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RESEARCH ARTICLE

INFESTATION DYNAMICS AND DAMAGE CAUSED BY *HELLULA* SPP. (LEPIDOPTERA: CRAMBIDAE) ON THREE HEAD CABBAGE (*BRASSICA OLERACEA* VAR. *CAPITATA*) CULTIVARS IN KORHOGO, CÔTE D'IVOIRE

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ABSTRACT

Background: Cabbage (*Brassica oleracea* var. *capitata*) is an important vegetable crop in Côte d'Ivoire, but its productivity is severely constrained by insect pests, particularly species of the genus *Hellula* (Lepidoptera: Crambidae). **Objectives:** This study aimed to evaluate the infestation dynamics, prevalence, and damage caused by *Hellula* spp. on three cabbage cultivars (KK cross, Super cross, and Fortune) grown in Korhogo, northern Côte d'Ivoire. **Methods:** The experiment was conducted from January to March 2026 using a randomized complete block design with three cultivars and three replicates. Weekly observations were carried out to record *Hellula* spp. larvae, assess infestation levels on different plant organs, and determine the yield of each cultivar. Data were analyzed using analysis of variance (ANOVA), followed by Tukey's honestly significant difference (HSD) test at the 5% significance level. **Results:** A total of 234 *Hellula* spp. individuals were recorded during the study. The first infestations were observed 28 days after transplanting, after which pest populations increased progressively, reaching their highest levels between 63 and 77 days after transplanting. The KK cross cultivar exhibited the highest infestation level (37.18%), followed by Super cross (36.32%), whereas the Fortune cultivar recorded the lowest infestation level (26.50%). Leaves were the most heavily infested plant organs. Despite relatively high infestation levels, the Super cross cultivar produced the highest yield (36.31 kg). However, differences in infestation prevalence among the three cultivars were not statistically significant ($p > 0.05$). **Conclusion:** These findings indicate that *Hellula* spp. is a major pest of cabbage under the agroecological condition of Korhogo. They highlight the importance of cultivar selection as a component of integrated pest management and provide valuable information for the sustainable improvement of cabbage production in Côte d'Ivoire.

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INTRODUCTION

Agriculture is one of the main pillars of food security, employment generation, and poverty reduction worldwide, particularly in developing countries, where it contributes nearly 25% of the gross domestic product (GDP) and employs more than half of the active workforce (Traoré, 2016; World Bank, 2023). In Côte d'Ivoire, the agricultural sector accounts for more than 25% of the GDP and nearly 60% of export earnings (FAO, 2020). Among food crops, vegetable production plays a major role through its contribution to food security, household income diversification, and poverty alleviation (Laameche, 2021). Head cabbage (*Brassica oleracea* L. var. *capitata*) is one of the major vegetable crops cultivated in Côte d'Ivoire. It ranks first in terms of cultivated area and production volume (Tuo *et al*., 2017).

National production is estimated at approximately 100,000 tonnes per year, with an average yield of 40 t ha^{-1} (CIRAD, 2019; Kouassi *et al*., 2021). Cabbage production represents an important source of income for farmers, with more than 83% of producers relying on this crop to meet the food and financial needs of their households (Soro *et al*., 2018). In northern Côte d'Ivoire, the country's main cabbage-producing area, this crop is widely cultivated, particularly by women, for whom it contributes significantly to economic empowerment and poverty reduction (N'Dri, 2000; Diop, 2014). From a nutritional perspective, cabbage is recognized for its high content of vitamins, minerals, and antioxidant compounds that are beneficial to human health (Depezay, 2006). Despite its socio-economic importance, cabbage production remains severely constrained by numerous insect pests that reduce both market quality and yield. In Côte d'Ivoire, approximately 25 insect pest species have been reported on this crop,

with Lepidoptera being the most destructive group, including *Plutella xylostella*, *Hellula undalis*, and *Spodoptera littoralis* (Kouassi *et al*., 2019). Among these pests, species belonging to the genus *Hellula* (Lepidoptera: Crambidae) are particularly destructive because they attack cabbage plants from the earliest stages of crop development. Their larvae destroy the terminal bud, bore into stems, and cause severe plant deformation, frequently resulting in blind plants or multiple heads and, in severe infestations, complete destruction of young seedlings (Sandhu and Bhalla, 1973; Sivapragasam, 1994; Solis and Adamski, 1998; Douan *et al*., 2013; Labou, 2016). The use of tolerant cultivars is considered one of the most promising approaches in integrated pest management (IPM) programs. However, information on the infestation dynamics of *Hellula* spp. and the response of the main cabbage cultivars grown under the agroecological conditions of northern Côte d'Ivoire remains scarce. A better understanding of the population fluctuations, prevalence, and infestation levels of these pests among cabbage cultivars is essential for developing effective integrated pest management strategies. Therefore, the present study was conducted at the experimental vegetable garden of Peleforo GON COULIBALY University to evaluate the infestation dynamics, prevalence, and damage caused by *Hellula* spp. on three cabbage cultivars grown under Sudanian agroecological conditions. Specifically, the study aimed to (i) analyze the temporal dynamics of *Hellula* spp. populations, (ii) compare infestation levels among cabbage cultivars, and (iii) assess the effects of these infestations on plant organs and crop production. The findings are expected to contribute to the identification of cultivars better adapted to local conditions and to provide useful information for the development of sustainable management strategies against cabbage pests.

MATERIALS AND METHODS

Study site: The study was conducted from January to March 2026 at the experimental vegetable garden of Peleforo GON COULIBALY University, located in Korhogo, Poro Region, northern Côte d'Ivoire. Korhogo lies between 9°29′ and 9°53′ N latitude and 5°36′ and 6°49′ W longitude. The region is characterized by a Sudanian climate, with a dry season extending from November to April and a rainy season from May to October. The mean annual rainfall is approximately 1,200 mm, and the average annual temperature is 27 °C (Soro *et al*., 2018; Sangaré *et al*., 2021).

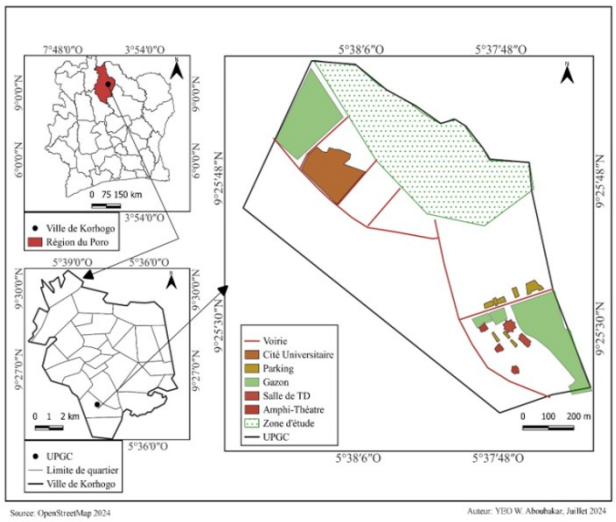

Figure 1. Location of the study sites

Study design: The study was conducted using three cabbage (*Brassica oleracea* var. *capitata*) cultivars, namely KK cross, Super cross, and Fortune. These cultivars were selected because of their agronomic importance, commercial value, and adaptation to local agroecological conditions. The experiment was arranged in a randomized complete block design (Fisher's block design) comprising three treatments corresponding to the three cabbage cultivars, with three replicates. Each experimental plot measured 1.5 × 1.0 m and consisted of 21 plants arranged in three rows spaced 40 cm apart, with 30 cm between plants within each row. Experimental plots were separated from one another to minimize interference among treatments. Seeds were sown in a nursery on 2 m² seedbeds. Seedlings were maintained through daily irrigation and manual weeding until transplanting. Twenty-eight days after sowing, seedlings with five true leaves were transplanted into experimental plots.

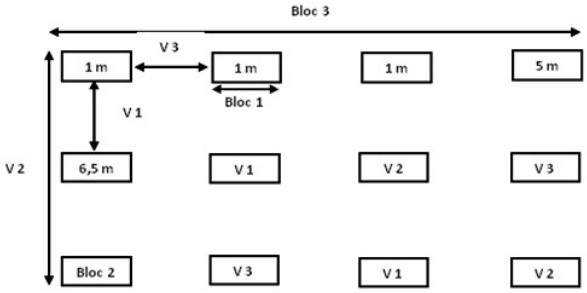

Figure 2. Experimental design

Crop management: Crop management consisted of regular irrigation and three manual weeding carried out at 14-day intervals. Two fertilizer applications were performed: an application of NPK (10–22–22) fertilizer 14 days after transplanting, followed by urea at a rate of 0.5 kg per 10 m² 28 days after transplanting. No insecticide or fungicide treatments were applied throughout the experimental period to allow the natural population dynamics of *Hellula* spp. to develop.

Data collection: Observations were conducted once a week for three months, from 14 days after transplanting until harvest. This period corresponds to the hot dry season in the Korhogo Department, which is favorable to the development of *Hellula undalis* and *Hellula phidilealis* (Kouassi, 2021). The presence of the pest was recorded, and the damage inflicted on cabbage plants was assessed. Field inspections were carried out by examining the terminal buds, stems, leaves, and cabbage heads of each plant. A plant was considered infested when one or more of these organs showed damage associated with the presence of *Hellula* spp. larvae. All observed symptoms and damage were described and recorded. The numbers of *Hellula* spp. larvae and pupae were counted during each assessment. Larvae were counted on all plants within each experimental plot. The resulting counts were expressed on a per-plant basis because a single *Hellula* larva can destroy an entire cabbage plant. All cabbage plants of each cultivar within every experimental plot were inspected. Observations were performed in the morning between 08:00 and 10:00 h. At each assessment, all plants infested by *Hellula* spp. were counted, and the location of the damage on the plant was recorded. At harvest, yield was determined by weighing the cabbage heads collected from each experimental plot.

Statistical Analysis: Data were analyzed using IBM SPSS Statistics version 20. Differences among cabbage varieties were assessed by one-way analysis of variance (ANOVA) at a 5% significance level. When the ANOVA indicated significant

differences, means were separated using Tukey's honestly significant difference (HSD) test at $p < 0.05$. In addition, Pearson's correlation analysis was performed to evaluate the relationship between the abundance of *Hellula* spp. and the cabbage varieties studied.

RESULTS

Population dynamics of *Hellula* spp: During the study period, a total of 234 *Hellula* spp. individuals were recorded across the three cabbage cultivars evaluated. No individuals were observed during the first two weeks after transplanting. The first infestations appeared 28 days after transplanting (DAT), with a total of 10 individuals. Thereafter, the population increased progressively until the end of the cropping cycle (Figure 3). Three population peaks were recorded during the experiment. The first occurred at 35 DAT, with 23 individuals, the second at 63 DAT, with 47 individuals, and the third at 77 DAT, with 46 individuals. The peak observed at 63 DAT represented the highest population recorded throughout the monitoring period. Furthermore, approximately 72.22% of all *Hellula* spp. individuals were recorded between 63 and 77 DAT, indicating a marked increase in the pest population during the late stages of the cropping cycle (Figure 3).

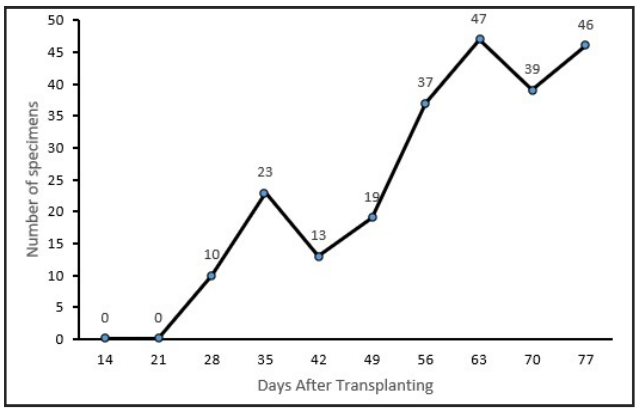

Figure 3. Temporal dynamics of *Hellula* spp. populations after transplanting

Variation in infestation levels among cabbage cultivars: Infestations began simultaneously on the three cabbage cultivars at 28 days after transplanting (DAT), but their population dynamics differed among cultivars (Table 1). The KK cross cultivar exhibited the highest infestation level, with 87 individuals, accounting for 37.18% of the total population recorded. It was followed by Super cross, with 85 individuals (36.32%), whereas the Fortune cultivar harbored the lowest population, with 62 individuals, representing 26.50% of the total pests observed. Population fluctuations were relatively irregular on the KK cross cultivar, reaching a maximum of 19 individuals at 63 DAT. In contrast, the Super cross cultivar showed a more gradual increase in population density, peaking at 21 individuals at 77 DAT, which was the highest number recorded for any cultivar during the experiment. Throughout the monitoring period, the Fortune cultivar consistently remained the least infested.

Prevalence of *Hellula* spp: The mean infestation prevalence varied among the cabbage cultivars (Table 2). However, statistical analysis revealed no significant differences among the three cultivars (ANOVA; $p = 0.170$). The Fortune cultivar exhibited the lowest mean infestation prevalence (27.97 ± 9.97), whereas KK cross (35.96 ± 21.43) and Super cross (36.06 ± 24.13) recorded higher values. Cabbage yield also varied among the cultivars evaluated (Table 2). The Super cross cultivar produced the highest yield (36.31 kg), followed by Fortune, whereas KK cross recorded the lowest.

Infestation rate of plant organs: Attacks by *Hellula* spp. affected several organs of cabbage plants, with varying levels of severity among the cultivars (Table 3). Leaves were the most frequently infested organs in all three cultivars, with infestation rates exceeding 50%. Stem and head infestations were less severe. Overall, the KK cross cultivar showed the highest infestation levels across the different plant organs, whereas Fortune recorded the lowest values.

Symptoms and observed damage: Larvae of *Hellula* spp. induced various symptoms on cabbage plants. The first damage symptoms were observed on the terminal bud, where larvae penetrated plant tissues. Subsequent attacks resulted in the formation of galleries within stems, drying of young leaves, foliar perforations, and severe deformation of plants. The most severe infestations led to the destruction of the apical meristem, causing the development of blind plants or plants with multiple heads, as well as growth delays. In some cases, the observed damage impaired the normal formation of cabbage heads (Figure 4).

DISCUSSION

The present study revealed a progressive increase in *Hellula* spp. populations during the cabbage development cycle, with the first infestations occurring from the 28th day after transplanting and abundance peaks recorded between the 63rd and 77th days. This population dynamic suggests that the dry-season conditions in Korhogo gradually become favorable for the development of this pest. These observations are consistent with the findings of Sivapragasam (1994), who reported that *Hellula undalis* has a short biological cycle and a high multiplication capacity under tropical conditions. They also support the observations of Sandhu and Bhalla (1973), who indicated that a female could lay between 120 and 185 eggs, thereby promoting rapid population growth when environmental conditions are favorable. The increase in pest abundance at the end of the crop cycle may also be associated with the vegetative development of cabbage plants. At this stage, increased foliar biomass and head formation provide additional food resources and refuge sites for larvae. Young leaves and terminal buds are indeed particularly preferred by *Hellula* larvae, as they provide suitable conditions for feeding and development (Solis and Adamski, 1998). The three studied varieties showed different levels of infestation, although statistical analyses did not reveal significant differences among them. Nevertheless, the Fortune variety recorded the lowest pest abundance and prevalence, whereas KK cross was the most infested. These differences may reflect genetic variability among varieties in response to *Hellula* spp. attacks. Several studies have shown that morphological and biochemical characteristics of cultivated plants influence feeding behavior and colonization by insect pests. The observed differences could therefore be related to variations in leaf texture, plant architecture, or plant tissue composition, which may affect larval establishment and development. Despite relatively high

Table 1. Number of *Hellula* spp. individuals according to infestation rates of cabbage cultivars

Varieties	Number of insects										
	14JAR	21JAR	28JAR	35JAR	42JAR	49JAR	56JAR	63JAR	70JAR	77JAR	Rate (%)
KK cross	0	0	7	10	5	8	16	19	12	10	37.18
Super cross	0	0	1	5	6	8	11	17	16	21	36.32
Fortune	0	0	2	8	2	3	10	11	11	15	26.50
Total	0	0	10	23	13	19	37	47	39	46	

Table 2. Prevalence of *Hellula* spp. and cabbage production according to varieties

Varieties	Prevalence (%)	Production (kg)
KK cross	35.96 ± 21.43	24.25 ± 12.90
Super cross	36.06 ± 24.13	36.31 ± 28.93
Fortune	27.97 ± 9.97	19.93 ± 18.62
Mean	33,33 ± 17.36	26.83 ± 19.79
p-value	0.170	0.480
Significance	NS	NS

Table 3. Infestation of cabbage organs according to varieties

Varieties	Infestation rate (%)			
	Global	Leaves	Stems	Cabbage heads
KK cross	37.18	**49.92**	20.50	23.49
Super cross	36.32	**52.39**	20.30	15.96
Fortune	26.50	**55.98**	22.32	12.29

a. Stem attacked by *Hellula* spp.

b. Leaf attacked by *Hellula* spp.

c.Cabbage plant attacked by *Hellula* spp.

d. Bud attacked by *Hellula* spp.

infestation levels, the Super cross variety showed the highest production among the three evaluated varieties. This result suggests that high infestation does not necessarily lead to a proportional reduction in yield.

Some varieties may maintain their production through greater compensatory ability after pest attacks or higher tolerance to pest damage. This ability represents an important criterion in selecting varieties for vegetable production systems and

integrated pest management programs. Leaves were the most frequently attacked plant organs, followed by stems and cabbage heads. This observation agrees with the biology of *Hellula* species, whose young larvae preferentially feed on leaf tissues before penetrating buds and stems (Solis and Adamski, 1998). The symptoms observed, including leaf perforations, stem galleries, terminal bud destruction, and the formation of blind or multiple-headed plants, correspond to the damage described by Douan *et al.* (2013) and Labou (2016). These authors highlighted that early attacks by *Hellula* spp. impair normal plant development and may result in significant yield losses. Under the agroecological conditions of Korhogo, the results obtained demonstrate that *Hellula* spp. infestations represent an important constraint to cabbage production. The lower infestation observed on the Fortune variety suggests that it could be a promising alternative in integrated pest management programs. However, the better production performance obtained with the Super cross variety indicates that varietal selection should not be based solely on infestation levels but should also consider agronomic performance. Further studies involving several cropping cycles, different seasons, and additional agronomic parameters would contribute to a better characterization of the behavior of these varieties toward *Hellula* species and help develop appropriate recommendations for producers.

CONCLUSION

This study evaluated the infestation dynamics and damage caused by *Hellula* spp. on three cabbage cultivars grown under the agroecological conditions of Korhogo, northern Côte d'Ivoire. The results showed that infestations began from the 28th day after transplanting and progressively increased until the end of the cropping cycle, with abundance peaks observed between the 63rd and 77th days. A total of 234 individuals of *Hellula* spp. were recorded during the experiment. The three cultivars studied exhibited variable levels of infestation. The KK cross cultivar recorded the highest number of pests, whereas Fortune showed the lowest infestation levels. However, the differences observed among cultivars were not statistically significant. In contrast, the Super cross cultivar achieved the highest production, indicating that higher infestation does not necessarily result in a proportional reduction in yield. Leaves were the most frequently attacked plant organs, followed by stems and heads. The observed damage was mainly characterized by leaf perforations, stem galleries, destruction of the terminal bud, and plant deformities. These results demonstrate that species of the genus *Hellula* constitute a limiting factor for cabbage production under the agroecological conditions of Korhogo. They also highlight the importance of cultivar selection in sustainable pest management strategies. The Fortune cultivar appears to be the least susceptible to infestations, whereas Super cross exhibits the highest production potential. Further studies involving several cropping seasons, different production periods, and multiple agroecological sites are needed to better characterize the interactions between *Hellula* spp., cabbage cultivars, and environmental factors. Evaluating mechanisms of varietal tolerance or resistance, combined with the integration of biological control methods and integrated pest management strategies, would contribute to the development of sustainable approaches for managing this pest in vegetable production systems in Côte d'Ivoire.

Author Contributions and Conflict of Interest: DC conceptualized the study. AZ collected the field data and conducted their analysis. DC wrote and prepared the first draft of the manuscript. AMK, ARN, and YT contributed to the revision of the manuscript by providing their comments and suggestions. All authors contributed to the final version of the manuscript. The authors declare that there is no conflict of interest related to this study.

Competing Interests: Authors have declared that no competing interests exist.

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