International Scholars Journals

African Journal of Agronomy ISSN 2375-1177 Vol. 8 (1), pp. 001-007, January, 2020. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Arthropod assemblage dynamics on cowpea (*Vigna unguiculata* L. Walp) in a subtropical agro-ecosystem, South Africa

Augustine Suh Niba

Department of Biological Sciences, Walter Sisulu University, P/B X1 NMD Mthatha 5117, South Africa.
E-mail: Aniba@wsu.ac.za.

Accepted 22, November, 2019

Arthropod assemblages were monitored on cowpea during the 2008/2009 cropping season in the Transkei area of South Africa. A total of 5953 insects belonging to 21 species, in 12 families and 5 orders (Coleoptera, Hemiptera, Orthoptera, Homoptera and Lepidoptera) were counted from 18 observations on cowpea from seedling to maturity. Aphids, Lepidoptera larvae, blister beetles and pod-sucking bugs accounted for high levels of population infestations, persistence and overall damage inflicted on the crop. Natural enemies recorded during the study were ladybird beetles, wasps, assassin bugs and spiders. Insect pest activity was much concentrated between eight and thirteen weeks after sowing (WAS) corresponding to flower budding and pod formation stages of cowpea respectively. Results from this study have significant implications for the integrated control of the insect pest complex of cowpea in sub-tropical agro ecosystems.

Key words: Cowpea, *Vigna unguiculata,* insect pests, natural enemies, Transkei.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp, is the third most important grain legume in South Africa after groundnut and dry beans (Asiwe, 2009) . It contributes immensely to the protein diet of most poor families, provides income to farmers for the sale of grain and fodder, and a good source of animal fodder. Although cultivated primarily for its edible seeds, direct consumption of cowpea leaves is also widespread in different parts of Africa (Nelson et al., 1997), especially in some rural areas of the Transkei area of South Africa (Voster et al., 2007). The phenology of cowpea comprises four main stages viz., pre-flowering (vegetative), flowering, pod formation and pod maturation (Ishiyaku and Singh, 2003). Insect pests pose the greatest threat to cowpea cultivation, and attack the crop from seedling (germination) to storage. Natural enemies play an important role in limiting potential pest population surges, although in a cowpea monocrop system, they are not usually present in sufficient numbers to suppress high pest population infestations. Although pest biology on cowpea has been studied extensively (Jackai, 1982), agro-climatic conditions differ completely among agro-ecosystems and these differences could influence the population fluctuation of insect pests. Thus, researching local information is valuable. A limited amount of work has been done to understand pest biology on cowpea in South Africa especially the Transkei area. Therefore, a field investigation was undertaken to determine when insect pests do occur in cowpea in the Transkei area, and to take an inventory of the natural enemies with potential to suppress the pests.

MATERIALS AND METHODS

On-farm trials were conducted during the 2008-2009 cropping season (November 2008 to April 2009), at three experimental locations viz., Walter Sisulu University (WSU) Research Farm, Mthatha (31°36'S; 28°46'E), Efata School for the Blind farming site, Mthatha (31°33'S; 28°42'E) and Tsolo Agricultural and Rural Development Institute, Tsolo (31º17'S; 28º45'E) (Figure 1). All trials were located in the grassland agro-ecological zone of the Transkei, South Africa. There was active cultivation of other field crops at the Efata and Tsolo experimental locations, while no agricultural activity was going on at the WSU research farm. Five cowpea varieties were grown at the three experimental locations (Table 1).

Varieties were planted in experimental plots during the first week of November, 2008. Experimental plots were laid in a completely randomized block design, with four replicates per cultivar. Plots

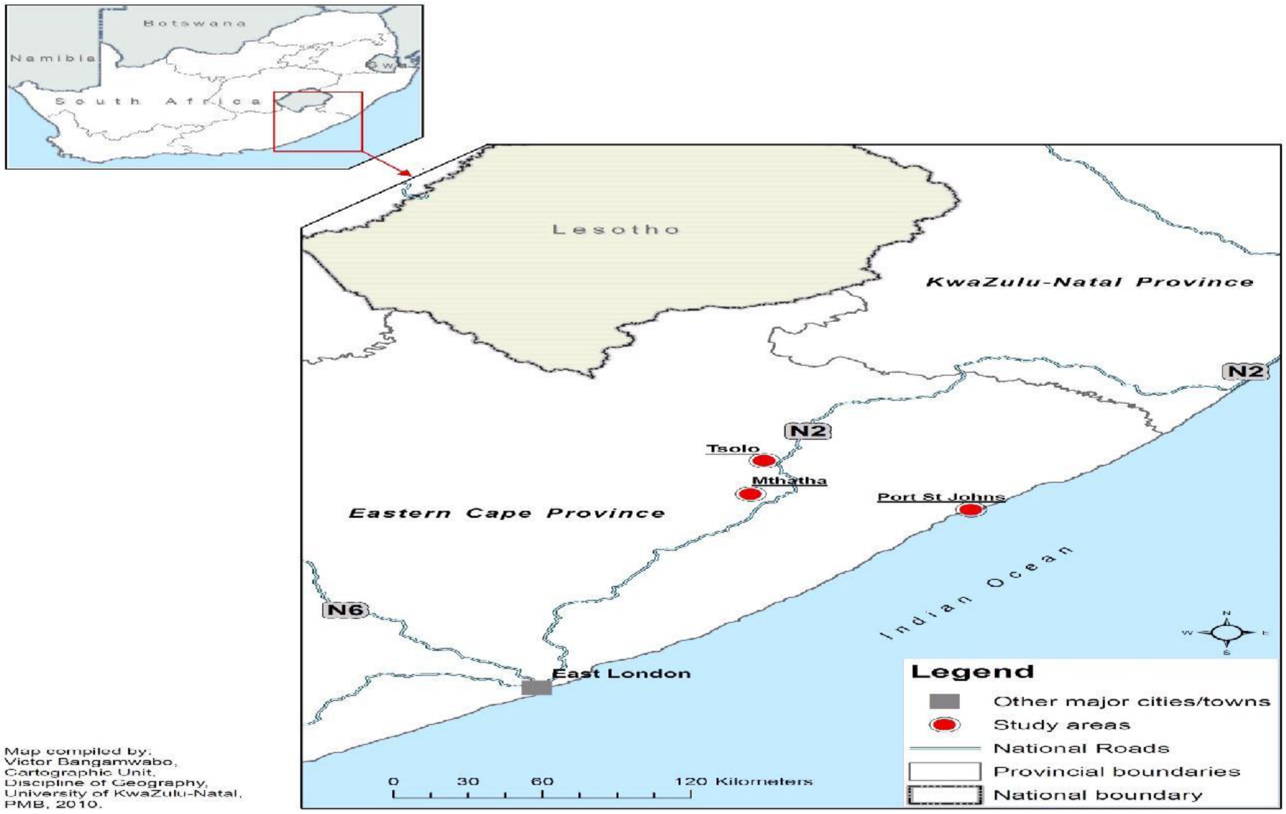

Figure 1. Map showing trial locations.

Table 1. Characteristics of varieties used in the study.

Variety	Source	Maturity	Growth habit	Photosensitivity	Seed coat colour
Glenda	ARC	Medium	Semi erect	PS	Red
Bechuana white	ARC	Late	Runner	PS	Cream
Ife Brown	IITA	Medium	Semi erect	PS	Brown
IT03K-369-3	IITA	Early	Semi erect	NPS	Red
IT04K-221-1	IITA	Early	Semi erect	NPS	White

NPS = Non-photosensitive, PS = Photosensitive, IITA = International Institute of Tropical Agriculture, ARC = Agricultural Research Council.

sizes (6 m^2) consisted of four ridges spaced at 0.50 m apart and 3.00 m long separated by 1.50 m weedy alley ways. Three seeds of each cultivar were sown at intra-row spacing of 0.30 m. The plants were later thinned to two plants per stand after emergence allowing about 96 plants per plot. Weeds were controlled between the rows by hand and hoe weeding at 2, 6 and 10 weeks after sowing. Data were collected on number of days to 50% flowering and pod maturity of the cowpea varieties.

Arthropods were sampled weekly in the morning (8:00 - 12:00) commencing two weeks after sowing till harvest maturity. The two middle rows of each plot consisting of 40 randomly selected cowpea plants were measured out into sampling units during each sampling session. Population counts of arthropods were undertaken by taking visual counts from these sampling units. Aphids were brushed off from the plant parts on which they occurred using a fine brush onto a white paper before counting.

Flowers and pods were cut open to expose lepidopterans larvae and pupae and then counted.

Predacious behaviour and feeding activity on insect herbivores by other arthropods were also recorded whenever this was observed. All arthropods found were identified using published identification keys and field guides (Picker et al., 2004). A total of 18 observations were made in each experimental location.

Data analysis

The chi-square (X^2) test was conducted to compare differences in numbers of insects counted in the 3 experimental locations. Insect pest species were categorized as ‘major pests’ if they infested the crop continuously in heavy population counts throughout the cropping season. Pests which occurred intermittently, and whose

Table 2. Phenology of cowpea varieties at experimental locations during the study.

Cowpea variety	Days to 50% flowering	Days to ripening	Days to 50% pod maturity
Glenda	66.3 ± 2.6 b (58-74)	31.8 ± 1.7b (27-37)	98.2 ± 1.3b (94-101)
Bechuana White	88 ± 2.2a (86-94)	40.8 ± 2.2a (33-47)	128 ± 2.1a (119-135)
Ife brown	65.8 ± 2.9b (53-74)	30.8 ± 2.4b (22-38)	98.2 ± 1.9b (91-105)
IT03K-369-3	65.8 ± 3.9b (53-72)	31.3 ± 2.5b (27-41)	97.2 ± 1.6b (91-101)
IT04K-221-1	63.5 ± 3.1b (53-75)	32.5 ± 2.5b (23-40)	96 ± 3.0b(93-110)
Mean	69.9	33.4	103.9
LSD (5%)	8.3	6.5	5.8
P < 0.05	0.001	0.05	0.001

Mean values (**±** SE**)** followed by the same letters are not significantly different at 5% level (LSD).

Table 3. Taxonomic profiles of insect pests sampled at all trial location plots during seedling (pre-flowering), flowering and pod stages for improved and local varieties of cowpea.

Order	Code*	Family	Common species sampled	Stage of infestation
Lepidoptera	LPD	Pyralidae	*Maruca testulalis*	Seedling/pod stages
Homoptera	HOM	Aphidae	*Aphis craccivora*	All stages
Coleoptera	COL	Melyridae Meloidae	*Astylus atromaculatus,* *Mylabris oculata, Decapotoma lunata.*	Mostly flowering/pod stage
Hemiptera	HEM	Alydidae Pentatomidae Coreidae	*Mirperus jaculus, Riptortus dentipes,* *Aspavia* spp., *Nezara viridula,* *Clavigralla tomentosicolis,* *C. shaddabi, Anoplocnemis curvipes.*	Pod stage

*Abbreviations used in analyses.

population counts never became high, were categorized as 'minor pests' according to Reddy et al., 1998.

RESULTS

Number of days to flowering and pod maturity

Mean number of days to flowering, days to ripening (difference between flowering and 50% pod maturity) and days to 50% pod maturity of cowpea varieties are given in Table 2. Significant differences were observed among the cowpea varieties in the number of days to flowering, ripening and maturity (Table 2). Bechuana White took significantly higher number of days to flower, ripen and mature than the other varieties. Glenda, Ife brown, IT03K-369-3 and IT04K-221-1 took about 9 to 10 weeks to 50% flowering, and 13 to 15 weeks to 50% pod maturity.

Insect pest population dynamics

Twenty-one insect pest species belonging to 12 families, and 5 orders were recorded on cowpea from early vegetative to maturity stage (Table 3). Coleoptera was most abundant with 2221 (37.3%), while Lepidoptera had the least number of only 591 (9.9%). Chi-square test (X^2 =101.5; P < 0.01) showed that there was a significant difference in insect pest numbers across the three trial locations. Of these were 12 hemipterans, 5 coleopterans, 2 lepidopterans, and 2 orthopterans. Data on weekly total insect population density (Figure 2) indicated that insects began to colonise cowpea fields as from 2 week after sowing (WAS). Low insect populations were observed at vegetative (2 to 8 WAS) and pod maturity (14 to 19 WAS) stages. Peak insect population density were recorded at flowering and pod formation stages (9 to 13 WAS).

The temporal trends in incidence of four important insect pests (aphids, lepidopteran larvae, blister beetles and pod-sucking bugs) of cowpea are shown in Figure 3. The incidence succession of insect pests colonizing cowpea showed that aphids and lepidopteran larvae were the first to invade the crop, at 4 weeks after sowing (WAS) (Figure 3). The peak level of these insects was observed at 7 and 10 weeks after sowing, respectively. Aphids remain active till harvest maturity, meanwhile Lepidoptera larvae disappeared at 13 WAS. The next important pest that appeared at cowpea trial plots were

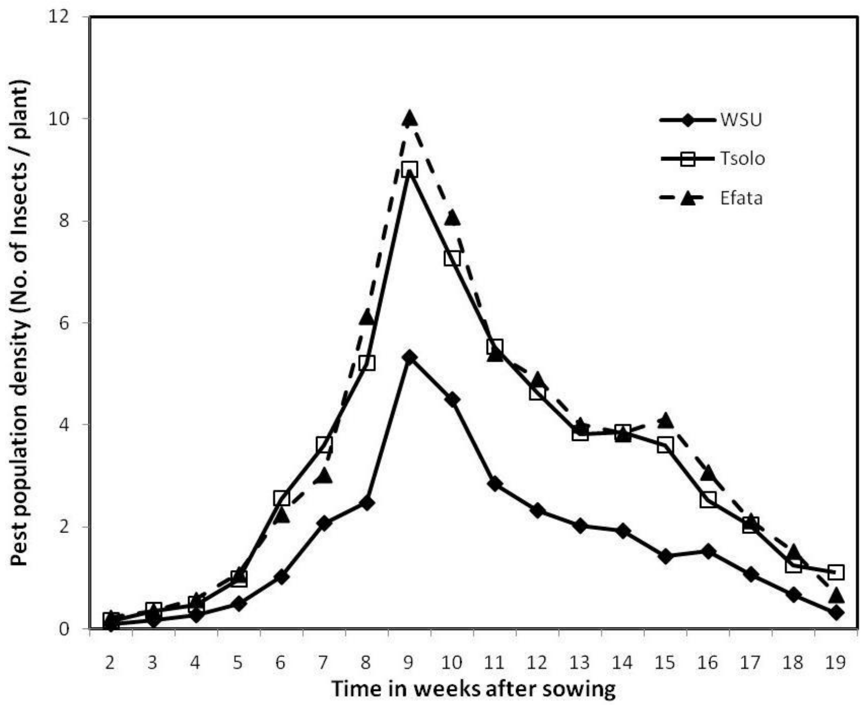

Figure 2. Temporal patterns of insect populations of cowpea at trial locations.

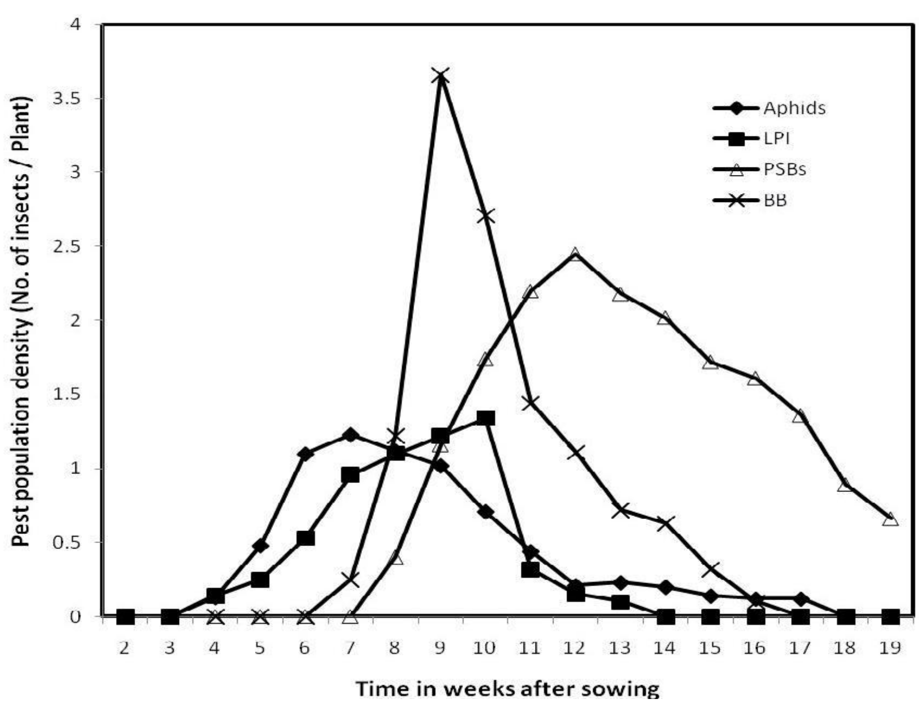

Figure 3. Weekly mean population trends of four important insect pests of cowpea at trial locations. (LPI: Lepidopteran larvae; PSBs: pod sucking bugs; BB: Blister beetles).

coleopteran blister beetles (Table 3). Their activity commenced 7 WAS and attained peak infestation levels at 9 WAS, but disappeared before harvesting. They caused severe damage to the floral parts and leaves of

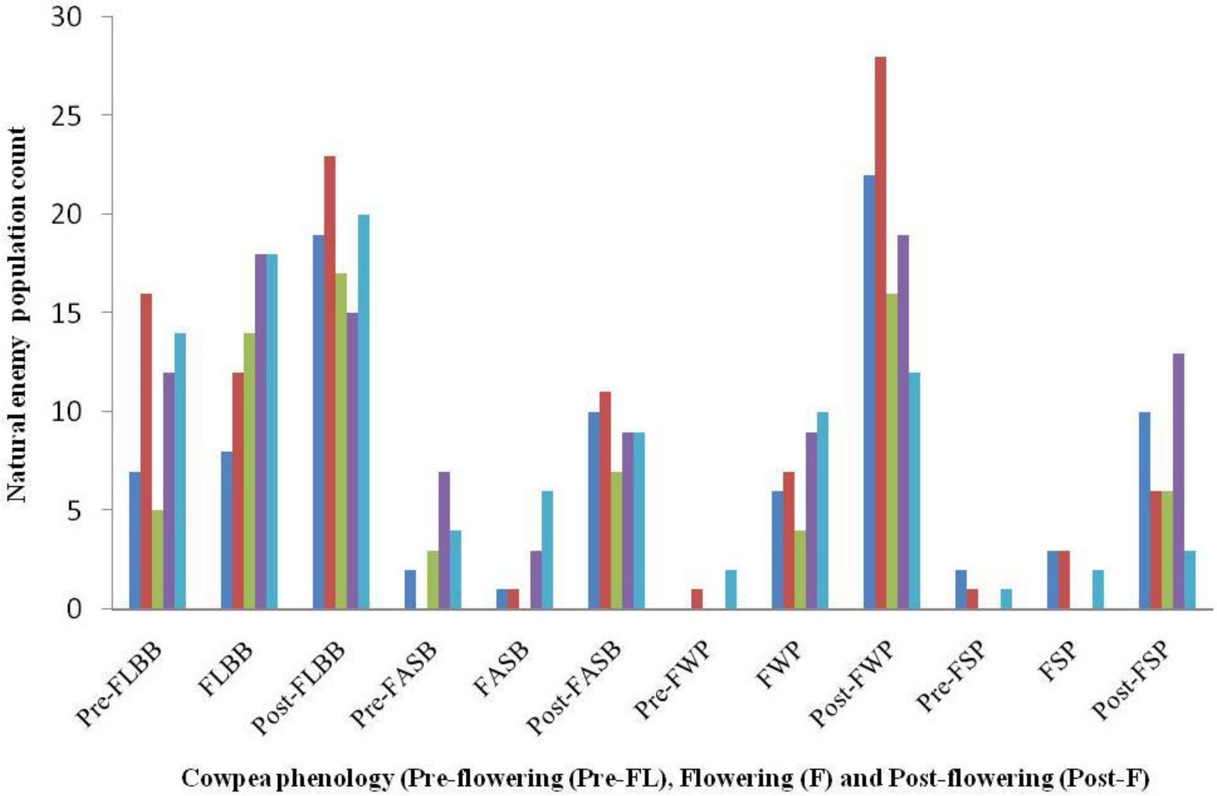

Figure 4. Occurrence of arthropod natural enemy populations relative to cowpea phenology at pre-flowering (Pre-F), flowering (FL) and post-flowering (Post-F) stages for Ladybird beetle (LBB), Assassin bug (ASB), Wasp (WP) and Spider (SP) populations.

Table 4. Total insect population counts per order from 18 observations at cowpea trial locations.

Order	WSU	Tsolo	Efata	Total	%
Coleoptera	546	798	877	2221	37.3
Hemiptera	229	644	794	1667	28.0
Orthoptera	192	301	327	820	13.8
Homoptera	127	274	253	654	11.0
Lepidoptera	121	267	203	591	9.9
Total	1215	2284	2454	5953	

Overall Chi-square, 101.5; *P*-value, significant at 1%

cowpea, and also made holes on young pods of the crop. Hemipteran pod-sucking bugs (PSBs) were the last insect pests to enter cowpea fields at 8 WAS and remained on the crop till harvesting. They attained peak population infestation levels at 12 WAS. The dominant PSBs species recorded were, *Clavigralla tomentosicollis* , *Anoplocnemis curvipes*, *Clavigralla elongata* and *Mirperus jaculus*. Other PSBs species such as *C. shadabi, Nezara viridula, Aspavia armigera, Acrosternum sp.,* and *Riptortus dentipes* had low populations and were less frequent. *Clavigralla tomentosicollis* was the only species of the PSBs to produce appreciably high levels of nymphal populations on the crop. These insects were found even when the pods were matured and dried, with adults and nymphs aggregated in large clumps.

Occurrence of potential arthropod natural enemies at cowpea trial locations

Major arthropod natural enemy populations recorded at cowpea experimental plots from vegetative to maturity stages (Figure 4) were Ladybird beetles (Coleoptera: Coccinellidae, 50% (n= 475)), Wasps (Hymenoptera: Vespidae, 28% (n= 235)), Assassin bugs (Hemiptera: Reduviidae, 18% (n=154)) and spiders (Arachnida, 11% (n=95) (Table 5). Predacious feeding activity of Ladybird beetles on aphids was observed. The assassin bug *Rhinocoris segmentarius* was also observed to feed on Lepidoptera larvae, and nymphs of pod-sucking bugs. Various spiders species were also recorded feeding on Lepidoptera larvae and other invertebrates usually trapped in their webs.

DISCUSSION

A majority of the arthropod assemblage recorded were

Table 5. Taxonomic profiles of arthropod natural enemies of insect pests recorded at cowpea trial plots during the trial period.

Predators	Scientific name	Taxonomic profile	Observed association
Ladybird beetles	*Cheilomenes lunata*, *Harmonia* sp., *Coccinella septempunctata*	Coleoptera: Coccinellidae	Aphid predator
Assasin bugs	*Rhinocoris segmentarius*	Hemiptera: Reduviidae	General predator
Ants	Unidentified species	Hymenoptera: Formicidae	General predator
Wasps	Unidentified species	Hymenoptera	Lepidoptera predator / Nectar
Spiders	Unidentified species	Arachnida	General predator

insect pests that fed on cowpea at different growth stages. Most of these pests had previously been recorded on the crop in the North West and Mpumalanga provinces of South Africa (Asiwe, 2009).

Results from the study showed that the population density of insect pests was considerably low at the WSU research location compared with those at Efata and Tsolo research locations. The presence of other field crops as alternate wild hosts around cowpea fields in Tsolo and Effata probably created additional food sources and shelter for various insect pest species. Hagstrum et al. (1996), had reported that factors, such as food availability, shelter, temperature conditions in different areas, are responsible for the spatio-temporal dynamics of pests, as well as for the population abundance levels. Low insect population at vegetative (pre-flowering), suggest that few insects specialized in leaf consumption, while high population counts at flowering and pod formation suggest that more insect species had a predilection for these two phenological stages. Low population counts at pod maturity may be as a result of reduced food resource availability, sporadic spray regimes amongst other factors. The peak population at flowering may be attributed to the high abundance of anthophilous coleoptera species that prefer inflorescences, flower and flower buds as feeding sites where they are able to get nutrients of high quality.

The data on the weekly mean density of aphids, lepidopteran larvae, blister beetles and pod- sucking bugs showed that aphids and lepidopteran larvae were the first major pests to enter the cowpea crop during the early vegetative stage. Aphids colonised swiftly and attained the maximum population within three weeks of its colonisation of cowpea fields. It can be inferred that softness and succulence of the plant tissues during early vegetative growth may have attracted these sucking pests. Green caterpillars (Lepidoptera) fed on tender foliage at the early vegetative growth stage of cowpea.

However, the most important Lepidoptera larvae of cowpea are legume pod borers whose larvae attackd flowers and developing pods. The early instar larvae of pod borers, usually bore into the fresh pods of cowpea, feed on the contents of the pods, remaining inside whereas, the grown-up larvae cause damage by inserting the anterior half portion of their body inside the pods and excavate the seeds (Oghiake et al., 1992).

Blister beetle adults are very mobile and often suddenly appear in large numbers during flowering. They cause severe damage to the floral parts, leaves and young pods of cowpea. It is likely, that farmers are not conversant with the devastating effects of blister beetles, reason why they seldom report them as major pests of cowpea. Pod-sucking bugs (PSBs) migrated to cowpea fields only at the early podding stage, where their population continued to rise, peaking within four weeks after which their population started to fall. This fall in pod bug populations is probably due to limited food resources resulting from pod drying (Ogenga- Latigo et al., 1993). Pod-sucking bugs attack the pods and seeds of cowpea, resulting in small, shrivelled and malformed grains.

Among the arthropod natural enemies recorded in cowpea fields, the coccinellid, *Cheilomenes lunata* had been reported as a predator of aphids in South Africa (Brown, 1972). However, it is not solely effective in protecting the susceptible varieties from damage (Aalbersberg et al., 1988). The assassin bug, *Rhinocoris segmentarius* are generalist predators that are also found on legumes and rice throughout Africa (Heinrichs and Barrion, 2004).

The results presented here indicate that the activity of important pests of cowpea is much concentrated between eight and thirteen weeks after sowing to coincide with flower budding and pod formation stages when there is abundant food resource availability. In the event where arthropod natural enemy populations are not present in the crop in sufficient numbers to control increasing pest populations, it would be better to use other control measures targeting flowering and pod formation stages.

The author acknowledges financial support from the Directorate of Research, Walter Sisulu University (WSU) and the National Research Foundation (NRF). The International Institute of Tropical Agriculture (IITA) and the Agricultural Research Council (ARC) are also acknowledged for providing the cowpea lines used in this work.

REFERENCES

Aalbersberg YK, Van der Westhuizen MC, Hewitt PH (1988). Natural enemies and their impact on *Diuraphis noxia* (Mordvilko) (Hemiptera: Aphididae) populations. Bull. Entomol. Res., 78: 111-120.

Asiwe JAN (2009). Insect mediated outcrossing and geneflow in cowpea (*Vigna unguiculata (L.)* Walp): Implication for seed production and provision of containment structures for genetically transformed cowpea. Afr. J. Biotechnol., 8(2): 226-230

Brown HD (1972). Predacious behaviour of four species of Coccinellidae (Coleoptera) associated with wheat aphid, *Schizaphis graminum* (Rondani), in South Africa. Trans. R. Entomol. Soc., 124: 21-36.

Hagstrum DW, Flinn PW, Howard RW (1996). Ecology. In: Subramanyam, B and Hagstrum DW (eds.) Integrated management of insects in stored products. Marcel Dekker, New York, p. 426.

Heinrichs EA, Barrion AT (2004). Rice-feeding insects and selected natural enemies in West Africa: Biology, ecology, identification. Los Baños (Philippines): International Rice Research Institute and Abidjan (Côte d'Ivoire): WARDA–The Africa Rice Center. p. 243

Ishiyaku MF, Singh BB (2003). Genetics of juvenile phase in cowpea (*Vigna Unguiculata* (L.) Walp). J. Food Agric. Environ., 1: 133-136

Jackai LEN (1982). A field screening technique for resistance of cowpea (*Vigna unguiculata*) to the pod-borer *Maruca testulalis* (Geyer) (Lepidoptera: Pyralidae). Bull. Entomol. Res., 72: 145-156.

Nelson SS, Ohlev TA, Mitchel CA (1997). Cowpea leaves for consumption: Production, utilization and nutrient composition. In: Singh BB, Mohan Raj DR, Dashiell KE, Jackai LEN (eds). Advances in Cowpea Research. Devon Sayce Publishing, p. 326-332

Ogenga-latigo MW, Ampofo JKO, Balidawa CW (1993). Factors influencing the incidence of the black bean aphid, *Aphis fabae* Scop. on common beans intercropped with maize. Afr. Crop Sci. J., 1: 49-58.

Oghiakhe S, Jackai LEN, Makanjuola WA, Hodgson CJ (1992). Morphology, distribution, and the role of trichomes in cowpea (*Vigna unguiculata*) resistance to the legume pod borer, Maruca testulalis(Lepidoptera:Pyralidae). Bull. Entomol. Res., 82, 449-505.

Picker M, Griffiths C, Weaving A (2004). Field Guide to Insects of South Africa. Struik Publishers. Cape Town, SA, p. 444.

Reddy C, Singh N, Vijai S (1998). Pest complex and their succession on pigeon pea variety. Indian J. Ent., 60 (4): 334-338.

Voster HJ, Jansen VRW, Van Zijl JJB, Venter SL (2007). The importance of traditional leafy vegetables in South Africa. Afr. J. Food, Agr. Nutr. Dev., 7(4): 1-13