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INFESTATION OF FOUR CRUCIFER SPECIES, DAMAGE AND PLANT LOSS CAUSED BY *LIPAPHIS ERYSIMI* KALT (HEMIPTERA: APHIDIDAE) IN SOUTHERN TOGO

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ABSTRACT

Lipaphis erysimi Kalt (Hemiptera: Aphididae) is an aphid pest of crucifers under different agroclimatic conditions, that causes enormous losses in agricultural yields in Togo. This study aimed to assess the infestation, damage and loss of cruciferous plants caused by this aphid. Crucifer plots were arranged in three randomized and balanced blocks at the Lomé Agronomic Experimentation Station from July to the end of September 2022. Each block was comprised of four elementary plots, each of which contained 40 cruciferous plants. The crucifers were head cabbage (*Brassica oleracea* var. capitata); cauliflower (*Brassica oleracea* var. botrytis), turnip (*Brassica rapa*) and radish (*Raphanus sativus*). By day 21 after transplanting, the infestation rate was 100% on all plots. This high infestation rate led to the death of all plants in the turnip plots on day 49, and in the cabbage, cauliflower, and radish plots on day 56. Yields were zero for all crucifers. The results of this study therefore showed that infestation of crucifers by *L. erysimi* can lead to total yield losses if no pest management measures are applied during the third quarter of the year in southern Togo.

***Keywords*:** Infestation; Crucifers; *L. erysimi;* Damage; Yield loss

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1. INTRODUCTION

Market gardening is a sector of activity that not only provides vegetables to feed populations in various countries. Especially in those of sub-Saharan Africa, the food production has been declining for several years (FAO 2012; FAO et al. 2021). It is also a sector of employment for most urban and rural youth who generally drop out of the school system early (Delamarche 2007; Mondédji et al. 2015). Vegetable cultivation under market gardening is an important component of value-added cropping system (Khan et al. 2020). Vegetable production in urban and peri-urban environments is important and attractive (Jansma et al. 2024), especially for highly perishable and delicate products such as vegetables often produced on soil treated with chemical fertilizers (Kambire et al. 2023). The overwhelming expansion of this sector in urban and peri-urban areas is mainly due to its fast income deriving potentials, compared to several other agricultural products cultivated on annual or biennial basis. This activity is mainly adopted by the urban poor and people who have moved from rural areas to urban areas. It is increasingly used in urban and peri-urban areas.

Vegetable production has been a booming activity in Togo for several years, as in most countries of the West African region (Monde et al. 2023). Among the various market garden products, leafy vegetables are better represented than vegetables produced for their fruits, roots, bulbs or tubers (Kanda et al. 2014). The Brassicaceae family includes species belonging to the *Brassica* genus. Cultivated *Brassica* species include head cabbage, cauliflower, kale, broccoli, Brussels sprouts, turnips, radishes, rutabaga, rape, various mustards and other leafy vegetables (Hong et al. 2008).

The leaves of some species of this genus are edible, and may form a compact head or “apple” (as in the case of cabbage) or may not (as in the case of cauliflower, radish or turnip). These vegetables are used in various meals and are much appreciated by the local population. Their production and marketing are sources of income for producers, wholesalers, retailers and others.

However, the cultivation of these crucifers is subject to significant pressure from insect pests at various phenological stages (Mondédji 2010; Kanda et al. 2014). The main insect pests recorded on these crucifers belong to the orders of Lepidoptera, Coleoptera, Hemiptera and others. Aphids are small sap-sucking insects of the family Aphididae. These are one of the most notorious, cosmopolitan louse-like and obligate ectoparasites, which are responsible for excessive qualitative and quantitative loss of *Brassica* crops in the world (Koirala 2020).

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Among these pests, *Lipaphis erysimi* (Hemiptera: Aphididae) is one of the most important insect pests of crucifers worldwide (Gautam et al. 2019). It infests crucifers from transplanting to maturity. *L. erysimi* infestation causes direct and indirect damage to its various hosts (Koirala 2020). As direct damage, stunting, distortion, yellowing and wilting, generally result from the sucking of sap from infested plants (Razaq et al. 2011; Mahendran et al. 2018) while indirect damage includes black fumagine formed by fungal growth on honeydew excretion and it is also a vector of several viral diseases (Blackman and Eastop 2000; Ng and Perry 2004). *L. erysimi* is a specialist aphid species on *Brassica* hosts, which poses a serious threat to their cultivation, including cabbage, cauliflower and rapeseed-mustard (Duhlian et al. 2020; Keerthi et al. 2020).

In Togo as in the West African sub-region, four main cruciferous *Brassica* species are grown. These are cabbage (*Brassica oleracea* L. var. capitata), cauliflower (*Brassica oleracea* L. var. botrytis), turnip (*Brassica rapa* L.) and radish (*Raphanus sativus* L.). *L. erysimi* infests crops from January to December. Especially in the south of the country with a tropical Guinean climate marked by two rainy seasons (April-July and September-October) separated by two dry seasons (August and November-March), *L. erysimi* is very prolific. It can cause a yield loss rate of up to 100% in southern Togo, depending on the severity of the infestation, the stage of the infested crop, the absence of treatment applied and the season (Mondédji et al. 2018; Gatzaro et al. 2023). Several studies have been conducted on cabbage (*B. oleracea* L. var. capitata), but not on other Brassicaceae in Togo. To combat insect pests, growers use chemical control by applying synthetic insecticides. Chemical control includes the application of systemic insecticides (Monde et al. 2023; Abbas et al. 2025). In addition to easy availability and application of synthetic insecticides and immediate knock-down effect on insects, producers prefer chemical insecticides to control pests (Mondédji 2010). The application of insecticides is associated with various problems like resistance, resurgence and residues to the ecosystem and harm to human health. In order to envisage a more reasonable management strategy, one that is mindful of human health and protects the environment, it is necessary to know the host plants of the insect pest in the area and their vulnerability to pests like *L. erysimi*.

Thus, the current study will identify the *Brassica* species most vulnerable to *L. erysimi* infestation among the four most widely grown in Togo. The aim of this study was to assess the infestation, damage and loss of four cruciferous species caused by the aphid *L. erysimi*.

2. MATERIALS AND METHODS

2.1. Study Framework

Plants of head cabbage (*Brassica oleracea* var. capitata); cauliflower (*Brassica oleracea* var. botrytis), turnip (*Brassica rapa*) and radish (*Raphanus sativus*) were grown at the Lomé Agronomic Experimentation Station/Station d'Expérimentations Agronomiques de Lomé (SEAL) located on the grounds of the University of Lomé, with coordinates of 6° 17' 62.58" North latitude and 1° 21'12,72" East longitude (Fig. 1). The station is located in the maritime region of southern Togo. This growing area benefits from a Guinean-type climate marked by two rainy seasons (April-July and September-October) alternating with two dry seasons (August and November-March). The prevailing average temperature and rainfall vary between 24 °C and 32 °C and 800 mm to 900 mm per year respectively (Badameli and Dubreuil 2015). The soil is a ferralitic type known as “terre de barre” with a sandy-clay texture (Worou 2002).

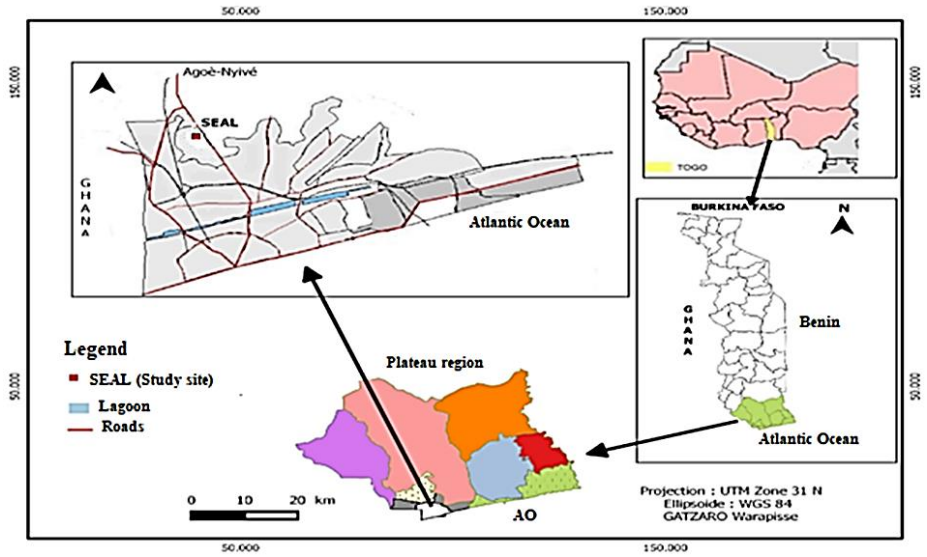

Fig. 1: Map of Lomé and the surrounding area showing the site where the experimental plots were installed

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During the cultivation, temperatures ranged from 25 to 30 °C. Rainfall and relative humidity were around 930 mm and 81% respectively. The photoperiod is 12: 12 h LD.

2.2. Cultivation of Host Plants

Four cruciferous *Brassica* species were used as host plants: cabbage (*Brassica oleracea* L. var. capitata), cauliflower (*Brassica oleracea* L. var. botrytis), turnip (*Brassica rapa* L.) and radish (*Raphanus sativus* L.). These four crucifers have very different morphological characteristics and are the most widely grown species of the *Brassica genus* in southern Togo. The seeds of these plants were purchased from TOGOSEM, a market gardening seed sales company.

Crops were planted and monitored from July to the end of September 2022. Crucifer plots were arranged in three randomized, balanced blocks. Each block comprised four elementary plots. Each plot contained 40 crucifer seedlings (Fig. 2). Transplanting was done out at the fourth unfolded leaf stage for all four varieties. Watering was carried out daily (morning and evening) until the end of the experiment.

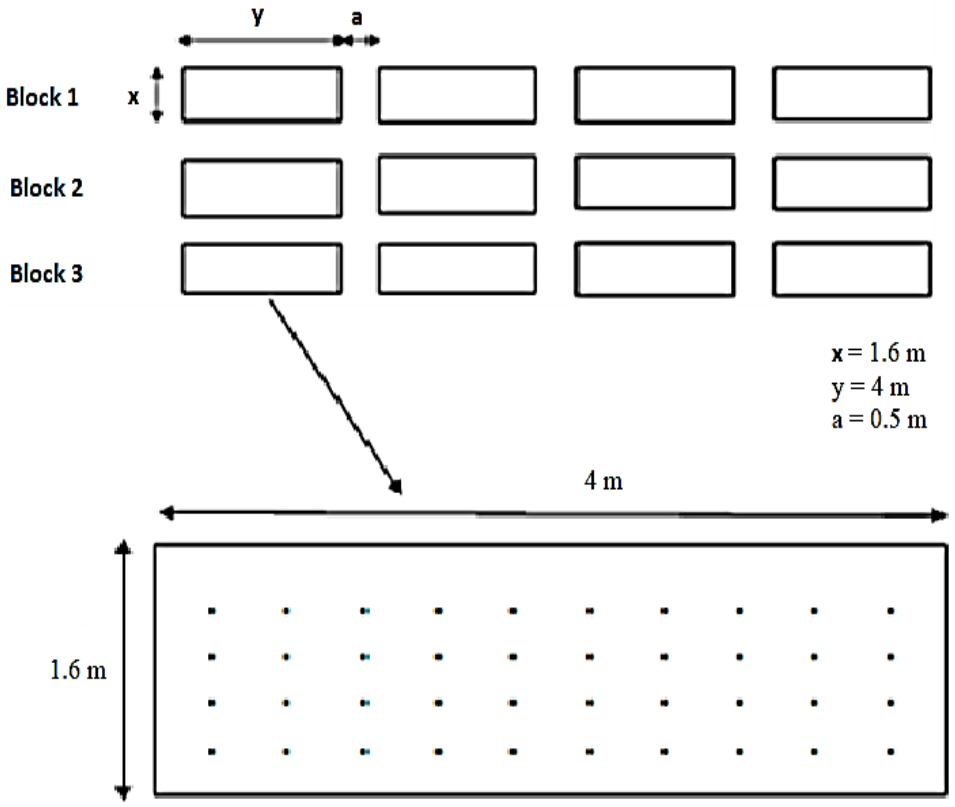

Fig. 2: Experimental set-up; *Cp=cabbage; Cf=cauliflower; Na=turnip; Ra=radish*

2.3. Assessment of Crucifer Infestation Rate, Damage and Yield Loss Caused by *L. erysimi*

Observations were made on crucifers planted on the elementary plots of each block from the 7th day after transplanting, at a frequency of one observation per week until the end of the experiment (complete death of plants on all plots). The infestation rate was assessed by recording the evolution of aphid invasion of each crucifer species in the plots until the end of the experiment. Damage was described and plant loss also assessed during observations.

2.4. Statistical Analysis

The data obtained from calculation of infestation rate and plant loss were subjected to an analysis of variance (ANOVA) at 5%, and the means were discriminated against with the Student-Newman-Keuls (SNK) test using the MINITAB statistical software.

3. RESULTS

3.1. Assessment of Infestation Rates of Crucifer Species by *L. erysimi*

L. erysimi infested the four cruciferous species throughout the experiment. *L. erysimi* infested plants from the first week after transplanting (on day 7) at average rates of 76.65±20.35% on cabbage; 74.15±5.2% on cauliflower; 70.82±16.25% on turnip and 62.5±18.87% on radish (P=0.737). There was no significant difference between the

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infestation rates of the four crucifer species on day 7. These rates increased to 100%; 99.15±1.45%; 96.65±5.77%; 86.65±13.77% on cabbage, cauliflower, turnip and radish respectively on day 14 (P=0.191). There were 100% on day 21 after transplanting for all cruciferous species (Fig. 3).

3.2. Damage and Plant Loss Rate Caused by *L. erysimi* to the Four Crucifer Species

The damage observed was stunting, non-growth of the plants, curling and purple discoloration of the leaves, yellowing from day 14 and wilting and then complete desiccation (or death) of the plants, generally resulting from the sucking of sap from the infested plants. Aphid populations also secrete honeydew, leading to the development of fumagine on the leaves.

Plant loss began on day 21 on turnips and radishes (Fig. 4). The plants showed yellowing, wilting leaves and eventually died. Plant loss rates on day 21 were 0% on cabbage and cauliflower, 15.82±1.42% on turnips and 5.82±1.42% on radishes (P=0.000). In addition to turnips and radishes, cabbage and cauliflower lost plants from day 28. Plant loss rates were 3.32±1.42% on cabbage and cauliflower, 22.5±22.5% on turnips and 12.5±11.45% on radishes (P=0.286). These rates gradually increased to 75±9%; 80±10.92%; 100%; 77.5±11.52% respectively on cabbage, cauliflower, turnip and radish on day 49 (P=0.027) and 100% loss on all four species on day 56. These rates were 18.32±14.42% on cabbage, 25.82±17% on cauliflower, 83.32±15.27% on turnips and 55.82±10.4% on radishes on day 35 (P=0.002). Rates were 38.32±12.82%, 57.5±43.92%, 98.32±2.87% and 74.15±9% on cabbage, cauliflower, turnips and radishes respectively on day 42 (P=0.063).

The very high infestation of cruciferous plants by *L. erysimi* meant that not a single cabbage head or flower, or tuberized root of turnip or radish could be harvested. This resulted in zero yield (i.e. 0 t/ha) for all cruciferous species.

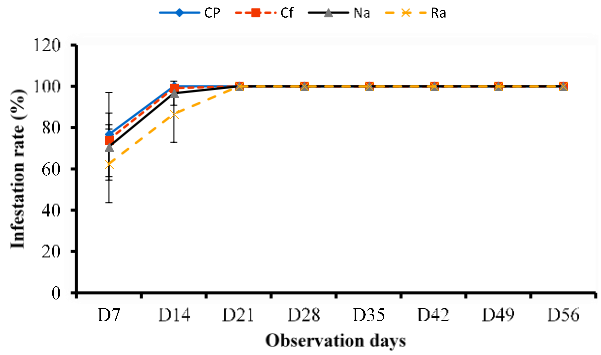

Fig. 3: Infestation rates of cruciferous species by *L. erysimi* as a function of observation days; Cp=cabbage; Cf=cauliflower; Na=turnip; Ra=radish; D=day

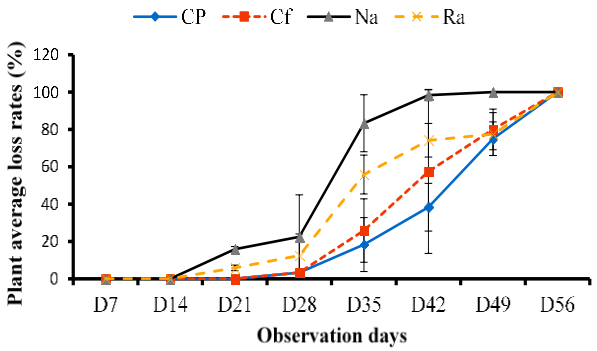

Fig. 4: Evolution of cruciferous species loss rates (dead plants) as a function of observation days; Cp=cabbage; Cf=cauliflower; Na=turnip; Ra=radish; D=day

4. DISCUSSION

At the experimental station, the severe infestation of crucifers by *L. erysimi* (100% of plants infested by day 21), can be explained by the aphid's short life cycle (Keerthi et al. 2024) and climatic conditions that are favorable for its development, such as temperature (between 15°C and 30°C) and rainfall (between 800 mm and 900 mm per year) (Sekkat 2015). Liu et al. (1997) reported that *L. erysimi* mainly infests crucifers under various agro-climatic conditions. Indeed, *L. erysimi* has a very high reproductive capacity. After a few days of infestation of the plants by a few individuals, *L. erysimi* populations covered practically all the undersides of the plants' leaves. Nevertheless, infestation was more severe on head cabbage and cauliflower (76.65±20.35% and 74.15±5.2%) than on turnip and radish (70.82±16.25% and 62.5±18.87%) on the 7th day after transplanting. This indicates that this aphid has a slightly greater preference for head cabbage and cauliflower than for turnip and radish. This aphid, is a specialist aphid species on *Brassica* hosts, which poses a serious threat to their cultivation, including cabbage, cauliflower and rapeseed-mustard in India (Duhlian et al. 2020; Keerthi et al. 2020; Akter et al. 2021).

Sap is the main food source for green plants, enabling them to develop and store nutrient reserves such as starch in the form of sap. Once the aphid has sucked this sap, it renders the plants highly vulnerable. Through its ability to transmit viruses to plants, it causes viral diseases, wilting, yellowing and drying of the leaves, and their subsequent death. A number of previous studies have evoked the same effects caused by this aphid on crucifers, such as those by Kennedy and Abou-Ghadir (1979), Guan and Wang (1980) and Ahlawat and Chenulu (1982). *L. erysimi* causes direct plant damage by sucking phloem sap and indirect damage by releasing honeydew, which later serves as a medium for fungal growth, restricting photosynthetic activity and respiration in plants (Mahendran et al. 2018).

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Infestation of crucifers by this aphid led to 100% plant death at the end of the experiment, but at different rates depending on the days of observation. This indicates that some crucifer species are more resistant to infestation than others. On day 49, the rate of plant loss was 100% on turnips, while on cabbage, cauliflower and radish, it was less than or equal to 80%. This may be due to the thinness and fragility of turnip leaves compared with those of the other three crucifer species. Brar and Sandhu (1978) and Saxena et al. (1995) had also shown in their work that crucifers, which are host plants for *L. erysimi*, differ in their resistance to infestation. Lack of an accessible resistance source has been the primary impediment in breeding varietal resistance against aphids. The nature of a cruciferous plant and the quality of its sap are also important factors influencing the aphid infestation rate and the duration of the plant's resistance to infestation (Dhatwalia et al. 2022; Muhammad and Khan 2022). Keerthi et al. (2024) found a difference in the life cycle of *L. erysimi* on mustard and broccoli, indicating the respective susceptibility and resistance of these host plants to the insect.

Regarding the yield obtained, our results are similar to those of Mondédji et al. (2018) who also obtained a 100% yield loss rate or 0 t/ha on cabbage control plots in 2006, eight weeks after transplanting. Some authors reported that infestation of crucifers by *L. erysimi* results in yield losses ranging from 35.4% to 96% (Bakhetia et al. 1989; Singh and Premchand, 1995). Aphids, members of the order Hemiptera, are one of the world's most notorious pests of *Brassica* crops, severely affecting crop yield yearly from 65 to 100% (Mondédji et al. 2018; Dhillon et al. 2022; Gatzaro et al. 2023). The investigation done by Kumar et al. (2022), has revealed that under unprotected conditions, the infestation of *L. erysimi* significantly ($P<0.01$) impacted all the yield parameters of *Brassica juncea* genotypes (RH 725 and RB 50).

The turnip aphid, *L. erysimi* is devastating insect pests of *B. oleracea* L. var. capitata, *B. oleracea* L. var. botrytis, *B. rapa* L. and *R. sativus* L. in Lomé, Southern Togo. Reasonable protection strategies for these crops against *L. erysimi* are therefore more than necessary to guarantee an income for market gardeners, safeguard human health and protect the environment.

5. CONCLUSION

L. erysimi is a major sucking pest that causes damage and plant loss on all four cruciferous *Brassica* species (*B. oleracea* L. var. capitata, *B. oleracea* L. var. botrytis, *B. rapa* L.) and *R. sativus* L.) From July to September in southern Togo. It adapts and develops under southern Togo agro-climatic conditions and is capable of infesting plants at all phenological stages (from transplanting to maturity). Not only does it cause damage to cruciferous crops, leading to the death of plants, but it also renders the efforts of market gardeners to naught, as it results in a zero yield for them whenever no control measures or techniques are applied. It is therefore imperative that available and innovative protection methods capable of providing effective control that is also economical and has no harmful effect on the environment be used in the management of this crucifer aphid.

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Ethics Approval: Not applicable to this paper.

Author's Contribution: AA, MAD, GW, NWS: initiation and development of protocol; AA, MAD, GW: data collection, processing and drafting of manuscript; AA, MAD, NWS: reading and correction of manuscript.

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