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Alternate host plants, hibernation sites and survival strategy of C*ylas puncticollis* Boh.: A new pest of cotton

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Abstract

Survey and field experiments from 2001 – 2005 were carried out on cotton farms and surroundings to determine the alternate host plants, hibernation and survival strategy of Cylas puncticollis Boh. (Coleoptera: Brentidae) in the Northern Guinea Savannah zone of Nigeria. Trials were also conducted on five malvaceous crops (cotton, kenaf, okra, red and white calyx roselle) in a completely randomised block design in three replications at Ngurore the 'hot spot' zone for the weevils. C.puncticollis was found on the following plants Astripomeoa lachnosperma, Ipomoea eriocarpa, Corchorus spp., Celeosia spp., Commelina spp., Boerhavia spp., Hibiscus spp. and Abelmoschus spp. Peak period C. puncticollis was Nov. 1st with about 12 weevils/5plants. Hibernation for the adult weevils were cotton bracts, exposed roots of cotton, thrash debris and cracked soils. Pupae and adults of C. puncticollis were found within 1 – 15cm cracked soil depths around cotton and Ipomoea weeds. Adult weevils prefers dark corners and when disturbed moves at a faster speed or fain/fake death to escape enemies.

Keywords: Alternate hosts, survival, hibernation, Cylas, Ipomoea, pests

1. Introduction

The major host plant of *Cylas* spp. has been the sweet potato, *Ipomoea batatas*, but it has been reported that 27 other *Ipomoea* spp and a few related genera serve as alternate host plants (Sutherland, 1986; Wolfe, 1991; Smit, 1997). However, Capinera (1998) reported that some members of family Convolvulaceae are possible alternate host plants such as *I. pes-caprae, I. penduratea*, with a range of others reported by Smit (1997) in Eastern Africa but no attempt has been made to verify whether *Cylas* spp breed on any of them. Besides, most of other *Ipomoea* spp do not form swollen storage roots and population build-up on the vines is usually slow (Smit, 1997). He also observed that only through vertisols or sandy soils that *Cylas* could move upward but cannot dig 1 cm beneath soil surface. So possible infestation could be through females gaining access to exposed root or cracked soil (Sutherland, 1986 and Smit, 1997). It has not been recorded anywhere that cotton, *Gossypium* spp, is a host plant, nor members of the family Malvaceae. However, Chandler and Wright (1990) found kenaf, okra, *Hibiscus* spp as alternate host plant of *Anthonomus grandis* (Boh.) which are of the same author with *C. puncticollis* Boh. (Boheman, 1843). Therefore, this study attempts to investigate the alternate hosts of *C. puncticollis*, its pest status on the alternate hosts and also determine its survival strategies from one season to the other.

2. Survey of Alternate Host Plants

During the course of survey from 2001-2005 and field experimentation, some weeds in and around cotton farms were carefully observed to determine the presence of *Cylas* spp. Such weeds were collected, photographed and were identified at the herbarium maintained by the Dept of Biological Sciences, A.B.U., Zaria. The surveys which were conducted during the rainy and dry seasons, were also extended to Fadama areas. The damage potential ratings on the alternate hosts were determined and ranked on a scale of 1 – 4, similar to Adamu, *et al.* (2000) and Malgwi and Onu (2004). Where 1 = few and little or not important; 2 = causes little and occasional damage; 3 = common and causes little damage and 4 = common and causes serious damage.

2.1 Trial on some Malvaceae Plants

The trial were conducted at Ngurore (AFCOTT Company Research farm given to cotton farmers) during the rainy seasons in 2001 to 2003. There were five types of Malvaceae, plants which served as the treatments. These included, cotton, (SAMCOT 8), white calyx roselle (*Hibiscus sabdariffa* L.), red calyx roselle (*H. sabdariffa* L.), kenaf, (*Hibiscus cannabinus* L.) and day length sensitive okra (*Abelmoschus esculentus*). The choice of these five plant spp. which cotton is inclusive for comparative investigation was that:

i) They are from the same family.
ii) They share the same flower structure and most times petal.
iii) Phenotypically they are of similar morphology
iv) They easily grow together.
v) Flower position and fruits formation are almost similar.
vi) SAMCOT 8, is the recommended cotton variety in the Eastern cotton zone.

The land was ploughed, harrowed and ridged five days before planting. The five crop varieties were sown in the first week of July from 2001 – 2003 on a plot size of 3 x 4 m in a randomized complete block design (RCBD) replicated thrice, with 1.5 m between each block. About six seeds per hole were planted on a broad crown ridge of 0.75 m inter-row spacing and 0.5 cm intra-row spacing was adopted. Seedlings were later thinned to 2 plants/stand after plant establishment at 2 weeks after germination. NPK fertilizer (20:10:10) at the rate of 30 kg N/ha was applied followed with a top dressing of urea at 45 kg N/ha was supplied immediately after the 2nd weeding at four (4) and eight (8) week after planting respectively. No insecticide or herbicides was used. Supplementary hoe weeding was done three times before harvesting. The various treatments were observed weekly beginning from crop germination at 2 weeks after sowing to determine the presence and activities of *C. puncticollis*. The damage potential ratings was determined and ranked on a scale of 1 – 4 as described by Admau, *et al.* (2000)*;* Malgwi and Onu (2004). Where 1 = little or not important; 2 = causes little and occasional damage; 3 = common and causes little damage and 4 = common and causes serious damage. The data collected was subjected to Analysis of variance (ANOVA) and Student-Newman-Keuls (SNK) test of variables was used for means separation at 5 %.

2.2 *Hibernation sites, behaviour, movement and survival*

During the cropping season, the activities of *C. puncticollis* were observed on different parts of the cotton plants and weeds on the farm. The habit in terms of movement, distance moved and general behaviour were observed in the hours of 0700-0900, 1200-1400, and 1700-1800. This observation was made at 75% boll formation during the rainy season in October 3 in 2004 (first week of October) and at the off-season (dry season) in 1st week of June, 2005 just after the first two rains giving an interval of 10-14 days maximum. The observations were made at Ngurore on cotton plant alone, cotton entwined with *Ipomoea* weed and cotton entwined with *Ipomoea* and *Celosia* weed. During the off-season, observation was on cotton alone and cotton entwined with *Ipomoea* weed, no *Celosia* weed was found in the dry season at time observations were carried out.

At the end of the rainy season, sites were searched round the farm. Soil samples were collected from the top 1-5 cm, 5-10 cm and 10-15 cm including cracked portions using soil auger of 0.9m^2 capacity. This was replicated thrice on different fields at Ngurore. The samples were taken to laboratory, dissolved in water inside a bucket and sieved using a screen mesh of 20 and 30, so as to extract the pupae and adults of *Cylas* spp. Also the roots of cotton were dug out and examined for the presence of larvae, pupae or adults and if there were entry points at the end of rains and later at the off-season towards beginning of rainfall. The roots and stems were split open using a pen knife. The number of life stages of *C. puncticollis* found were recorded.

3. Alternate host plants

Cylas was found on the plants belonging to one order (Dicotyledonaceae and seven families (Table 1 and Plates 1 – 10). *C. puncticollis* were found feeding (nibbling and cutting holes or punctures) on various plant parts which included young flowers, buds and the soft apical growing points. The damage was rated on a scale of 1 – 4, where 1= few and little or not important, 2 = causes little and occasional damage; 3= common and cause little damage and 4 = common and causes serious damage. The highest damage rating was on *I. eriocarpa* (4), followed by *A. lachnosperma*, *C.*

argenta and *H. cannabinus*, having (3), followed by *C. oliotorius, C. benghalensis, H. sabdaiffa and A. esculentus* with (2) each while the least was *C. falcata* with (1).

3.1 Preferential host plant

Hibiscus cannabinus plant maintained significantly a higher population of *C. puncticollis* between 1st week in October and second week in November. The figure ranged from 6.3 to 10.00. At the early part of the year, *Cylas* spp. was not found from seedling up to fruiting stage in September on the experimental plots, except on farmers' field. Tables 2 – 4 showed the trend of *Cylas* number within the period sampled. SAMCOT 8, showed a consistent low number of *Cylas* compared to others, and okra. There was steady increase in number from 2001-2003 (Fig.1) the peak period being 1st week in November, with 5.67 weevils per 5 sampled plants in 2003 followed by 5.33 weevils in 2002, while 4.4 weevils were obtained in 2001 irrespective of the five crop plant types. There was a significant difference on kenaf and the other crop plants (okra, roselle and cotton). Kenaf harbours more *Cylas* spp., having 12 weevils/5 plants followed by red roselle (5.0 plants), white roselle (4.4/5plants) cotton (3.1/5 plants) and okra (0.8/5 plants) in a decreasing order (Fig.2). 1st week of November was the peak period of *Cylas* spp, based on the crop plants irrespective of the years (2001 – 2003) on the average basis as shown in Fig.2, while the weevils decreased beginning 3rd week of Nov. the 15th.

3.2 Hibernation site

Cylas spp. was found in the root of exposed cotton roots, thrash, debris and in cracked soils. The average depth of cracked soil where adult *cylas* was found, was 35cm as it crawls or roles into the cracked soil in December middle, while by March, average soil depth increased to about 70-75 cm with a width of 1-5cm maximum. Length of cracked soil ranges was between 20-100 cm. Plates 11–13, showed cracked soil, roots of plants where adult *Cylas* spp. were found and its survival in the root line within the soil cracked.

The results showed that 5.33 pupae and 6.67 adults were found at the depth of 1-5 cm, while about 1.67 and 2.33 pupae and adults were found in 5-10 cm soil respectively, and also 0.67 and 0.33 pupae and adult were found in 10-15 cm (Table 6). However, for pupae, there was no significant difference between 5-10 and 10-15 cm soil depth ,while there was a significant difference for number of adults found.

3.3 Behaviour, movement and survival strategy of Cylas spp.

In this study, it was consistently observed that adult *Cylas* spp. males, move faster than the females. It was easier catching the females than the males of *Cylas* spp. At a sound or disturbance, *Cylas* will pause noting probably direction of disturbance and will drop and feign death, while some drop and on continuous disturbance will crawl and hide under thrash or fall into a cracked soil. Immediately after rains, when sampled, higher number was found in bracts of cotton up to 20-25 adults/bracts. When disturbed, adult will crawl at the rate of 1-1.2cm/30 sec., while undisturbed it moves slowly, grubbing on plant part at the rate of 30cm/90 sec, on top soil to the tip of cotton plant or host where found. In cracked soil, on when disturbed the weevils spend between 120-150 seconds in the soil crevices before emerging on the top of soil surface.

Higher number of *C. puncticollis* were collected in unweeded farms surrounded by bushes in shaded areas by noon, but they were more uniformly distributed by 0730 hours. Nineteen (19/5 plants) C*ylas* adults were recorded on cotton entwined by *Ipomoea* weed alone. While twenty six (26/5 plants) of *Cylas* was recorded on cotton entwined with *Ipomoea* and *Celosia* weeds (Table 7, Plates 14 and 15).

There was no significance difference on cotton plant alone than observed at 0700 – 0900 (12.67) and 1700 – 1800 (1300) hours but the number was significantly lower at 1200 – 1400 hours. A similar trend followed but higher numbers when cotton was entwined with *Ipomoea* weed having 19.0/5 plants and 18.67/5 plants at 0700 – 0900 and 1700 – 1800 hours respectively. The value was significantly lower at 1200 – 1400 hours (6.33). The same trend was observed also where cotton, *Ipomoea* and *Celosia* inclusive entwined together with higher numbers of 26.0 and 26.67 at 0700 – 0900 and 1700 - 1800 hours, while at 1200 – 1400 hours the number decreased significantly to 7.33 weevils /5 plants. There was a steady increase on cotton alone, cotton entwined with *Ipomoea* weed to cotton entwined with *celosia* and *Ipomoea* weed with all the hours observed as presented on Table 7. During the dry season, a similar trend was observed, but the abundance or numbers of *C. puncticollis* was lower than in the dry season. Where the highest number of weevils were 9.33 and 9.67 at 1700 – 1800 and 0700 – 0900 hours was recorded on cotton entwined with *Ipomeoa* weed than on cotton alone having 5.67 at same hours recorded. Lower number was recorded at 1200 – 1400 which was 3.33 on cotton alone and 5.00 on cotton entwined with *Ipomeoa* weed.

4. Discussion

About 10 species of weed and crop plants were identified to be potential alternate host plants for *Cylas* spp. Out of all these, only two weeds *A. lachnosperma* and *I. eriocarpa* are members of the family Convolvulaceae, but are not listed in literature as alternate host plants of *Cylas*, but it corroborates the earlier work of Sutherland (1986), Wolfe (1991) Capinera (1998) and Smit (1997) that members of the wild relatives of the family Convolvulaceae, are potential hosts or alternate host plants of *Cylas* which could serve as source of carryover from one season to the other.

Also members of the family Malvaceae could be potential hosts of *Cylas* and although this was not reported in literature, but in this study, they were found feeding on them. It may be assumed that since *Cylas* is of the same family curculionidae formerly with *Anthonomus grandis* which has members of the Malvaceae family as its alternate host plants, that is the closest resemblance recorded in literature. It may be that *Cylas* has been in existence but might have been overshadowed by the most destructive pest in the U.S.A on cotton which was *A. grandis*. It could be that *Cylas* is increasing it host plants. (Boheman, 1843; Chandler and Wright, 1990). This is the first time *Corchorus* spp, and *Boerhavia* spp are reported as alternate hosts of *Cylas*. Therefore additional studies is required on these weeds along side with all members of the Malvaceae. On all the plants observed *Cylas* spp. were found on the growing tips and reproductive structures, where nibbling and feeding punctures were the notable signs of damage by *Cylas* spp.

The results obtained on hibernating sites in soils, showed that, *Cylas* spp, actually completes its life-cycle in thrash, and open roots of cotton in soil that are partially cracked or loose in 1-5 cm depth. This is similar to the findings of Sutherland (1986) and Smit (1997) that *Cylas* cannot dig below 1cm of soil thickness, its probable way of gaining access to roots of plants is when it is exposed or when soil cracks. This may suggest why they were found mainly in cracked soil pathways, and soil surfaces. In the earlier findings of Sutherland (1986) and Smit (1997), *Cylas* moves faster from soil beneath to top and not from top to bottom. The snout or ovipositor is probably not sharp enough to dig heavy vertisol soils or it could be a natural habit for adaptation and that is why lower number was found in cracked soil depths not more than 15cm in this study.

Cylas puncticollis showed no special behavioural exception to other insects. Every organism desires shelter and protection and will do anything possible to protect itself by evolving different kinds of defensive mechanisms which in most cases results in the development of camouflage mimicking or feigning death to escape potential enemies. It is normal for insects to seek for shelter in harsh weather by hiding in dark corners, thus it is not surprising that *Cylas* was found exhibiting these characteristics, hiding in concealed locations and in bracts of cotton after a heavy rainfall. These insects are easily swept by rains, and this might have form one of its dispersal strategies, through thrash or water runoffs from field to field. This further corroborates Sakuratani *et al.* (1994) and Smit (1997) findings, that *C. puncticollis* aggregates together during the day but becomes active in the dark. Talekar (1982), reported that the major means of *Cylas* dispersal is through the movement of debris or planting materials from neighbouring fields. In the present study no sweet potato field was found within 1 km distance from cotton farms, and sweet potato has been recorded as the initial host plant of *Cylas*. Movement of *Cylas* to places as Gombi and Mubi could only have been achieved through the movements of plant parts to these areas through the sale of cotton seeds from AFCOTT, Ngurore which the present study has confirmed to be a hot-spot zone for the weevils. Weevils generally could fly only short distances according to Chalfant *et al*. (1990), however even those short flights was not observed during the cause of this study, probably because *Cylas puncticollis* are more active at night as earlier reported by Smit (1997).

The observation in the present study showed that a high number of *Cylas* were observed on the wild relatives of *Ipomoea* on the fields towards the end of the cropping season, which suggest that complete weeding off of such plants on and around the fields of cotton may greatly reduce the incidences of *Cylas*.

5. Conclusion

This study clearly determined the possible alternate hosts of *Cylas* , their survival and how carryover to the next season. This probably will provide the initial means of eradication of *Cylas puncticollis* or reducing their numbers appreciably. The present findings also indicated that, members of Malvacae family other than cotton as potential hosts of *Cylas*. It is suggested here as a first step in the control, not to mix crop of such family members with cotton or even rotate them on designated cotton fields, as this will increase their host range multiplication and dispersal and survival of *C. puncticollis* which is developing into a major pest of cotton.

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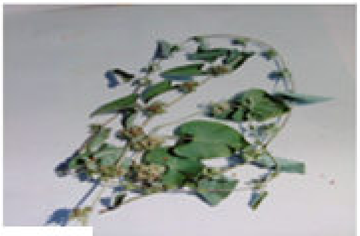

Plate 1: *Ipomoea ericarpa* R. Br.
Family-Convolvulaceae

Plate 2: *Astripomoea lachnosperma* (Choisy) Meause Family-Convolvulaeae.

Plate 3: *Corchorus olitorius* Linn.
Family-Tiliaceae

Plate 4: *Celosia argentea Linn*. **Family-Amaranthaceae**

Plate 5: *Crotolaria falcata* **Vahl. Ex. De. Family-Leguminoseae/Papillionidae**

Plate 6: *Commellina benghalensis* **Bengha Family-Commelinaceae**

Plate 7: *Boerhavia coccinea*
Family-Myctaginaceae

Plate 8: *Hibiscus cannabinus* Linn.
Family- Malvaceae

Plate 9: *Hibiscus sabdariffa* Linn.
Family-Malvaceae

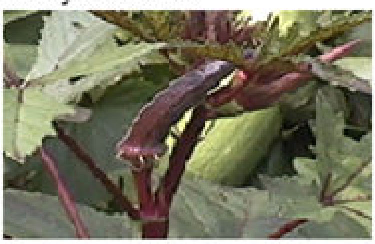

Plate 10: Okra *Abelmoschus esculentus* Linn. Family Malvaceae

Plate 11: Live adult *Cylas* in ratoon cotton stem with cracked soil beneath which provides shelter, hibernation and pupation site for next planting season at the end of the rainy season.

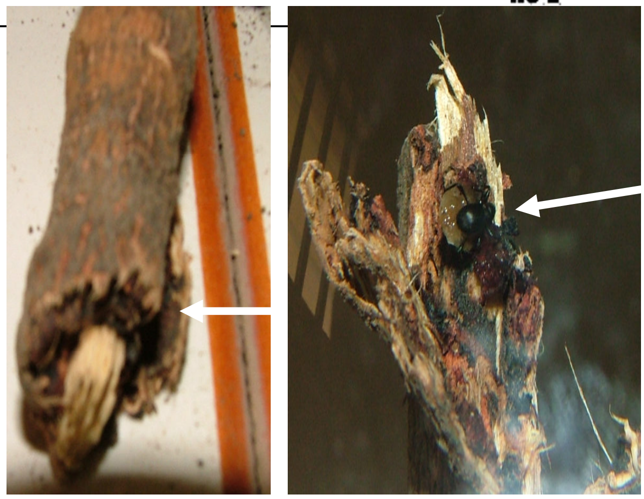

Plate 12: Hibernation site *Cylas* on cotton stem cut 1cm below soil surface

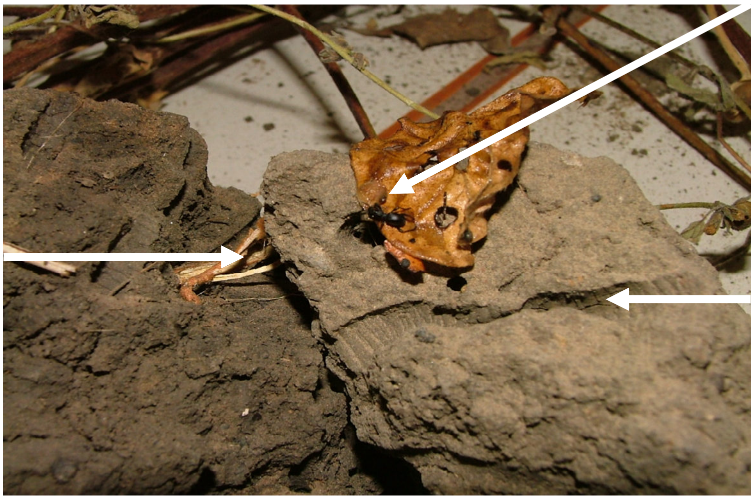

Plate 13: Cracked soil showing root lines where *Cylas* hibernate and completes its life-cycle to adulthood.

Plate 14: *Ipomoea* weed entwined *Celosia* on a Cotton farm infested with *Cylas puncticollis* mating with a lot of oviposition site on plant stem

Plate 15: *Ipomoea* weed entwined round cotton

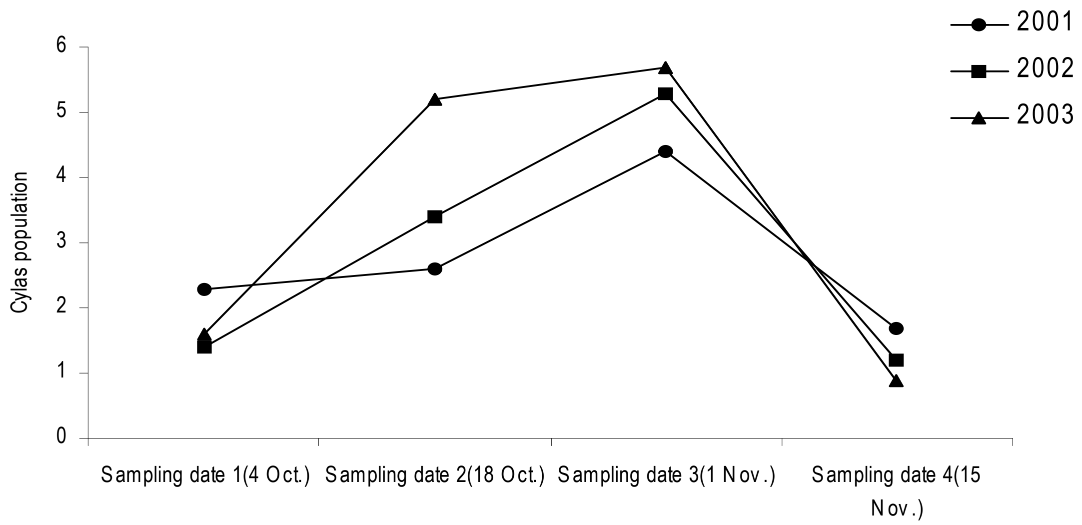

Fig. 1: Seasonal Fluctuation of *Cylas puncticollis* sampled/5 plants for 3 years (2001 - 2003) at Ngurore, Adamawa State, Nigeria.

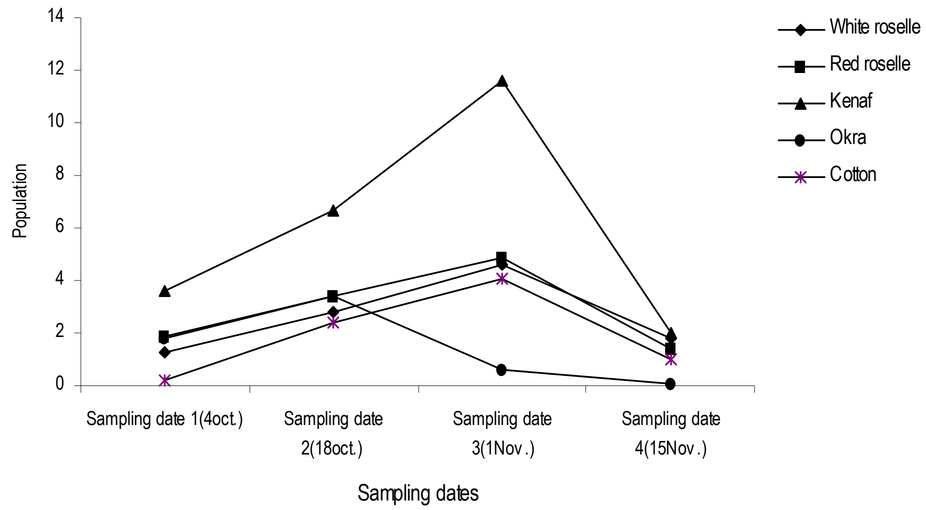

Fig. 2: Seasonal Fluctuation of *Cylas puncticollis*/5 plants sampled fortnightly on five Malvaeae crop plants for 3 years (2001 - 2003) cropping season at Ngurore, Adamawa State, Nigeria.

Table 1: Alternate Host Plants of *C. puncticollis*

	Order	Family	Scientific names	Part of Plant Found/Damaged	Damage ratings
1.	Dicotyledonae	Convolvulaceae	*Astripomea lachnosperma*	Flower buds, developing fruit and leaves	3
2.	Dicotyledonae	Convolvulaceae	*Ipomoea eriocarpa*	Same	4
3.	"	Teliaceae	*Corchorus oliotorios* Linn.	Same	2
4.	"	Amaranthaceae	*Celosia argentea* Linn.	Same and stem also	3
5.	"	Leguminoseae	*Crotalaria falcata* vahl. Ex. De	Flower & developing fruit	1
6.	"	Commelinaceae	*Commelina benghalensis* Bengha	Flower buds, and leaves	2
7.	"	Myctaginaceae	*Boerhavia coccinea*	Same	2
8.	"	Malvaceae	*Hibiscus cannabinus* Linn.	Flower bud and developing fruit	3
9.	"	"	*Hibiscus sabdariffa* Linn.	*Same*	2
10.	"	"	*Abelmoschus esculentus* Linn.	Same	2

Table 2: Abundance of Cylas spp on some selected Malvaceae crops at Ngurore in 2001 rainy season

Host Plants	Sampling dates (number/5 plants)			
	1st Week, Oct.	3rd Week, Oct.	1st Week, Nov.	3rd Week, Nov.
1. White Roselle *Hibiscus sabdariffa*(L)	1.3b (1.3ab)	1.3b (1.3b)	4.0b(2.1b)	2.7a(1.7a)
2.Red roselle *H. sabdariffa* (L.)	2.7b(1.7ab)	2.7b(1.8ab)	4.7b(2.3b)	2.0ab(1.6a)
3. Kenaf, *H. cannabinus* (L.)	6.0a (2.5a)	5.3ab(2.4a)	10.0a(3.2a)	2.7a(1.8a)
4. Okra,*Abelmoschus esculentus*	1.4b(1.3ab)	2.3b(1.7ab)	0.0c(0.7c)	0.3c(0.9c)
5. Cotton (SAMCOT 8) *Gossypium hirsitum*	0.0b (0.7b)	1.3(a.3b)	3.3b(1.9b)	1.0bc(1.2b)
Mean	2.27(1.50)	2.60(1.69)	4.40 (2.05)	1.73(1.44)
CV (%)	72.9(34.9)	44.9(23.1)	27.5(11.40	3.33(11.7)

Means followed by the same letters in a column are not significantly different at P=0.05 SNK (Student-Newman-Keuls) test for variables. Figures in parenthesis are square root transformation of number of *Cylas* on different sampling dates

Table 3: Abundance of Cylas spp. on some selected Malvaceae crops at Ngurore in 2002 rainy season

Host Plant	Sampling dates (number/5 plants)			
	1st Week, Oct	3rd Week Oct	1st Week Nov	3rd Week, Nov
1. White roselle *Hibiscus sabdariffa* (L.)	1.0b(1.2a)	2.7b(1.8a)	5.0b(2.3b)	1.7a91.4a)
2.Red Roselle *H. sabdariffa* (L.)	1.3b(1.29ab)	3.0b(1.8a)	5.3b(2.4b)	1.3ab(1.3a)
3. Kenaf, *H. cannabinus* (L.)	2.7a(1.8a)	5.0b(2.3a)	12.0b(3.5a)	2.0a91.6a)
4. Okra, *Abelmoschus esculentus*	2.0ab(1.6a)	3.3b(1.9ab)	0.7c(1.1c)	0.0b(0.7b)
5. Cotton (SAMCOT 8) *Gossypium hirsitum*	0.0c(0.7b)	3.0b(1.9b)	3.7b(2.0a)	1.0ab(1.2a0
Mean	2.40(1.32)	4.40(1.9)	5.33(2.3)	1.20(1.3)
CV (%)	36.9(16.7)	21.1(10.7)	15.5(9.0)	50.5(15.9)

Means followed by the same letters in a column are not significantly different at P=0.05 SNK (Student-Newman-Keuls) test for variables. Figures in parenthesis are square root transformation of *Cylas* on different sampling dates

Table 4: Abundance of Cylas spp. on some selected Malvaceae crops at Ngurore in 2003 rainy season

Host Plant	Sampling dates (number/5 plants)			
	1st Week, Oct	3rd Week Oct	1st Week Nov	3rd Week, Nov
1. White roselle *Hibiscus sabdariffa* (L.)	1.7ab(1.5ab)	4.3b(2.2b)	4.7b(2.3b)	1.0a(1.2a)
2.Red roselle *H. sabdariffa* (L.)	1.7ab(1.5ab)	4.7b(2.3b)	4.7b(2.3b)	1.0a(1.2a)
3. Kenaf, *H. cannabinus* (L.)	2.0a(1.6a)	9.3a(3.1a)	12.7a(3.6a)	1.3a(1.3a)
4. Okra, *Abelmoschus esculentus*	2.0a(1.6a)	4.7b(2.3b)	1.0c(1.2c)	0.0b(0.7b)
5. Cotton (SAMCOT 8) *Gossypium hirsitum*	0.7a(1.1b)	3.0b(1.9b)	5.3b(2.4b)	1.0a(1.2a)
Mean	1.60(1.4)	5.20(2.3)	5.67(2.6)	0.87(1.14)
CV (%)	27.7(12.9)	20.5(10.2)	3.3(5.4)	29.8(8.0)

Means followed by the same letters in a column are not significantly different at P=0.05 SNK (Student-Newman-Keuls) test for variables. Figures in parenthesis are square root transformation of *Cylas* on different sampling dates

Table 5: Damage assessment of *C. puncticollis* on some Malvaceae plants

	Common names	**Scientific names**	**Parts found**	**Pest damage rating**
1.	White roselle	*Hibiscus sabdariffa* (L.)	Flowers, buds, and developing bolls	2
2.	Red Roselle	*Hibiscus sabdariffa* (L.)	"	2
3.	Kenaf	*Hibiscus cannabinus* (L.)	"	3
4.	Okra	*Abelmoschus esculentus* (L.)	Flowers, buds, developing fingers	2
5.	Cotton,SAMCOT 8	*Gossypium hirsutum* (L.)	Flowers, bracts, buds, developing bolls	2

Table 6: Number of pupae and adult *Cylas* spp. at different soil depth on cotton farm at the end of the rainy season, 2005 at Ngurore

Soil depth (cm)	Number of pupae	Number of adult
1.0-5.0	5.33^{a}	6.67^{a}
5.0-10.0	1.67^{b}	2.33^{b}
10.0-15.0	0.67^{b}	0.33^{c}
Mean	2.56	3.11
CV (%)	26.09	21.43

Means followed by the same letters in a column are not significantly different at P=0.05 SNK (Student-Newman-Keuls) test for variables.

Table 7: Abundance of *C. puncticollis* (number/5 plants) at different times of the day on farmers' field at Ngurore, at 75% boll formation of cotton

Time of the day (hrs)	**Rainy (cropping) Season 2005**			**Off (Dry) Season 2006**		
	Cotton alone	**Cotton entwined with *Ipomoea* weed**	**Cotton entwined with *Ipomoea* & *Celosia* weed**	**Cotton alone**	**Cotton entwined with *Ipomoea* weed**	**Cotton entwined with *Ipomoea* & *Celosia* weed**
0700 – 0900	12.67^{a}	19.00^{a}	26.00^{a}	5.67^{a}	9.67^{a}	-
1200 – 1400	4.67^{a}	6.33^{b}	7.33^{b}	3.33^{a}	5.00^{b}	-
1700 – 1800	13.00^{a}	18.67^{a}	26.67^{a}	5.67^{a}	9.33^{a}	-
Mean	10.11	14.67	20.00	4.89	8.00	-
C. V(%)	30.39	7.87	16.33	25.96	16.14	

Means followed by the same letters in a column are not significantly different at P $\leq$ 0.05 Student-Newman keuls (SNK) test for variable.

At the off season no *Celosia* weed was observed, it normally comes towards end of rains in September – October.