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ORIGINAL RESEARCH

Major insect pests attacking okra; *Abelmoschus esculentus* (L) Moench, in Sebele; Botswana

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MDC; designed study, collected and identified insects, analysed results, prepared manuscript, attended to reviewer's comments. TAB; supervised field data collection, processed and prepared insect specimens for identification, partial data analysis.

ABSTRACT:
Abelmoschus esculentus (L) Moench (Okra) is an important crop in many African countries but its production is constrained by insect pests. Species that cause yield losses on the crop in Botswana have not been identified. This study identified major pests of okra found in surveys conducted during three seasons from 2006 to 2009 at the Botswana College of Agriculture farm at Sebele in Gaborone. Yield losses caused by pod-damaging species were estimated on three cultivars: Clemson spineless, Asontem and Legon 6. The most important pests were *Earias biplaga, Pachnoda rubrocincta, Mylabris* sp*., Dysdercus* sp. *and Aphis gossypii.* Pod damage caused by *P. rubrocincta* was similar ($P < 0.05$) on the three cultivars at about 23% per plant. *E. biplaga* caused 0.0, 2.0 and 16.7% damage on Legon 6, Asontem and Clemson spineless, respectively. *Dysdercus* sp. and *A. gossypii* damaged okra throughout the growing period. *Dysdercus* sp. was most abundant during the late podding period of plants, 100 days after plant emergence, while *A. gossypii* was most abundant 78 days after plant emergence. Application of control measures against pod-damaging species and those that occur throughout the growth of the plants should be made before podding begins to prevent yield losses.

Keywords Okra, insect pests, pod damage, yield loss

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INTRODUCTION

Abelmoschus esculentus (L) Moench (okra) is an annual vegetable crop that originated in tropical Africa but is now widely cultivated in tropical regions worldwide (Hill, 1987). However, it is a relatively new crop in Botswana. Okra is grown for its pods which are harvested while they are still immature and used in salads and soups. Many pests have been reported to attack the crop at different stages of growth (Critchley, 1997, Praveen and Dhandapni 2001, Dabire-Binso *et al*., 2009, Echezona *et al*., 2010). They include species that damage the foliage, shoots, flowers and pods. Hill (1987) identified nine insect species as serious pests of this crop worldwide: *Aphis gossypii* (Glov.), *Empoasca* spp., *Ferrisia virgata* (Ckll.), *Dysdercus* spp*.,Oxycarenus hyalipennis* (Costa), *Earias vittella* (Stoll.), *Earias biplaga* (Wlk.), *Earias insulana* (Boisd.) and *Helicoverpa armigera* (Hub.). Of these, five; *A. gossypii*, *Empoasca* spp., *E. biplaga*, *E. insulana* and *H. armigera* were considered to be important in many regions of Africa. Flea beetles, *Podagrica uniforma* (Jac.) and *Nisotra sjostedt* (Jac.) were found to be the most destructive on the crop in West Africa (Critchley, 1997, Dabire-Binso *et al*., 2009, Echezona *et al*., 2010). Coreid bugs such as *Acrosternum hilare*, *Euschistus servus* and *Leptoglossuis phyllopus* and other hemipteran insects including *Bemisia tabaci*, *Amrasca biguttula biguttula* and *Dysdercus superstitiosus* that pierce and suck sap from leaves, shoots and pods are also important pests of the crop in Africa and other regions (Sumathi, 2007, Sigh and Joshi 2003, Obeng-Oferi and Sackey, 2003, Omondi *et al*. 2005). *Aphis gossypii* is one of the most important piercing and sucking pests of okra world-wide (Blackman and Eastop, 2000). It is commonly known as the cotton or melon aphid and is particularly abundant in the tropics. It is a polyphagous species that has been reported to colonise over 300 host plants in Africa, including cultivated as well as wild plants (Deguine *et al*., 1999). The pest status of this species has increased from being insignificant in the 1960s to being serious in most cotton and okra growing areas of Africa (Deguine *et al*., 1999). *A. gossypii* is considered to be a major pest of cotton, cucurbits and okra (Hill, 1987, Matthews, 1989, Deguine *et al*., 1999, Blackman and Eastop, 2000, Munthali and Mmapetla, 2008). Flower feeding insects belonging to the genus *Mylabris* also cause serious damage on okra (Singh and Joshi, 2003). Although many studies on major pests that attack the crop in other countries have been conducted, relatively little research has been done on the crop in Botswana. Apart from the studies on population dynamics of *A. gossypii* conducted by Munthali and Mapetla (2008), little is known about other species that attack the crop in Botswana. The present study identified the major insect species that attack okra and estimated percentage damage caused by pod-damaging species under Botswana conditions.

MATERIAL AND METHODS

Insect pests that attacked okra were identified in studies conducted on the Botswana College of Agriculture farm, at Sebele, Gaborone, Botswana (24^{O}34'S, 25^{O}54'E, altitude: 994 m) over three cropping seasons: 2006-2007; 2007–2008; 2008–2009. Three okra cultivars (Asontem, Clemson spineless and Legon 6) were used in the study. The cultivars were sown in rows in field plots measuring 150 cm wide and 540 cm long. A randomized complete block design was used with each cultivar replicated four times. The inter-row spacing was 75 cm and the inter-plant spacing was 25 cm. The okra seeds were soaked in water for 12 hours before sowing. Two seeds were sown *per* hole and the seedlings were thinned at the three leaf stage. Any gaps were filled at the three leaf stage using seedlings removed in thinning. Plants in the outer rows and those at the ends of the two inner rows formed the borders while the inner plants in each plot formed the net plot. Pest damage assessments were conducted on plants in the net plot while insect specimens for species identification were collected from plants in the borders. Specimens of sclerotised insects were preserved as dry specimens while soft bodied species were preserved as wet specimens using the methods described by Millar (1999). Assessment of relative abundance of damage caused by pod-damaging insects was done on 10 randomly selected plants in each net plot during the 2006–2007 cropping season. The total number of pods produced and the number damaged by pod-boring caterpillars and beetles was recorded when 90% of the pods had reached the harvestable stage. The results were used to calculate the percentage yield losses caused by pod-damaging pests *per* plant. Weekly assessments to determine pest abundance were conducted from the three leaf stage to crop maturity (107 days after emergence). Abundance of *Dysdercus* sp. was estimated once a week by direct counts of insects on each of five randomly selected plants *per* plot. Abundance of *A. gossypii* on each cultivar was assessed on five randomly selected plants in each net plot. Leaf samples were collected from five randomly selected plants and later examined for aphids under a dissecting microscope at 40x magnification. All aphids found on each sampled leaf were counted and the average density *per* leaf was calculated.

Statistical analysis

Data were analysed using analysis of variance (ANOVA) and averages were separated using the Tukey test with the MSTAT-C (1985) package.

RESULTS

Five insect species, *Earias biplaga, Pachnoda rubrocincta, Mylabris* sp., *Dysdercus* sp. and *Aphis gossypii*, were consistently found on okra on the Botswana College of Agriculture farm during all three cropping seasons (Table 1).They includes species that attack leaves, flowers, stems, shoots and pods. Some of the species damaged the crop through biting and chewing activities while others injured the crop by piercing and sucking sap from tissue. Figure 1 shows that cultivar had a significant effect on the damage caused by *E. biplaga* to okra pods. *E. biplaga* caused the greatest damage (16.7% of pods *per* plant damaged) on Clemson spineless but it was significantly lower on Asontem and did not damage Legon 6 okra cultivars. The damage caused by the Scarabaeidae, *P. rubrocincta*, on the Clemson spineless was significantly greater that on Legon 6 as shown in Figure 2. The overall average damage ranged from 32.2% per plant on Clemson spineless to 14.9% on Legon 6 plants (Figure 2).

Figure 3 shows that the average pod damage caused by ants differed significantly among the three okra cultivars. Ants caused the greatest damage (84.9% of pods *per* plant damaged) on Legon 6 and the lowest (17.6%) on Clemson spineless plants.

Dysdercus sp. attacked okra throughout the study period, from 50 days to 107 days after plant emergence (Table 2). Overall average abundance of *Dysdercus* sp. was significantly ($P < 0.05$) affected by okra cultivar and by the period after plant emergence but the interaction between cultivar and period was not significant ($P < 0.05$). Overall average abundance on Clemson spineless and Asontem plants was similar ($P < 0.05$) and significantly greater ($P < 0.05$) than on Legon 6 plants. The overall average number of *Dysdercus* sp. increased significantly ($P < 0.05$) from 1.33 per plant on 50 days old plants to a peak of 3.25 per plant on 100 days old plants. The average abundance of the cotton aphid (*A. gossypii*) varied significantly ($P < 0.05$) among the three okra cultivars and between assessment dates (Table 3). The interaction between cultivar and dates was also significant ($P < 0.05$). The greatest abundance was on Clemsom spineless assessed 78 days after plant emergence while the lowest was on 1 to 50 days old plants of all three cultivars. The overall averages show that aphid abundance on the Clemson spineless and Asontem cultivars was similar ($P < 0.05$) and significantly greater ($P < 0.05$) than on the Legon 6 cultivar, while the overall assessment date average shows that *A. gossypii* increased from 10.5 per leaf on 50 days old plants to a peak of 242 per leaf on 78 days old plants and then declined to 86.8 aphids per leaf on 107 days old plants.

DISCUSSION

While *Aphis gossypii* has been reported on okra before (Munthali and Mmapetla 2008), the present study provides a first record of *Earias biplaga, Pachnoda rubrocincta*, *Mylabris* sp. and *Dysdercus* sp. damage to okra pods in Botswana. Pods are the marketable part of okra, therefore the damage by the five species identified is considered important for the crop since they cause direct injury to pods (Pedigo, 2002). The variation in intensity of pod damage per plant among the okra cultivars shows that.

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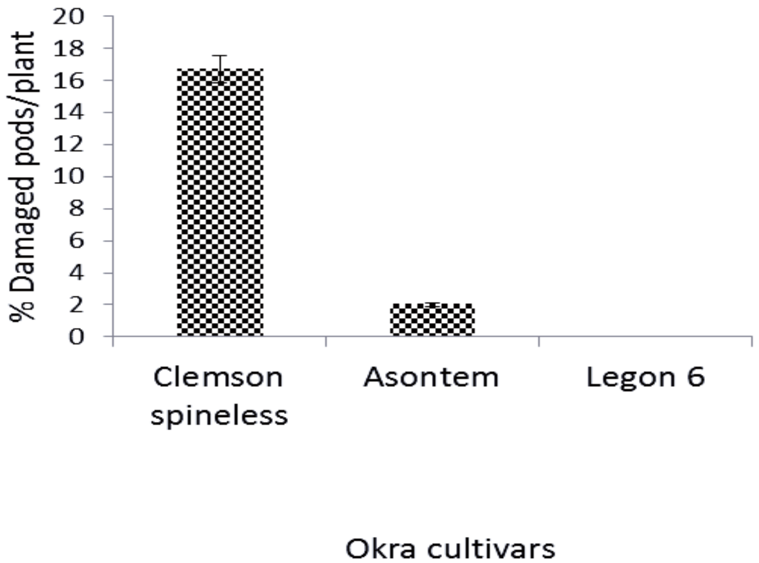

Figure 1: Average % pod damage per plant caused by *Earias biplaga* (HSD = 1.362, α=0.05)

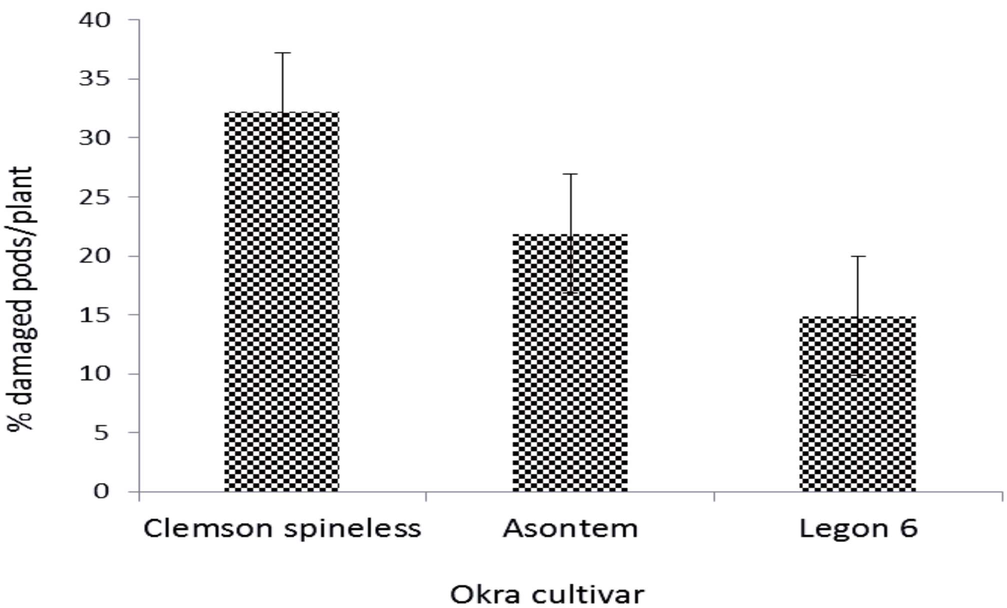

Figure 2: Average % pod damage caused by *Pachnoda rubrocincta*

Table 1: Major pests of okra in BCA farm during 2006-2007, 2007-2008 and 2008-2009 cropping seasons

Scientific name	Common name	Parts of plant attacked	Type of damage caused
Earias biplaga (Wlk.)(Lepidoptera: Noctuidae)	Spiny bollworms	Pods	Boring inside the pod
Pachnoda rubrocincta (Coleoptera: Scarabaeidae)	-	Pods	Chewing pod tissue from the surface inwards, forming large hole in the pod
Mylabris sp. (Coleopteraa: Meloidea)	Blister beetles	Flowers	Destroying flowers through feeding on the whole inflorescence
Formicidae (Hymenoptera)	Ants	Flowers and pods	Destroyed flowers and made large holes in pods
Dysdercus sp. (Hemiptera: Pyrrhocoridae)	Cotton stainers	Leaves and pods	Pierce and suck sap from leaf and pod tissue, causing distortion of pods
Aphis gossypii (Glov.) (Hemiptera: Aphididae)	Cotton aphid	Leaves, shoots, stems, flowers and pods	Pierce and suck sap from leaves, shoots, flowers and pods; produce large quantities of honeydew resulting in growth of black sooty mould on the leaves and pods

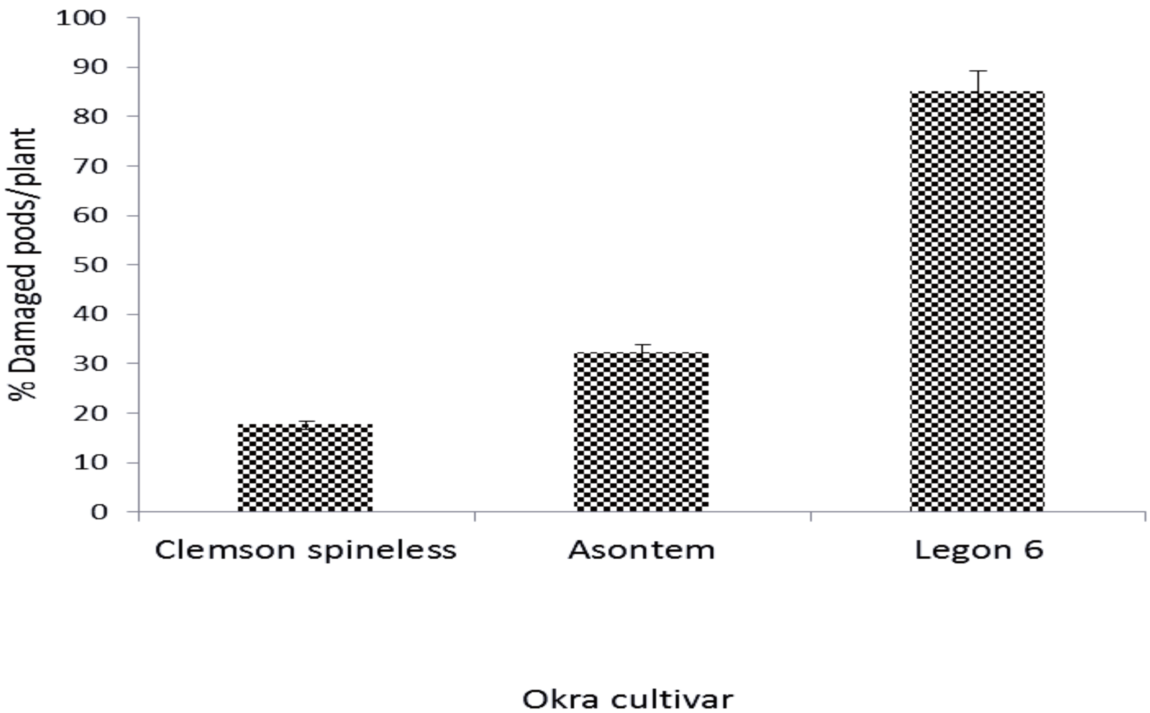

Figure 3: Average % pods damaged by ants (Formicidae) (HSD=3.748, $\alpha = 0.05$)

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Table 2: Average abundance of *Dysdercus* sp. on three okra cultivars at different periods of growth of plants

Days after plant emergence	Average no. of *Dysdercus* sp. per okra plant, by cultivar			Overall date averages
	Clemson spineless	Asontem	Legon 6	
50	1.25^{NS}	1.75	1.00	1.33^{b*}
57	2.00	3.25	1.00	2.08^{ab}
64	2.75	2.50	1.00	2.08^{ab}
71	3.50	3.00	1.00	2.50^{ab}
78	3.50	1.75	1.00	2.08^{ab}
86	1.75	3.00	1.00	1.92^{ab}
93	4.00	1.00	2.00	2.33^{ab}
100	2.75	4.00	3.00	3.25^{a}
107	4.25	2.75	2.25	3.08^{ab}
Overall varietal averages	2.86^{a**}	2.56^{a}	1.47^{b}	2.29

**Overall date column averages with different superscript are significantly different (Tukey, P < 0.05)*
***Overall varietal row averages with same superscript are not significantly different (Tukey, P < 0.05)*
NS = Interactions between cultivar and date did not have significant effects (Tukey. P > 0.05)

Table 3: Average abundance of *Aphis gossypii* per leaf on three okra cultivars at different periods of growth of plants

Days after plant emergence	Average number of *A. gossypii* on each okra leaf, by cultivar			Overall date averages
	Clemson spineless	Asontem	Legon 6	
0	0.0^{l*}	0.0^{l}	0.0^{l}	0.0^{f**}
50	$5.3k^{l}$	17.9^{jkl}	8.3^{kl}	10.5^{f}
57	17.3^{jkl}	76.2^{hij}	45.4^{ijkl}	46.3^{e}
64	109.4^{ghi}	238.1^{abc}	131.4^{efgh}	159.6^{c}
71	222.7^{abcd}	240.5^{abc}	161.0^{defg}	208.0^{b}
78	278.9^{a}	242.9^{ab}	204.4^{bcd}	242.0^{a}
86	249.4^{ab}	194.8^{bcde}	176.4^{cdef}	206.9^{b}
93	191.8^{bcde}	130.5^{efgh}	107.2^{ghi}	143.2^{c}
100	102.4^{ghi}	118.6^{fgh}	87.7^{hi}	102.9^{d}
107	87.9^{hi}	104.5^{ghi}	67.9^{hijk}	86.8^{d}
Overall varietal average***	126.5^{a}	136.4^{a}	99.0^{b}	120.6

**Interaction averages in the main body with different superscript are significantly different (Tukey, P < 0.05)*
*** Overall date column averages with different superscripts are significantly different (Tukey, P < 0.05)*
****Overall varietal row averages with different superscripts are significantly different (Tukey, P < 0.05)*

E. biplaga damage can be reduced to negligible levels by cultivating the resistant cultivars Legon 6 and Asontem (Figure 1). This suggests that application of control measures against *E. biplaga* may not be required when Legon 6 is grown. However, cultivation of the highly susceptible cultivar, Clemson spineless, resulted in significatly higher yield losses that would warrant application of control measures against the pest. These results suggest that varietal resistance can be employed as a biological measure to control *E. biplaga* on okra. It also suggests that breeding the crop for resistance may be possible. In Botswana and other countries that grow okra, farmers grow the crop to produce pods for own consumption and/or for sale. Any damage to pods must be avoided since it represents direct reduction in yield. In the current study the significant differences in yield losses caused by the scarabaeid beetle, *P. rubrocincta,* show that cultivar Legon 6 is 2x more resistant to the beetle than Clemson spineless (Figure 2). On the basis of relative susceptibility to *P. rubrocincta,* the more resistant cultivar Legon 6 would be recommended for use by farmers since it was least susceptible to beetle damage.

Ants have not been reported as major pests of okra before. The findings in the present study are a first record from Botswana. The significant differences in pod damage found in Figure 3 show that varietal resistance can play an important role in the control of ant damage on okra. Since the yield losses on Legon 6 were 4.8x greater than on the more resistant cultivar, Clemson spineless, the growing of Clemson spineless, would be recommended in areas where ants are prevalent.

Dysdercus spp. suck sap from okra causing production of distorted, unmarketable pods (Critchley, 1997, Schaefer and Ahmad, 2000). The differences in the overall number of *Dysdercus* sp. in the present study show that the cultivars Clemson spineless and Asontem, with the greatest abundance of the pest were more susceptible to its infestation than Legon 6. Application of control measures against *Dysdercus* sp. on these cultivars is essential to avoid rapid population build up in the crop. Results of the present study show that *Aphis gossypii* infests okra from the vegetative to the pod formation stages of the plant and that its population builds up rapidly to a peak 78 days after plant emergence (Table 3). Similar results were previously reported by Munthali and Mapelta (2008). The 19.8 times increase in *A. gossypii* abundance over a four week period confirms the conclusion by Munthali and Mapelta (2008) that *A. gossypii* must be controlled early after detection to prevent the species from reaching peak population levels. The rapid build up of the pest occurs at a critical phenological stage when the plant is producing its pods. *A. gossypii* damages okra through direct sucking of sap from leaves, shoots and pods (Critchley, 1997, Blackman and Eastop, 2000). Its presence on infested pods and also the covering of pods with the honeydew which the aphids produce lowers the quality of the pods, making them unmarketable. The present finding that the peak pest abundance occurred at the same age of the plant regardless of cultivar shows that the pest must be controlled during flowering, before the onset of pod production.

CONCLUSION

Farmers grow okra to produce pods which they utilize as a vegetable or sell to earn income. It can be concluded that since the insect species found damaging okra pods in this study affect the yield of okra directly they are serious pests of the crop. The study also illustrates that insect pest species can cause damage to over 80% of pods on highly susceptible cultivars.

The differences in susceptibility to pod damage of different cultivars can be utilised to select those that are least susceptible for use by farmers in an integrated pest management strategy against specific species. It is recommended that pest control measures should be applied to prevent serious damage to okra pods on cultivars that are susceptible to specific pest species.

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Conflict of interest None

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