Environment & Ecology 35 (2) : 630—637, April—June 2017
Website: environmentandecology.com ISSN 0970-0420

Diversity of Insect Fauna Associated with Cowpea Crop Ecosystem

Gopi Ram Yadav, Poonam Srivastava, Vijay Kumar Mishra, Rajveer, Deepika Chauhan

Received 25 May 2016 ; Accepted 30 June 2016 ; Published online 15 July 2016

Abstract A total of 33 species of insects belonging to 11 different orders and 30 families were encountered from cowpea, *Vigna unguiculata* (Linn.) at Pantnagar during *Zaid* and *kharif* season of the year 2014-15. Among the various insect pests of cowpea, the cowpea thrips (*Megalurothrips* sp.) and cowpea pod borer (*Maruca vitrata* Fabricius) have been recorded as the most prevalent species and caused significant damage and natural enemies are associated with cowpea crop ecosystem.

Keywords Insect diversity, Cowpea crop ecosystem.

Introduction

Cowpea (*Vigna unguiculata* L.) is one of the important leguminous crops also known as crowder pea, black-eyed bean or Southern pea in English, while Chola or Choli, Chavli, Lobia in various vernacular languages in India with highly nutritive values viz. organic matter content, protein, K, Ca, P and N amount are 90.58%, 20.31%, 0.0058%, 0.00106%, 0.142% and 3.25%, respectively [1]. Worldwide cowpea is cultivated in approximately 11.36 million hectare area, production is 5.19 million tonnes, and yield is 460 kg/ha [2]. The nutritional value of cowpea is very high due to its high protein content of 23%, fats 1.3%, fiber 1.8%, carbohydrate, 67% and water 8–9% [3]. Area under cowpea in India is 3.9 million hectare with a production of 2.21 million tonnes with the national productivity of 683 kg/ha crop. Worldwide food plants are damaged by more than 10,000 species of insects [4]. Despite using various control methods the control of agriculture pests continues to be critical for farmers. The yield loss by insects reaches as high as 60–70%. In India agriculture is currently suffering an annual loss of about Rs 8, 63, 884 million due to insect pests [5]. This heavy crop loss causes the farmer to use huge amount of pesticides [6]. Several insect pests attack the crop in the field and at storage, with the flower bud thrips, *Megalurothrips sjostedti* and spotted pod borer, *Maruca vitrata* being one of the most damaging and other include, thrips (*Thrips tabaci*), aphid (*Aphis craccivora* Koch), leaf hopper (*Empoasca kerri* Purthi), whitefly (*Bemesia tabaci* Genn.), leafminer (*Acrocercop scaerulre* Meyrick), tobacco caterpillar (*Spodoptera litura* Fabricius), blue butterfly, *Euchrysops cnejus cnejus* and the sucking bug complex, of which *Clavigralla* spp, *Anoplocnemis* spp, *Riptortus* spp, *Mirperus* spp,*Nezara viridula* Fab and *Aspavia armigera* L are most important and prevalent. Beside major insect pests galerucid beetle, jassid, bean weevil, stem

G. R. Yadav, P. Srivastava
Department of Entomology, GB Pant University of Agriculture and Technology, Pantnagar 263145, India

V. K. Mishra*, Rajveer, D. Chauhan
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi 221005, India
e-mail: premvijaybhu@gmail.com
*Correspondence

fly, coreid bug, leaf roller and hairy caterpillar are also attacking the crop and cause significant damage [7] and associated with natural enemies in cowpea crop ecosystem.

Materials and Methods

The field experiments were conducted at Breeder Seed Production Center, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar 263145 District Udham Singh Nagar (Uttarakhand) India Forty eight plots of two varieties (PL-1 and PL-3) were demarcated and arranged in randomized block design with three replication of eight treatments. Each plot had five rows. The plot size was 4×2.25 m^2 with 45 cm row spacing. The test crop was cowpea varieties Pant Lobia-1 and Pant Lobia-3. Sowing of cowpea var. Pant Lobia-1 and Pant Lobia-3 was done on 14th April 2014 and 20th March 2015 during *Zaid* season and cowpea var. Pant Lobia-1 and Pant Lobia-3 on 21st August 2014 during *kharif* season.

Regular surveys were carried out at weekly interval to record and identify the insect fauna including both harmful and beneficial insects at various stages (form vegetative to harvesting stage) in cowpea crop.

Results and Discussion

Diversity of insect fauna associated with cowpea

Regular surveys were conducted at weekly interval in cowpea crop at Breeder Seed Production Center, during *Zaid* season from March to June of the year 2014 and 2015, *kharif* season from the August to October of the year 2014, to study the status of major insect pests and beneficial insects on cowpea. The biodiversity of insect-pests fauna associated with cowpea crop has been enlisted in Table 1 (Figs. 1 and 2). A total of 33 species of insect belonging to 11 different orders and 30 families with two species of spider belonging to order Arachnida, family Metidae and Agelenidae were encountered in the cowpea crop. Among these 22 species were recorded as pest, 6 species as predator and 5 species as insect pollinator in cowpea crop. Out of 22 species of insect pests in cowpea seven insect species belonged to the order Hemiptera, five to Lepidoptera, three each to Coleoptera and Orthoptera, one each to Diptera, Thysanoptera, Hymenoptera and Isoptera [8]. The collected insect-pests were categorized as major / minor on the basis of their incidence and the extent of damage caused. The observations on various insect pests attacking cowpea at Pantnagar is given below:

Cowpea thrips, *Megalurothrips sp*. (*Thysanoptera* : *Thripidae*)

Cowpea thrips (*Megalurothrips* sp.) is one of the major pest, which is frequently responsible for total crop losses. The incidence of thrips, *Megalurothrips* sp. was observed during the months of March-May and August - September on leaves ; flower buds and flowers, resulting their premature fall without forming any pod. The adult appeared very tiny, black-brown insects, and were found feeding on leaves, flower buds and flowers. Severely infested plant did not produce any flowers. High population of thrips resulted discolor and distorted flower. Gopalakrishnan [7] observed that nymphs and adult thrips sucked the sap from leaf buds, leaves, flower buds, flowers and fruits, which become deformed or remain underdeveloped, often showing scars.

Spotted pod borer, Maruca vitrata Fab. (*Lepidoptera : Pyralidae*)

The next major insect pest of cowpea is spotted pod borer (*M. vitrata*) which occurred during the month of April - May and September-October. The larvae bored the buds, flowers and pods. The infested pods and flowers were webbed together and the larvae also feed on seeds. Female laid eggs singly on flowers, buds or pods. After hatching larvae was 20 mm in length. Aktar et al. [6] has been reported spotted pod borer, *Maruca vitrata* (Lepidoptera : Pyralidae) reported as a major constraint for the production of grain legume crops such as pigeon pea, cowpea, mungbean, urdbean and field bean at critical flowering and pod formation stages in the Southern Zone of Andhra Pradesh.

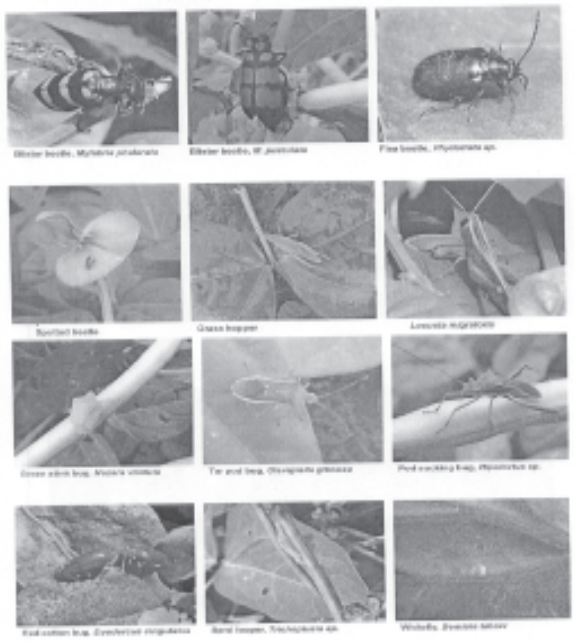

Fig. 1. Diversity of insect fauna in cowpea crop ecosystem.

Pod borer, *Helicoverpa armigera Hubner* (*Lepidoptera* : *Noctuidae*)

The larvae of *H. armigera* were observed in cowpea crop during both the season, *Zaid* and *kharif*. However, the incidence of this pest was higher in the month of May and September. It is a polyphagous pest and caterpillar first feed on foliage and later on bores into pods and feed on seeds. Larvae were observed feeding with the head alone thrust inside the parts and the rest of the body hanging out. Bore holes on cowpea pods, absence of seeds on pods and defoliation in early stages were noticed as clinical symptoms of the attack of the pest. White colored eggs were laid singly on stems, leaves, buds and pod of the plant. Full grown larvae were 30 to 40 mm long, greenish with dark brown grey lines with dark and pale bands. It show color variation from greenish to brown. Sharma et al. [9] has been reported several insect pests damaging this crop, of these pod borer, *Helicoverpa armigera* caused extensive losses. The incidence and extent of losses due to this pest varies across seasons, locations, and cropping system.

Pod sucking bug, *Clavigralla gibbosa Spinola and Riptortus* sp. (*Hemiptera* : *Coreidae*)

The activities of pod sucking bugs (*Riptortus* sp. and *C. gibbosa*) were observed during the month of May and September-October. Both nymph and adult suck the sap from green pods, causing them to shrivel and dry prematurely, resulting in yield loss. Adults were brownish to black and hemispherical in shape. Nymphs resembled dark brown ants. The infested seeds within pod become rough and rugged. Tender pods when attacked do not develop, also reported seasonal incidence of pod sucking bugs infesting vegetative cowpea. The nymphal population of the alydid pod bugs, *Riptortus pedestris* (F.) and *Riptortus linearis* (F.) was significantly higher during the first overnight of May and succeeding three fortnights. Adult population of *R. pedestris* and *R. linearis* peaked significantly during the first and sec-

Fig. 2. Diversity of insect fauna in cowpea crop.

ond fortnights of June respectively, when compared to most other period of the year. Damage from insect pests such as pod borers (*Maruca vitrata* F.) Pod–sucking bugs (PSBs) complex of which *Clavigralla* sp., *Anoplocnemis* sp., *Nezara* sp., *Riptortus dentipes* and *Mirperus jaculus* could lead to losses of cowpea grains both in the field and store [10, 11].

Cowpea aphid, *Aphis craccivora Koch* (*Hemiptera* : *Aphididae*)

Cowpea aphid (*A. craccivora*) was observed on cowpea in the months of March and August to October which coincides with the flowering and poding stage of cowpea. Both nymph and adults sucked the sap from the leaves and tender shoots mostly up to two months after germination. It resulted in withering of tender shoots and leaves become mottled with chlorotic or dark green spots ultimately plants become stunted.

Leaf hopper, *Empoasca kerri Pruthi* (*Hemiptera* : *Cicadellidae*)

Leaf hopper or jassids occurred in large numbers during the months of March–May and August–October on cowpea. Both nymphs and adults were of same shape but nymph did not have wings. Nymphs run sideways when disturbed. As a result of feeding leaves become cup shaped with yellow margins. Sharma et al. [9] reported that leafhopper can cause extensive losses in cowpea.

Tobacco caterpillar, Spodoptera litura Fab. (*Lepidoptera* : *Noctuidae*)

The activity of tobacco caterpillar (*S. litura*) was observed during the months of April-May and August-September. The eggs hatched into tiny caterpillars with smooth-skinned and having patterns of red, yellow and green lines, with a dark patch on the mesothorax. Larval color varies from pale green to dark green and then finally brown for the later instars. They

Table 1. Diversity of insect fauna associated with cowpea at Pantnagar during the *Zaid* and *kharif* season of the year 2014-15.

Sl. No.	Pest species	Common name	Order	Family	Status	Stage attacked	Activity period
1.	*Spodoptera litura* Fab.	Tobacco caterpillar	Lepidoptera	Noctuidae	Minor	Leaves	Apr-Sep Aug-Sep
2.	*Helicoverpa armigera* Hub.	Pod borer		Noctuidae	Major	Pods	May-Sep
3.	*Maruca vitrata* Fab.	Spotted pod borer		Pyralidae	Major	Pods	Apr-May Sep-Oct
4.	*Trichoplusia ni* Hub.	Semi looper		Geometridae	Minor	Leaves	Mar-Apr Aug-Sep
5.	*Spilarctia obliqua* Walk.	Bihar hairy caterpillar		Arctiidae	Minor	Foliage	Aug
6.	*Aphis craccivora* Koch	Cowpea aphid		Aphididae	Minor	Leaves, Flower, Pods	Mar Aug-Oct
7.	*Empoasca kerri* Pruthi	Jassid or leaf hopper		Cicadellidae	Major	Leaves	Mar-May Aug-Oct
8.	*Bemisia tabaci* Genn.	Whitefly		Aleyrodidae	Minor	Leaves	Aug-Sep
9.	*Nezara viridula* L.	Green stink bug		Pentatomidae	Major	Leaves, pods	Mar-May Aug-Oct
10.	*Clavigralla gibbosa* Spinola	Tur pod bug	Hemiptera	Coreidae	Major	Leaves, pods	May
11.	*Riptortus* sp.	Pod sucking bug		Coreidae	Major		Sep-Oct
12.	*Dysdercus cingulatus* Fab.	Red cotton bug		Pyrrhocoridae	Minor	Leaves	May-Sep
13.	*Mylabris phalerata* Pallas *Mylabris pustulata* Thunberg	Blister beetle	Coleoptera	Meloidae	Minor	Flowers	Sep
14.	*Phyllotreta* sp.	Flea beetle		Chrysomelidae	Minor	Leaves	Mar-May Aug-Sep
15.	*Aulacophora foveicollis* Lukas	Red pumpkin beetle		Chrysomelide	Minor		Apr Aug
16.	*Locusta migratoria* L.	Migratory locust		Acrididae	Minor	Leaves	Mar-May Aug-Oct
17.	*Conocephalus* sp.	Long grass-hopper	Orthoptera	Tettigoniidae	Minor		Mar-May Aug-Oct
18.	*Hieroglyphus banian*	Short horn grasshopper		Acrididae	Minor		
19.	*Liriomyza* spp.	Leaf miner	Diptera	Agromyzidae	Minor	Leaves,	Mar-Apr Aug-Sep
20.	*Megalurothrips* sp.	Bean flower thrips	Thysanoptera	Thripidae	Major	Flowers, Buds	Mar-May Aug-Sep
21.	*Polyrhachis* sp.	Black ant	Hymenoptera	Formicidae	Minor	Leaves, Flowers	Sep-May
22.	*Odontotermes obsessus*	Termites	Isoptera	Termitidae	Minor	Root	Mar-May Aug-Oct

Table 1. Continued.

Sl. No.	Common name	Scientific name	Order	Family	Activity period
Pollinators / Insect visitor on flower					
1.	*Apis mellifera* L.	Honey bee	Hymenoptera	Apidae	Sep, May
2.	*Xylocopa iridipennis* L.	Carpenter bee		Xylocopidae	May
3.	*Lampides boeticus* L.	Blue butterfly	Lepidoptera	Lycaenidae	May
4.	*Pieris brassicae*	Cabbage butterfly		Pieridae	Sep, May
5.	*Colias erate* Esper	Yellow butterfly		Pieridae	Sep
Predators					
1.	*Coccinella septempunctata* L.	Lady bird beetle	Coleoptera	Coccinellide	Aphids, Jassids, Thrips	Aug-Oct Mar-Jun
2.	*Chrysoperla carnea* Stephens	Green lace wing	Neuroptera	Chrysopidae	Aphids, Thrips, Lepidopteran larvae	April-May
3.	*Ceriagrion fallax* R.	Damsel-flies	Odonata	Coenagriide	Lepidopteran larvae, small moth	Aug-Oct Apr-Jun
4.	*Anax* sp.	Dragonfly		Aeshnidae	Lepidopteran larvae, small moth	Aug-Oct Apr-Jun
5.	*Meta menardi* Latreille	Spider			Aphids, Thrips, small flies	Aug-Oct Apr-Jun
6.	*Agelenopsis* sp.		Arachnida	Metidae Agelenidae		

initially feed on new leaves by scrapping leaf tissue leaving the veins intact but as they grew, they consume whole leaves and even flowers and fruit [9—11].

Leaf miner, *Liriomyza spp*. (*Diptera* : *Agromyzidae*)

Infestation of leaf miner (*Liriomyza* spp.) was observed on the leaves of cowpea during the months of March-April and August-September at vegetative stage. The larval feeding causes serpentine mines on the leaf surface. Drying and dropping of leaves was noticed due to severe infestation. Ali [12] also reported a high infestation of leaf miner attack at vegetative stage of the crop.

Blister beetle, *Mylabris phalerata Pallas and Mylabris pustulata Thunberg* (*Coleoptera* : *Meloidae*)

The activity of blister beetles (*Mylabris phalerata* Pallas and *Mylabris pustulata* Thunberg) was observed in the month of September. The adult fed voraciously on buds and flowers. A single beetle could destroy as many as 20—30 flowers / day. Large numbers of beetle in the field may result in total crop loss. Elytra were black in color with a round orange spot and two transverse wavy orange bands across the wings. Sharma et al. [9] also observed that blister beetles, *Mylabris* spp. cause extensive losses to cowpea crop. The presence of blister beetles in different crops is usually not considered to be a serious constraint [13], infestations of crops grown in small-holder plots may cause considerable damage because of the gregarious nature of adult beetles [14]. As for example, more than 80% of flowers and developing pods of a prairie legume, Baptisia australis (Fabaceae) were damaged by the ash-gray blister beetle Epicauta fabricii (LeConte), thereby adversely affecting seed production in Kenya [15].

Green stink bug, Nezara viridula L. (*Hemiptera* : *Pentatomidae*)

Green stink bug (*Nezara viridula* L.) was observed active on cowpea throughout the experiment with

peak activity during the months of March—May and August—October. Both nymph and adults were found sucking cell sap from the leaves, which gradually wilt and dry up, also observed that the nymphal and adult population of the pentatomid stink bug, *Nezara viridula* (L.) attained peak values during the first fortnight of April and May. Damage from insect pests such as pod borers (*Maruca vitrata* F.) Pod – sucking bugs (PSBs) complex of which *Clavigralla* sp., *Anoplocnemis* sp., *Nezara* sp., *Riptortus dentipes* and *Mirperus jaculus* could lead to losses of cowpea grains both in the field and store [10, 11].

Semi-looper, *Trichoplusia ni Hubner* (*Lepidoptera* : *Geometridae*)

The caterpillar of green semilooper (*T. ni*) were recorded primarily on leaves and caused irregular holes. Young caterpillar utilized leaf lamina as their food by making small holes, but older caterpillar feed on the tissue between the veins and skeletonizing the leaves giving them a ragged appearance during March-April and August-September.

Whitefly, *Bemisia tabaci Gennadius* (*Hemiptera* : *Aleyrodidae*)

The nymph and adults of whitefly (*B. tabaci*) were observed in the month of August-September on cowpea. Both nymph and adults suck the cell sap from the undersurface of leaves. Severe infestation result in premature defoliation and development of sooty mould. Yellowish color on leaves was noticed as the clinical symptom of the attack of whitefly. Sharma et al. [9] also reported that whitefly, *Bemisia tabaci* caused extensive losses to the cowpea crop. Singh et al. [16] has been reported that *M. persicae*, *B. tabaci* , *P. perpusilla* and *Melanitis leda* are common insect pest species which persist throughout the year. This is due to their polyphagous nature and ability to migrate from one host to other.

Flea beetle, *Phyllotreta sp*. (*Coleoptera* : *Chrysomelidae*)

Adults of flea beetles (*Phyllotreta* sp.) occurred during the months of March—May and August-September. The adult flea beetle feed externally on plants, observed to feed the surface of the young leaves, stems and petals with their chewing mouthparts.

Red pumpkin beetle, *Aulacophora foveicollis Lukas* (*Coleoptera* : *Chrysomelidae*)

Adults of pumpkin beetle (*A. foveicollis*) was mainly responsible for the damage of the plant above ground, attacking on the leaves, flowers and fruits and observed during the months of April and August. Young plants were defoliated and deflowered sooner than older ones. Khan et al. [17]. Influence of weather factors on the incidence and distribution of red pumpkin beetle infesting cucurbits.

Red cotton bug, *Dysdercus cingulatus Fab*. (*Hemiptera* : *Pyrrhocoridae*)

The damage is caused by both nymph and adult of red cotton bug (*D. cingulatus*). The bugs were observed on the tender shoot as well as leaves during the months of May and September. The bugs were gregarious in habit. The adult was red and black bug with white stripes ventrally on the abdomen.

Pollinators and natural enemies

Beside above insect pests, *Locusta migratoria* L. and *Spilarctia oblique* Walk were also observed frequently on the leaves and flowers of cowpea during the experimental period. A total of five insect species were recorded visiting on cowpea flowers. Of which three insect species belong to Hymenoptera and two species of Lepidoptera. The most common pollinator on the cowpea crop is honey bee *Apis mellifera* L. (Hymenoptera : Apidae), which was observed to visit on the flowers of cowpea crop in the months of May and September. The next pollinator is Carpenter bee, *Xylocopa iridipannis* Lepeletier (Hymenoptera : Xylocopidae) was observed in the months of May and September visiting on cowpea crop. Out of six species of predators recorded on cowpea, ladybird beetles (*Coccinella septempunctata* Linnaeus ; Coleoptera : Coccinellidae) were found predating on jassids, aphids and thrips throughout the experimental period with peak activity in the months of August—October and March—May. While green lacewing

(*Chrysoperla carnea* Stephens ; Neuroptera : Chrysopidae) was observed predating on thrips, aphids and lepitopteran larvae in the month of April-May. Spiders, *Meta menardi* Latreille and *Agelenopsis* sp. (Arachnida : Metidae) and (*Agelenopsis* sp. Giebel.) were found predating on aphids, thrips and small flies and observed throughout the period of study. Besides, damselflies (*Ceriagrion fallax* Ris.) and dragonflies (*Anax* sp. Eichkoff.) were also frequently observed predating on lepidopteran larvae and small moth in the months of August—October and April—June. 561 individual insects collected 58.5% were bees whereas 41.5% were non-bee species including wasps, ants, butterflies, flies, bugs and beetles. The bee fauna comprising 12 species, belonged to three families (*Apidae*, *Megachilidae* and *Halictidae*). With the exception of *Dactylurina staudingeri*, all the species foraged for pollen and nectar. *Apis mellifera* and *D. staudingeri* were observed foraging from immature pods, flower buds and peduncles of both flowers and pods. The foraging resources of flower visitors collected as well as their activities on the cowpea flowers suggest pollen movement which could lead to cross pollination [18].

References

1. Kabas O, Yilmaz E, Ozmerzi A, Akinci I (2007) Some physical and nutritional properties of cowpea seed (*Vigna sinensis* L.). J Food Engg 79 : 1405—1409.
2. Akibode S, Maredia M (2011) Global and regional trends in production, trade and consumption of food legume crops.
3. Jefferson T (2009) Cowpea : Aversatile crop for hot dry conditions. Thomas Jefferson Agric Inst, West Nifong Soulevard, Colombia.
4. Dhaliwal GS, Dhawan AK, Singh R (2007) Biodiversity and ecological agriculture: Issues and perspectives. Ind J Ecol 34 : 100—109.
5. Dhaliwal GS, Jindal V, Dhawan AK (2010) Insect pest problems and crop losses: Changing trends. Ind J Ecol 37 : 1—7.
6. Aktar MW, Sengupta D, Chowdhury A (2009) Impact of pesticide use in Indian agriculture—Their benefits and hazards. Interdisciplinary Toxicol 2 : 1—12.
7. Gopalakrishnan TR (2007) Vegetable crops. New India Pub, New Delhi 4 : 181—187.
8. Gahukar RT (2004) Bionomics and management of major thrips species on agricultural crops in Africa. Outlook on Agric 33 : 191—199.
9. Sharma HC, Srivastava CP, Durairaj C, Gowda CLL (2010) Pest management in grain legumes and climate change. Climate change and management of cool season grain legume crops 1 : 115—139.
10. Amatobi CI, Dike MC, Oparaeke AM (2005) Integrated pest management of thrips and Maruca on cowpea at Samaru. Cropping Scheme Meeting Report on Legume and Oil seed Research Program, IAR Ahmadu Bello Univ, Zaria, Nigeria 5 : 23—24.
11. Dzeme WD, Niba AS, Asiwe JAN (2010) Effects of insecticide spray application on insect pest infestation and yield of cowpea (*Vigna unguiculata* (L.) Walp) in the Transkei, South Africa. Afr J Biotechnol 9 : 1673—1679.
12. Ali SA (2009) Occurrence and distribution of insect pest attacking some vegetative plants at five localities of EL Qassin province, Saudi Arabia. Faculty of Sci, Univ of Hai, Saudi Arabia 31 : 148—154.
13. Zhu F, Lei C-L, Xue F (2005) The morphology and temperature-dependent development of *Mylabris phalerata* Pallas (Coleoptera : Meloidae). Coleopt Bull 59: 521—527.
14. Nikbakhtzadeh MR (2004) Transfer and distribution of cantharidin within selected members of blister beetles (Coleoptera : Meloidae) and its probable importance in several behavior. PhD dissertation. Universitat Bayreuth, Germany, pp 105.
15. Lebesa LN, Khan ZR, Krüger K, Bruce TJA, Hassanali A, Pickett JA (2012) Farmers knowledge and perceptions of blister beetles, *Hycleus* spp. (Coleoptera : Meloidae), as pest herbivores of desmodium legumes in western Kenya. Int J Pest Manag 58 : 165—174.
16. Singh Anita, Sharma Amarjit Lal (2014) Agriculturally important insects diversity in *kharif* and *rabi* crops of Talwandi sabo, Punjab 4 : 1—5.
17. Khan MMH, Alam MZ, Rahman MM, Miah MI, Hossain MM (2012) Influence of weather factors on the incidence and distribution of red pumpkin beetle infesting cucurbits. Bangladesh J Agric Res 37 : 361—367.
18. Kwapong PK, Danquah POA, Asare AT (2013) Insect floral visitors of cowpea *Vigna unguiculata* (L.). Annal Biol Res 4 : 12—18.