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Effects of Agricultural Practices on the Populations of Two Grasshopper Pests, *Acrotylus blondeli* Saussure and *Arnithacris cavroisi* (Finot)

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ABSTRACT

Effects of farming practices namely, continuous cropping, crop rotation, cattle grazing, afforestation and fallowing on two grasshopper pests, *Acrotylus blondeli* Saussure and *Orithacris cavroisi* (Finot) were investigated for the period 1987 - 1989 in the northern Sudan savanna of Nigeria. Advanced afforestation and intensive cultivation adversely affected grasshopper populations.

O. cavroisi was more tolerant of afforestation but more adversely affected by cultivation than *A. blondeli*. Intensification of fallow, grazing and trampling of a field by the cattle did not adversely affect the breeding of the grasshoppers.

INTRODUCTION

Agricultural land use causes changes in environmental factors such as vegetation, soil and fauna (Roffey, 1970). The acridid population responds to these changes in various ways. In Thailand, Roffey (1970) reported that Bombay locust, *Pantana succinta* (L.) increased in numbers following deforestation. In Cyprus, Merton (1959) found that the sites likely to produce swarms of Moroccan locust (*Dociostaurus maroccanus* Thunberg) were pastures derived from the natural forest climax and maintained by persistent grazing.

In Sudan, *Ailopus savingnyi* Krauss became a serious pest of sorghum when the mechanized agriculture was introdued into the natural grassland (Joyce, 1952). Cultivation and settlement of the great plains of the United States and Canada caused *Melanoplus bivittatus* Say and *Cammula pellucida* Scudder to become important pests during the periods of drought (Bird, *et al.*, 1966). In the Sahellian zone, south of the Sahara, outbreaks of *Locusta migratoria migratorioides* (R and F) occured in fallow lands from which they migrated to flood plains or cropped lands (Davey, 1959). Popov (1965) found that swarm breeding of *Schistocerca gregaria* (Forsk.) occured more frequently in fallow or abandoned areas. Barnes (1959) reported that cultural practices such as shortening the period during which alfalfa was grown on the same land and rotation with cotton and other crops reduced the grasshopper populations in alfalfa farms. In Nigeria, the nymphs of *Kraussaria angulifera* Krauss and *Oedaleus senegalensis* Krauss were adversely

affected by afforestation and cultivation (Amatobi *et al.*, 1988).

In the northern Sudan savanna of Nigeria. *K. angulifera* and *O. senegalensis* are the most important grasshopper pests of cereal crops (Hergert, 1975; Bindra and Amatobi, 1981). But recently, with expansion of agricultural programmes in this zone, other grasshopper species such as *Ornithacris cavroisi* (Finot) and *Acrotylus blondeli* Saussure, have caused a considerable damage to pearl millet *Pennisetum glaucum* (L.) R. Br. Adults of *A. blondeli* and *O. cavroisi* feed on seedlings of *gero* millet, *Pennisetum glaucum* in June or July while the adults of *O. cavroisi* damage the grains on the heads of late pearl millet (*maiwa*) in October.

To reduce the damage on crops by *O. cavroisi*, aerial spraying of the insect was carried out in this zone during April, 1986. Bearing in mind the financial and technical limitations as well as concern for the environmental pollution involved in the insecticide control of grasshoppers in this zone, it was considered important to identify other control measures which would reduce the use of insecticides. This paper reports the effects of farming practices on the population of two grasshopper pests, namely, *A. blondeli* and *O. cavroisi*.

MATERIALS AND METHODS

The study was conducted at Kazaure (12° 20'N, 08° 11'E) situated in the northern Sudan savanna of Nigeria during the period of 1987 - 1989. In 1987, eight habitats were selected, namely, two plantations, *Acacia arabica* (Lam.) and *Azadirachta indica* A. Juss (neem) which measured 2.0 ha and 1.5 ha respectively. Neem was transplanted in 1982 whereas *A. arabica* was transplanted in 1985 and both habitats were not cropped but were protected from grazing by fences of barbed wire. Other habitats were a grazing field with an area of 3.0 ha, three farmers' fields cropped with late millet, (*P. glaucum*), sorghum (*Sorghum bicolor*) (Linn.) Moench and sorghum with groundnut (*Arachis hypogea* L.) which measured 0.9 ha, 0.95 ha and 0.75 ha respectively, one-year fallow with an area of 0.85 ha and two-year fallow measuring 0.7 ha.

In 1988, the cropping sequence changed (Table 1) in some of the habitats. The previous millet farm was planted to sorghum, the sorghum was planted to millet, the sorghum/groundnut farm was left fallow (one year fallow) and the two year fallow was cropped to millet. In 1987, the pearl millet, sorghum and groundnut were planted on 7 June. The fields were weeded two times by hoe. The crops were harvested in October. In 1988, crops were also planted in June.

During 1987 - 1988, the floristic composition of the habitats was assessed and the plant species were identified at the herbarium section of the Institute for Agricultural Research, Zaria. The percentage vegetative cover was estimated visually at monthly intervals.

The populations of the adults and nymphs of *A. blondeli* and *O. cavroisi* were assessed at weekly intervals. In each of the habitats, the adults were sampled in five 50 x 1 m quadrats which were delimited with white ribbons and pegs at random in the morning of the day preceding the sampling day so as to allow time for normal spread of the

grasshoppers.

Before sampling began, the distinguishing features of the two grasshopper species were studied. On each sampling day, a pre-sample was taken in an area quite outside the 50 m^2 quadrats. The pre-sample was necessary in order to remind the workers of the structure, colour and behaviour of each grasshopper species. An adult of *A. blondeli* was recognized by its small size, brown elytra and bluish posterior wing which was visible as it flew, the geophilous behaviour, the light take-off for flight and landing, the low key stridulation while on flight and the characteristic short distance flights of 1 - 3 m. In contrast, *O. cavroisi* was recognised by the large size, reddish brown elytra with white bands, posterior wing with reddish base, the heavey take-off or landing which shook the vegetation it rested or landed on and lack of stridulation while flying.

To estimate the populations of the adults, each of 50 m^2 quadrats was approached cautiously from one end and the insects were flushed by disturbing the vegetation. The adults of the two species that flew into the quadrats were recorded on a chart. Those that flew out of the quadrats were not counted so as to avoid double counting. In all cases where a bushy shrub was located in a quadrat, and it blocked some parts of the quadrat from the worker's view, a trained assistant stood to record the two grasshopper species leaving the area out of view.

Other species of grasshoppers which occured in large numbers and may be confused with those being studied included *K. angulifera* with yellow elytra and light yellow hind wing and which flew less vigorously than *O. cavroisi*; and *O. senegalensis* with green to brown marking on the elytra, the hind wing with yellow base and large infumate crescent extending from the front of the rear, and sharp stridulation while flying. The numbers of nymphs in each habitat were estimated in 25 1 m^2 quadrats. The quadrats were made of metal frames and wrapped with white ribbons so as to make them visible. The quadrats were also laid down in the morning of the day preceding the sampling day. The early instar nymphs of the two grasshopper species were not very fast moving and did not hop away readily. One could move as close to to them as 30 - 100 cm and they could therefore be identified by trained eyes without difficulty. The later instar nymphs could hop away before one got that close. Nevertheless, they could be identified from as far as 2 m. Thus the nymphs that were flushed from the quadrats were counted and recorded.

The nymphs of *A. blondeli* were grey to brown and smaller in size than those of *O. cavroisi* which were light green with elongated body and raised carina.

All the countings were taken when the grasshoppers were normally active in the morning hours usually at ambient temperatures of 28 - 30°C.

RESULTS

Vegetation of habitats

The plantations of *A. arabica* and neem protected from grazing had more luxuriant vegetation than the rest of the habitats. They had few native evergreen shrubs, *Guiera senegalensis* J.F. Gmel, *Cadaba farinosa* Forsk and *Stylochiton zenkeri* Engli. The predominant emphemerals were

Brachiaria xantholeuca (Hochst ex Steud) Stapf, *Cenchrus biflorus* Roxb ., *Cassia tora* Linn. and *Hibiscus asper* Hook. F. The grazing field had ephemerials like the plantations but differed by having native trees such as *Balanites aegyptiaca* (Linn.) Del., *Commiphora africana* (A. Rich.) Engli., and *Ziziphus mauritiana* Lam. The shrubs were *G. senegalensis*, *Pergularia tometosa* Linn. and *Calotropis procera* (Ait.) Ait. f. The ephemerals flora in the one-year fallow and the two-year fallow lands consisted of *B. xantholeuca*, *C. biflorus* and *Mitracarpus scaber* Zucc. The predominant shrubs were *Piliostigma thonningii* (Schum) Milne Readhead and *G. senegalensis*. The vegetation was more luxuriant in the two-year fallow than in the one-year fallow. In February 1988 the shrubs were cut as the land was being prepared for the next cropping season. The main weeds in the cropped fields consisted of *M. scaber*, *Jacquemontia tamnifolia* (Linn.) Hallier, *B. xantholeuca*, *Commelina nudiflora* Linn. and *Eragrositis gangetica* (Roxb.) Steud. The farms had few shrubs and trees.

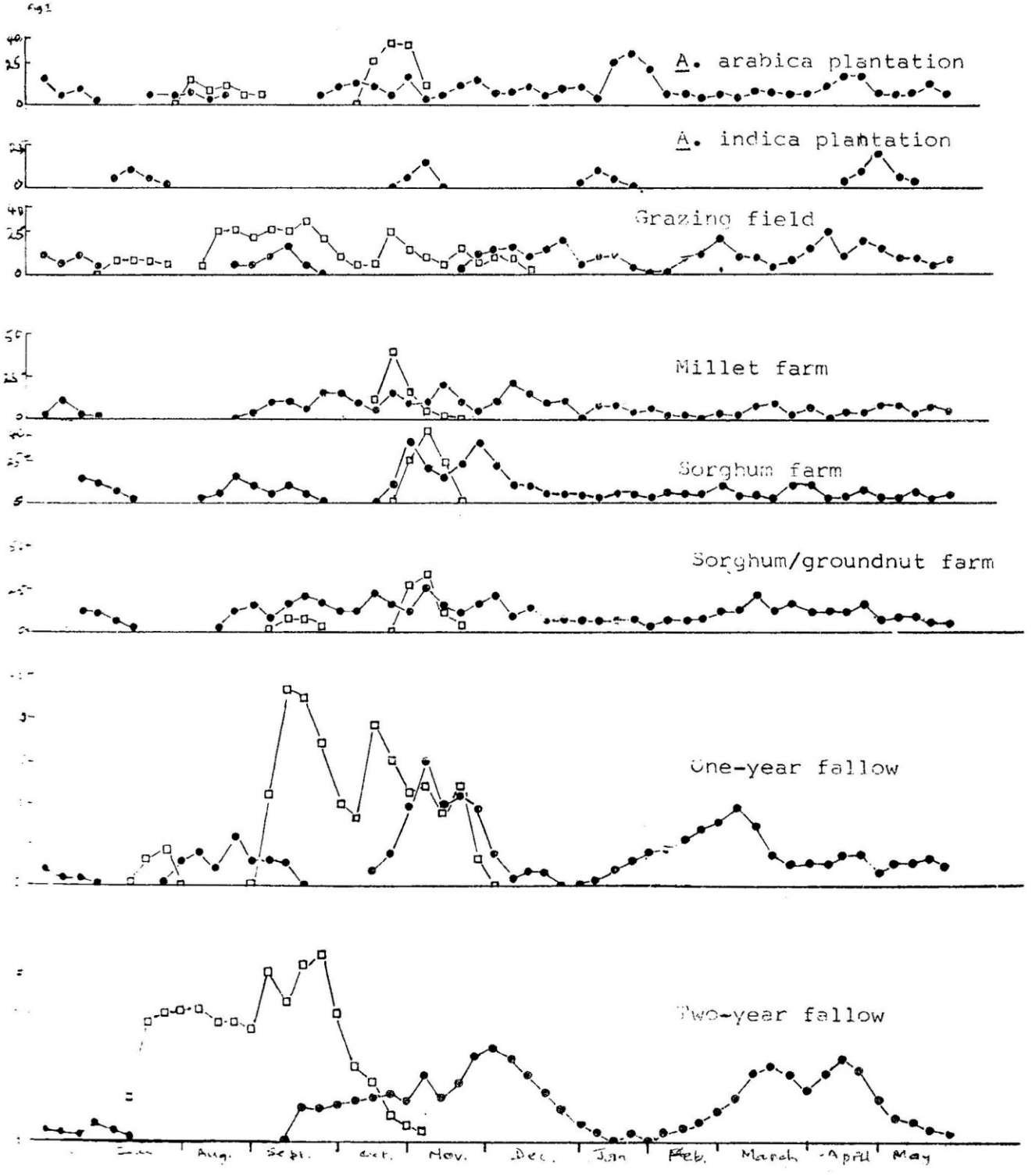
During the rainy seasons, the vegetative cover of the annuals ranged from 20-90% in *A. arabica* plantation, 20 - 70% in the neem plantation, 20 - 80% in the grazing field, 10 - 70% in the fallow lands and 5 - 20% in the cropped fields. In the dry season, neem had a heavier canopy and layer of litter cover than the rest of the habitats probably due to the accmmulation of dead annuals and shed leaves of the plantation trees. The litter cover was later attacked by termites. The cropped fields had scanty litter cover. The grazing and trampling by the cattle caused rapid reduction of vegetation and litter cover in the fallow lands and the grazing field.

Number of *A. blondeli*

Adults: In 1987/88, the adults of *A. blondeli* occured in varying numbers in all the habitats (Fig. I). Adults were few in July but increased in numbers towards the end of July in one-year fallow. In other habitats, adults were seen again in August. The first major population peaks occured in November, December and January. In 1988, the number fell in late January and February. There was a resurgence of the adults in March and peaks occured from March to May. A population crash was observed in June.

The adult population in 1988/89 (Fig. 2) did not quite follow a similar trend like in 1987/88 probably because the former was a more favourable year due to higher amount of rainfall. In 1988/89 peaks occured in June for *A. arabica*, one-year fallow followed by two-year fallow and one-year fallow followed by millet.

In 1987/88, the numbers of adults in the fallow lands were significantly higher ($P>0.05$) than the values for the other habitats which did not differ from one another (Table 2). In 1988/89, the one-year fallow followed by the two-yar fallow had the higher number but the value was not significantly different ($P>0.05$) from that of the the sorghum/groundnut followed by one-year fallow but different from the rest. *A. indica* had lower values for the two years than the rest of the habitats, although the value only differed significantly from the rest of the values in 1988/89.



...e of nymphs and adults of Acrotylus blondeli in different habitats ... at Kazure in 1987/1988. Key: a–a = nymphs; ●–● = adults.

Nymphs: In 1987/88, young nymphs were first taken in samples in July (Fig 1). These occurred in different stages of development till early December. Low peaks were observed in September and October. In 1988/89, the nymphs were seen in samples from July to November. Population peaks occurred in July and August.

The nymphs were higher in numbers during 1988/89 than in 1987/88. In 1987/88, the two-year fallow had the highest number of nymphs although the value did not differ significantly ($P>0.05$) from those of the grazing field, millet farm, one-year fallow land and the sorghum farm. The plantations had low numbers. In 1988/89, one-year fallow followed by two-year fallow land had the highest number of hoppers which significantly ($P>0.05$) differed from the values for all habitats except sorghum/groundnut followed by one-year fallow and two-year fallow followed by millet. No nymphs were recorded in samples taken in *A. indica* plantation.

Table 1: Habitats sampled for grasshoppers at Kazaure in 1987-1989.

Acacia arabica
Azadirachta indica (Neem))- plantations protected from grazing.

Grazing field - full grazing, no cultivation

Year I millet, Year 2 sorghum)
Year I sorghum, Year 2 millet) intensifying cultivation
Year I sorghum/groundnut, Year 2 fallow-cultivation returning to fallow
Year I fallow, Year 2 fallow-intensifying fallow
Year I fallow, Year 2 millet-fallow returning to cultivation.

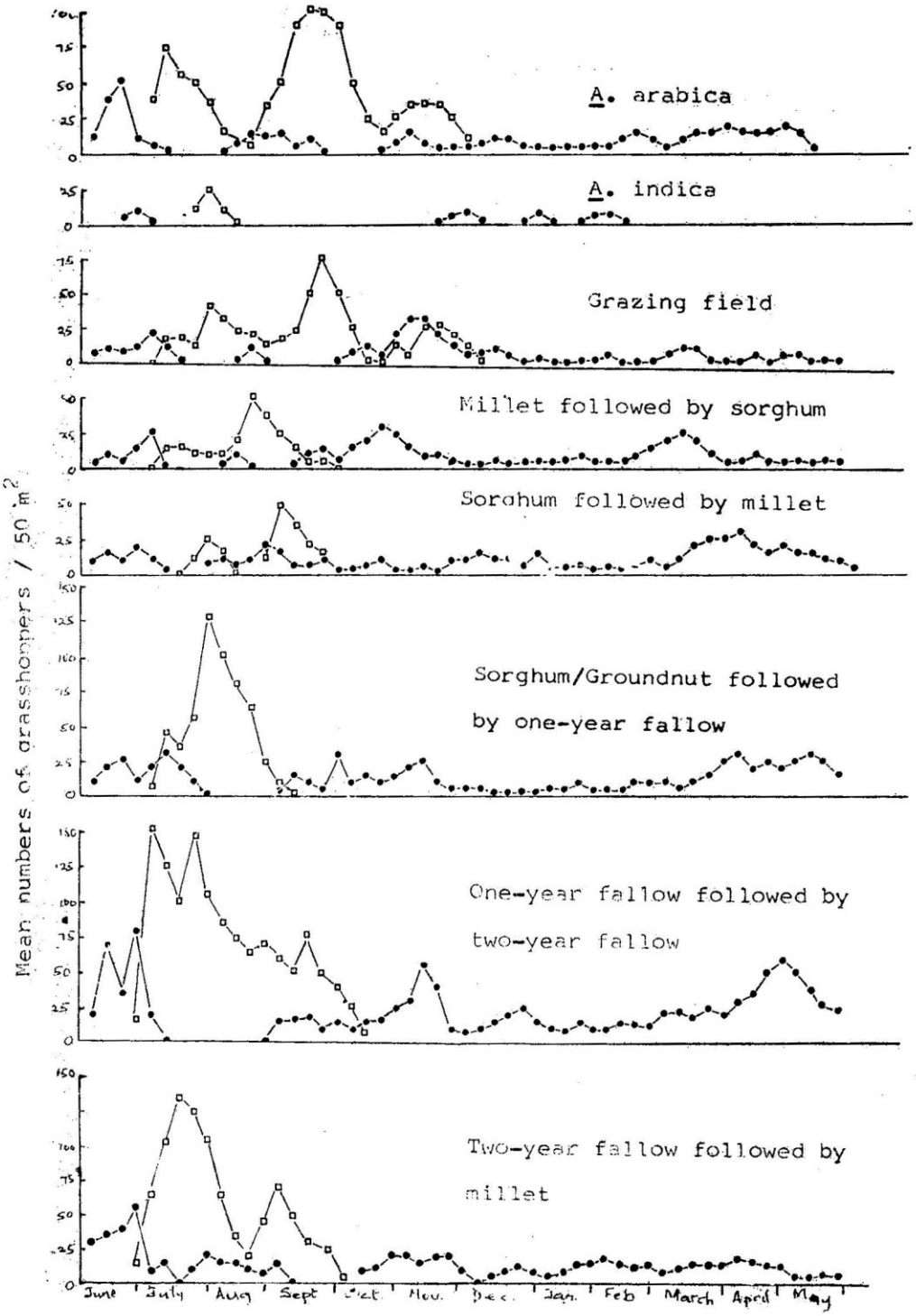
Table 2: Mean numbers of nymphs and adults of *Acrotylus blondeli* in different habitats studied at Kazaure in 1987-1989

Habitats	1987/1988		1988/1989	
	N	A	N	A
Acacia arabica	$0.4^{\pm}0.2^{b}$	$1.5^{\pm}1.0^{b}$	$1.2^{\pm}0.7^{b}$	$2.64^{\pm}1.8^{c}$
Azadirachta indica	$0.3^{\pm}0.1^{b}$	$1.3^{\pm}0.8^{b}$	$0.0^{\pm}0.0$	$0.30^{\pm}0.1^{d}$
Grazing field	$0.8^{\pm}0.6^{ab}$	$1.9^{\pm}1.1^{b}$	$1.2^{\pm}0.4^{b}$	$3.00^{\pm}2.4^{bc}$
Millet farm	$0.5^{\pm}0.3^{ab}$	$1.7^{\pm}1.1^{b}$		
Millet farm followed by sorghum			$1.1^{\pm}0.6^{b}$	$3.30^{\pm}2.5^{bc}$
Sorghum farm	$1.3^{\pm}0.6^{a}$	$1.8^{\pm}1.6^{b}$		
Sorghum farm followed by millet			$1.1^{\pm}0.2^{b}$	$2.1^{\pm}1.2^{c}$
Sorghum/groundnut	$0.4^{\pm}0.1^{b}$	$1.6^{\pm}1.0^{b}$		
Sorghum/groundnut followed by one-year fallow			$1.6^{\pm}1.0^{ab}$	$4.0_{\pm}2.3^{ab}$
One-year fallow	$1.1^{\pm}0.6^{a}$	$3.8^{\pm}3.2^{a}$		
One-year fallow followed by two-year fallow			$2.2^{\pm 1.1}a$	$5.1^{\pm 3.7}a$
Two-year fallow	$1.6^{\pm}0.7^{a}$	$4.3^{\pm 2.7}a$		
Two-year fallowed by millet			$1.4^{\pm}0.5^{ab}$	$2.6^{\pm}1.8^{c}$

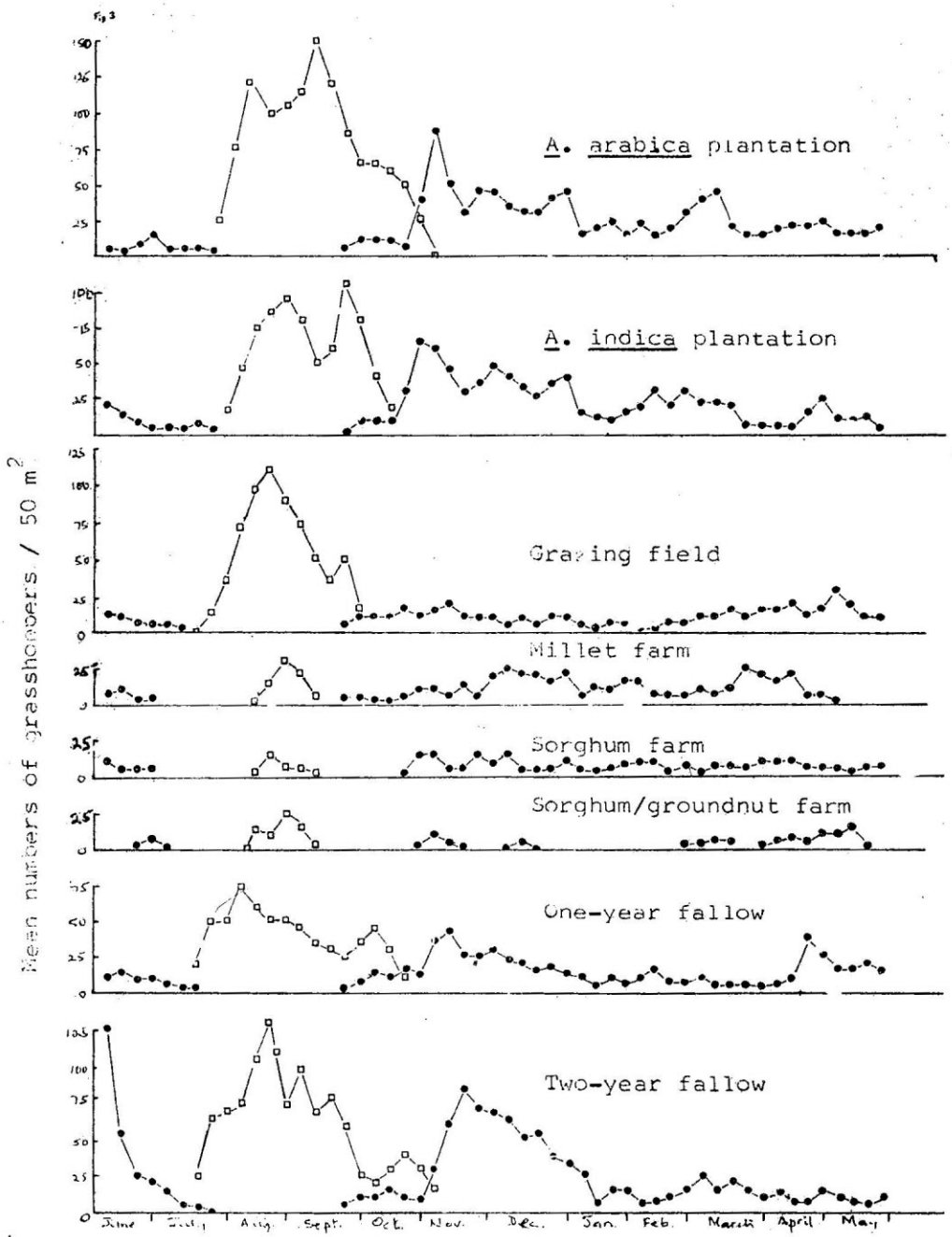
*Means followed by the same letter in each column are not significantly different (P=0.05), N=nymphs/m^2 A = adults/50m^2.

Numbers of *O. cavroisi*

Adults: In 1987/88, the adults of *O. cavroisi* were taken in samples in June with very high number recorded for two-year fallow (Fig. 3). A noticeable drop in numbers occurred in July probably due to death of the adults after egg-laying. At the end of July, no adults were seen in the samples. The adults were again observed in samples from September to May. Major peaks in the population occurred in



ig.2 Numbers of nymphs and adults of Acrotylus blondeli in different habitats studied at Kazaure in 1988/1989. Key: □-□=nymphs; ●-●=adults



Numbers of nymphs and adults of Ornithacris cavroisi in different habitats studied at Kazaure in 1987/1988. Key: □ – □ = nymphs; ● – ● = adults

October and November. The numbers declined in December and January probably due to the effect of harmattan. The number rose in February and March and peaked in April and May.

In 1987/88, there was no significant difference (P>0.05) between the numbers for the plantations and the two-year fallow but they differed significantly (P>0.05) from the values for the cropped land, one-year fallow and the grazing field (Table 3). In 1988/89 the number of adults in the one-year fallow followed by two-year fallow was not significantly higher (P>0.05) than value for the sorghum/groundnut followed by one-year fallow but differed significantly (P>0.05) from the values for the other habitats. The lowest number was recorded in the *A. indica* plantation.

Observation showed that *O. cavroisi* fed on *A. arabica* and that the cutting of shrubs during land preparation on two-year fallow in 1988 for the next cropping season resulted in low numbers of *O. cavroisi* (Fig. 4) and subsequent aggregation of the insect on some shrubs (*G. senegalensis, P. thonnigii* and *A. arabica*) left standing in the farm.

Nymphs: In 1987/88, the nymphs were observed in samples from July to October (Fig. 3). Very few nymphs and old adults occurred together in the *Acacia* plantation during July. The nymphs had the population peak in August and September. In 1988/89, the distribution of nymphs was similar to that of 1987/88, except that no nymphs were found in the millet followed by sorghum and in the sorghum followed by millet (Fig. 4).

In 1987/88, the highest mean numbers of nymphs were recorded in A. arabica plantation and the grazing field which differed significantly (P>0.05) from the values for the cropped fields (Table 3). In 1988/89, the number of nymphs in *A. arabica* was significantly (P>0.05) higher than the values for the cropped fields but did not differ from those of the grazing field and the fallow lands.

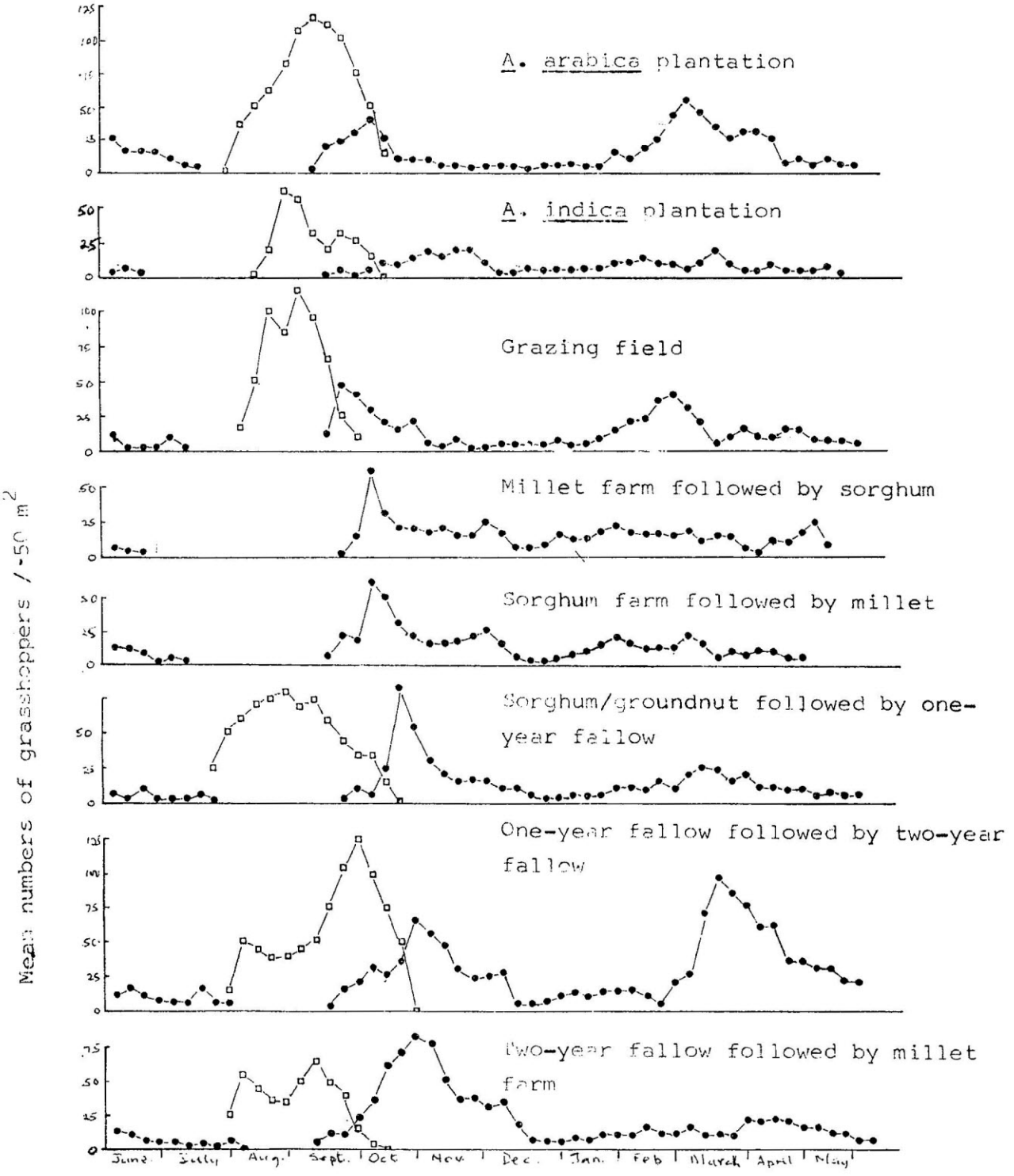


Fig.4 Numbers of nymphs and adults of Ornithacris cavroisi in different habitats studied at Kazaure (1988/1939. Key: ▫-▫ =nymphs; ●-● =adults

Table 3: Mean numbers of nymphs and adults of *Ornithacris cavroisi* in different habitats studied at Kazaure in 1987-1989.

Habitats	1987/1988		1988/1989	
	N	A	N	A
Acacia arabica	$1.5^{\pm}0.8^{a}$	$8.3^{\pm}6.8^{a}$	$2.0^{\pm}6.8^{a}$	$4.8^{\pm}4.4^{bc}$
Azadirachta indica	$0.9^{\pm}0.2^{b}$	$7.7^{\pm}5.7^{a}$	$1.0^{\pm}0.4^{ab}$	$3.2^{\pm}2.3^{d}$
Grazing field	$1.5^{\pm 0.8}a$	$3.4^{\pm}2.0^{b}$	$1.8^{\pm}0.8^{a}$	$4.9^{\pm}4.6^{bc}$
Millet farm	$1.0^{\pm}0.2^{b}$	$3.8^{\pm}2.4^{b}$		
Millet farm followed by sorghum			$0.0^{\pm}0.0$	$5.7^{\pm}4.1^{b}$
Sorghum farm	$1.0^{\pm}0.2^{b}$	$2.2^{\pm}1.1^{c}$		
Sorghum far followed by millet			$0.0^{\pm}0.0$	$5.8^{\pm}4.8^{b}$
Sorghum/groundnut farm	$1.0^{\pm}0.4^{b}$	$2.3^{\pm}1.1^{c}$		
Sorghum/groundnut followed by one-year fallow			$1.4^{\pm}0.9^{ab}$	$5.9^{\pm}6.0^{b}$
One-year fallow	$^{0.7}\pm 0.1^{b}$	$4.4^{\pm}2.8^{b}$		
One-year fallow followed by two-year fallow			$1.2^{\pm}0.8^{ab}$	$9.3^{\pm}8.0^{a}$
Two-year fallow	$^{1.2}\pm 0.7^{ab}$	$10.1^{\pm}7.3^{a}$		
Two-year fallow followed by millet			$0.7^{\pm}0.3^{b}$	$7.6^{\pm}6.8^{ab}$

*Means followed by the same letter in each column are not significantly different (P.0.05), N = nymphs/m^2, A = adults/50m^2.

DISCUSSION

The study showed that agricultural practices influenced the distribution and abundance of the two grasshopper species, confirming the observation of Guseva (1970). The Acacia plantation supported higher numbers of grasshoppers than the neem plantation. The apparent difference in the grasshoppers populations may be related to some factors such as age, level of canopy density, vegetative diversity and the presence of food-plants of the grasshopper.s The neem plantation was three years older and therefore had heavier shade, more homogenous vegetation with heavier litter and neem seeds, less bare ground and scanty emphemeral host-plants of the grasshoppers than the Acacia plantation. Although neem leaves and kernel seeds contain azadirachtin which has insecticidal or repellent action on insect pests of various crops (Cobbinah and Osei-Owusu, 1988; Tanzubil, 1991 and Jackai *et al.*, 1992), it was not investigated if the reduced grasshopper population in neem plantation was also due to the residual effect of the compound on the developing eggs or on the emerging nymphs. The proportionately lower numbers of the adults and the absence of the nymphs of *A. blondeli* in the neem plantaion in 1988/89 as compared with the number in 1987/88 suggests that increase in canopy density decreased the number. It implies that such species would be eliminated earlier in a plantation than the more shade-tolerant species like *O. cavroisi*. This tends to show that the grasshopper species inhabiting a habitat at any point in time will depend on the developmental stage of the vegetation. It could be deduced that during the land preparation for transplantating of tree seedlings (Phase I), the grasshoppers are caused to vacate the area; as few grasses and herbs establish with some open area, there is influx of geophilous species such as *A. blondeli* (Phase II); a further increase in vegetation leads to formation of tall vegetation and thickets (Phase III) which tends to become unfavourable for geophilus species but will attract the phytophilous species like *O. cavroisi*. During the later stage (Phase IV), the plantation develops heavy canopy and it is inhabitated by shade-tolerant species like *O. cavroisi* with the exclusion of geophilous species. The neem plantation during this study was probably approaching the last phase. Clark (1950) observed that the abundance of non-swarming Australian plague locust, *Chortoicetes terminifera* Walk. was greatly limited by the presence of trees. The early stages of a plantation are suitable for grasshopper breeding, and should be watched for outbreaks. However, the later stages seem to offer a good control measure but the time the plantation will attain this vegetative level will depend on environmentatl factors (soil moisture, soil fertility and plant species used for the plantation) and will therefore be difficult to predict.

The grazing fields had a more complex flora with the patches of natural forest in the depression or low lying areas and appeared to approach the natural vegetation of the area. Like the Acacia plantation, it supported high numbers of the grasshoppers. The intensive grazing and heavy trampling by the cattle reduced the vegetation and created a favourable condition for the grasshoppers. Golding (1934) observed that in the Lake Chad area, the feeding and trampling down of grasses provided suitable condition for grasshopppers.

The consistent high numbers of the grasshoppers found in the two-year fallow presupposes that the habitat had suitable conditions which included abundant food-plants (*B. xantholeuca*, *C. biflorus*, *E. gangetica* and *P. thonningii*), a considerably less disturbed bare ground for oviposition and fairly high plant density providing shelter. The one-year fallow was recovering from the effect of cultivation and had less number of grasshoppers than the two-year fallow.

The absence or low numbers of grasshopper nymphs in the cropped habitats indicates that the cropped lands were unsuitable for breeding. The habitat alteration by man such as soil tillage probably made the soil unsuitable for oviposition. It seems paradoxical however, that there were high numbers of grasshooper adults and proportionately few nymphs in the cropped habitats. It appears that the recruitment of adults into the cropped habitats was from the surrounding habitats. Jago (1971) noted that grasshoppers moved from adjacent fallow lands to cropped fields.

Continuously cropped habitats had consistently low numbers of nymphs and when a two-year fallow was cultivated, the nymphal population decreased. Thus intensifying cultivation adversely affected grasshoppers. However, the fairly high number of nymphs C.I. AMATOBI of *A. blondeli* compared with *O. cavroisi* in the cropped fields suggests that the former insect was more tolerant of cultivation pressure than the latter.

The increase in numbers of nymphs when one-year fallow was followed by two-year fallow indicates that fallow lands favoured the breeding of the grasshoppers. Jago (1971) reported that fallow lands were favourable habitats of grasshoppers.

Clearly, the result showed that cultivation and afforestation were important strategies in reducing the populations of the grasshoppers. However, the disadvantages of continuous cropping such as the reduction of soil fertility, should be noted. This loss in fertility could be restored by application of fertilizer or by the adoption of well planned crop rotation. It may be argued that afforestation can reduce arable and grazing land and that its establishment may be expensive but the advantages in checking desert encroachment in this zone, the improvement of soil fertility and the tempering effect of crop microclimate (Ojo *et al.*, 1985) as well as the adverse effect it has on grasshopper pests should be borne in mind. In this zone, forest plantations are grown in belts so that the areas between the belts are available for crop and animal husbandry.

In the Sudan savanna zone of Nigeria, it is the practice of some farmers to leave their lands fallow to regain their fertility or to abandon them as a result of pest problems.

It is advised that such farms should not be left fallow for more than three years, otherwise, they will become favourable breeding habitats for grasshoppers.

The results of the investigation suggest that minimal use of insecticide is possible in the control of the two grasshopper species. *A. blondeli* is geophilous and occurs in the bare ground area of the favourable breeding habitats which included the fallow lands, grazing field, roadside and newly established plantation. The adults mature and lay eggs at the onset of the rains usually in May or June and

nymphs begin to emerge in late July. The incubation period of the eggs is about 40 days. The nymphs and adults avoid bushy area. One way of aggregating the insect in an infested area is to leave patches of bare ground. Insecticides like Fenitrothion e.c. or Karate e.c. could be applied in the bare ground of the breeding habitats and during the morning hours of the rainy season (August and September) to kill the nymphs and adults. Insecticide dust (Fenitrothion) could be applied about mid-July in the bare ground area so that the emergent nymphs pick up the insecticides. *A. blondeli* is known to pass the dry season (October - May) as an immature adult during which the adults and older nymphs bury themselves in the sand. Insecticides applied during the early morning hours when the insects are still buried in sand, may not hit them directly which may result in poor control. Also, because quite a large area of land becomes bare during the dry season, *A. blondeli* is widely dispersed and any insceticide control measures at this period would be costly. However, during aerial spraying of a Tree locust, *Anacridium melanorhodon* Walker which occured in large numbers during the dry season of 1987), quite a large number of *A. blondeli* was killed. Thus, *A. blondeli* was unconsciously controlled along with the locust.

O. cavroisi unlike. *A. blondeli* is phytophilous but like *A. blondeli*, it passed the dry season (October - May) as immature adult. The adults mature at the onset of the rains in May - June and lay eggs in June or July. The incubation period of the eggs is about 42 days. Nymphs begin to emerge in August and change to adult in late September or October. Because the nymphs are widely dispersed in the vegetated area of the preferred habitats (grazing field, fallow lands and plantations), they would be costly to control with insecticides. However, during the dry season, the adults are largely associated with some evergreen shrubs such as *G. senegalensis*, *P. thonningii* and *A. arabica*. Cutting some of the shrubs during land preparation in February or March would cause the adults of *O. cavroisi* to aggregate on fewer standing shrubs which could be sprayed with recommeded insecticides. This method would reduce considrably the quantity of insecticides to be used. Application of the insceticides is better in the morning hours when the insect is less active.

The feeding on *A. arabica* by *O. cavroisi* is important. This means that a favourable habitat is created for the grasshopper if *A. arabica* is planted in large numbers. This further confirms the importance of a thorough study of plant/animal relationship in any plantation project.

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REFERENCES

AMATOBI, C.I., APEJI, S.A. and OYIDI, O. 1988. Effects of farming practices on populations of two grasshopper pests (*Kraussaria angulifera* and *Oedaleus seneganlensis* Krauss (Orthoptera: Acrididae) in northern Nigeria. *Tropical Pest Management* 34: 173 - 179.

BARNES, O.L. 1959. Effect of cultural practices on grasshopper population in alfalfa and cotton. *Journal of Economic Entomology* 52: 336-337.

BINDRA, O.S. and AMATOBI, C.I. 1981. Bionomics of *Kraussaria angulifera* Krauss (Orthoptera: Acrididae) in northern Nigeria. *Samaru Journal of Agricultural Research* 1: 59-67.

BIRD, R.D., ALLEN, W. and SMITH, D.S. 1966. The responses of grasshoppers to ecological changes produced by agricultural development in South-Western Manitoba. *Can. Ent.* 98: 1191 - 1205.

CLARK, L.R. 1950. On the abundance of Australian plague locust (*Chortoicetes terminifera* Walk.) in relation to the presence of trees. *Australian Journal of Agricultural Research* 1: 64 - 65.

COBBINAH, J.B. and OSEI-OWUSU, K. 1988. Effects of neem seed extracts on insect pests of eggplant, okra and cowpea. *Insect Science and its Application* 9: 601-607.

DAVEY, J.T.. 1959. The African migratory locust (*Locusta migratoria migratorioides* (R. & F.) in Central Niger Delta, Part II: The ecology of Locust in semi-arid land and seasonal movement of populations. *Locusta* no. 7: 180 pp.

GOLDING, F.D. 1934. On the ecology of Acrididae near Lake Chad. *Bulletin of Entomological Research* 25: 263-303.

GUSEVA, V.S. 1970. The effect of cultivation of virgin land on grasshopper populations. Proceedings of the International Study Conference on Current and Future Problems of Acridology, London 1970, pp. 185-190.

HERGERT, C.R. 1975. An analysis of grasshopper problems in Kano State. *Samaru Agricultural Newsletter* 17: 91-94.

JACKAI, L.E.N., INANG, E.E. and NWOBI, P. 1992. The potential for controlling post-flowering pests of cowpea, *Vigna unguiculata* Walp. using neem, *Azadirachta indica* A. Juss. *Tropical Pest Management* 38: 56-60.

JAGO, N.D. 1971. Migratory Locust, *Locusta migratoria migratorioides* (R. and F.) Survey in the north east Bornu Province of Nigeria. Interim Report, September - October, 1971, London, Centre for Overseas Pest Research. 9 pp.

JOYCE, R.J.C. 1952. The ecology of grasshoppers in the East Central Sudan. *Anti-Locust Bulletin* 11: 99 pp.

MERTON, L.F.H. 1959. Studies in the ecology of the Moroccan Locust (*Dociostaurus macrocanus* Thunberg) in Cyprus. *Anti-Locust Bulletin* 24: 123 pp.

OJO, G.O.A., ONYEWOTU, L.O.Z. and UJAH, J.E. 1985. Use and management of shelter belt. A paper presented at the National Workshop on Ecological Disasters: Drought and Desertification, Federal Ministry of Science and Technology Kano, Nigeria. 9 - 12th December, 1985.

POPOV. G.B. 1965. Review of Work of the Desert Locust Ecological Survey June 1958 - March 1964 and the Consideration and conclusion arising from it. Rome, F.A.O. Progress Report no. UNSF/DL/ES/8. 80 pp.

ROFFEY, J. 1970. The effects of changing land use on locust and grasshoppers. Proceedings of the International Study Conference on Current and Future Problems of Acridology London 1970, 199 - 204.

TANZUBIL, P.B. 1991. Control of some insect pests of cowpea (*Vigna unguiculata*) with neem (*Azadirachta indica* A. Juss.) in northern Ghana. *Tropical Pest Management* 37: 216-217.