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Research Article

COTTON PLANT DEVASTATORS (HETEROPTERA) ASSOCIATED WITH THE REPRODUCTION PHASE OF COTTON: SPECIES RICHNESS AND ABUNDANCE IN THE AGRO-ECOLOGICAL REGIONS OF TOGO (WEST AFRICA)

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ABSTRACT

It is worth controlling arthropods, cotton plant devastators for a production in quantity and quality. Phytophagous bugs, secondary devastators before 1980 in Togo constitute nowadays an important entomological factor with regard to their density and damage they cause. Their inventory was conducted through young plant felling and threshing in 4 agro-ecological regions. This process shows that these insects connected to floral and fruit-bearing phase are abundant and diversified. 55 species belonging to 7 families have been counted. The family of Pentatomidae is the most represented in species. In contrary, the family of Miridae is the most abundant followed respectively by Pyrrhocoridae and Pentatomidae. The four (4) agro-ecological regions are similar in terms of bugs' diversity. These results can be useful in the improvement of fighting strategies.

Keywords: Cotton plant, Devastative Heteroptera, Abundance and richness, Togo.

INTRODUCTION

Cotton is a driving force for the socio-economic development of cotton producing countries in West Africa. In Togo, despite the decline in production in recent years, cotton is the country's second largest export product after phosphate and the largest agricultural income product. Cultivated in rainfed conditions, its cultivation constitutes both an important source of income for rural producers and currency for the country. Thus, cotton cultivation has an impact on the development of farms, on monetary incomes and on poverty reduction (NSCT, 2013). However, this crop is at its limit of profitability because of the constraints of edaphic, climatic and phytosanitary nature including the control of insect pests. Cotton is one of the most insect-infested crops in the world. Its cultivation is prone to attack by bioaggressors, among whom entomological fauna is one of the most important and difficult to control (Matthews, 1989). In Togo, losses from pest complexes without phytosanitary protection range from 60 to 80% on average (Akantetou, 2014). The geographical extension of this culture, its alternation or association with vegetable and food crops and its genetic improvement have as consequences the evolution of the diversity of the parasitic features with an economic impact of some pests considered as minor a few years ago. Among these pests, the Heteroptera commonly known as bugsconstitute an important entomological factor in relation to their density and the damage they cause to cotton, other cultivated plants and this, at all stages of development. They are very polyphagous (Poutouli, 1992) with many species associated

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with cotton cultivation (Cadou, 1994; Poutouli and Maldes, 2000; Poutouli *et al*., 2012). The damage of bugs is important on the cotton especially in the floro-fructiferous stages. On flower buds and young capsules, the nutritional bites of bugs are directed to the stamens and the contents of the seeds causing their abscission or abortion respectively (Mauney, 1984; Leigh *et al*., 1988; Cadou, 1994; Tozoou *et al*., 2015). On immature green capsules, the damage of bugs is characterized by internal rot, fiber staining (premature opening of the capsules, orange quarter and loss of seed germinated value) (Cauquil, 1988; Bundy *et al*., 2000; Willrich *et al*., 2004; Bommireddy *et al*., 2007). Despite phytosanitary protection, the damage of bugs is currently of concern in every agro-ecological region of cotton cultivation in Togo (Tozoou *et al*., 2014). As a matter of fact, it is necessary to take these bugs into account in the management of the cotton pest complex by appropriate phytosanitary protection methods in order to ensure the profitability and sustainability of the crop. This takes into account knowledge of potential pests, their biology and their behavior. The present study aims to know the abundance, the specific richness of plant bug in the different agro-ecological regions of cotton cultivation in Togo and the similarity of these regions for effective phytosanitary protection strategies.

MATERIAL AND METHODS

Area of study

The study was carried out in 2013 during the agricultural season. It was carried out on the site of the Centre de Recherche Agronomique-Savanes Humides (CRA-SH) in Kolocopé (Plateaux region) at 7°49'N and 1°20'E about 250 km north of Lomé and on 4 Supporting sites(PA) in various cotton-producing agro-ecological regions in Togo: Tantigou RAP (10°52'N and 0°10'E) in the Savannah region; Kabou RAP (9°27'N and 0°47'E) in the Kara region; Babamè RAP (7°60'N and 1°11'E) in the Central region; Amoutchou RAP (7°23'N and 1°10'E) in the Plateau region (Figure 1). The Savannah and Kara regions are characterized by a sub-Sahelian climate (hot and dry) with a rainy season (May to October) and a dry season (November to April). The central region is characterized by a Guineo-Sudanese climate (Rainy) with also a rainy season (May to October) and a dry season (November to April). The Plateaux region is marked by a subtropical climate of Guinean type with two seasons of more or less marked rains (from March to July and then from September to October) and a big dry season (from November to February).

Inventory of Phytophagous Heteroptera associated with the reproduction phase of cotton

The study was carried out on cotton trees with no insecticide protection. The harvesting was carried out by use of two active trapping methods (mowing and threshing) of the plants during the floro-fruiting period of the crop. The mower net was used as harvesting material. The pocket of the mower net is impregnated with a cypermethrin/acetamipride binary (1 ml of product for 50 ml of water). Mowing and threshing of the plants were done once a week (Wednesday) in plots of 20 lines of 20 meters exclusively reserved for these observations. Harvests by mowing covered three cotton lines of 20 metres long and those by threshing on a 20-metre line. A sample of 20 plants was randomly selected on the line and threshed. The insects in contact with the cypermethrin/acetamipride binary of the bag of the mower net are weakened; then the bugs are captured using a mouth aspirator and put in bottles containing ethyl acetate. They were examined and counted in the laboratory. Phytophage Heteroptera have been identified using a reference collection held at the CRA-SH laboratory by Poutouli (1994) and through various studies (Poutouli and Maldès, 2000; Poutouli *et al*., 2012).

To analyze the data, ecological parameters such as abundance (number of individuals) and richness (number of species) were determined. The specific composition of the different locations in the agro-ecological regions was compared using the Sorensen coefficient (Cs). Data related to the presence and absence of different species was used. Thus, the similarity coefficient was calculated using the following formula (Magurran, 1988):

$$C_s = \frac{2j}{(a + b)}$$

a = richness in the first area of study;

b = richness in the second area of study;

j = species common to both areas.

The Sorensen coefficient equals 1 if there is complete similarity between the areas compared to 0 if the latter have no common species. There is similarity between the areas compared if this coefficient is greater than or equal to 0.5. The relative abundance of each species and family was calculated. The relative abundance of a species is the ratio of the number of individuals of the same species to the total number of individuals of all species. It provides information on the importance of each species in relation to all species present.

RESULTS AND DISCUSSION

During the study, 1327 plant bug individuals were harvestedin all the five sites during the floro-fructiferous cotton period. Harvestingwas higher at Kolocope (39.04%) compared to Babamè (17.41%), Amoutchou (15.98%), Kabou (15.30%) and Tantigou (12.28%). From this inventory, it can be seen that cotton plant bugs are abundant and diversified (Table 1). A total of 55 species in 7 families were identified. Although the families of bugs are similar to the sites, the number of species identified is variable: 55 species in Kolocoped, 52, 45, 46 and 34 respectively in Amoutchou, Babamè, Kabou and Tantigou (Table 1). The coefficient of similarity of Sorensen showed

that there is a similarity in the specific diversity in phytophage bugs of the floro-fructiferous phase between the different study sites (Table 2). Thus, the 5 study sites are similar in terms of plant bug diversity in cotton. In general, species richness showed that Pentatomides are best represented (15 species), followed by Coreides (10 species). The Mirides and Lygaeides were equally represented with 9 species. The lowest richnesses were found in Pyrrhocorides (3 species) and Alydides (2 species, Table 3). The Miridae family was more abundant in harvesting at each study site. The relative abundance of this family was 47% in Kolocope, 40.47% in Amoutchou, 45.45% in Babamè, 39.41% in Kabou and 49.08% in Tantigou. This family was followed by Pyrrhocoridae (20.66%) in Kolocopé, (19.34%) in Amoutchou, (19.91%) in Babamè, (24.14%) in Kabou and (19.02%) in Tantigou. The family of Pentatomidae comes next with 16.41% in Kolocope, 16.04% in Amoutchou, 17.32% in Babamè, 17.73% in Kabou and 11.04% in Tantigou. Lygaeidae are 8.69% in Kolocope, 10.38% in Amoutchou, 8.66% in Babamè, 8.87% in Kabou, and 11.04% in Tantigou. The families of Coreidae, Scutelleridae and Alydidae are poorly represented in descending order in the different study sites (Table 4).

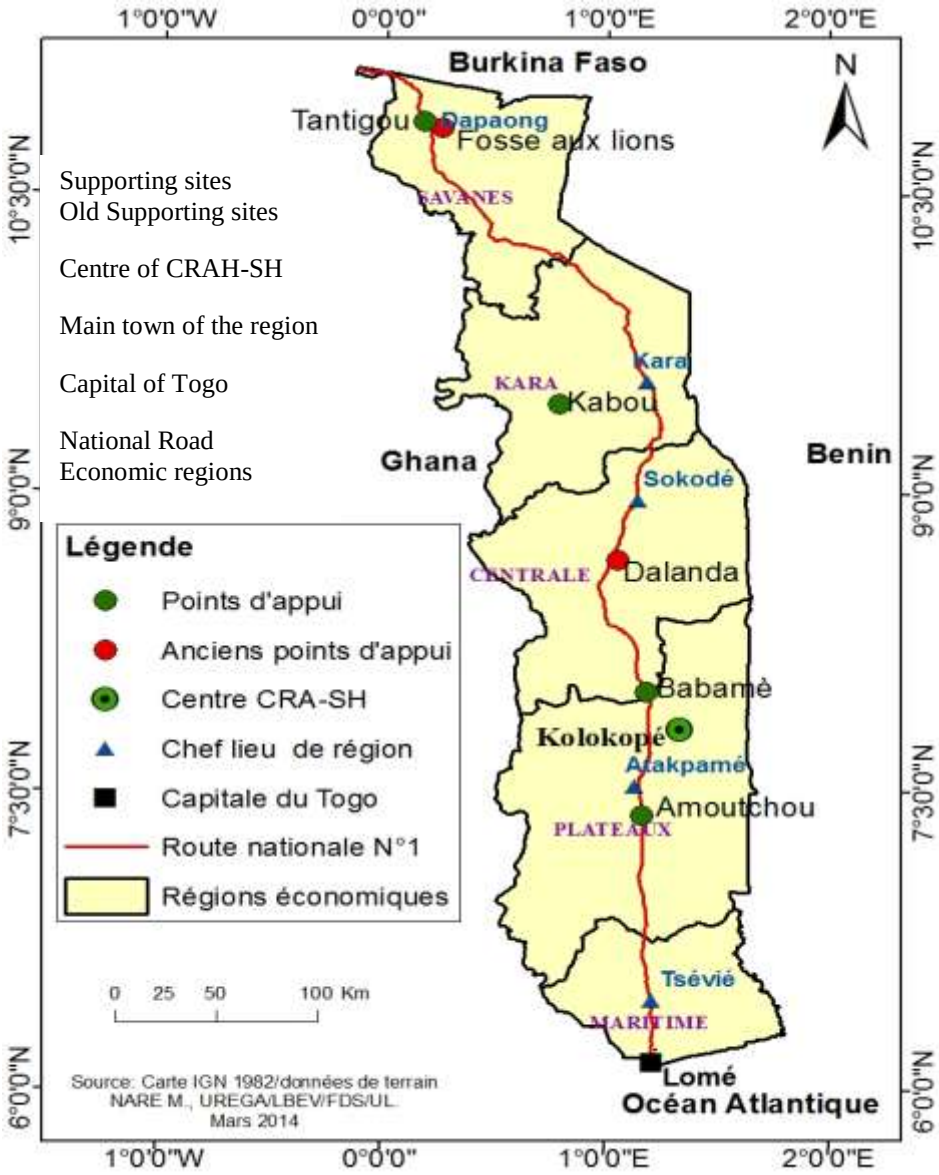

Figure 1.Togo map showing the study sites in each region.

Table 1. Relative ratios and richness of phytophagous bugs in Togo.

Families and identified species	Relative ratio (%)				
	Kolocopé	Amoutchou	Babamè	Kabou	Tantigou
Miridae					
Campylomma unicolor Poppius	1,35	2,36	1,30	0,99	0,61
Creontiades pallidus (Rambour)*	8,88	4,72	5,63	4,43	4,91
Halticus tibialis Reuter*	0,97	0,94	0,87	1,48	1,23
Taylorilygus arboreus (Taylor)*	2,70	4,25	4,76	3,45	1,84
Proboscidocoris fuliginosus Reuter	1,93	1,42	1,73	1,97	1,23
Campilomma subflava Odhiambo	0,39	1,42	2,60	1,48	0,61
Megacoelum apicale Reuter*	22,39	20,28	22,51	21,67	31,9
Helopeltis schoutedeni Reuter*	1,93	0,94	1,30	0,99	1,84
Deraeocoris oculatus Reuter*	3,86	4,25	4,76	2,96	4,91
Pentatomidae					
Acrosternum acutum (Dallas)*	1,54	1,42	2,60	1,97	1,23
Agonoscelis versicolor Bergroth	1,16	0,94	1,73	1,48	1,84
Aspavia armigera (F.)	1,54	0,94	0,43	0,99	1,23
Carbula sp	0,39	-	0,43	0,49	-
Diploxys floweri Distant	0,19	-	0,43	0,99	-
Nezara virudula L.*	3,47	2,83	3,03	4,43	2,45
Piezodorus rubrofasciatus F.	0,39	0,47	0,43	-	-
Pseudatelus spinulosa (P. de B.)*	2,32	1,89	3,46	2,46	1,84
A. pallidoconspersum (Stål)	0,39	0,94	0,43	-	-
Aspavia acuminata Montandon	0,58	1,42	0,43	0,49	0,61
Boerias ventralis (Dallas)*	2,70	2,83	2,60	2,96	1,23
Diploxys cordofana Mayr	0,39	0,47	-	0,49	-
Eudryadocoris goniodes (Dallas)	0,19	0,47	-	0,49	-
Piezodorus pallens (Germar)	0,39	0,94	0,43	0,49	-
P. teretipes Stål	0,77	0,47	0,87	-	0,61
Families and identified species	Relative ratio (%)				
	Kolocopé	Amoutchou	Babamè	Kabou	Tantigou
Scutelleridae					
Calidea dregei Germar	0,97	1,42	1,73	0,99	2,45
Calidea sp	0,39	0,94	0,87	0,49	-
Sphaerocoris annulus F.	0,39	0,47	-	0,49	-
Sphaerocoris testudogrisea De Geer	0,19	0,47	-	-	1,23
Calidea nana H. & H-Sch	0,58	0,94	-	0,99	0,61
Hotea subfasciata (Westwood)*	0,19	0,47	0,87	0,49	1,23
Sphaerocoris ocellatus Klug	0,58	0,47	0,87	0,49	-
Coreidae					
Acanthocoris collarti Schouteden	0,58	1,42	0,43	0,49	0,61
Clavigralla horrida (Germar)	0,39	0,47	0,43	0,49	1,23
Anoplocnemis curvipes (F.)	097	0,94	0,43	0,99	1,23
Cletus sp	058	0,47	0,43	0,49	-
Mavanidea granulifera Reuter	0,19	0,47	-	0,99	-
Clavigralla curvipes Stål	1,54	0,47	0,43	0,49	0,61
C. tomentosicollis (Stål)	0,19	0,47	0,87	-	-
Cletus ochraceus H-Sch	0,39	0,47	-	-	-
Homoeocerus sp	0,58	0,47	-	0,49	-
Petalocnemis sp	0,39	0,47	-	0,49	-
Lygaeidae					

Aspilocoriphus fasciativentris Stål	0,58	0,47	1,30	0,99	0,61
Geocoris sp	0,39	1,42	0,43	0,49	-
Lygaeus fuscatus F.	0,39	0,47	0,87	0,49	0,61
*Oxycarenus fieberi Stål**	2,12	2,83	2,16	3,94	3,68
O. dudgeoni Distant*	1,54	1,89	1,73	0,99	1,84
*O. hyalinipennis (Costa)**	2,32	1,89	1,30	1,48	3,68
Spilostethus rivularis (Germar)	0,39	0,47	0,43	-	-
Geocoris amabilis Stål	0,58	0,94	0,43	0,49	-
Graptostethus servus F.	0,39	-	-	-	0,61
Pyrrhocoridae					
*Dysdercus fasciatus (Signoret)**	0,77	1,89	2,16	1,97	1,23
*D. superstitiosus (F.)**	1,54	1,42	2,60	2,96	-
*D. voelkeri Schmidt**	18,34	16,04	15,15	19,21	17,79
Alydidae					
Mirperus jaculus (Thunberg)	0,39	0,94	0,87	0,99	0,61
Riptortus dentipes (F.)	0,39	1,42	0,43	-	-
Total number of individuals	518	212	231	203	163
Number of species	55	52	45	46	34

* Common depredators of cotton

The most abundant species during the floro-fructiferous phase, if we consider all the sites, are respectively: *Megacoelum apicale* (22.83%) of the collected individuals), *Dysdercus voelkeri* Schmidt (16.28%), *Creontiades pallidus* (6.48%), *Deraeocoris oculatus* (4.07%), *Nezara viridula* (3,84 %), *Taylorilygus arboreus* (3,32 %), *Boerias ventralis* (3,01 %), *Oxycarenus fieberi* stål (2,71 %), *Pseudatelus spinulosa* (2,58 %) et *Acrosternum acutum* (1,88 %). The presence of eggs and/or larvae on cotton plants indicates that this crop promotes the development of bugs. Thus, 30.09% of the identified species are common cotton depredators (Table 1) that have carried out their life cycle on this plant. It can therefore be considered as a host plant for these common depredators of cotton.

Table 2.Similarities between the different study sites in terms of specific diversity in cotton plant phytophagous bugs.

	Sorensen coefficient of similarity			
Study site	Kolocopé	Amoutchou	Babamè	Kabou
Tantigou	0,764	0,767	0,785	0,775
Kabou	0,911	0,896	0,857	-
Babamè	0,9	0,886	-	-
Amoutchou	0,972	-	-	-

Table 3. Richness of different families of plant bugs.

Phytophagous bugs family	Richness (number of species)
Pentatomidae	15
Coreidae	10
Miridae	9
Lygaeidae	9
Scutelleridae	7
Pyrrhocoridae	3
Alydidae	2
Total	55

Table 4. Relative abundance of different plant bug families identified at study sites.

Phytophagous bugs family	Relative aboundance (%) Study sites				
	Kolocopé	Amoutchou	Babamè	Kabou	Tantigou
Miridae	44,40	40,57	45,45	39,41	49,08
Pyrrhocoridae	20,66	19,34	19,91	24,14	19,02
Pentatomidae	16,41	16,04	17,32	17,73	11,04
Lygaeidae	8,69	10,38	8,66	8,87	11,04
Coreidae	5,79	6,13	3,03	4,93	3,68
Scutelleridae	3,28	5,19	4,33	3,94	5,52
Alydidae	0,77	2,36	1,30	0,99	0,61

The knowledge of the predatory bugs depending vitally on fruiting cotton plant in the different agro-ecological zones of Togo is the first step in the development of control methods against these pests in the country. After identification, 55 species of phytophagous bugs, all known to be pests of cotton were listed. The results confirmed the richness and diversity of the entomofauna of agrosystems in tropical regions, which often include several crops grown according to various polycultural models (Gethi and Khaemba, 1991). In Togo, Poutouli (1994) lists 85 species in a maize, cotton and cowpea crop rotation, 56 of which were found in the cotton crop alone at Kolocopé. Silvie *et al* (1993) recorded pests other than bugs in the same crop rotation and in the same locality: 45 on cotton, 21 on maize and 13 on cowpea. This places cotton at the top of the list of crops hosting the most pests. This observation had already been made by other authors (Hargreaves, 1948; Dième, 1980). Several identified pests have been reported in West Africa (Deeming, 1981; Doumbia and Bonzi, 1989; Lecoeur and Vaissayere, 1991, Nibouche, 1992; Tchibozo, 1995). In Ivory Coast, the inventory of the entomofauna of cotton by Lecoeur and Vaissayre (1991) identified 51 species of phytophagous Heteroptera, a number close to that inventoried in Togo (Poutouli, 1994) and in this study. The inventory of insects associated with cotton cultivation by Nibouche (1992) in Burkina Faso revealed 93 phytophagous species including 26 species of Heteroptera, a number close to that found in this study in Tantigou (34), located close to that country. The main families of species obtained by this author are those found in the different agro-ecological zones of Togo, with the exception of the family Dinidoridae represented by the species Coridius (Aspongopus) viduatus (Fabricius) in Burkina Faso. In total, 30 species, i.e. 54.54% of the identified species are common to the different agro-ecological zones. The different sites belonging to each agro-ecological zone are similar in terms of specific diversity of phytophagous cotton bugs. This result suggests that the host plants associated with these different species of bugs is present in the different sites. With the work of Poutouli (1994) in Kolocopé, it is now known that more than 33 cultivated or wild plant species, belonging to 12 botanical families, are likely to host eggs, larvae and adults of Heteroptera.

Indeed, 13 cultivated species belonging to 6 botanical families and 22 non-cultivated species belonging to 9 families were identified as host plants of phytophagous bugs. The same results also showed that the Fabaceae family was well represented among the host plants and that the Malvaceae family hosted more phytophagous bugs that developed there. Our observations in the different study sites showed that the cultivated Heteroptera hosts are in a cultural association with other species in the crops and that the non-cultivated hosts are weeds growing in the fields and are observed in both the rainy and dry seasons. The abundance of Mirids, Pyrrhocorids and Pentatomids in the different study sites and the similarity of the sites in terms of richness of bugs showed that these pests are real handicaps to cotton crops. However, the extent and the precocity of the colonisation of a crop by pests largely determine the extent of the damage caused to it. The abundance of Pyrrhocoridae, Pentatomidae and Miridae among the phytophagous Heteroptera of cotton is consistent with the results of Hofs *et al*. (2013) in Burkina Faso. Indeed, these authors concluded, by following the population dynamics of Hemiptera on Bt and non-Bt cotton, that Cicadellidae (Typhlocibinae), Pyrrhocoridae, Pentatomidae, Coreidae and Miridae have a great impact on the cotton crop in this country. The same work showed a high frequency of these insects on the Bt cotton crop and an increase in individuals on both crops (Bt and non-Bt cotton) in a dominant trend in the population dynamics of these Heteroptera families. The most abundant bug species (*M. apicale*, *D. voelkeri* Schmidt, *C. pallidus*, *D. oculatus*, *N. viridula*, *T. arboreus*, *B. ventralis*, *O. fieberi stål*, *P. spinulosa* and *A. acutum*) and those (*Helopeltis shoutedeni* and *Campylomma spp*) in this study are known to be common pests of cotton in Africa and Madagascar (Silvie *et al*, 1989; Couilloud, 1989; Cadou, 1994; Poutouli, 1994). The other species of phytophagous bugs observed in this study have been reported on cotton in Africa and Madagascar, sometimes quite regularly as adults. For them, cotton is only a temporary food plant, but susceptible to be damaged by these insects. *Deraeocoris oculatus* has been reported as a mixed diet bug species (Poutouli, 1992; Cadou, 1994; Wheeler, 2000).

CONCLUSION

The phytophagous Heteroptera entomofauna of the cotton reproduction phase is rich and much diversified in the agro-ecological regions of Togo. The results of this inventory allowed the identification of 55 phytophagous species divided into 7 families. In our study conditions, the family Pentatomidae was the most represented in terms of species richness. The family Miridae was the most abundant and dominant, followed respectively by Pyrrhocoridae and Pentatomidae. The different localities surveyed in the agro-ecological regions are similar to each other in terms of phytophagous bug diversity. The most abundant and dominant species were identified. Of the 55 phytophagous species inventoried, 30.09% are common pests of cotton. Sustained attention in the field is therefore necessary, throughout the country, in order to monitor the evolution of the population dynamics of the various species observed.

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