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Relative abundance of chrysomeles and damage on squash (*Cucurbita moschata* Duchesne) and pistachio (*Cucumeropsis mannii* Molina Standl.) in Korhogo commune northern Côte d'Ivoire

Yalamoussa Tuo[1*], Klana Koné[2], Michel Laurince Yapo[1], Soumaila Traoré[1], Fokin Soro[1], Drissa Traoré[1], Herve Kouakou Koua[2]

[1]*Faculty of Biological Sciences, Department of Animal Science, Peleforo Gon Coulibaly University BP 1328 Korhogo, Cote d'Ivoire*

[2]*Faculty of Biosciences, Department of Zoology, Animal Science and Ecology, Félix Houphouët-Boigny University of Cocody (Abidjan Côte d'Ivoire) 22 Bp 1611 Abidjan 22, Cote d'Ivoire*

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Abstract

Squash and pistachio are very popular in the diet of people in Côte d'Ivoire. However, their production is faced with the pressure of insect pests including the chrysomeles. These African cucurbites are prone to attacks by beetles, the main pests that can lead to yield losses of 40 to 70%. Despite this importance, there is very little published data on this pest in Côte d'Ivoire. In order to reinforce the information on these pests for better management, the abundance and the damage of the beetles on these plants were evaluated in the vegetable garden of the Peleforo Gon Coulibaly University of Korhogo. This study consisted of enumerating the chrysomeles and evaluating their rates of attack on the different organs of the plants. In total, three species of beetle were identified on both squash and pistachio. This is *Lamprocopa occidentalis* (88.32%), *Asbecesta cyanipennis* (7.94%) and *Aulacophora africana* (3.74%). This study claims that *L. occidentalis* is the main pest of squash and pistachios in northern Côte d'Ivoire. The most favorable phenological stage for sprouting chrysomeles is flowering.

* **Corresponding Author:** Yalamoussa Tuo ✉ yalamoussatuo@gmail.com

Introduction

Pistachio (*Cucumeropsis mannii*) and squash (*Cucurbita moschata*) are herbaceous plants of the family Cucurbitaceae. They are cultivated on a small scale, mainly by women, for their seeds (Zoro Bi *et al.*, 2003; Zoro Bi *et al.*, 2005) and for pulp, used in human nutrition (Fondio *et al.*, 2000; Vodouhe *et al.*, 2000, Zoro Bi *et al.*, 2003). Pistachio seeds are a source of lipids and proteins (Achu *et al.*, 2005, Chinyere *et al.*, 2009, Augem *et al.*, 2011, Enzonga-Yoca *et al.*, 2011). This species occupies an important place in the socio-cultural life of several peoples. In Côte d'Ivoire, pistachio sauce is very popular during popular festivities (Zoro Bi *et al.*, 2003). Pistachios are a source of income for some vulnerable groups, including women who produce them in association with the main food crops (National Agency for Rural Development Support ANADER, 2004). Cleaned and dried, pistachio seeds are three times more expensive than cocoa and seven times more expensive than coffee (Zoro Bi *et al.*, 2003). On one hectare, it is possible to obtain up to 200 kg of pistachio seeds; this makes a recipe of 300,000 FCFA for the first crop or 600,000 FCFA / year (Nouza, 2011). Squash is rich in beta-carotene, a precursor to vitamin A and E. In Côte d'Ivoire, annual production of squash is estimated at 110 000 tons (FAO 2009). Despite their nutritional and socio-economic importance, these African cucurbites are prone to attacks by beetles, the main pests that can lead to yield losses of 40 to 70% (Fondio *et al*, 2000, Vodouhé *et al*, 2000). To increase the production of these plants, pest management is necessary. It is in this context that the present study aims to evaluate the diversity, relative abundance and damage of chrysomeles on pistachio and squash.

Materials and methods

Study area

This study was carried out during the rainy season on experimental plots housed in the vegetable garden at Peleforo Gon Coulibaly University in Korhogo. The sub-prefecture of Korhogo is located between 8°26 and 10°27 north latitude and 5 °17 and 6 °19 west longitude 600 km from Abidjan in northern Ivory Coast. The locality belongs to the Sudano-Sahelian dry tropical climate regime whose rhythm of the seasons is regulated by the displacement of the Intertropical Front (Jourda *et al.*, 2005). This climate is characterized by two seasons.

The rainy season that runs from May to October with a maximum of precipitation in September and the dry season from November to April, characterized by the harmattan that settles from December to February (Sodexam, 2017).

Experimental device

For each culture, the experimental device was a Fischer block with 2 blocks (or repetitions) and 2 objects or treatments (treated plots and control plots).Each block consisted of 4 elementary plots, a total of 8 elementary plots per crop. The control plots received no treatment. For the other plots, they were treated once a week with a synthetic insecticide based on Cypermethrin. Each elementary plot consisted of four (4) brackets spaced 0.7 m apart. The elementary plots were separated by 1 m. The area of the experimental plot per crop was 28 m² (8m x 3.5m). Plowing by hand, followed by leveling and picking, and then the intake of chicken dung in each pocket was done before sowing. Seeding was carried out on June 7, 2017, at a rate of 4 seeds per seedling. After emergence, unmarriage was performed to maintain two (2) plants per pouch. In total, one elementary plot had eight (8) plants.

Assessment of Diversity, Abundance and Variation of Chrysomeles Populations

It consisted of observing insects on pistachio and squash plants. The number of beetles per species, crop and treatment was noted. It was performed once a week from 6am to 8am to avoid the agitation of insects. Specimens of each insect species observed were collected using a sweeper net to be identified in the laboratory.

Identification of insects

Insects were identified at the species level on the basis of morphological characteristics using the keys

of Delvare and Alberlenc (1989) and a reference collection of chrysomeles at INPHB. The observation of the morphological characters of the insects was made using a binocular magnifying glass magnifier at 10x20 magnification.

Evaluation of the damage

Damage assessment on leaves, flowers and fruits was conducted once a week throughout the cycle of both crops. For the leaves, it was a question of randomly observing 50 leaves on each elementary parcel to determine the number of attacked leaves and healthy leaves. For flowers and fruits, the attack rate of flowers and fruits was determined for each crop and for each treatment.

Statistical analyses

The variance analyses and Newman Keul tests were performed using Statistica software version 7.1.

Results

Diversity and relative abundance of chrysomeles

On the squash and pistachio, the harvested chrysomeles were divided into three (3) species: *Lamprocopa occidentalis* Weise 1895, *Asbecesta cyanipennis* Harold 1877 and *Aulacophora africana* Dejean 1835. The numbers of these species depended on the plant species.

For Pistachio, 488 chrysomeles were harvested, compared with 428 chrysomeles on squash.

Table 1. Impact of insecticide treatments on damage reduction.

	Pistachio		Squash	
	Witness (%)	Treated (%)	Witness (%)	Treated (%)
Feuilles	80,7	70,6	60,5	56
Flowers	59,21	32,36	27,04	20,43
Fruits	0	0	0	0

There was no significant difference between the populations of rootworms harvested on pistachio and squash (p> 0.05). The proportions of these pests depended on the species of chrysomeles. On the pistachio, the most abundant species was *L. occidentalis* (86.89%). The species *A. cyanipennis* (11.48%) and *A. africana* (1.64%) had a similar abundance (F = 10.94, p <0.05). Concerning squash, the Newman-Keuls test showed that *L. occidentalis* (88.32%) was the main species of rootworm. In contrast, *A. cyanipennis* (7.94%) and *A. africana* (3.74%) had similar proportions (F = 21.15, p <0.05) (Fig. 1).

Fluctuation of chrysomeles populations during the cycle

For each crop, the numbers of chrysomeles varied during the plant cycle. For the pistachio, during the vegetative phase, harvested chrysomeles specimens accounted for 23.77% of the total population. During flowering it was 65.16% against 11.07% during flowering-fruiting. On the squash, the numbers of chrysomeles were average at the beginning of culture (33,64%), raised during flowering (49,53%) and weak at the end of culture (16,82%). For both crops, *L. occidentalis* was the most abundant species during the different phases of each plant (Fig. 2).

Damage of chrysomeles

Leaves

On the pistachio, the lowest attack rates were observed during the vegetative phase (14.6%) and the flowering phase (27.44%). On the other hand, with an attack rate of 51%, the flowering-fruiting phase recorded the highest attack rates. As for squash, the leaves were more attacked during the vegetative phase with 29.4%. During the bloom it was 20%. The lowest attacks were recorded during the flowering-fruiting phase (11.1%) (Fig. 3).

Flowers

On the pistachio, attack rates of flowers were high. They were respectively 59.21% during flowering and 63.67% during flowering-fruiting phase. By cons on

the squash attacks on the flowers were relatively weak. During flowering the attack rate was 27.04% compared to 13.04% during the flowering-fruiting phase (Fig. 4).

Fruits

No fruit showing signs of chrysomeles attack was recorded on pistachio and squash.

Impact of insecticide treatments

On the diversity and abundance of beetles

Insecticide treatments had no impact on the diversity of the chrysomeles. In both treated and control plots, three species of chrysomeles were collected. In terms of proportions, control plots with an average of 6.88 ± 2.43 harbored more beetles than treated (1.81 ± 0.19) pistachio plots.

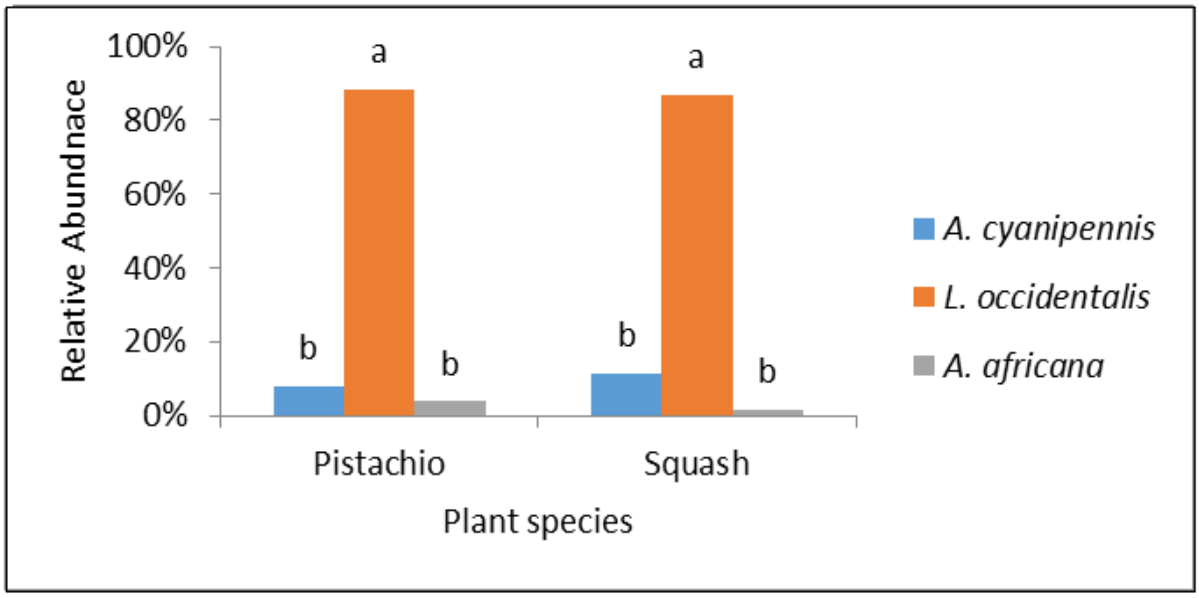

Fig. 1. Relative Abundance of chrysomeles species.

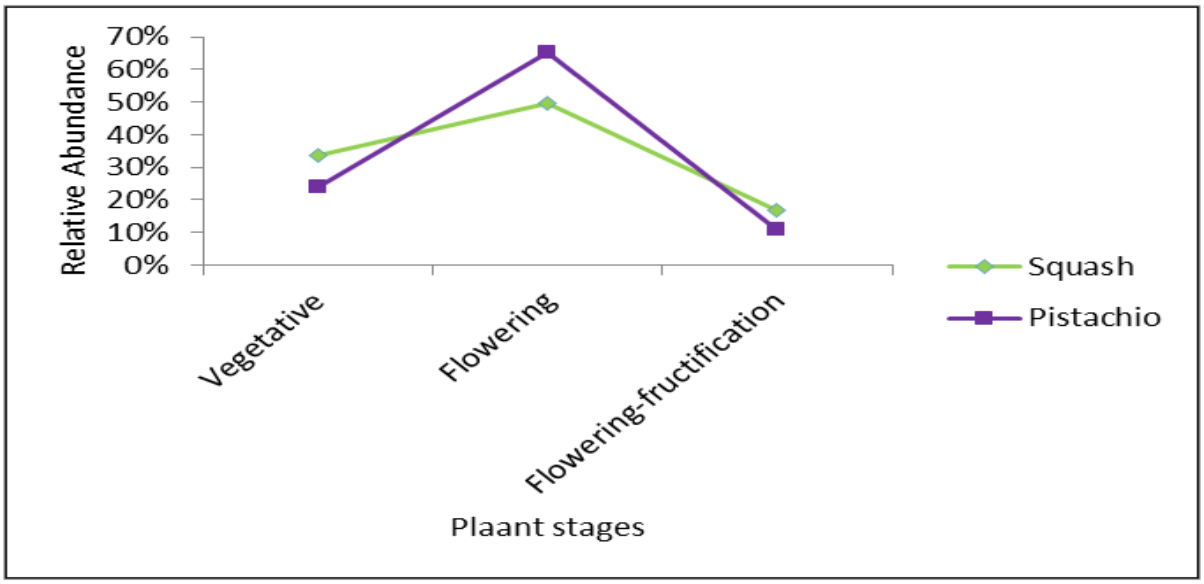

Fig. 2. Variation of chrysomeles populations during the crop cycle.

Analysis of variance revealed a significant difference between the number of insects collected on the control plots and the treated plots ($F = 4.30$, $p < 0.05$). At the squash level, control plots housed an average of 6 ± 1.78 chrysomeles per unit plot. While on the treated plots, the average abundance of the chrysomeles was 1.92 ± 0.82 per elemental plot. The ANONA test revealed a significant difference (F =

4.29, p <0.05) between these different proportions (Fig. 5).

On reducing damage

Leaves

For the pistachio, on the control plots, 80.7% of the leaves were attacked whereas on the plots treated, 70.6% of the leaves showed signs of attack. At the squash level, the attack rate was 60.50% on the control plots and 56% on the treated plots (Table 1).

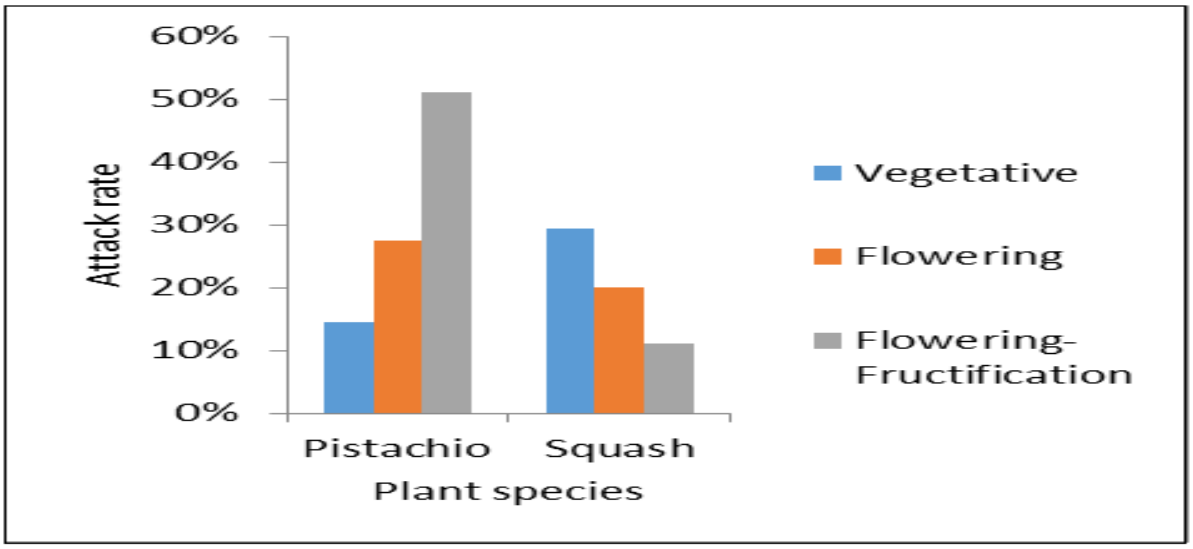

Fig. 3. Attack rate of leaves.

Flowers

On the control plots of the pistachio the attack rate was 59.21% against 32.35% on the treated plots. Concerning the squash, on the control plots, 27.04% of the flowers were attacked, on the other hand on the plots treated, it was 20.43% (Table 1).

Discussion

The analyzes revealed the presence of three (3) species of chrysomeles on squash and pistachio. The presence of these three species is explained by the ecological relationships existing between these species of insects and the plants of the Cucurbitaceae family. Indeed, the presence of an insect on a plant is not fortuitous. He comes either to lay eggs or to feed himself. According to Leroy *et al.* (2009), tritrophic relationships between plants, phytophagous insects and auxiliaries are essentially based on the presence of chemical stimuli released by these plants into the environment. Volatile compounds derived from plant honeydew guide insects to a source of food, prey or hosts, but also stimulate certain behaviors: research, location and attacks of prey / hosts. These three species of chrysomeles were also harvested by kone *et al.* (2018). Unlike the present study, Adja *et al.* (2015) revealed the presence of six species of chrysomeles. This difference could be due to the difference in climate between the two study areas. That of Adja *et al.* (2014) took place in Yamoussoukro located in a sub-equatorial climate, hot and humid. While the present study was conducted in Korhogo located in a dry tropical Sudano-Sahelian climate. During this study, the beetles were harvested at all phenological stages of the plant, but especially during flowering.

This strong outbreak during the flowering phase may be due to the fact that it is during this stage that the nutrients that these insects need are the most available. In fact, according to Nicole (2002), a plant-specific insect finds in it an adequate nutritive content, that is to say that the nutrient content of the plant allows it to continue its life cycle. Also ensures a good fitness and survival of his offspring.

These results are similar to those of Gardner *et al.* (2015). Indeed according to the work of these authors, plots of Cucurbitaceae in flowering shelter more Chrysomelidae than those in vegetation.

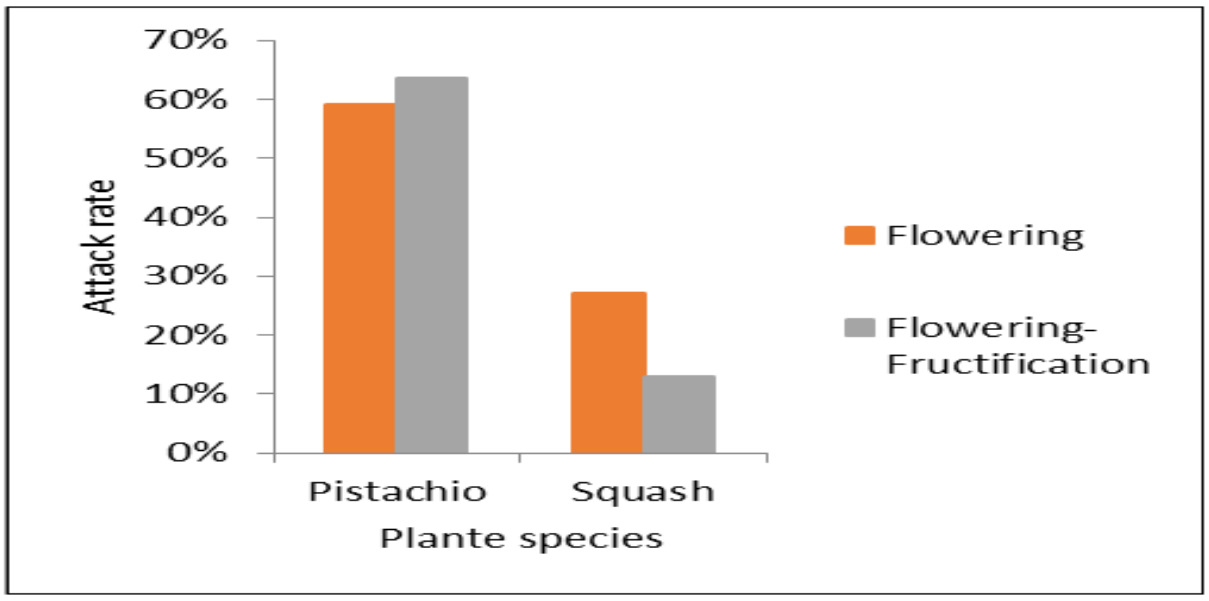

Fig. 4. Attack rate of flowers.

Attacks on leaves and flowers could be explained by the biological characteristics of these organs. Indeed, according to Fomekong *et al.* (2008), pistachio leaves are prized by insects because of their turgid and tender appearance unlike stems and fruits. Alao *et al.* (2016) observed similar results on the same plant. In this study, pistachio flowers were more attacked than leaves. These results are different from those of Adja *et al.* (2014). According to these authors pistachio leaves are the most attacked organs of the plant.

The application of insecticide treatments, has reduced the populations of chrysomeles compared to the control. Similarly, these treatments have reduced the damage caused by these insects to different organs of pistachio and squash.

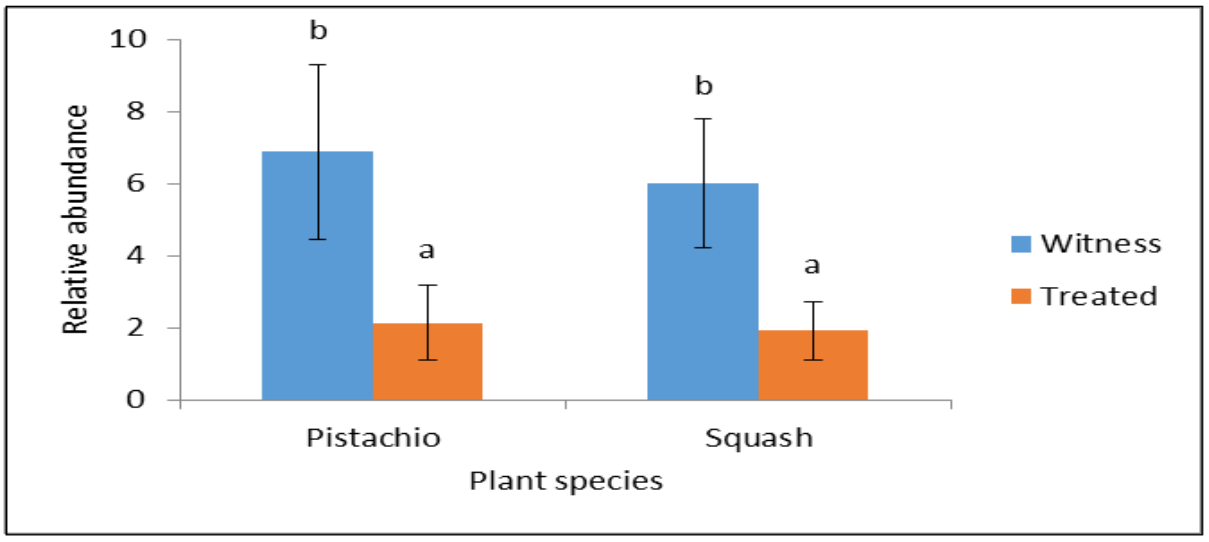

Fig. 5. Impact of insecticides treatments on chrysomeles abundance.

This would be related to the fact that the insecticide used allows control of the beetles and their damage. Similar results were obtained by Adja *et al.* (2014). These authors showed that the application of insecticides made it possible to control the populations of beetles and reduce the damage associated with their presence.

Conclusion

This study shows that the pistachio and squash

chrysomeles were *L. occidentalis*, *A. cyanipennis* and *A. africana*. The main insect pest of these two cucurbits was *L. occidentalis*. For these two crops, the flowering phase recorded the greatest number of chrysomeles. These insects have caused serious damage to the leaves and flowers of the plants. However, the use of an insecticide has made it possible to control the populations of chrysomeles and to reduce the damage of these pests. However, in the context of sustainable agriculture, it is necessary to control the populations of insect pests by alternative control methods in order to improve the income of producers.

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