Journal of the Saudi Society of Agricultural Sciences (2013) 12, 67–71

King Saud University

Journal of the Saudi Society of Agricultural Sciences

www.ksu.edu.sa
www.sciencedirect.com

FULL LENGTH ARTICLE

Studies on biology and ecology of *Galeatus scrophicus* Saunders (Hemiptera: Tingidae) in Sudan

Abdalla Abdelrahim Satti *, El Imam El Khidir

Department of Alternatives to Pesticides and Biocontrol, Environment and Natural Resources Research Institute, National Centre for Research, P.O. Box 6096, Khartoum, Sudan

Received 8 April 2012; accepted 7 July 2012
Available online 16 July 2012

KEYWORDS

Galeatus scrophicus;
Life cycle;
Distribution;
Host range;
Seasonal abundance

Abstract Among insect fauna reported in Sudan, *Galeatus scrophicus* Saunders, was detected earlier in last century, and known as a pest of sunflower. Nevertheless, very limited research works have yet been conducted on this pest. Therefore, this study was proposed to cover certain bio-ecological aspects of *G. scrophicus*, including host range, geographical and intra-host distributions, seasonal abundance and life cycle of pre-adult stages. Such parameters were fulfilled through surveys, field experiments and laboratory works. The results revealed seven host plants for the pest under the family Compositae, viz., *Helianthus annus* L., *Lactuca sativa* L., *Lactuca taraxifolia* (Willd.) Schumach, *Sonchus cornutus* Hochst. Ex Oliv. + Hiern, *Sonchus oleraceus* L., *Xanthium brasilicum* Vell. and *Pluchea diosecoridis* (L.) DC., all of them, except the former species, were new records. Higher numbers of nymphs and adults were reported on the upper surfaces than on the lower sides of plant leaves. However, the pest was found in all sunflower areas in central Sudan. The seasonal counts showed that the highest population of the pest occurred in winter as compared with autumn season. On the other hand, the mean total durations of pre-imaginal stages were shorter in autumn (14.12 ± 0.15 days) than in winter (25.27 ± 0.26) season. Therefore, some detrimental factors that seem to suppress the pest population buildup in autumn were suggested, and recommended for additional studies so as to design appropriate ecologically sound control measures.

1. Introduction

Different insects were recorded as economic pests of agricultural crops in Sudan, depending on the prevailing biotic (e.g., natural enemies and host plants) and abiotic (climatic conditions) factors (El Khidir, 1960; Venkatraman and El Khidir, 1967; Schmutterer, 1969; Gaddoura et al., 1984). Among these insects, *Galeatus scrophicus* was found preserved in the Insect Collection of the Agricultural Research Corporation as early as 1926. It was reported as a pest of sunflower (*Helianthus annus* L.) crop in the Blue Nile and Khartoum Provinces. Afterwards, the morphological characteristics of *G. scrophicus* were described by Gaddoura (1977), who confirmed the damage inflicted by this pest to sunflower as the only host plant recorded in the country.

* Corresponding author. Mobile.: +249 916017797.
E-mail address: satisattisat@yahoo.com (A.A. Satti).

Peer review under responsibility of King Saud University.

ELSEVIER Production and hosting by Elsevier

1658-077X
http://dx.doi.org/10.1016/j.jssas.2012.07.001

Globally, *G. scrophicus* is found in several countries especially in Africa, Mediterranean region, Middle East and Asia. So, the pest is prevalent in a number of countries in Afro-Asian Arab region. However, variable incidences of damage were exerted on sunflower crop, as the main host plant in these countries. In addition, the Niger plant (*Guizotia abyssinica*) is the second important host attacked in some countries (Drake and Ruhoff, 1965; Schmutterer, 1969; Verma et al., 1974; Rao and Thirumalachar, 1977; Rohilla et al., 1980; Onder and Lodos, 1983; Al Mallah, 1999).

However, due to the meagre research that limited to certain morphological features of *G. scrophicus*, local information on biology, ecology and control of this pest is entirely lacking.

Therefore, this study was proposed to fill the research gaps on certain bio-ecological aspects of *G. scrophicus*, including host range, distribution, seasonal abundance and life cycle of pre-adult stages. Such parameters were tackled through surveys, field trials and laboratory works.

2. Materials and methods

2.1. Field surveys of host plants and distribution

Field surveys of host plants for *G. scrophicus* were carried out mainly at Khartoum State, but different areas in some other States were also sporadically checked in the period 2009–2011. Besides sunflower, several cultivated and wild plant species, particularly among the family Compositae, were randomly investigated in search of new hosts. Species of plants showed damage or infestations by lace bugs and the area where encountered were listed. Samples of the detected insects were taken from each host to the laboratory for further studies and species confirmation based on morphological descriptions given by Gaddoura (1977). Accordingly, updated information on the current host range and important distribution areas in the country were recorded for the pest.

2.2. Intra-host distribution and seasonal abundance

The intra-host distributions of nymphs and adults of *G. scrophicus* between upper and lower leaf surfaces were studied on two varieties of sunflower (HYSUN33 and HSHA9) during winter season. However, the seasonal population densities of the pest were followed on the same varieties grown in two field experiments conducted during winter (November–January) and autumn (August–October) seasons (2010/11) in Khartoum State. Each variety was grown in plots (5.0×6.0 m) of five ridges with three replications. Seeds were sown 20 cm apart, and thinned after germination to one plant per hole. Moreover, the population levels of *G. scrophicus* were also counted on two wild plants (*Xanthium brasilicum* and *Lactuca taraxifolia*) during winter. Therefore, regular weekly counts of insects were carried out per 50 leaves (5 leaves from each 10 randomly chosen plants) per replicate of each plant during both seasons (Satti and Nasr, 2000, 2006). The levels of lace bugs were compared among the two varieties of sunflower, as well as among the two wild plants, applying the F-test analysis.

2.3. Durations of the pre-adult stages

Life cycle studies of pre-adult stages were performed during autumn (August–October) and winter (January–February) seasons on sunflower (cv. HYSUN33) and a wild host (*Lactuca taraxifolia*). Such stages included pre oviposition period, egg-incubation and durations of the different nymphal instars.

Adults of the pest were collected from the previous hosts, and then the intended durations were followed on the same hosts under laboratory conditions. Such plants were grown in small plastic pots with three replications to study the pre-oviposition and incubation periods, but due to the failure to grow *Lactuca* seeds such stages were followed on sunflower seedlings. Hence, newly emerged sexed adults were released on the sunflower seedlings, enclosed with glass housing and covered on its top vent with muslin cloth tied with a rubber band. These insects were transferred daily to new pots, with each one being labelled and dated. From daily investigations, the number of days from adult's emergence up to the day of the first oviposition on seedlings was indicated as the pre-oviposition period, while the days from insects' removal to egg hatching represent incubation period. Thereafter, a number of newly hatched nymphs were transferred individually to Petri dishes, each lined with a moist filter paper and a fresh plant leaf (renewed daily), where the durations of different nymphal instars of the pest fed on each of the two plants were followed. These dishes were inspected twice a day (morning and evening), during which moulted insects were recorded, hence the average durations were calculated.

3. Results and discussion

3.1. Detected host plants and general distribution

The results of field surveys conducted in different parts of the country have revealed that seven host plant species, belonging to the family Compositae, were attacked by *G. scrophicus*. These included two cultivated crops, sunflower *Helianthus annus* L. and lettuce *Lactuca sativa* L., and five wild plants [i.e., *Lactuca taraxifolia* (Willd.) Schumach., *Sonchus cornutus* Hochst. Ex Oliv. + Hiern, *Sonchus oleraceus* L., *Xanthium brasilicum* Vell. and *Pluchea diosecoridis* (L.) DC.]. The first three wild species are locally named ''moleita'', while the rest two are called ''Ramtouk'' and ''Rehan ElGadawil'', respectively. All these hosts, except sunflower, were considered as first records in Sudan. The result added the lettuce (*L. sativa*) as the second cultivated plant among the host range of the pest. However, *G. scrophicus* was already reported, locally and abroad, as a pest of sunflower (Drake and Ruhoff, 1965 and Gaddoura, 1977), but no literature was encountered anywhere regarding the other recorded hosts.

Considering geographical distribution, the surveys indicated the presence of the pest on one or more of the listed host plants in several parts of the country, namely; Khartoum, River Nile, Gezira, Gedarif, Blue Nile and White Nile States. Consequently, all sunflower areas in central Sudan were found attacked at variable levels. Since the previous studies have designated only two distribution areas (Khartoum and Blue Nile provinces), the current findings proved wider occurrence of the pest in most parts of the country.

Table 1 The intra-host distribution of adults and nymphs of *Galeatus scrophicus* (Mean ± S.E.) between upper and lower leaf surfaces of *Helianthus annus* (two varieties), during winter season.

Variety / Leaf side	HYSUN33			HSHA9		
	Adults	Nymphs	Adults + Nymphs	Adults	Nymphs	Adults + Nymphs
Upper	3.5 ± 1.5^{ns}	16.1 ± 4.3^{ns}	19.7 ± 4.4^{ns}	4.9 ± 3.0^{ns}	22.3 ± 6.4^{ns}	27.3 ± 8.2^{ns}
Lower	1.3 ± 0.2	9.4 ± 3.5	10.7 ± 3.3	0.5 ± 0.3	8.7 ± 4.4	9.2 ± 4.8

ns = non significant.

Table 2 The monthly mean populations (per 50 leaves) of *Galeatus scrophicus* on two varieties of sunflower grown during winter and autumn seasons.

Variety/month	Winter		Variety/month	Autumn	
	HYSUN33	HSHA9		HYSUN33	HSHA9
November	0.8	1.1	August	0.0	2.0
December	22.3	28.0	September	2.2	6.7
January	58.4	84.1	October	2.3	21.6
Average	27.2 ± 13.3	37.7 ± 19.4^{ns}	Average	1.5 ± 0.6	10.1 ± 4.4^{ns}

ns = non significant.

3.2. Intra-host distribution and seasonal abundance

The feeding damage by *G. scrophicus* was observed to start mainly at the leaf marginal area, and then extends progressively inwards. Damage spots appear firstly as small white batches which increases gradually in sizes as the nymphs grow. This occurred because of the gregarious feeding habit of the nymphs. In severely infested plants the whole leaves were ruined and turned dark brown to blackish colour, as a result of insect excreta, looking as if they were burned. Such characteristic damage was found to occur mainly on the upper surfaces and sometimes on the lower sides of leaves, in connection with the insect aggregations.

Therefore, the results of studying intra-host distribution of the pest on the two tested varieties (Table 1) confirmed that the congregations of both adults and nymphs were always higher on the upper than on the lower surfaces of leaves, though no significant differences were found. The reasons governing this distribution are still in the dark. However, the finding contradicted what have been reported by Al Mallah (1999) in Iraq, who showed that the insect preferred the lower part of the plant and lower surface of the leaf. The latter author proved that the number of insects depicted significantly positive and negative correlations with the temperature and humidity levels, respectively. Accordingly, it was thought that the distribution of the pest is largely linked to climatic conditions rather than to the kind of host.

The results of seasonal population counts of *G. scrophicus* on the two sunflower varieties are shown in Table 2. During both winter and autumn seasons the populations of insects increased gradually to show their peaks at the end of each season. However, the latter season showed very low infestation incidences (average 1.5 ± 0.6 and 10.1 ± 4.4 insects/50 leaves, on HYSUN33 and HSHA9, respectively) as compared with those of the winter season (27.2 ± 13.3 and 37.7 ± 19.4). Fortunately, the results explained that HYSUN33, the widely grown variety, sustained relatively lower infestation levels than HSHA9, but without significant differences between them. Moreover, Table 3 showed the monthly mean counts of the pest on two wild hosts (*Xanthium brasilicum* and *Lactuca taraxifolia*) during the winter. It is clear that such wild hosts were subjected to higher infestations than the sunflower varieties, with *X. brasilicum* being the most susceptible host among the studied plants. Similarly, the population numbers of the pest on the wild hosts also showed progressive increase towards the end of the season. However, the drop in insect counts depicted on *X. brasilicum* from January onwards was found to be coincided with severe powdery mildews infection which caused drying of leaves. As noticed in the field, *X. brasilicum* appeared to be the most susceptible plant species to powdery mildews, a disease that seems to render the plant inconvenient for insect pests' infestation.

Table 3 The monthly mean populations (per 50 leaves) of *Galeatus scrophicus* on *Xanthium brasilicum* and *Lactuca taraxifolia* during winter season.

Month	*Xanthium brasilicum*	*Lactuca taraxifolia*
November	143	10.8
December	241.8	19.6
January	48.5	90
Average	144.5 ± 45.0*	40.1 ± 20.2

* Significant difference.

The lowest population densities of *G. scrophicus* recorded during autumn, as compared with winter season, may necessitate more studies on this aspect. Nevertheless, various reasons were suggested to share in this phenomenon including; mechanical killing of insects by rain splashing, effect of high humidity enhanced by the rainfalls and the possible activities of natural enemies. For instances, Hanna (1950) and El Khidir (1960) reported detrimental effects of rainfalls splashing on

Table 4 The durations of pre-adult stages of *Galeatus scrophicus* on *Helianthus annus* (cv. HYSUN33) and *Lactuca taraxifolia,* during two seasons.

Season/host	Mean (±S.E.) durations							Total pre-adult
	Pre-oviposition	Incubation	Nymphal instars					
			1st	2nd	3rd	4th	5th	Total	
Autumn									
H. annus	2.6 ± 0.2	6.4 ± 0.1	1.7	1.1	1.2	1.3	2.2	7.7 ± 0.2	14.1 ± 0.2
Lactuca sp.	–	–	1.7	1.2	1.2	1.3	2.3	7.8 ± 0.3	14.2 ± 0.2
Winter									
H. annus	4.8 ± 0.2	10.8 ± 0.2	3.1	2.2	2.4	2.5	4.4	14.5 ± 0.3	25.3 ± 0.3
Lactuca sp.	–	–	3.3	2.5	1.7	2.8	4.3	14.6 ± 0.4	25.4 ± 0.3

–, Not studied.

populations of some pests. However, the effect of humidity was suggested among the depressing factors of *G. scrophicus* based on the results raised by Al Mallah (1999) as mentioned before. Al Mallah (1999) showed that the pest occurred on sunflower in Iraq from April to November. Earlier in India, the same pest exhibited an outbreak on sunflower during May–September (Verma et al., 1974). However, putting in mind the difference in timing of the rainy season in different regions, which is actually summer rains in Sudan (August–October), as opposite to winter rains, the contradicted seasonality levels of *G. scrophicus* which were supposed to be affected by humid periods among these regions were justifiable.

3.3. Durations of the pre-adult stages

The different durations manifested by the pre-adult stages of *G. scrophicus* were indicated (Table 4). Regarding the nymphal instars, the fifth one showed the longest duration, followed by the first instar, while the three intermediate stages were the shortest. Comparing the results on the two plants, the nymphal and total periods were more or less similar on the wild and cultivated species, during both seasons. However, the durations of the different stages in winter were nearly doubling those recorded in autumn. They showed an average egg to adult life span of about 14 and 25 days in autumn and winter seasons, respectively. Such life cycle study was the first one to be carried out on *G. scrophicus* in the country.

Based on the current findings, it is extraordinary to see that shorter life cycle durations were coupled with the lower population densities of the pest in autumn, and vice versa in winter season. The results obtained on other lace bugs (e.g., *Urentius* spp.) in the country proved that shorter life cycle durations were connected with higher populations of lace bugs in autumn, as opposite to winter season (Satti and El Khidir, unpublished). However, the contradicted results attained in this study may advocate the presence of certain adverse conditions (biotic and/or abiotic) impeding *G. scrophicus* buildup in autumn season, as discussed above. However, rainfall was suggested among the main factors delaying upsurge of the pest in this season. As explained in intra-host distribution, the highest occurrence of insects on the upper surfaces of leaves indisputably subjected them to wash out and devastation through falling rains. However, due to the lack of information on these aspects, more future investigations are required to clarify the real situation for proper management of the pest.

4. Conclusion

The results explained that *G. scrophicus* is not merely a pest of sunflower in the country, as seven host plants (cultivated and wild) were recorded to be attacked. The detected wild hosts showed wider distribution and higher infestation than the cultivated plants, hence, represent the real reservoir for the pest which may put additional burden on control. The pest also manifested wider prevalence in different States showing its peak populations in winter season. Since the shorter life cycle of the pest was found to be connected with the lower population abundance in autumn, several detrimental factors were suggested, and recommended for further investigations. Answering such questions may contribute in designing appropriate strategic measures for enhancing the natural control that currently apparent on the cultivated hosts.

References

Al Mallah, N.M., 1999. First record and biological study of *Galeatus scrophicus* Saund. and *Galeatus helianthi* O. and L. attacking sunflower crop in Iraq. Arab University Journal of Agricultural Sciences 7 (2), 673–688.

Drake, C.J., Ruhoff, F.A., 1965. Lace bugs of the world; a catalog (Hemiptera: Tingidae). Smithsonian Institution, Washington, p. 634.

El Khidir, E., 1960. Morphological and biological studies on whiteflies in the Sudan. M.Sc. Thesis, Faculty of Agriculture – University of Khartoum, Sudan.

Gaddoura, E., 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.

Gaddoura, E., Fadl, G.M., Burgestaller, H., 1984. A survey of insect pests, diseases and weeds on vegetable crops in Khartoum Province. Acta Horticulture 143, 359–367.

Hanna, A.D., 1950. The effect of rainfall on the cotton jassid, *Empoasca lybica* (de Berg.) in the Sudan Gezira. Bulletin of Entomological Research 41, 359–369.

Onder, F., Lodos, N., 1983. Preliminary list of Tingidae with notes on distribution and importance of species in Turkey. Ziraat FaKultesi Yayinlari Ege Universitesi 449, 51.

Rao, K.J., Thirumalachar, D.K., 1977. *Galeatus scrophicus* Saund. (Hemiptera: Tingidae), a new tingid pest of sunflower and niger in Karnataka. Current Rsearch 6 (7), 119–120.

Rohilla, H.R., Singh, H.V., Gupta, D.S., Krishnan, S., Singh, K., 1980. Pest complex other than diseases of sunflower, *Helianthus*

annus in Haryana. Indian Journal of Plant Protection 8 (2), 117–182.

Satti, A.A., Nasr, O.E., 2000. Evaluation of neem (*Azadirachta indica* A. Juss) seed kernels aqueous extract in controlling the main insect pests on eggplant (*Solanum melongena* (L.)). In: The 7th Annual Scientific Report for the Year 1999, Environment and Natural Resources Research Institute, National Centre for Research, Khartoum, Sudan. pp. 52–61.

Satti, A.A., Nasr, O.E., 2006. Effect of neem (*Azadirachta indica* A. Juss) seed powder and aqueous extract on the control of some major foliage insect pests of eggplant. Al Buhuth 10 (1), 1–16.

Schmutterer, H., 1969. Pests of Crops in Northeast and Central Africa. Gustav Fisher Verlag. Stuttgart, Germany, p. 296.

Venkatraman, T.V., El Khidir, E., 1967. Observations on crop pests in the Sudan in 1966/67. FAO Plant Protection Bulletin 15, 115–116.

Verma, N.D., Gupta, D.S., Sing, H.V., 1974. Biology of tingid bug *Galeatus scrophicus* Saund. (Hemiptera: Tingidae) on sunflower. Haryana Agricultural University Journal of Research 4 (1), 13–17.