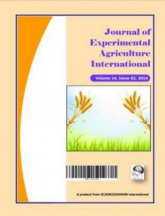


Journal of Experimental Agriculture International

21(2): 1-7, 2018; Article no.JEAI.38820
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Abundance and Incidence of Zucchini (*Cucurbita pepo* L) Flies in the Korhogo Department of Northern Côte d'Ivoire and Pest Control Methods Used by Farmers

Yalamoussa Tuo[1*], Klana Kone[2], Michel Laurince Yapo[1] and Koua Kouakou Herve[2]

[1]Unité de Formation et de Recherche (UFR) des Sciences Biologiques, Département de Biologie Animale, Université Peleforo Gon Coulibaly, BP 1328 Korhogo, Côte d'Ivoire.
[2]Unité de Formation et de Recherche (UFR) Biosciences, Département de Zoologie, Biologie Animale et Ecologie, Université Felix Houphouet-Boigny de Cocody, 22 Bp 1611 Abidjan 22, Abidjan, Côte d'Ivoire.

Authors' contributions

This work was carried out in collaboration between all authors. Author YT designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors KK and MLY managed the analyses of the study. Author KKH managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2018/38820
Editor(s):
(1) Mariusz Cycon, Professor, Department and Institute of Microbiology and Virology, School of Pharmacy, Division of Laboratory Medicine, Medical University of Silesia, Poland.
Reviewers:
(1) Hamit Ayberk, Istanbul University, Turkey.
(2) Hanife Genç, Canakkale Onsekiz Mart University, Turkey.
(3) Jian-Hong Liu, Southwest Forest University, China.
(4) M. Indar Pramudi, Lambung Mangkurat University, Indonesia.
Complete Peer review History: http://www.sciencedomain.org/review-history/23522

Short Research Article

Received 28th December 2017
Accepted 3rd March 2018
Published 8th March 2018

ABSTRACT

To improve the production of zucchini in Côte d'Ivoire and particularly in to Korhogo Department, a study was carried out at the Peleforo Gon Coulibaly University research site and at four farmers' sites during dry and rainy seasons. On each plot, the number of healthy and attacked fruits was evaluated, based on a random sample of 100 fruits. The attacked fruits were transported to the

**Corresponding author: E-mail: yalamoussatuo@gmail.com;*

laboratory and incubated to determine the causative agents. The methods and pesticides used to control insect pests by farmers were listed. During the rainy season, 86.06% of the fruit was attacked by flies while 13.94% remained healthy. In the dry season, for a total of 9,617 controlled fruits, 7,439 (77.35%) were healthy and 22.65% were attacked. Four insects species emerged from infested fruit. They were *Bactrocera cucurbitae, Dacus ciliatus*, *Dacus bivittatus,* belonging to the family of Tephritidae, and *Scaeva pyrastri* belonging to Syrphidae. The method used by farmers to control pests was not effective. In conclusion, flies represent the limiting factor of zucchini production during the rainy season in to Korhogo Department.

Keywords: Zucchini; fly; attacked fruits; dry season and rainy season.

1. INTRODUCTION

Zucchini contains protein, amino acids, minerals, vitamins, and fatty acids. The seeds and leaves of this vegetable are used in the treatment of many uro-genital diseases [1] this vegetable is therefore very important for health. The production cycle of zucchini is, on average, 45 days. It could be an excellent substitute for eggplant (4 months) and cabbage (3 months) in the diet. The cultivation of zucchini could thus contribute to improving the living conditions of people. According to the 2014 estimates of United Nations Food and Agriculture Organization (FAO), zucchini production in Côte d'Ivoire was 19,296 tons. However, production is limited by several constraints, including insects, pests, and particularly fruit flies [2]. The pressure of fruit flies causes damage ranging from 30 to 100% depending on the species of cucurbits and the season [3]. Using their oviposter, females generally lay their eggs in tender fruits. The sting area is marked by the presence of a brown resin deposit. At hatching, the larvae feed on the pulp, causing the fruit to rot [3,4]. The sting marks depreciate the market value of the fruit and the activity of the larvae renders them unfit for consumption. Seeing the extent of the damage, it would be important to know the species of zucchini flies in Côte d'Ivoire, evaluate their impact on production, and study the methods used by the producers to control the insects. These different activities will allow the establishment of an appropriate control method.

2. MATERIALS AND METHODS

2.1 Study Site

The present study was carried out in the sub-prefecture of Korhogo, located between 8°26 and 10º27 N, and 5º17 and 6º19 W, 600 km from Abidjan in the north of the Côte-d'Ivoire. This locality belongs to the Sudano-Sahelian dry tropical climate regime in which the rhythm of the seasons is regulated by the displacement of the Intertropical Front [5]. This climate is characterized by two seasons.

The rainy season extends from May to October with a maximum of precipitation in September. The dry season lasts from November to April and is characterized by the harmattan that settles from December to February. During the year 2016, an average rainfall of 1324.7 mm was recorded, and the annual average temperature varies between 24.6°C and 30.2°C [6]. This research was done on 5 sites, including an experimental plot housed in the botanical garden of Peleforo Gon Coulibaly University and four (4) others distributed throughout the sub-prefecture. These sites (Promafolo, Lataha, Kassirimé and Takali) were chosen for their high production of zucchini.

2.2 Methodology

Vegetable equipment was made up by the varieties of zucchini most produced in the north of Côte d'Ivoire, in particular Aurore F1 and Color F1.

2.2.1 Experimental device

The experimental device was a block of Fisher, completely randomized with two (2) blocks and five (5) repetitions. Each variety of zucchini was represented by a block, with two (2) objects (T0=untreated plots, T1=plots treated with approved synthetic insecticide). The zucchini varieties used were Aurore F1 and Color F1.

2.2.2 Abundance of zucchini flies

Fruits with bite marks were systematically harvested during the various surveys. These fruits were brought back to the laboratory in plastic bags and were incubated. The fruits were placed on wet sand, which facilitated the metamorphosis. Once a week, this sand was

washed and sieved to collect pupae of the week. These pupae were then placed on moistened blotting paper in boxes and were monitored. After emergence, young flies were kept in 70% alcohol.

2.2.3 Incidence of flies on production and pest control methods

Following the method used by [7] in 2014, each plot was visited once a week from flowering to fruiting. During these visits, the number of healthy fruits and the number attacked by the flies was estimated.
The attack of the flies on the fruits is characterized by the presence of exudates and the shape of the fruit at the point of bite. In addition, farmers were questioned. The questionnaire submitted to the farmers requested information about the fighting methods, the kind of pesticide, and the efficiency of pesticide.

2.2.4 Identification of flies

Harvested flies were identified using the binocular loupe based on morphological characteristics. Identification keys of [8] and [9] were used.

2.2.5 Statistical analyses

The analyses were performed using Statistica software (version 7.1). Single-factor variances (ANOVA, $p<0.05$) were performed. Homogeneous averages were pooled using the Newman-Keuls test. Thus, the abundance of species, the rate of attacked fruits, and the impact of insecticides have been evaluated. The four sites of the study were compared by an Ascending Hierarchical Classification (ACH) based on fly populations.

3. RESULTS AND DISCUSSION

3.1 Abundance and Incidence of Flies

In the Korhogo Department the fruits of zucchini were attacked by *B. cucurbitae, D. ciliatus, D. bivittatus* of the family Tephritidae, and *Scaeva pyrastri* of the family Syrphidae (Fig. 1). The averages of the different fly species differed significantly at $\alpha=0.05$, $p=0.000001$ and ddl=44. The Newma-Keuls test showed that *B. cucurbitae,* with a total of 109 specimens, was the most abundant. In addition, no significant difference was observed between the means of *D. ciliatus* (4.75), *D. bivittatus* (2.66), and *S. pyrastri* (2.00) (Fig. 2). These results are similar to those obtained by [10,11,12] on the island of Reunion. According to these authors, *Bactrocera cucurbitae*, *Dacus ciliates,* and *Dacus demmerezi* were the most devastating flies of Cucurbitaceae on this island. According to the results of these authors, the three species of Tephritidae identified are responsible for fruit rot.

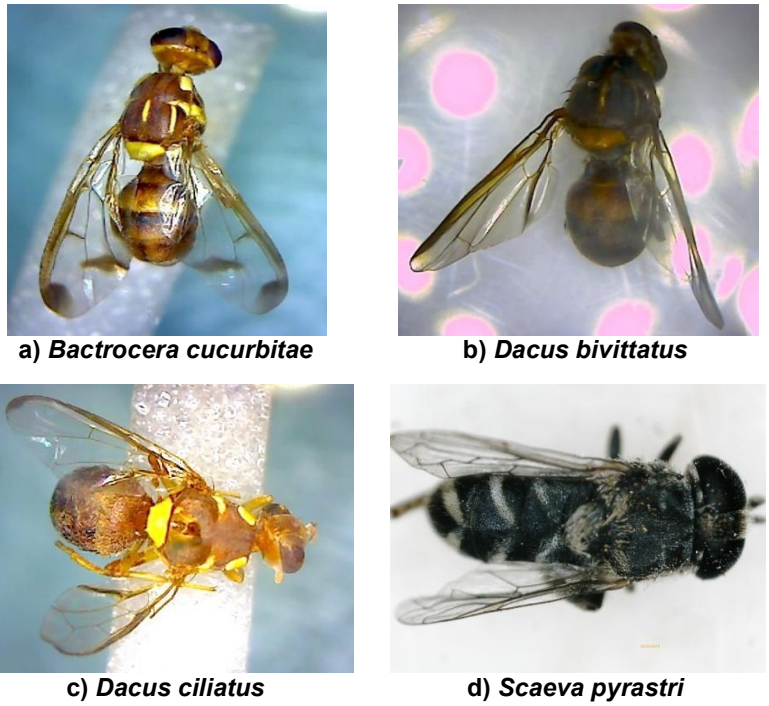
This result is similar to those obtained by [3]. According to this author, female fruit flies lay their eggs in the fruit. At hatching, the larvae feed on the fruit pulp, thus causing the decomposition of the fruit. At the experimental plot level, 86.06% of the fruits were attacked in the rainy season while 13.94% were healthy. In the dry season, 75.48% of the fruits were healthy versus 24.52% of attacked fruits. Regarding the farming environment, 77.35% of the fruits were healthy and 22.65% were attacked. For all four sites surveyed in the dry season, those of Kassirimé and Promafolo were the most infested by the flies with 26.70% and 26.22%, respectively, of fruits being attacked. The site of Takali, with 20.82% of fruit destroyed, was a little less attacked. With an attack rate of 17.26%, fruits from Lataha were the least infested. Based on the fruit infestation rate, the Ascending Hierarchical Classification revealed two groups: the one consisting of the Kassirimé and Promafolo sites, which have the highest infestation rates, opposed to the group formed by the sites of Lataha and Takali with low infestation (Fig. 3). Ultimately, these results suggest that the incidence of flies on fruit depend on the season and the production site.

According to [3], losses related to flies could be between 90% and the total production, depending on the site, the season and the species of Cucurbitaceae. These high losses may explain the low production of zucchini during the rainy season. Indeed, during this study, very few producers of zucchini were counted. The main reason is the poor performance of yield during this season.

3.2 Characteristics of the Flies Harvested

No specimens of *S. pyrastri* emerged from the attacked fruits that were in a poor state of field degradation. Those specimens hatched fruits whose decomposition was already well advanced in the field. As regards three species of Tephritidae, they were found only in the boxes containing stung fruits whose decomposition was in the very early stages. The decomposition of zucchini fruits is not directly due to *S. pyrastri*. The action of this fly is secondary. In fact, during

this study, the fly only emerged from fruit that was in a state of advanced decomposition in the field. This species only lays its eggs on the zucchini when it is in process of decomposition. This observation is consistent with the results of [7]. According to these authors, some zucchini flies are saprophagous.



a) ***Bactrocera cucurbitae*** b) ***Dacus bivittatus***

c) ***Dacus ciliatus*** d) ***Scaeva pyrastri***

Fig. 1. Zucchini flies species

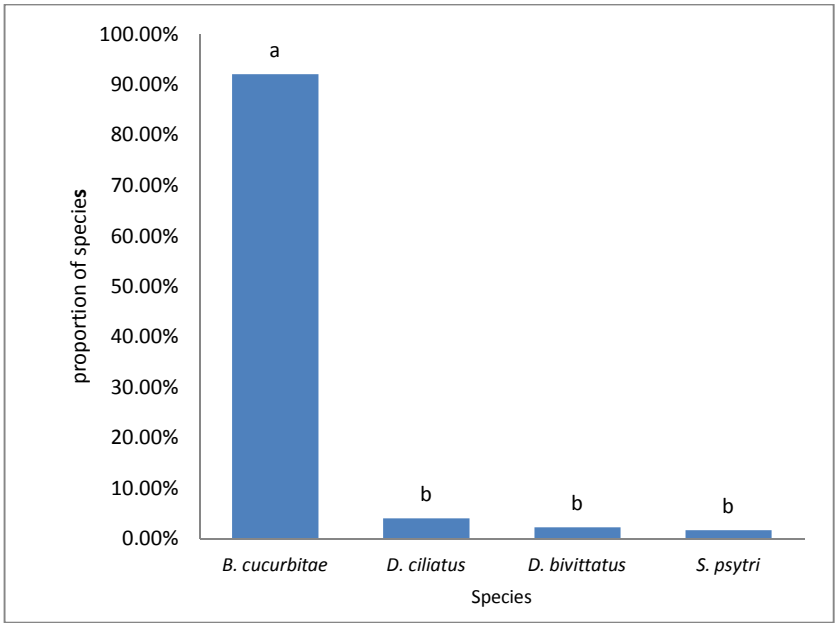


Fig. 2. Proportion of fly species recovered from infested zucchini fruits

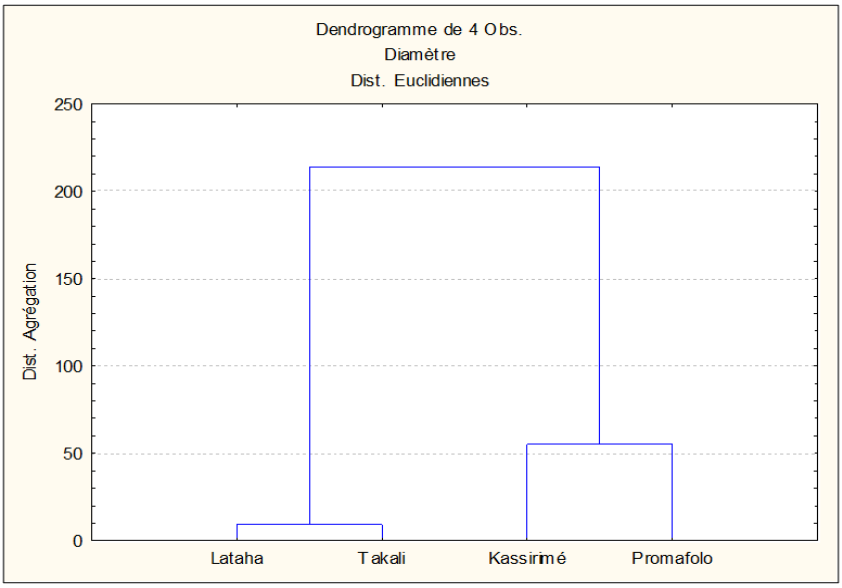


Fig. 3. Classification of collection sites based on fly infestation rate

Table 1. Insecticides used by zucchini producers

Commercial name	Active substance	Plant approved
Lambda 25 EC	Lambda-cytrine	Food crops
Cypercot 336EC	Cyperméthrine 36g /L	Coton,
Tropist P336 EC	Cyperméthrine 36g/L	Coton
Conquest C 88	cyperméthrine 72g/L	Coton
K.optimal	Lambda-cyhalotrine 15g/L	Market gardening
Doni 672 EC	Cypermetrine 36g/L	Coton
Blast 52 EC	Lambda-cyhalotrine 36g/L	Coton
Polytrine 336 EC	Cyperméthrine 36g /L	Coton

3.3 Pest-Control Methods

The investigation revealed that farmers used chemical methods to control pests in zucchini production. Eight (8) types of insecticides were used. These are Lambda 25 EC, Cypercot 336EC, Tropist P336 EC, Conquest C 88, K. Optimal, Doni 672 EC, Blast 52 EC, Polytrine 336 E (Table 1). Among all the pesticides used, 6 (96, 38%) are advised in cotton cultivation, while 2 (3, 62%) are authorized on food crops in Côte d'Ivoire. Therefore, despite the use of these pesticides, insect damage is important. In the farmers' environment, nearly ¼ of the production is lost in the dry season. In addition, due to high parasite pressure and bad phytosanitary practices, very few farmers produce zucchini in the rainy season. In conclusion, the chemical method is not effective in controlling zucchini flies. The inefficiency of the chemical method observed during our investigation could be explained by the fact that zucchini fruits serve only as a substrate for spawning. According to [3] and [11], flies spend more time on refuge plants than on Cucurbitaceae. Females come to zucchini plantations during the flowering period and fruiting only for egg-laying. According to [13], the selection behavior of the plant by flies involves a system of exchange of information between the plant and the phytophagous insect. Perceived information can be of a physical nature (visual stimuli) but is mainly of a chemical nature (volatile compounds emitted by the plant). In addition, the ineffectiveness of insecticides could be related to the way of life of Tephritidaae. In fact, at hatching, larvae develop inside the fruit and pupation occurs in the soil [8] (White & Elson-Harris, 1992). All of these constraints could be the cause of the inefficiency of the chemical method.The investigation revealed that

the pesticides used in zucchini cultivation are not indicated for this plant. This could be explained by the high cost of pesticides approved in market gardening compared to those of cotton. Due to the production of cotton in this area, cotton pesticides are available on the market at low cost. Indeed, cotton companies offer insecticides to cotton growers at the beginning of the season. Moreover, when farmers need money, producers offer pesticides at low prices. In addition, according to the survey, the majority of farmers are unaware of the risks associated with unconventional use of pesticides.

These results are similar to those obtained by [14].

According to these authors, market gardeners in the city of Abidjan and suburbs (Dabou and Anyama) use unapproved pesticides. The phytosanitary practices that are appropriate would be linked to the total ignorance of the producers. According to a study conducted in Abidjan, 73.4% of producers are not aware of the risks of contamination due to their behavior versus 8.3% who claim to know their share of responsibility in the contamination of market garden produce [15]. The majority of market gardeners cannot read. Consequently, they cannot make use of the instructions of good use written on the ambalages of the pesticides. Similar results have been obtained by [16]. According to these authors, the inappropriate use of pesticides is due to the inability of market gardeners to implement the instructions for use on packaging.

4. CONCLUSION

At the end of this research, it emerges that the main zucchini pests in the Korhogo Department are *Bactrocera. cucurbitae*, *Dacus. ciliatus*, and *Dacus. bivittatus* of the family Tephritidae. The species *Scaeva pyrastri* of the family of Syrphidae is not responsible for the loss of fruit; it comes only secondarily after the attack of Tephritidae. Pesticides used by growers in the control of pests are not indicated. Because of the strong presence of flies in the rainy season on zucchini and the damage they cause, the production of zucchini during this season may not be profitable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. European Medicines Agency. Assessment report on *Cucurbita pepo* L. semen, EMA/HMPC/136022/2010 Committee on Herbal Medicinal Products (HMPC). 2012;44.
   Available:www.ema.europa.eu/.../document...assessment_report/.../WC5001.
2. Bharathi TE, Sathiyanandam VKR, David PMM. Attractiveness of some food baits to the melon fruit fly, *Bactrocera cucurbitae* (Coq.) (Diptera : Tephritidae). International Journal of Tropical Insect Science. 2004;24:125–134.
3. Dhillon MK, Singh R, Naresh JS, Sharma HC. The melon fruit fly, *Bactrocera cucurbitae*: A review of its biology and management. Journal of Insect Science, 2005;5(40):16.
   Available:https://doi.org/10.1093/jis/5.1.40
4. Ganie SA, Khan ZH, Ahangar RA, Bhat HA, Barkat H. Population dynamics, distribution, and species diversity of fruit flies on cucurbits in Kashmir valley, India. Journal of Insect Science. 2012;13(65):1-7.
   Available:https://doi.org/10.1673/031.013.6501
5. Jourda JP, Saley BM, Djagoua EV, Kouamé KJ, Biémi J, Razack M. Utilisation des données ETM+ de Landsat et d'un SIG pour l'évaluation du potentiel en eau souterraine dans le milieu fissuré précambrien de la région de Korhogo (Nord de la Côte d'Ivoire) : Approche par analyse multicritère et test de validation. *Télédétection*, Google scholar. 2005;5(4): 339-357.
6. SODEXAM 2017. Etat du climat de l'année 2016 en Côte d'Ivoire. 12 p Côte-d Ivoire consulté le 10/12/2017.
   Available:www.acmad-au.org/wpcontent/uploads/.../stateofclimatein2016
7. Mokam DG, Djiéto-Lordon C, Bilong CFB. Patterns of species richness and diversity of insects associated cucurbit fruits in the southern part of Cameroon. Journal of Insect Science. 2014;14(1):9.
   Available:https://doi.org/10.1093/jisesa/ieu110
8. White IM, Elson-Harris MM. Fruit flies of economic significance : Their identification and bionomics. CAB/ACIAR, London, United Kingdom; 1992.
   Available:https://trove.nla.gov.au/version/43034159. xii, 601 p. : ill. ; 24 cm.

9. White IM. Taxonomy of the dacina (Diptera: Tephritidae) of Africa and the Middle East (Hatfield, South Africa). Entomological Society of Southern Africa. African entomology memoir, 0373-4242; no. 2 BOOK [vi]. 2006;156.
10. Vayssières JF, Carel Y, Coubes M, Duyck PF. Development of immature stages and comparative demography of two cucurbit-attacking fruit flies in reunion island : *Bactroceracucurbitae* and *Dacus ciliatus* (Diptera Tephritidae). *Environ. Entomol*. 2008 ;37(2):307-314.
Available:https://doi.org/10.1603/0046-225X(2008)37[307:DOISAC]2.0.CO;2
11. Bonnet E, Interactions entre les mouches des Cucurbitaceae (Diptera : Tephritidae), une plante hôte (courgette) et une plante piège (maïs) disposée en bandes et patchs intra-parcellaires à La Réunion. Mémoire de Master professionnel « Biodiversité des Écosystèmes Tropicaux » Spécialité « Biodiversité des Écosystèmes Cultivés » Université de La Réunion Année 2009 / 2010.
12. Boyer E. Etude des composés volatils des cucurbitaceae susceptibles d'attirer les femelles de mouches de fruits (diptera : Tephritidae). memoire de stage master 2 mention « sciences du vivant » specialite « valorisation des ressources naturelles » Universite de la Reunion . UFR des Sciences et Technologies. 2012;84.
13. Deguine JP, Lavigne A, Atiama M. Dynamiques des populations de Mouches des légumes durant l'hiver austral à La Réunion. Cah Agric. 2012;21:395-403.
14. Doumbia M, Kwodjo KE. Pratiques d'utilisation et de gestion des pesticides par les maraîchers en Côte d'Ivoire : Cas de la ville d'Abidjan et deux de ses banlieues (Dabou et Anyama) Journal of Applied Biosciences. 2009;18:992–1002.
Available:http://www.biosciences.elewa.org/
15. Wognin AS, Ouffoué SK, Assemand EF, Tano K, Koffi-Nevry R. Perception des risques sanitaires dans le maraîchage à Abidjan, Côte d'Ivoire. Int. J. Biol. Chem. Sci. 2013;7(5):1829-1837.
DOI: 10.4314/ijbcs.v7i5.4
16. Tuo Y, Dougba DN, Michel Laurince Yapo ML, Koua KH. Screening of phytosanitary practices in vegetable growth activities northern of Côte D'Ivoire International Journal of Recent Scientific Research. 2017;8(6):17396-17402.
DOI: 10.24327/IJRSR

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/23522