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Full Length Research Paper

Investigations on biology and host plants of the pentatomid sorghum bug (*Agonoscelis pubescens* (Thunb.)) in Sudan

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Among the major national pests in Sudan, sorghum bug (*Agonoscelis pubescens*) represents a big threat to sorghum (*Sorghum bicolor*) production in central rain fed belt north of latitude 11°N. The pest enters a resting period from November to July, and resumes activities with the onset of the rainy season (August-October). In spite of the intensive chemical control directed annually to the resting adults, the pest almost keeps the same trend every year. Therefore, this research aimed to through light on certain aspects of the insect's biology and host plants, which may lead to find out ecological means of control. The results showed that the first generation of *A. pubescens* produced directly after resting period was significantly weaker than the last generation that attacks the crop, as with respect to fertility, egg hatchability, and development. This revealed the critical role of the first generation in subsequent pest multiplication and crop damage. Moreover, the distribution areas, resting sites and preferred hosts utilized for resting or feeding purposes were indicated. The area lies east of the Blue Nile River ranked first in infestation level, followed by Darfur and lastly Kordofan States. The findings obtained were considered as important baseline data for ecological management.

Keywords: *Agonoscelis pubescens*, sorghum, resting sites, host preference, Sudan.

INTRODUCTION

Among the important national pests in Sudan, sorghum bug (*Agonoscelis pubescens* (Thunberg), which belongs to the order Hemiptera (family: Pentatomidae), is a serious pest of sorghum which known locally as the "Dura Andat". It is found mainly in rain fed and some irrigated areas in central belt of the country north of the latitude 11°N, with isohyets between 250 and 800mm. The pest is also widely spreading in most African countries south of the Sahara (King, 1908; Whitefield, 1929; Whitefield and Cameron, 1932; Joyce, 1955; Schmutterer, 1969; Pelley and Le-Pelley, 1979; Adamu *et al*., 1999). In Sudan, sorghum (*Sorghum* spp.) and sesame (*Sesamum indicum*) are the main hosts, but other crops (e.g. *Triticum vulgare*, *Helianthus annus*, *Medicago sativa* and *Vicia faba*) and some wild plants (e.g. *Leucas urticifolia*, *Heliotropium* spp. And *Ocimum basilicum*) are also attacked (Schmutterer, 1969; Mohamed, 1977; Kannan, 1989; Khalid, 2002; Moneer and Adam, 2004). The adults and sometimes the final nymphal instars generally feed on the crops when they are in the milky stage and cause atrophied grains (Whitefield, 1929; Bilal, 2003). Twenty or more bugs per head of sorghum crop may destroy all the grains so that the entire head becomes sterile. Heavy outbreak can therefore result in complete loss of the crop (Schumtterer, 1969). Razig (1986) reported that *A.*

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pubescens could damage 20-30% of the sorghum crop, but in certain times total losses can occur.

However, *A. pubescens* is very active, feeding and breeding, during the rainy season from August to October or up to mid November, followed by a resting period during the dry season from November to July when the adult bugs clustered in large numbers around hundred thousands of individuals on certain trees and shrubs for nine months without feeding or breeding (Schmutterer, 1969; Razig, 1986). Based on this adaptive behaviour with ecology of the area, the intensity of feedings on ripening grains of cultivated crops during the last period of active phase, leads to substantial accumulation of fats and other metabolic compounds which sustain the bugs during the resting period. Mariod *et al*. (2007) indicated that the total lipid content of sorghum bug is 60% of the insect dry weight. That is why the voracious feeding of adult bugs coinciding with the milky stage of sorghum and other crops constitutes a profound threat to the annual production of such stable food crops. Although, the country spends millions of pounds annually for controlling this pest particularly during the resting period, the number of insect populations invades the crops almost keeps the same trend every year (Whitefield, 1929; Whitefield and Cameron, 1932; Schmutterer, 1969; Razig, 1986).

Biological and ecological studies are considered very important in pest management for pinpointing the weak link in the life cycle of a pest and to find the optimum time and suitable measure(s) of control. Regarding *A. pubescens*, few studies were found on its biology and ecology, and even the number of the insect generations during the year is a controversial issue in Sudan (Whitefield, 1929; Schmutterer, 1969; Razig, 1986; Khalid, 2002). Hence, in this research a laboratory investigation was carried out to see the differences in some aspects of the lifecycle between the first and last generation of the pest. Moreover, the distribution areas of the pest, resting locations, and important host plants utilized for resting, feeding and/or breeding purposes in the field were also highlighted.

MATERIALS AND METHODS

This study sheds light on certain biological and ecological aspects of *A. pubescens* with emphasis on their host plants in Sudan. These aspects were fulfilled through laboratory and field investigations during 2008/09, besides the accumulated annual field data reported by the Plant Protection Directorate (PPD), Ministry of Agriculture.

Laboratory studies

Laboratory studies were conducted to compare the biological strengths between the first generation (produced immediately after resting period) and the last generation (which attacks sorghum before returned back to resting) of sorghum bug during the active period. Adults of *A. pubescens* moved to the weeds at the end of resting period were collected from Sennar area during August 2008, and reared in the laboratory at the Environment and Natural Resources Research Institute, National Centre for Research, Khartoum. The purpose was to study the fertility (in terms of average number of eggs produced per egg batch) of these insects and the survival of eggs and nymphal stages produced by such first generation of the pest. Male and female pairs were kept in mesh cages (30X30X40cm) with three replications, fed on sesame pods, and observed daily for oviposition. The eggs laid by each couple were counted and transferred to glass jars covered with muslin cloth, where the numbers hatched and their survival and subsequent development into adults were followed. The same experiment was repeated during October using the last generation which supposed to invade the cultivated crops (sorghum). The data recorded from all the studied parameters were compared statistically among the two generations, based on Completely Randomized design.

Field surveys

Sporadic surveys of sorghum bug areas were conducted at Sennar, Blue Nile and White Nile States during 2008/09. Meanwhile, nine natural forests were inspected around Sennar area in April-May 2008, where the numbers of different tree species and percent colonized by sorghum bugs were roughly determined per each forest. Hence, the prevalent tree species exploited as resting sites by the sorghum bug were listed, and other observations were taken. Also, host preference was studied among six dominant tree species exhibiting the highest clustering of bugs. Such preference was realized from population levels of resting bugs counted on three randomly selected branches per each tree. On the other hand, observations on wild and cultivated plants utilized for feeding and breeding purposes by the bugs were also indicated through several surveys during the rainy season (August-October). Accordingly, a list of important host plants was prepared. However, more information regarding the distribution of the pest in other parts of the country, locations of resting sites and host plants utilized during resting and active periods were computed from the field data of bug surveys recorded by the PPD for six years (PPD, 2003-2008). Therefore, the important bug areas and preferred host plants were designated based on population levels of the bug.

Table 1. Comparison of fecundity and survival of egg and nymphal stages produced by the first and last generations of *Agonoscelis pubescens* during its active period.

Pest generation	Means (±S.E.) offspring produced and developed by each generation		
	No. Eggs laid/ batch	Eggs hatched/ batch	No. developed to adults
First generation	23.6 ± 1.9 b	11.9 ± 1.0 b	07.4 ± 0.9 b
Last generation	39.5 ± 3.6 a	31.9 ± 3.4 a	27.3 ± 2.8 a

Table 2. Results of surveys conducted at Sennar area (average of nine forests) showing the average numbers of tree species and percent colonized by *Agonoscelis pubescens*, during April-May 2008.

Tree species	Aver. No. trees/ forest		Tree species	Aver. No. trees/ forest	
	Total	% colonized		Total	% colonized
Caesalpinia sp.	0.8	7.8	*Acacia seyal*	76.1	03.9
Capparis deciduas	5.6	2.8	*Acacia tortilis*	06.0	07.2
Lagerstroemia indica	1.7	1.1	*Azadirachta indica*	12.2	30.0
Acacia albida	0.8	1.1	*Acacia nilotica*	331.0	35.0
Ziziphus spina-christi	20.2	9.4	*Balanites aegyptiaca*	105.9	83.3

RESULTS AND DISCUSSION

Biological studies

The results of biological studies on the first and last generations of *A. pubescens* are shown in Table 1. It is clear from this table that insects coming from the resting sites have very low fertility rates compared with the subsequent generations produced later in the field. Adults of the last generation produced significantly higher numbers of eggs (aver. 39.5 ± 3.6/ batch) than those of the first generation (23.6 ± 1.9). Moreover, the numbers of hatched eggs and numbers of nymphs developed into adults (per batch) were also significantly higher in the last generation. Although, the meager literature available on these aspects reflected controversial results on the number of insect generations produced during the year, but agreed with the present research regarding the variability in strengths of these generations. Khalid (2002) showed gradual increases in fecundity from the first (213.9 ± 27.4) up to the third (336.1 ± 99.9) generation of the pest under laboratory conditions. The insect is known to store plenty of fats and other metabolic compounds during the active period (Mariod *et al*., 2007) so as to be utilized in resting stage. However, the kind of host plants fed upon seems to indicate the magnitude and probably the quality of the energy reserved. Therefore, it appears that the amount of consumed energy in resting period more or less affected the subsequent fertility and vitality of adult bugs migrating to the field. Since the duration of the resting phase was found to be linked with the availability of suitable host plants in the field (Khalid, 2002), the modification of this factor in future strategy to extend the resting period might be of crucial impact in weakening the reproduction ability of the pest.

According to the current findings, the resting adults of *A. pubescens* were found to produce little number of eggs with very low vitality and weak development as compared with that of the last generation produced at the end of active period. Therefore, such later generations are the actual cause of population buildup which threatening crop yields at the end of autumn season. These later generations seem to gain their superior fertilities and strong developmental viabilities after a journey of extensive feedings and breeding in the field. Consequently, controlling the first weak generation before breeding can be of significant value in cutting the way for the subsequent generations' threats to sorghum and other crops. This study pay attention to the importance of studying the different generations produced in the field before and after insects' invasion to cultivated crops, which might help in pinpointing the weak linkages in the annual life cycles for designing appropriate control measure.

Field Results

From the field surveys of nine forests at Sennar area ten of major plant species were investigated and compared as resting habitats for the pest. Table 2 reflected the relative density of these plants and the average percentage of plant individuals colonized by the pest for each plant species. However, from the studied plants *Acacia nilotica*, *Balanites aegyptiaca*, *Acacia seyal*, *Ziziphus spina-christi* and *Azadirachta indica* were the most abundant trees. On the other hand, the most colonized trees by the pest were nearly the same as previous species including *Balanites aegyptiaca*, *Acacia nilotica*, *Azadirachta indica* and *Ziziphus spina-christi*, in

Table 3. The important plant species utilized by *Agonoscelis pubescens* either for sheltering or feeding and breeding purposes in Sudan.

Plant species used for resting		Plant species used for feeding and/or breeding	
Scientific name	Local name	Scientific name	Local name
Acacia albida	Haraz	*Acalipha indica*	Umimairat
Acacia mellifera	Kitir	*Amaranthus viridis*	Lissan Tair
Acacia nilotica	Sunt	*Cajanus cajan*	Adasi
Acacia nubica	Laot	*Calotropis procera*	Usher
Acacia senegal	Hashab	*Cassia senna*	Senamakka
Acacia seyal	Taleh	*Cyperus rotundus*	Seada
Acacia tortilis	Seyal	*Datura stramonium*	Sakran
Albizzia spp.	Dignelbasha	*Digera muricata*	Lablab
Azadirachta indica	Neem	*Euphorbia* spp.	Umlebeina
Balanites aegyptiaca	Heglig	*Helianthus annus*	Zahrat Shams
Boscia senegalensis	Mukhet	*Heliotropium* spp.	Danb Elagrab
Cadaba rotundifolia	Kermt	*Leucas urticifolia*	Umgalloat
Caesalpinia sp.	Sesaban	*Medicago sativa*	Berseem
Capparis deciduas	Tundub	*Ocimum basilicum*	Rehan
Citrus spp.	Mawalih	*Pennisetum typhoideum*	Dukhun
Combretum spp.	Habil	*Saccharum officinarum*	Gasab Succar
Eucalyptus spp.	Ban	*Sesamum indicum*	Simsim
Mangifera indica	Mango	*Solanum dubium*	Gubbain
Psidium guajava	Guava	*Sorghum* spp.	Dura
Pheonix dactylifera	Nakheil	*Triticum vulgare*	Ghamh
Ricinus communis	Khirwaa	*Vicia faba*	Ful Masri
Ziziphus spina-christi	Sider	*Vigna unguiculata*	Lubia Hilu
-	-	*Xanthium brasilicum*	Ramtouk

a descending order. The rest of plants were the least abundant and the least infested. These results partially concurred with Bilal (2003) and Bilal and El Bashir (2004) who indicated the preferred trees for resting as; *Acacia nilotica* and *Balanites aegyptiaca* in Blue Nile, *Eucalyptus camaldulensis* and *Acacia nilotica* in the Rahad scheme area, and *Balanites aegyptiaca* and *Acacia albida* in Northern Darfur. These authors concluded that preference for sheltering sites is influenced by the geographical distribution of trees.

The conducted surveys were also assisted in preparing a list for the important plant species exploited by sorghum bug whether for sheltering or for feeding and breeding purposes (Table 3). This table included scientific and local names of 22 and 23 plant species utilized for resting and feeding, respectively. It is obvious that the resting hosts were principally natural trees, fruit trees and some shrubs, while the feeding hosts were restricted mostly among weeds and cultivated crops, besides some shrubs. Comparing six tree species from the previous list for host preference as resting sites in two States (White Nile and Sennar), revealed that *Balanites aegyptiaca*, *Ziziphus spina-christi* and *Acacia nilotica* sustained significantly the highest populations of clustering adults in both States (Table 4). The depiction of the average population in the two States reflected the same ranking of preference (Figure 1). This result more or less confirmed what has been detected in Table 2, as these trees were included among the five highly colonized hosts. Though, little information is found about host preference of *A. pubescens*, most of the listed hosts besides few others were found reported in scattered literature (Schmutterer, 1969; Mohamed, 1977; Razig, 1986; Kannan, 1989; Khalid, 2002; Bilal, 2003; Moneer and Adam, 2004).

According to PPD (2003-2008), the results of the annual surveys regarding the pest counts in various sheltering habitats (forests, weeds and rocks) at different States were summarized in Table 5. Forests of trees and shrubs represent the dominant sheltering habitat in most areas of *A. pubescens* in Sudan. However, in areas where rocks and small bushes are available, the pest seems to prefer these sites for sheltering, although another sorghum bug species, *Carbula pedalis*, is also known to prefer resting in mountains caves. Higher percentages of weed thickets in Gedarif, Sennar, Blue Nile and Darfur States were generally occupied by higher bugs compared with forests, whereas mountain crevices

Table 4. Host preference for resting *Agonoscelis pubescens* among six prevalent tree species at White Nile and Sennar States, during 2008/09.

Tree species	Mean No. of insects/ 3 branches per tree	
	White Nile State	Sennar State
Balanites aegyptiaca	2067.22 a	3577.11 a
Ziziphus spina-christi	1811.78 ab	3076.67 a
Acacia nilotica	1565.33 b	2974.44 a
Capparis deciduas	1499.00 b	1380.56 b
Azadirachta indica	582.56 c	931.33 bc
Acacia albida	949.67 c	625.44 c
C.V.%	18.51	20.84

Means followed by the same letter(s) in each column are not significantly different (p=0.05) according to Duncan's Multiple Range test.

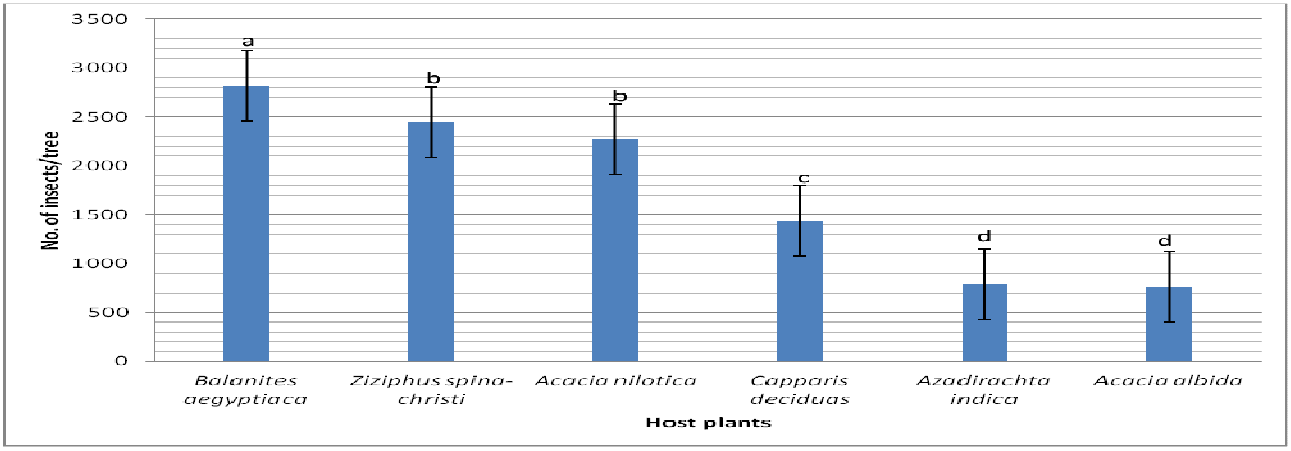

Figure 1. Mean (±S.E.) numbers of *Agonoscelis pubescens* recorded resting on six tree species at two States (White Nile and Sennar), 2008/09.

Table 5. Mean percent of different habitat sites (forest, weeds or rocks) colonized by the resting adults of *Agonoscelis pubescens*, during six years of surveys (2003-2008)*, at different States of the Sudan.

State	Mean percent habitat infested by *A. pubescens* (2003-04)			
	Forest	Weeds(Shrubs)	Rocks	Overall mean
Kassala	19	33	63	38.3
Gedarif	39	46	-	42.5
Khartoum	50	-	-	50.0
Gezira	69	-	-	69.0
Sennar	36	51	82	56.3
Blue Nile	25	81	79	61.7
Upper Nile	11	-	-	11.0
White Nile	22	-	-	22.0
South Kordofan	20	19	31	23.3
North Kordofan	26	-	-	26.0
West Kordofan	7	28	23	19.3
South Darfur	39	43	84	55.3
North Darfur	56	68	42	55.3
West Darfur	45	50	47	47.3

*Data obtained from annual records of PPD, Khartoum 2003-2008.

were more targeted for sheltering in Kassala, Sennar, Blue Nile, and Darfur. Based on these data, the area lies east of the Blue Nile river including parts of the Gezira, Gedarif, Sennar and Blue Nile States, and extended east up to Kassala and down north to Khartoum, ranked first in infestation level, followed by Darfur and lastly Kordofan States. However, the present compilation of data gave more insight on sorghum bug distribution and its preferable sheltering places in various areas. The results obtained also confirmed the previous records (Schmutterer, 1969) regarding the general occurrence of *A. pubescens* in different parts across the central belt of the country.

CONCLUSION AND RECOMMENDATIONS

Although, *A. pubescens* is an old economic pest in Sudan essential research gaps are still found concerning different biological and ecological aspects of the insect life. The detected variability in fertility and survival rates among the two studied generations of the bug proved the importance of biological status in pest control. Therefore, the number of insect generations and their relative durations and biological strengths need to be studied all over the active period. Moreover, the results of field investigations particularly of sheltering and feeding preferences may provide significant baseline data for a future ecologically sound control. A part from ecological studies, emphasis should also be paid on indigenous natural enemies and their interactions with *A. pubescen*s both during resting and active periods.

REFERENCES

Adamu RS, Dike MC, Onu I, Ogunlana MO (1999). Influence of planting date and spacing on the infestation and damage to two soybean varieties by insect pests at Samaru-Zaria. Niger. J. Entomol. 16: 32-41.

Bilal AF (2003). Some aspects of the biology, physiology and ecology of *Agonoscelis pubescens* (Thnb.) (Hemiptera: Pentatomidae) and the environmental implications of its chemical control. Ph.D. Thesis, Graduate College, University of Khartoum, Khartoum, Sudan.

Bilal AF, El Bashir ME (2004). Identification, ecology and population biology of resting *Agonoscelis pubescens* (Thnb.) (Hemiptera: Pentatomidae). The Second National Pest Management Conference in the Sudan, 6-9 December 2004, Faculty of Agricultural Sciences, University of Gezira, Sudan.

Joyce RJV (1955). Some observations on the effect of insecticides on the growth of cotton plant. Emp. Cott. Gr. Rev., 32: 266-237.

Kannan HO (1989). Dura andat *Agonoscelis pubescens* (Pentatomidae), as a pest of faba bean in EL-Rahad, Sudan, FABI Newsletter 23: 24-25.

Khalid MAA (2002). Studies on the biology and ecology of *Agonoscelis pubescens* Thunb. (Hemiptera: Pentatomidae) in Dinder District, Sudan. M.Sc. Thesis, Faculty of Agriculture, University of Sennar, Abu-Naama, Sudan.

King HH (1908). Report on economic entomology, Sudan Government 3rd Rep. Well. Trop. Res. Labs., 201-248.

Mariod AA, Matthäus B, Eichner K, Hussein IH (2007). Fatty acids composition, oxidative stability and transesterification of lipids recovered from melon and sorghum bugs. Sudan J. Sci. and Technol. 8: 16-20.

Mohamed EG (1977). Studies on the Heteroptera of the Sudan with special reference to species of agricultural importance. Ph.D. Thesis, Faculty of Agriculture, University of Khartoum, Sudan.

Moneer MI, Adam DA (2004). A report on dura andat control campaign at Kosti, Assalya and Elmeganes (February and May). Plant Protection Directorate, Ministry of Agricultural, White Nile State, Sudan.

Pelley RH, Le-Pelley RH (1979). Some scelionid egg-parasites reared from coffee bugs (*Antestiopsis* spp.) and from annual pentatomid pests. *Entomophaga*, 24 (3): 255-258.

PPD (2003-2008). Annual Reports of sorghum bug surveys and control at different States for the years 2003 – 2008. Plant Protection Directorate (PPD), Ministry of Agriculture, Khartoum North, Sudan.

Razig AA (1986). Control strategy against the millet bug, *Agonoscelis pubescens* based on forecast system. In: (eds.) El Bashir *et al.*; Crop Pest Management in the Sudan. Proceedings of a Symposium held in Khartoum, Feb. 1978, Khartoum, Sudan. pp. 251 – 256.

Schmutterer H (1969). Pests of Crops in Northeast and Central Africa. Gustav Fisher Verlag Stuttgart Portland,U.S.A.. 296 pp.

Whitefield FGS (1929). The Sudan millet bug, *Agonoscelis versicolor* F. *Bull. Ent. Res.*, 20: 209 – 224.

Whitefield, F.G.S. and Cameron, W.P.L. (1932). The Sudan dura bug, *Agonoscelis versicolor* F. Wellcome Tropical Research Laboratories, Entomological Division. Bull. No. 28.