8 ± 1.2 larvae per plant at the 109th DAT can be explained by the fact that the brinjal plants were developing with the emergence of numerous tender shoots and flowers, attracting adult *L. orbonalis* for mating and the laying of a number of eggs by the females. After the eggs hatch, the larvae pierce the growing tips of the young tender shoots, into which they penetrate and feed, as reported by Atwal and Dhawal, 2007[3], in their studies in India.

Evolution of average number of larvae during the fruiting phase.

During the fruiting period, larvae were recorded in both shoots and fruits.

Average number of larvae per plant fluctuated between 2.13±0.8 and 12.6±1.86 larvae per plant during this fruiting phase. In first week of fruiting (116 DAT), the average number of larvae, which was 5.24±1.4 larvae per plant, increased gradually to reach a peak of 12.6±1.86 larvae per plant at full of fruiting (165 DAT). This average number gradually decreased to reach 2.13 ±

0.8 larvae per plant at the end of fruit harvesting (214 DAT). (Figure: B).

Important increase in the average number of larvae during the fruiting phase, could be explained by the fact that the plants grew considerably with the appearance of numerous flowers and fruits, which would attract many female *L. orbonalis* to lay large numbers of eggs. After hatching, the larvae would enter the shoots and fruits in large numbers to feed and develop. This hypothesis is consistent with the observation made by Alam *et al.,* 2006[1], who noted that one hour after the eggs hatched, *L. orbonalis* larvae bore into the shoots and fruits, where they fed and developed. The high number of larvae is also due to the fact that the larvae were present in both the shoots and the fruits, and that they were more numerous in the fruits than in the shoots. The same observation was made by Alpuerto, 1994[2], who reported a high percentage of larvae in the fruits, and by Frempong, 1979[9], who noted that a single fruit can contain up to 20 larvae.

The decrease average number of larvae from 165 DAT onwards is likely due to the plants becoming increasingly older, with a decrease in the number of shoots and fruits; consequently, these plants would become less and less attractive for egg-laying by *L. orbonalis* females because the nutritional resources had decreased. Our results corroborate those of Djieto-Lordon *et al.,* 2014[5], who reported in their work a considerable decrease in the aphid population at the end of the chilli pepper cycle due to a decline in nutrient resources. Licciardi *et al.,* 2008[13], also reported that the numbers of larvae of the pests *Plutella xylostella, Hellula undalis* and *S. littoralis* declined on cabbage plants as they aged.

Correlation between the average number of larvae and abiotic factors

The study of the relationship between the average number of larvae on brinjal plants and certain abiotic factors (average temperature, relative humidity and rainfall) revealed positive and negative correlations between these factors and the larval population. Thus, significant positive correlations (r = 0.46) were observed between average temperature and the average number of larvae. Significant negative correlations (r = -0.52) were also observed between the average number of larvae and relative humidity (Table).

The gradual increase in the average number of larvae from the first week of observation through to peak fruiting could also be linked to abiotic factors, namely average temperature and relative humidity, which were positively and negatively correlated, respectively, with the average number of larvae. As the average temperature rises and relative humidity falls, these conditions would favour the reproduction of *L. orbonalis* adults and larval development. This observation corroborates that of Yadav and Sharma., 2005 [19], who revealed in their study that the larval population of *L. orbonalis* was positively correlated with average temperature and negatively correlated with relative humidity.

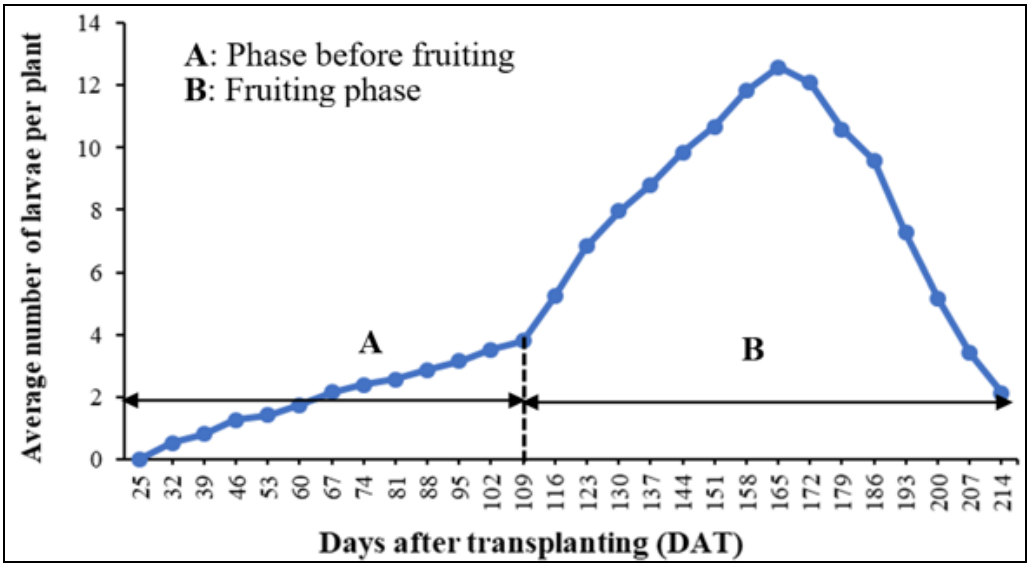

Fig 1: Fluctuation of larvae population of *L. orbonalis* in brinjal cultivation

Table 1: Correlation between average number of larvae and abiotic factors

Abiotic factors	Average temperature (°C)	Relative (%) humidity	Rainfall (mm)
Correlation coefficient (r)	r = 0.46	r = -0.52	r = 0.07
Significance level (p)	p = 0.003*	p = 0.001*	p = 0.67 ns
Equation of the regression line	y = 135x + 5.1	y = 117x + 1.45	y = 102x + 8.2

*****: significant at $p < 0.05$; ns: not significant at $p \geq 0.05$; y = ax + b, with a and b are constants.

Conclusion

The study revealed that the population of *L. orbonalis* larvae varied throughout brinjal cycle.

This population, which was low at the start of the cycle, increased gradually to reach its peak during the full fruiting of brinjal. It then declined to a low number at the end of the fruits harvest. Average temperature and relative humidity are abiotic factors that appear to play an important role in the fluctuation of the *L. orbonalis* population throughout brinjal cycle.

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