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Main insect pests of zucchini (*Cucurbita pepo* L), in the dry season and impact on production in Northern Côte d'Ivoire

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Abstract
Zucchini growing is booming in Korhogo in northern Côte d'Ivoire. However, increasing of its production is limited by the action of insect pests. Thus, insects visiting zucchini crops in dry season were collected in 2016 and 2017 from fileting net, coloured traps, pit fall traps and direct observation. This collection was carried out on a plot of 63m^2 set up within the vegetable patch of the Peleforo Gon Coulibaly University of Korhogo. From the inventory it emerged that the entomofauna of zucchini consists of 9 orders and 39 families. Homoptera (2264.4 ± 295 individuals) were the main order, while Aleyrodidae (1481 ± 152.7 individuals) and Aphididae (762.8 ± 315.17 individuals) constituted the most families registered. The main pests are aphids, whiteflies and flies of the family Tephritidae. Aphids and whiteflies suck the sap of plants, and flies are responsible for the loss of one third of the production.

Keywords: Insects, zucchini, dry season, Côte d'Ivoire

1. Introduction
Zucchini is an herbaceous plant of the family Cucurbitaceae. It is a vegetable plant, grown mainly for its fruits. The fruit is rich in protein, amino acids, minerals, vitamins and fatty acids. Zucchini seed and leaf extracts are used in the treatment of many urogenital diseases (European Medicines Agency, 2012) [1]. This vegetable is therefore very important for health. The production cycle of zucchini averages 45 days compared with 90 days for cabbage and 120 days for eggplant (Erard *et al*., 2002) [2]. Currently widely used in cooking in northern Côte d'Ivoire, zucchini cultivation could thus contribute to improving the living conditions of people, as its cycle is short. According to the 2014 estimates of the United Nations Food and Agriculture Organization (FAO), zucchini production in Côte d'Ivoire was 19,296 tons. However the increase of its production is limited by several constraints, in particular the parasite pressure. Given that in the sub-prefecture of Korhogo, the cultivation of zucchini is mainly done in the dry season, the knowledge of the entomofauna of this plant during this season could allow increasing the production by a better management of the pests.

2. Material and Methods
2.1 Study site
This study was conducted over two years during the dry season, on experimental plot housed in the botanical garden of Peleforo Gon Coulibaly University 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 sub-prefecture 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 (Jourda *et al*., 2005) [3]. 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 (SODEXAM, 2017) [4].

2.2 Methodology
2.2.1 Experimental device
The varieties of zucchini used are Aurore F1 and Color F1, main varieties produce in Korhogo. The experimental device was a block of Fisher, completely randomized with two (2) blocks

and five (5) repetitions per blocks. Each variety of zucchini was represented by a block, with two (2) objects (T0=untreated plots, T1=plots treated with approved synthetic insecticide). Treatment was realized once a week. The blocks, were spaced 1 m apart and each made up of 5 elementary plots, making a total of 20 elementary plots for the entire system. Each elementary parcel consisted of 4 holes with gaps of 0.70 m between them. The total area of the experimental plot was 63 m^2 (9m x 7).

2.2.2 Harvest and insect identification

Once a week, four types of harvest were made. The first from the filleting net, the second by direct observation and harvest by hand, the third with the help of coloured plates and the fourth by pit fall traps. The method from the filleting net consisted of lateral and transverse movements in each elementary parcel for 5 minutes. Harvested insects were kept in 70% alcohol pills and a label showing the date of harvest, parcel number, harvest method and crop phase pending identification. The one using coloured plates consisted of placing a yellow plate containing soapy water in each elementary parcel during forty-eight hours, for a total of 20 yellow plates for the whole of the experimental parcel. To sample the mobile epiphytic arthropods, Barber pit, were set up at a rate of one trap in each elementary parcel of the experimental plot for forty-eight hours. These traps consist of a pot embedded in the ground, containing soapy water. These operations were done once a week and insects were kept in the same way as in the case of the filleting net. Concerning direct observation, it consisted of observing all the plants of each elementary parcel of the experimental plot to record the number of individuals per species. Insects that cannot be directly identified were harvested by hand and stored in the same way as in the case of coloured plates.

The insects collected were identified using the identification keys of Delvare and Aberlenc (1989) [5]; Bordat and Arvanitakis (2004) [6]; Picker *et al*. (2004) [7], after the observation of the morphological characters using a magnifying glass of Motic brand at 10X20 magnification. For the most important insects, the identification was pushed to the level of the species.

2.2.3 Effect of insecticide treatments on fruit quality

To evaluate the impact of insecticide treatments on the quality of fruits, the number of good fruits per plant and the average weight per fruit were calculated at harvest on the control and treated plots.

2.2.4 Data analysis

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.

3. Results

3.1 Diversity of the entomofauna

The insects collected were grouped into nine (9) orders and 39 families (Table 1).

At Diptera level, collected insects belonged to twelve (12) families were harvested. These are Agromyzidae, Anthomyidae, Sarcophagidae, Stratiomyidae, Diopsidae, Calliphoridae, Syrphidae, Muscidae, Drosophilidae, Dolicopodidae, Culicidae and Tephritidae.

For the order of the Hymenoptera, the insects collected were grouped into six (6) families. Formicidae, Tenthredidae, Apidae, Ichneumonidae, Halictidae and Sphecidae.

Coleoptera order was represented by seven (7) families, including Coccinellidae, Scarabaeidae, Tenebrionidae, Carabidae, Elateridae, Meloidae and Chrysomelidae.

Concerning the order of Orthoptera, four (4) families have been identified. These are Acrididae, Tetrigidae, Tettigoniidae and Gryllidae.

Similarly, the Homoptera Order was composed of four (4) families. Aphididae, Aleyrodidae, Aphrophoridae and Cicadellidae.

Lepidoptera included three (3) families, including Pieridae, Noctuidae and Nymphalidae.

The order of the Isoptera, Heteroptera and Thysanoptera were represented respectively by the families Termitidae, Coreidae and Thripidae.

3.2 Abundance of harvested insects

For the complete cycle of zucchini, 13895 insects belonging to 9 orders were harvested. A significant difference ($p < 0.005$) was observed between the averages of the various orders harvested. According to the Newman-Keuls test, with an average abundance of 2264.4 ± 295 individuals Homoptera were the main order in zucchini cultivation during the dry season. The second homogeneous group consisted of Diptera (241 ± 40,27), Hymenoptera (223,2 ± 42,41), Orthoptera (22,2 ± 2,05), Coleoptera (21,6 ± 5,38), Isoptera (5 ± 2.96), Lepidoptera (1 ± 0.54), Thysanoptera (0.4 ± 0.24) and Heteroptera (0.2 ± 0.2).

At the level of the families, during the two years of the study, a total of 39 families of insects were identified in the dry season on zucchini. A significant difference between family averages was observed. According to the Newman-Keuls test, Aleyrodidae were the most represented with an average abundance of 1481 ± 152.7 individuals. Aphididae constituted the second homogeneous group with an average abundance of 762.8 ± 315.17 individuals.

Formicidae, Agromyzidae, Anthomyidae, Stratiomyidae, Calliphoridae, Cicadellidae, Muscidae, Acrididae, Syrphidae, Sarcophagidae, Coccinellidae, Apidae, Ichneumonidae, Sphecidae, Dolicopodidae, Termitidae, Diopsidae, Tenebrionidae, Chrysomelidae, Halictidae, Aphrophoridae, Gryllidae, Tetrigidae, Tettigonidae, Drosophilidae, Tephritidae, Scarabaeidae, Noctuidae, Thripidae, Tenthredidae, Elateridae, Meloidae, Carabidae,, Coreidae, Nymphalidae, Pieridae, Culicidae constituted the third homogeneous group. Their average abundance varied between 195 ± 30 and 0.2 ± 0.2 individuals, respectively (Table 1).

3.3 Relative Abundance of Insects by plant phases

3.3.1 Vegetative phase

During the vegetative phase of the zucchini, 4163 insects were harvested. They belonged to 6 orders including and 26 families. The main order of the vegetative phase is Homoptera (81.14%). It is followed by Diptera (10.23%) and Hymenoptera (7.01%). The orders least encountered during this phase were Orthoptera (1.10%), Coleoptera (0.43%) and Lepidoptera (0.07%).

Regarding families, in terms of proportions, Aleyrodidae were the main family of insects colonizing zucchini plots during the vegetative phase. It is followed by families of Formicidae (6.20%), Stratiomyidae (2.52%), Anthomyidae (2.11%), Calliphoridae (1.51%), Agromyzidae (1.30%), and Muscidae

(1.23%). The least common insect families were Syrphidae, Acrididae, Cicadellidae, Aphididae, Coccinellidae, Apidae, Sarcophagidae, Dolicopodidae, Sphecidae, Aphrophoridae, Ichneumonidae, Gryllidae, Halictidae, Tettigonidae, Chrysomelidae, Drosophilidae, Tetrigidae, Noctuidae and Nymphalidae. The size of each of these families is less than 1% for both years of study (Table 1).

3.3.2 Flowering phase

During the flowering phase, 3033 insects divided into 7 orders and 29 families were identified. Of the seven (7) orders listed, the main one was the Homoptera (83.78%). It was followed by Hymenoptera (9.89%) and Diptera (3.99%). The least represented orders were Orthoptera (0.92%), Coleoptera (0.86%) and Isoptera (0.53%). With only one individual harvested, ie 0.03% of the total population, Lepidoptera are the least represented.

At the family level, Aleyrodidae (47.12%) and Aphididae (35.94%) were the main families of insects during the flowering phase of zucchini. They are followed by the family Formicidae with 258 individuals or 8.51% of the total population. With a proportion less than 1% for each, the families of Agromyzidae, Acrididae, Stratiomyidae, Cicadellidae, Anthomyidae, Termitidae, Apidae, Calliphoridae, Muscidae, Coccinellidae, Sarcophagidae, Dolicopodidae, Ichneumonidae, Sphecidae, Chrysomelidae, Halictidae, Syrphidae, Aphrophoridae, Tenebrionidae Tettigonidae, Diopsidae, Tetrigidae, Elateridae, Gryllidae, Meloidae, Pieridae were poorly represented (Table 1).

Table 1: Relative Abundance (%) of Insect Families by Zucchini Phenological Stages

Orders	Famillies	Cc	Vég	Flo	Flo-Fru
Diptera	Agromyzidae	2,36	1,30	0,82	3,72
	Anthomyidae	2,14	2,11	0,53	2,90
	Sarcophagidae	0,46	0,34	0,40	0,57
	Stratiomyidae	1,43	2,52	0,63	1,12
	Diopsidae	0,17	-	0,07	0,25
	Calliphoridae	0,81	1,51	0,49	0,51
	Syrphidae	0,47	0,86	0,23	0,33
	Muscidae	0,55	1,23	0,49	0,16
	Drosophilidae	0,04	0,05	-	0,06
	Dolicopodidae	0,19	0,31	0,33	0,10
	Culicidae	0,01	-	-	0,01
	Tephritidae	0,01	-	-	0,09
Coleoptera	Coccinellidae	0,44	0,38	0,43	0,48
	Scarabaeidae	0,04	-	-	0,07
	Tenebrionidae	0,14	-	0,13	0,24
	Carabidae	0,01	-	-	0,01
	Elateridae	0,01	-	0,03	-
	Meloidae	0,01	-	0,03	-
	Chrysomelidae	0,14	0,05	0,23	0,15
Hymenoptera	Formicidae	7,02	6,20	8,51	6,85
	Tenthredidae	0,01	-	-	
	Apidae	0,42	0,36	0,49	0,43
	Ichneumonidae	0,24	0,14	0,33	0,25
	Halictidae	0,12	0,10	0,23	0,09
	Sphecidae	0,22	0,22	0,33	0,18

Table 2: Relative Abundance (%) of Insect Families by Zucchini Phenological Stages

Orders	Famillies	Cc	Vég	Flo	Flo-Fru
Orthoptera	Acrididae	0,55	0,84	0,73	0,30
	Tetrigidae	0,08	0,05	0,07	0,10
	Tettigoniidae	0,06	0,10	0,10	0,03
	Gryllidae	0,10	0,12	0,03	0,12
Homoptera	Aphididae	27,45	0,60	35,94	40,29
	Aleyrodidae	53,31	79,53	47,12	39,81
	Aphrophoridae	0,12	0,19	0,13	0,06
	Cicadellidae	0,61	0,82	0,59	0,49
Lepidoptera	Pieridae	0,01	-	0,03	-
	Noctuidae	0,02	0,05	-	0,01
	Nymphalidae	0,01	0,02	-	-
Isoptera	Termitidae	0,18	-	0,53	0,13
Heteroptera	Coreidae	0,01	-	-	0,01
Thysanoptera	Thripidae	0,01	-	-	0,03

Cc: Complete cycle; Veg: Vegetative phase; Flo: Flowering phase; Flo-Fruc: Flowering-fruiting phase

3.3.3 Flowering-Fruiting Phase

A total of 6699 insects were identified in zucchini plots during the flowering-fruiting phase. These insects are divided into nine (9) orders and 35 families. Of the nine (9) orders identified during this phase, the main was Homoptera with 5403 individuals or 80.65% of the total population. It is followed by Diptera (9.82%) and Hymenoptera (7.82%). The least common orders were Coleoptera (0.96%), Orthoptera (0.55%), Isoptera (0.13%), Thysanoptera (0.03%), Lepidoptera (0.001%) and Heteroptera (0.001%).

The main families of insects colonizing zucchini plots during flowering-fruiting periods were Aphididae (40.29%) and Aleyrodidae (39.81%). They were followed by Formicidae (6.85%), Agromyzidae (3.72%), Anthomyidae (2.90%) and Stratiomyidae (1.12%). With a population less than 1% for each of them, the families of Sarcophagidae, Calliphoridae, Cicadellidae, Coccinellidae, Apidae, Syrphidae, Acrididae, Diopsidae, Ichneumonidae, Tenebrionidae, Sphecidae, Muscidae, Chrysomelidae, Termitidae, Gryllidae, Dolicopodidae, Tetrigidae, Halictidae, Tephritidae, Scarabaeidae, Aphrophoridae, Drosophilidae, Tettigonidae, Thripidae, Carabidae, Coreidae, Culicidae, Noctuidae, Tenthredinidae were poorly encountered (Table 1).

3.4 Main pests of zucchini in the dry season

During the zucchini cropping cycle in the dry season, a total of 13895 insects were harvested. The major insect families were Aphididae (53.31%) and Aleyrodidae (27.45%), respectively. The Aphididae were represented by the specie *A. gossypii* while the Aleyrodidae were represented by the white fly *B. tabaci*. In addition to these pests, *B. cucurbitae* and *D. ciliatus* flies were responsible for fruit damage. The main pests of zucchini in the dry season were aphids, whiteflies and zucchini flies.

3.5 Action of main pests

The main pests of zucchini during the dry season are sucking biting insects and zucchini flies. Sucking-pruners belong to the order of Homoptera. Homoptera is represented by the families Aphididae, Aleyrodidae, Aphrophoridae and Cicadellidae. Concerning aphids and whiteflies, they were found in colonies on the underside of the leaves. Aphrophoridae and Cicadellidae did not form colonies. All these insects sting and suck the sap in the tender organs thus weakening the plants. The zucchini flies belong to the family Tephritidae. The females of these flies lay their eggs in the young and tender fruits. At hatching, the larva feeds on the pulp, causing the rot of fruit.

3.6 Impact of insecticide treatments on fruit quality

During the two years of the study, 278 fruits were collected on the control plots and 306 fruits on the treated plots. At the control plots, 29.86% of fruits were attacked by flies and 70.14% were healthy. For the treated plot, the attack rate of the fruits was 24.51% and 75.49% of healthy fruits. The average number of fruits per plant was 3.47 on the control plots and 3.82 on the treated plots. In terms of average weight of good fruits, it was 0.68 kg on the control plots and 0.69 kg on the treated plots.

4. Discussion

The entomofauna of the zucchini was evaluated in the dry season in the sub-prefecture of Korhogo. The knowledge of insects in Zucchini crops is the first step in the development of methods to control insect pests of this plant. During the dry season, insects collected belonging to 39 families divided into 9 orders. This great diversity could be explained by the fact that the cultivated plants are conducive to the proliferation of insects. Similar results were obtained by Obodji (2016) [8] during his study on eggplant. This author has identified a diversity of 21 families belonging to 7 orders. The main orders of insects harvested are Homoptera, Diptera and Hymenoptera. Our results are similar to those of Lozano *et al.* (2013) [9], during their study on market gardening in China. These authors showed that the main insect orders in zucchini culture were Hemiptera, Hymenoptera, Diptera and Coleoptera, respectively. These results are different from those of Koné *et al*. (2018) [10] obtained on zucchini in Korhogo. According to these authors, the main orders of insects colonizing zucchini plots are Coleoptera and Diptera. This difference could be explained by the fact that both studies were conducted at different seasons. Koné *et al*. (2018) [10] study was conducted during the rainy season, while ours was conducted during the dry season. It appears that the season influences the entomofauna of the zucchini. The most commonly harvested species during the dry season were *B. tabaci* and *A. gossypii*. This observation is similar to that of Hinds and Hooks (2013) [11], which indicates that the main pests of zucchini are aphids and white flies. These insects have been reported in Côte d'Ivoire on eggplant (Obodji, 2016) [8], on tomatoes (Diabaté *et al*., 2014) [12], and in Jamaica on pepper trees (Mc Donald *et al*., 2003) [13]. This reflects the ability of white flies and aphids to colonize several families of plants. During this study, proportions of these major pests varied according to the phenological stage of the plant. Aphids colonized young zucchini plants early in the vegetative phase. The highest populations were identified during this phase. Then populations gradually decreased during the crop cycle. This could be explained by the ability of these insects to colonize seedlings. In fact, aphids were observed on the plants from the three-leaf stage. These results are close to those of Michael and Donahue (1998) [14] and Fournier (2010) [15]. According to these authors, aphids attack young plants that are most susceptible to wing and wingless contamination. This sensitivity decreases when the plant acquires a certain maturity. For white flies, the lowest proportions were found during the vegetative phase. This number has increased proportionally with the growth of the plant with the greatest outbreak at the end of culture. The abundance of these two species may be related to the absence of rainfall. This has favoured their proliferation over the entire crop cycle. The action of aphids and white flies on zucchini was evaluated. These insects are bitters-suckers. They sting and suck the sap of tender organs. According to Christelle (2007) [16] and Armelle *et al*. (2010) [17], aphids are only phytophagous and feed on plant sap. The food activity of these insects is the channel of transmission of several diseases. Indeed, aphids constitute the largest insect group vectors of pathogenic viruses by transmitting at least 275 viruses (Rabatel 2011) [18]. Moreover, according to Christelle (2007) [16], the food stings of aphids are irritating and toxic for the plant, inducing the appearance of galls which result in the deformation of the leaves or fruits and thus a loss of yield.

About whiteflies, adults and larvae are usually found on the underside of the leaves where they suck sap and transmit more than 110 viruses to plants (Perring, 2001; Jones, 2003) [19, 20]. The sucking of sap weakens the plant and causes physiological disorders, including dwarfism and nerve chlorosis, early maturity, irregular staining of the fruit and death of plants (Brown and Czosnek, 2002) [21]. Zucchini flies were responsible for the loss of one-third of the production, both on the treated plots and on the control plots. The important impact of these flies could be explained by the fact that the development of the larva is inside the fruit, which protects it from insecticide treatments. These results are similar to those of Dhillon *et al*. (2005) [22]. These authors mentioned that, because the larva of the fly grows inside the fruit, insecticide control is difficult. In addition, during the study the number of flies harvested was low. But their damage on the fruits was high. This could be explained by the fact that adult flies do not stay long in the fields. These results are similar to those of Tuo *et al*. (2018) [23]. The work of these authors has shown that Cucurbitaceae flies spend a short time on a zucchini. The females are staying in crop just to lay eggs. Then, they return to their refuge plants. This behavior is also one of the causes of the poor of effectiveness of insecticide treatments in the fight against this pest.

5. Conclusion

The entomofauna of zucchini during the dry season was rich and diversified. It included 9 orders and 39 families. Homoptera were the main order in zucchini cultivation during the dry season. At the level of the families, Aleyrodidae and Aphididae were the most important. The main pests of the vegetative phase and the flowering phase were aphids and whiteflies. These insects caused damage to leaves and flowers. During the flowering-fruiting stage, the main pests were the zucchini flies. They caused the loss of one third of the production. However insecticide treatments did not have an effect on the impact of these flies. In order to increase the production of zucchini in the dry season, an effective control method for Cucurbitaceae flies should be developed.

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7. References

1. European Medicines Agency. Assessment report on *Cucurbita pepo* L. semen, EMA/HMPC/136022/2010 Committee on Herbal Medicinal Products (HMPC), 2012, 44. www.ema.europa.eu/.../document...assessment_ report/.../WC5001, 28 December, 2018.
2. Erard P. The courgette. Centre Technique Interprofessionnel des Fruits et Légumes, 2002, 149.
3. 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. 2005; 5(4):339-357.
4. SODEXAM. État du climat de l'année 2016 en Côte d'Ivoire, 2017, 12. www.acmad-au.org/wpcontent/ uploads/.../stateofclimate in2016 Côte-d'Ivoire. 10 December, 2018.
5. Delvare G, Aberlenc P. Les insectes d'Afrique et d'Amérique tropicale. Clés pour la reconnaissance des familles. Prifas, Cirad-Gerdat, Montpellier, 1989, 302.
6. Bordat D, Arvanitakis L. Arthropodes des cultures légumières d'Afrique de l'Ouest, Centrale, Mayotte et Réunion, Ed. Cirad: Montpellier, France, 2004, 291.
7. Picker M, Griffiths C, Weaving A. Field Guide to insects of South Africa. Cape Town. Edition: Penguin Random House South Africa, 2004, 444.
8. Obodji A. Entomofaune des cultures d'aubergine, *Solanum aethiopicum* L. (Solanaceae) à Azaguié (Côte d'Ivoire), abondance, dégâts et contrôle de *Leucinodes orbonalis* Guenee, 1854 (Lepidoptera, Pyralidae), principal ravageur, au moyen d'extraits aqueux de plantes locales. Thèse de doctorat unique. Université Félix Houphouêt-Boigny, Abidjan Cocody, 2016, 186.
9. Lozano DP, Bosquée E, Lopes T, Chen J, Fa CD, Yong L *et al*. Évaluation de la diversité de l'entomofaune en cultures maraîchères dans l'est de la Chine. Entomologie faunistique. 2013; 66:27-37.
10. Koné K, Tuo Y, Yapo ML, Kouakou KH. Entomofaune de la courgette (*Cucurbita pepo L*) en saison pluvieuse, à korhogo, dans le nord de la côte d'ivoire. Int. J Biol. Chem. Sci. 2018; 12(3):1286-1297.
11. Hinds J, Hooks CRR. Population dynamics of arthropods in a sunn hemp zucchini interplanting system. Crop Protection. 2013; 53:6-12.
12. Diabaté D, Gnago JA, Koffi K, Tano Y. The effect of pesticides and aqueous extracts of *Azadirachta indica* (A.juss) and *Jatropha carcus* L. on *Bemisia tabaci* (Gennadius) and *Helicoverpa armigera* (Hübner) found on tomato plants in Cote d'Ivoire. Journal of Applied Biosciences. 2014; 80:7132-7143.
13. Mc Donald SA, Halbert SE, Tolin SA, Nault BA. Seasonal Abundance and Diversity of Aphids (Homoptera: Aphididae) in a Pepper Production Region in Jamaica. Environ. Entomol. 2003; 32(3):499-509.
14. Michael JB, Donahue JD. Leaf and Stem Feeding Aphids. College of Agriculture. Entomology Program, University of Wyoming, 1998.
15. Fournier A. Assessing winter survival of the aphid pathogenic fungus Pandora neoaphidis and implications for conservation biological control. Thèse Doctorat. Univ Eth Zurich, 2010.
16. Christelle L. Dynamique d'un système hôte-parasitoïde en environnement spatialement hétérogène et lutte biologique Application au puceron *Aphis gossypii* et au parasitoïde *Lysiphlebus testaceipes* en serre de melons. Thèse Doctorat., Agro Paris Tech, Paris, 2007, 43-44.
17. Armelle CD, Nicolas PH, Olivera PO. Aphids (Hemiptera, Aphididae). BioRisk. 2010; 4(1):435-474.
18. Rabatel A. Développement embryonnaire du puceron *Acryhospion pisum*: caratérisation de voies métaboliques et gènes clé dans les interactions trophiques avec *Buchnera aphidicola*. Thèse de doctorat. Institut national des Sciences appliquées de Lyon. France, 2011, 223.
19. Perring TM. The *Bemisia tabaci* species concept. Crop prot. 2001; 20:725-737.
20. Jones DR. Plant viruses transmitted by whiteflies. Eur. J. Plant Pathol. 2003; 109:195-219.
21. Brown JK, Czosnek H. Withefly transmission of plant viruses. Adv. Bot. Res. 2002; 36:65-100.
22. 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.
23. Tuo Y, Koné K, Yapo ML, Koua KH. 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. Journal of Experimental Agriculture International. 2018; 21(2):1-7.