International Journal of Agriculture, Environment and Bioresearch

Vol. 4, No. 02; 2019

ISSN: 2456-8643

RELATIVE ABUNDANCE OF APHIDS IN VEGETABLE CROPS IN THE MARKET GARDEN AREAS OF KORHOGO, SINEMATIALI AND FERKE, NORTHERN COTE D'IVOIRE

Yalamoussa Tuo[1*], Klana Kone[2], Metiehoule Kone[2], Herve Kouakou Koua[2]

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

+225 07407680

[2]Felix Houphouet-Boigny University, Cocody (Abidjan Côte d'Ivoire), Faculty of Biosciences Departement of Zoology, Animal Science and Ecology 22 Bp 1611 Abidjan 22

+225 77384630

ABSTRACT

The increase in vegetable production in northern Côte d'Ivoire is severely limited by insect pests, particularly aphids, whose action is poorly studied. An inventory of aphids was carried out at 600 producers of zucchini, cucumber, cabbage, eggplant and sorrel distributed in the market gardening areas of Korhogo, Sinématiali and Ferkéssédougou by sampling attacked leaves. Similarly, pest control methods and cultural practices have been identified. Analyses showed that vegetable crops in this area were infested by Aphis. gossypii, Aphis. fabae and Aphis. nasturtii. Of these three species, A. gossypii was the most common. The most infested crops were cucumber with 347.22±12.69 aphids and cabbage (326.78 ± 10.56). To control aphids, growers use insecticides, the majority of which are not indicated. In addition, monoculture plants recorded more aphids (749.78 ± 27.82) than those in crop associations (706.44 ± 11.26).

Keywords: Diversity; Abundance; Aphids; Cropping system

1. INTRODUCTION

In Côte d'Ivoire, market gardening is one of the main components of agriculture. They are of great importance in the economic development of cities in northern Côte d'Ivoire (FAO, 2012). These crops play a key role in nutrition and poverty alleviation programmes by contributing significantly to family incomes (Youlou et *al*., 2015). The development of market gardening allows people to consume vegetables containing vitamins and to be less vulnerable to disease. They ensure a healthy life for them by meeting nutritional and medicinal needs (Kahane et *al*., 2005). However, the increase in vegetable crop production is limited by the action of insect pests, particularly aphids. According to Emden et *al*. (1969), these insects cause physical damage by feeding on sap and transmitting viruses to plants. They can transmit more than 50 different viruses to plants (Jeanneaux, 2014). However, in Côte d'Ivoire, very little data exists on aphids. The overall objective of this study is to contribute to sustainable production of vegetable crops through aphid management. Specifically, it aims at assessing aphid diversity and abundance in relation to plant types and cropping systems.

2.METHODS

2.1 Study area

The study was conducted in the dry season in the Districts of Korohogo, Sinématiali and Ferkéssédoudou. These localities are subject to a tropical climate with an alternation of two seasons. A dry season that generally lasts from November to April, characterized by a dry wind called "Harmattan". The rainy season generally begins in April and ends in October. (Coulibaly et *al*. 2016). In each commune, insects were collected on the plots of 40 farmers by speculation. That is 200 market garden producers per commune. The crops sampled were eggplant, cucumber, cabbage, zucchini and sorrel.

2.2 Phytosanitary survey

A phytosanitary survey was conducted with producers in the study area. It consisted in assessing producers' knowledge of aphids and their damage and identifying all pesticides used in aphid control and the different application methods.

2.3 Aphid collection and identification

In each plot sampled, an aphid-infested leaf was collected and stored in pill boxes containing 70% alcohol. For each plot, the farming practice (monoculture or crop association) was recorded. A total of 200 samples per municipality were taken, 40 samples per speculation. For each speculation, 20 samples were taken in monoculture and 20 samples in crop associations. Aphids were identified by observing morphological characteristics with a binocular motic brand magnifying glass at magnification (4 x 10) and using the Leclant identification key, 1999a; Leclant, 1999b; Leclant, 1999c.

3.RESULTS

3.1 Aphid diversity and abundance

Three aphid species have been identified in market gardening in northern Côte d'Ivoire. These were A. gossypii (840 ± 13.93), A. nasturtiii (495.67± 8.66) and A. fabae (120.56 ± 5.81) of the order Homoptera and the family Aphididae. The Kruskal-Wallis test, performed using XLSTAT software, version 2014.5.03, showed that there is a significant difference at $\alpha=0.05$ and $p<0.05$ between these different means.

Taking into account the sites, on average 252 ± 6.69 specimens of A. gossypii, 48.89 ± 5.09 individuals of A. nasturtii and 30.89 ± 5.39 aphids of A. fabae were collected at Sinematiali. A significant difference at $\alpha=0.05$ and $p<0.05$ was also observed between the different means of these aphids.

At the Korhogo site, the average number of specimens of the species A. gossypii (248.44 ± 5.9) was the highest, followed by A. gossypii (189 ± 8.14) and 89.67 ± 3.28 for A. fabae.

In Ferké, according to the Kruskal-Wallis test, the average number of A. gossyoii (339 ± 7.45) was significantly higher than that of A. nasturtii (203.33 ± 5,) at $\alpha=0.05$ and $p<0.05$. No specimens of A. fabae were collected (Figure 1d). This analysis shows that the aphid population

ISSN: 2456-8643

was dominated by A. gossypii followed by A. nasturtii. The species A. fabae was the least encountered.

3.2 Aphid abundance by site

Of all the sites sampled, Ferké with an average population of 602 ± 33 specimens of all species was the most infested. It was followed by Korhogo with an average of 527.11 ± 13.69 individuals. Sinematiali was the site with the lowest number of aphids (326.78 ± 14.53). The Kruskal-Wallis test, performed using XLSTAT software, version 2014.5.03, showed that there is a significant difference between these averages at $\alpha=0.05$ and $p<0.05$.

3.3 Aphid abundance by crop

At all sites, cucumbers recorded 347.22±12.69 aphids, cabbage 326.78 ± 10.56, zucchini 275.44 ±9.91, eggplant 273.67±10.54 and sorrel 233.11 ± 8.04. The Kruskal-Wallis test, carried out using XLSTAT software, version 2014.5.03, made it possible to group the crops into 3 groups according to the number of aphids inferred. This is the group formed by sorrel, eggplant and zucchini, the group formed by eggplant, zucchini and cabbage. The third group is made up of cabbage and cucumber.

At the Ferké site, a variable number of aphids was recorded. Thus, an average of 156.11±6.68 aphids were recorded for eggplant, 148.89 ± 3.76 for cucumber, 106.11 ± 5.55 for zucchini, 96.78 ± 4.49 for sorrel and 94.44 ± 4.90 for cabbage.

In Korhogo, eggplant recorded an average of 86.67 ± 3.54 aphids, cucumber 102.78 ± 2.33 aphids, zucchini 69.89 ± 2.08 aphids, sorrel 79, 33 ± 3.39 aphids and cabbage 188, 44 ± 7, 02 aphids.

In Sinematiali, the average number of aphids was 30.89 ± 2.57 on eggplant, 95.56 ± 11.08 on cucumber, 99.44 ± 7.07 on zucchini, 57 ± 3.74 on sorrel and 43.89 ± 7.41 on cabbage. The various Kruskal-Wallis tests, performed using XLSTAT software, version 2014.5.03, revealed significant differences between the different averages at $\alpha=0.05$. The different multiple pairwise comparisons using the Dunn / Bilateral Tests procedure revealed 2 groups at the Ferké site, 4 at the Korhogo site and 3 at the Sinematiali site (Table 1; 2 ;3).

Table 1: Multiple comparisons in pairs according to the Dunn procedure / Bilateral test: Ferké site case

Sample	Number	Sum of ranks	Average of ranks	Groups		
eggplant	9	48,500	5,389	A		
cabbage	9	124,500	13,833	A	B	
sorrel	9	205,000	22,778		B	C
cucumber	9	318,500	35,389			C
zucchini	9	338,500	37,611			C

Table 2: Multiple comparisons in pairs according to the Dunn procedure / Bilateral test: Korhogo site case

Sample	Number	Sum of ranks	Average of ranks	Groups			
zucchini	9	45,000	5,000	A			
sorrel	9	131,000	14,556	A	B		
eggplant	9	202,000	22,444		B	C	
cucumber	9	288,000	32,000			C	D
cabbage	9	369,000	41,000				D

Table 3 : Multiple comparisons in pairs according to the Dunn procedure / Bilateral test: Sinematiali site case

Sample	Number	Sum of ranks	Average of ranks	Groups	
cabbage	9	78,500	8,722	A	
sorrel	9	103,000	11,444	A	
zucchini	9	196,500	21,833	A	B
cucumber	9	306,500	34,056		B
eggplant	9	350,500	38,944		B

3.3 Influence of the cropping system on aphid diversity and abundance

Overall, the analyses showed that there is a significant difference at α=0.05 between the average aphids harvested in monoculture (749.78 ± 27.82) and that harvested in polyculture (706.44 ± 11.26).

At the Sinematiali site, the Man-whitney test showed that the average number of aphids harvested from polyculture crops (172.22 ± 6.9) is higher than that obtained from monoculture (154.56 ± 10.71).

In Korhogo and Ferké, the Man-Whitney test showed that aphids were more abundant in monoculture. In Korhogo, the average number of aphids was 300.67 ± 19, 17 in comparison to polyculture 226.44 ± 12.46 in polyculture. For Ferké it was 307.78 ± 8, 49 in monoculture and 294.56 ± 9.54 in polyculture.

Taking into account the types of plants, the Man-Whitney test showed that aphids are more abundant on cucumbers when they are used in combination with other plants than in monoculture. On the other hand, for cabbage and eggplant, aphids were more abundant on these plants when combined with other plants than when grown in monoculture. For zucchini and sorrel, no significant difference could be observed between the average aphids harvested in monoculture and polyculture (Table 4 ;5 ;6 ;7 ;8)

3.4 Insecticides used in market gardening

Chemical control was the only control used by farmers to control aphids. A total of 14 pesticides were used in the study area. Of these insecticides, only two were recommended for market gardening. These were K-optimal and Lamba-super 25EC. The other 13 were registered for cotton cultivation. The main insecticides used for aphid control were Cayman 19EC (33.17%), Ema star 112EC (15.50%) and Thalis 56 EC (10%) respectively. These three insecticides are cotton insecticides. For the K-optimal and Lamba-super 25EC insecticides registered on the market gardener, they were used by 2.5% and 1.33% of producers respectively (Table 9).

Table 4: Abundance of aphids according to the cropping system, case of cucumber

Variable	Observations	Obs. with missing data	Obs. with missing data	Minimum	Maximum	Average	Mean Standard deviation
mono	9	0	9	131,000	173,000	151,111	15,870
poly	9	0	9	185,000	217,000	200,000	11,435

Table 5: Abundance of aphids according to the Cropping system, cabbage case

Variable	Observations	Obs. with missing data	Obs. with missing data	Minimum	Maximum	Average	Mean Standard deviation
mono	9	0	9	182,000	208,000	197,222	10,072
poly	9	0	9	115,000	146,000	129,556	10,236

Table 6: Abundance of aphids according to the cropping system, case of eggplant

Variable	Observations	Obs. with missing data	Obs. with missing data	Minimum	Maximum	Average	Mean Standard deviation
mono	9	0	9	125,000	173,000	150,667	15,867
poly	9	0	9	117,000	130,000	123,000	4,359

Table 7: Abundance of aphids according to the cropping system, case of zucchini

Variable	Observations	Obs. with missing data	Obs. with missing data	Minimum	Maximum	Average	Mean Standard deviation
mono	9	0	9	117,000	154,000	136,333	10,794
poly	9	0	9	121,000	150,000	135,222	8,899

Table 8: Abundance of aphids as a function of the cropping system, case of sorrel

Variable	Observations	Obs. with missing data	Obs. with missing data	Minimum	Maximum	Average	Mean Standard deviation
mono	9	0	9	90,000	126,000	114,444	12,982
poly	9	0	9	107,000	135,000	118,667	9,447

Table 9: Pesticides used in market gardening

Commercial Name	Active Ingredients	Proportion of use (%)	Approved Crops
Cayman B 19 EC	Emamectin-Benzoate 19,2g/l	33,17	Cotton
Ema star 112 EC	Acetamiprid 64g/l + Emamectin 48g/l	15,50	Cotton
Thalis 56 EC	Emamectin-Benzoate 20g/l + Acetamiprid 36g/l	10,00	Cotton
Hope 50 EC	Cypermethrin 50g/l	8,50	Cotton
Polytrin 336 EC	Profenofos 300g/l + Cypermethrin 600g/l	8,33	Cotton
Attakan 344 EC	Imidacloprid 200g/l + Cypermethrin 144g/l	6,50	Cotton
Polytrin 186 EC	Cypermethrin 36g/l + Profenofos 150g/l	5,33	Cotton
Super Lambda 25 EC	Lambda-cyhalotrin 25g/l	3,33	Cotton
K-optimal	Lambda-cyhalotrin 15g/l + Acetamiprid 20g/l	2,50	Vegetables
Malaxin	Sulphadoxin 500 mg/l + pyrimethrin 50 mg/l	2,33	Cotton
Dual 336 EC	Cypermethrin 36g/l + Profénofos 300g/l	2,00	Vegetables
Doni 672 EC	Profenofos 300g + Cypermethrin 72g/l	1,67	Cotton
Stork P 336 EC	Profenofos 300g/l + Cypermethrin 36g/l	1,17	Cotton

ISSN: 2456-8643

4. DISCUSSION

Three aphid species were collected from the five targeted specimens in northern Côte d'Ivoire. This low diversity may be due to the fact that it is rare to find several aphid species on the same plant. These results are similar to those obtained by Lozano et *al* (2013) and Lopes et *al* (2011). These authors found two species during their study in eastern China. A species on zucchini and also a species on potatoes. The inventory of aphids in maize crops carried out by Diab (2012) in Rennes, France, made it possible to harvest three aphid species. Ammar et *al* (2007) obtained a single species in pea and rapeseed cultivation in Belgium. Benoufella-Kitous et *al* (2019) recorded 43 aphid species on food legumes

In addition, contrary to the low diversity, analyses showed that the aphid population was high. This abundance could be explained by the fact that the study area has agro-climatic conditions favourable to aphid outbreaks. Indeed, aphids are found in citrus fruits and cotton. As the study area is an area of high cotton and fruit production, market gardening would serve as a relay. According to Bayendi-Loudit et *al* (2017), the most well known insects in market gardening in Gabon are aphids (Aphididae).

In terms of proportion by species, A. gossypii was the most abundant in vegetable crops. This abundance could be explained by the fact that its development is favoured by the dry tropical climate of northern Côte d'Ivoire. These results are close to those obtained by Bakroune (2012). Indeed, according to this author, the species A. gossypii was the most abundant among 25 species collected in vegetable crops at two test stations in Algeria. However, they are different from those obtained by Mostefaoui et *al* (2014) on clementine. According to these authors, the aphids of this plant were rather dominated by Aphis spiraecola. This difference could be related to the type of plant. Indeed, this study took place on market gardening, unlike the Mostefaoui study, which was carried out on a fruit tree.

The high number of aphids harvested in the locality of Ferké could be explained by the fact that market gardening is practised all year round in this area, unlike in the other two areas where, during the rainy season, the plots are used for rice cultivation. This alternation could interrupt the aphid development cycle and could be the cause of the observed population difference. The alternation of crops observed in the localities of Korhogo and Sinematiali could encourage the proliferation of auxiliary animals such as ladybirds, which considerably limit aphid outbreaks. According to Sekkat (2015), due to their soft body and low mobility, aphids are easy prey for a wide range of natural enemies, including 7-point ladybugs.

From the analyses, it emerged on the cucumber recorded the highest number of aphids. This could be due to the fact that aphids have a preference for cucumber over other speculations. Indeed, according to Sekkat (2015), fertility is another factor that favours aphids. Although it varies from one species to another, it remains generally very high and is influenced by temperature and host plant.

The results showed that aphid outbreaks were higher in monoculture than in polyculture. This difference could be related to the repellent odours emitted by some non-host plants observed in polyculture. Indeed, according to Karban, (1993); Karban and Myers, (1989), cited by Ndzana

Abanda (2012), volatile substances emitted by plants play an important role in the location and selection of the host by herbivores. The work of Nottingham et *al* (1991) shows that the aphids Aphis fabae Scopoli, Myzus persicae Sulzer or Brevicoryne brassicae L, whether apterous or winged, are attracted by the odors of their host plants while they are repelled by the odors of non-host plants. The latter may possibly mask the attraction of the former. According to Ndzana Abanda (2012), the diversity of olfactory stimuli perceived by phytophagous plants in a polyculture can mask those that specialized pests use to locate their host plant, causing a slowdown in their establishment or even their departure, as Tahvanainen and Root (1972) have shown. These results are similar to those obtained by Bedoussac et al (2009) in southern France. These authors showed a higher abundance of aphids in pure pea cultivation compared to its association. According to these authors, crop associations are an effective way to reduce pea aphid populations.

In terms of phytosanitary practices, the investigation revealed that the majority of pesticides used by producers in market gardening are not registered on these crops. This could be explained by the fact that cotton pesticides are more accessible because northern Côte d'Ivoire is the main cotton production area. In their operations, cotton companies offer pesticides on credit at the beginning of the season to producers. These cotton producers are most often also producers of market gardening. These results are similar to those of Doumbia and Kwadjo (2009) who state that 61% of pesticides used in vegetable crops in Dabou-Anyama in Côte d'Ivoire are not registered. Similar results were obtained by Tuo et al (2017) in zucchinifarming in Korhogo. For these authors, this is due to the fact that very few market gardeners can read and write in Korhogo.

5. CONCLUSION

Three species of aphids were present in market gardening in northern Côte d'Ivoire. These were *A. gossypii*, *A. fabae* and *A. nasturtii*. This study argues that the cropping system significantly influences aphid abundance. Thus, aphids are more abundant in polyculture than in a combination of several plants. The main aphid encountered in market gardening in the localities of Korhogo, Sinematiali and Ferké was *A. gossypii*. To protect their plants from these pests, growers used a wide variety of pesticides, the majority of which were registered on cotton but not on market gardening. These phytosanitary practices could seriously influence the populations of auxiliary insects that regulate pests and aphids in particular

REFERENCES

Ammar A., Frédéric F., Bernard B. et Éric H.,(2007). Évaluation de la diversité des pucerons et leurs ennemis naturels en grande culture à proximité de parcelles d'orties.152 p. Belgique.

Bakroune Nour-Elhouda., (2012). *Diversité spécifique de l'aphidofaune (Homoptera, Aphididae) et de ses ennemis naturels dans deux (02) stations: El-Outaya et Ain Naga (Biskra) sur piment et poivron (Solanacées) sous abris – plastique.* Masters thesis, Université Mohamed Khider - Biskra.

Bayendi-Loudit, S., Ndoutoume Ndong, A., & Francis, F. (2017). Le maraîchage périurbain à Libreville et Owendo (Gabon): pratiques culturales et durabilité. *Cahiers Agricultures*.

Bedoussac L, (2009). Analyse du fonctionnement des performances des associations blé dur-pois d'hiver et blé dur-féverole d'hiver pour la conception d'itinéraires techniques adaptés à différents objectifs de production en systèmes bas intrants. Thèse de Doctorat, Institut National Polytechnique de Toulouse, France, Spécialité : Agrosystèmes, écosystèmes et environnement, 220 pages.

Benoufella-Kitous, K., Medjdoub-Bensaad, F., & Kheloul, L. (2019). Diversité des pucerons des legumineuses alimentaires dans la region de Tizi-Ouzou. *Entomologie faunistique-Faunistic Entomology*. *Entomologie Faunistique – Faunistic Entomology* 72, 5-12

Coulibaly L, Kouassi K.H., SORO G.E., and Issiaka S., (2016) "Analysis of the savannization process by remote sensing method of northern Côte d'Ivoire: Case study of Ferkessedougou County," *International Journal of Innovation and Applied Studies*, vol. 17, no. 1, pp. 136–143

Diab Al Hassan., (2012). Thèse : rôle et du paysage sur la répartition et l'abondance des pucerons et leurs prédateurs carabique. 202 p. France.

Doumbia M. et Kwadjo K F., (200). 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 Bioscience 18: 992-1002p.

FAO., (2012). Growing greener cities in Africa. First status report on urban and periurban horticulture in Africa. Rome : FAO 116p.

Jeanneaux S., (2014). Lutte contre les pucerons Aphis gossypii par association culturale; agriculture biologique (Pays de Loire). 15-30 p. 176 p.

Kahane R., Temple L., Brat P. et De Bon H., (2005). Les légumes feuilles des pays tropicaux :Diversité, richesse économique et valeur santé dans un contexte très fragile. In : Parrot L., Njoya A.,Temple L., Assogba-Komlan F., Kahane R., Ba Diao M., Havard M. (Eds). Agricultures et Développement urbain en Afrique de l'ouest et du centre : atelier du 30 octobre au 3 novembre 2005, Yaoundé, Cameroun. Montpellier : CIRAD, 9 p.. Colloque Agricultures et développement urbain en Afrique de l'Ouest et du Centre, 2005-10-30/2005-11-03, Yaoundé, Cameroun.

Karban R. (1993). Costs and benefits of induced resistance and plant density for a native shrub, Gossypium thurberi. Ecology, 74: 9-19.

Karban R & Myers H. (1989). Induced plants responses to herbivory. Annual Review of Ecology & Systematics, 20: 331-348.

Leclant F., (1999a). Les pucerons des plantes cultivées : clefs d'identification II cultures maraîchères. INRA, Paris pp 9-14.

Leclant F., (1999b). Les pucerons des plantes cultivées : clefs d'identification II cultures maraîchères. Ed. Association coor.tech. agri.(A.C.T.A.) et Inst. Nati. Rech. Agro. (I.N.R.A.), Paris, 98p.

Leclant F., (1999c). Les pucerons des plantes cultivées, clefs d'identification, volume 3 : cultures fruitières et cultures maraîchères.

Lopes T., Emilie B., Lozano D.P., Chen J.L., DengFa C., Yong L., Fang-Qiang Z., Haubruge E., Bragard C., & Francis F.,(2011). Evaluation de la diversité des pucerons et de leurs ennemis naturels en cultures maraîchères dans l'est de la Chine. Entomologie Faunistique-Faunistic Entomology, 64 (3), 63-71

Lozano D P., (2013). Cultures annuelles des légumes sur une production des cucurbitacées en culture conventionnelle. Lycée professionnel agricole, Mayotte 122 p.

Mostefaoui, H., Allal-Benfekih, L., Djazouli, Z. E., Petit, D., & Saladin, G. (2014). Why the aphid Aphis spiraecola is more abundant on clementine tree than Aphis gossypii?. *Comptes rendus biologies*, *337*(2), 123-133.

Ndzana Abanda, R. F. X. (2012). *Régulation des bio-agresseurs dans les cultures associées de blé dur et de pois: impact de la diversité végétale sur la démographie des pucerons du pois* (Doctoral dissertation, Université de Toulouse, Université Toulouse III-Paul Sabatier).

Nottingham SF, Hardie J, Dawson GW, Hick AJ, Pickett JA, Wadhams LJ, Woodcock CM (1991). Behavioral and electrophysiological responses of aphids to host and non host plant volatiles. Journal of Chemical Ecology 17:1231-1242

Sekkat, A. (2015). Les pucerons du Maroc: abrégé bioécologique des espèces évoluant sur les cultures. *Revue Marocaine de Protection des Plantes*, 2015, N° 7: 1-23

Tahvanainen, J. O., & Root, R. B. (1972). The influence of vegetational diversity on the population ecology of a specialized herbivore, Phyllotreta cruciferae (Coleoptera: Chrysomelidae). *Oecologia*, *10*(4), 321-346.

Tuo Y., Dago N.D., Yapo M.L., & Koua K.H., (2017). Screening of phytosanitary practices in vegetable growth activities northern of Côte d'Ivoire. International Journal of Recent Scientific Research 0976-3031. 8. 17396-17402. 10.24327/ijrsr.2017.0806.0346.

Van Emden, H.F., Eastop, V.F., Hughes, R.D. & Way, M.J. (1969) The ecology of Myzus persicae. Annual Review of Entomology, 14, 197–270.

Youlou F.I, YabiI., Kombieni F. ,. Tovihoudji P. G, A.Y. Jacob, PARAÏSO A. A. , AFOUDA F. (2015). Maraichage en milieu urbain à Parakou au Nord-Benin et sa rentabilité économique Int.J. inovation Sci Res m., 19(2), 290-302