



C·A·B INTERNATIONAL INSTITUTE OF BIOLOGICAL CONTROL

REPORT

THE POPULATION ECOLOGY OF HELICOVERPA
ARMIGERA IN SMALLHOLDER CROPS IN KENYA
WITH EMPHASIS ON ITS NATURAL ENEMIES.

FINAL REPORT, PHASE I:
APRIL 1987-MARCH 1988.

M. J. W. Cock, J. K. Waage,
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ODA-NRE Project R4365

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1. Introduction

This is the final report prepared at the termination of ODA Project R4365 'The population ecology of Helicoverpa armigera in small holder crops in Kenya, with emphasis on its natural enemies' which concluded in March 1988. Phase II is expected to start in April 1988.

2. Summary

This project has completed a survey and selection of sites for population and mortality studies in Phase II: the field site for detailed studies is expected to be the Kenya Agricultural Research Institute (KARI) Station at Kakamega, while regular, less intensive, sampling programmes will be undertaken at KARI Stations at Kibos (near Kisumu), Msabaha and Embu. A vigorous culture of Helicoverpa armigera has been established at the CIBC Station at Muguga, where phenological (light trap) studies of H. armigera populations are initiated.

Due to unavoidable delays in project initiation and posting of the scientific assistant to Kenya, field and lab work on natural enemies in Kenya was less than planned, but an uncharacteristically low level of H. armigera during 1988 would have made this difficult in any case.

Instead, the research assistant, Mr H van den Berg, remained in UK and undertook analyses of unpublished data-sets on natural enemies of H. armigera in smallholder plots in Tanzania. This work, as well as close collaboration established with similar studies on H. armigera studies in South Africa and Malawi, provided the information necessary to plan the field sampling programme for Phase II and anticipate laboratory research needed on natural enemies and their crop associations in Kenya.

Mr Van den Berg also compiled a review of the natural enemies of H. armigera in Africa, their distribution, impact and crop associations. This review has been issued separately (van den Berg, Waage & Cock 1988). Important natural enemy groups posing taxonomic difficulties have been identified for additional research now under way at the CAB International Institute of Entomology (CIE).

Thus, four of the seven objectives of Phase I have been met despite a very poor field season and administrative delays, these being a survey of information of natural enemies of H. armigera, surveys in Kenya and establishment of collaboration in other countries, initiation of taxonomic studies, and experimental sites selection. Two other objectives, natural enemy studies in Kenya, field sampling studies in Kenya have not been made for the reasons stated above and in the report, but compensatory work in UK on existing data-sets has allowed much progress to be made in this area. A planned trip to Tanzania was not made because the collaborator there, Dr Nyambo, has been assigned to a different research station and no longer working on H. armigera. A visit to Sudan has been postponed to Phase II in agreement with Dr Cooter.

3. Work in Kenya

Notice of approval of this project by ODA came in late May 1987. Due to this delay (from the anticipated starting date of 1st April) and the posting of Dr Cock, work in Kenya could not begin until June. By this time, the main rainy season had passed and with it the period of most significant numbers of H. armigera (see Figure 1).

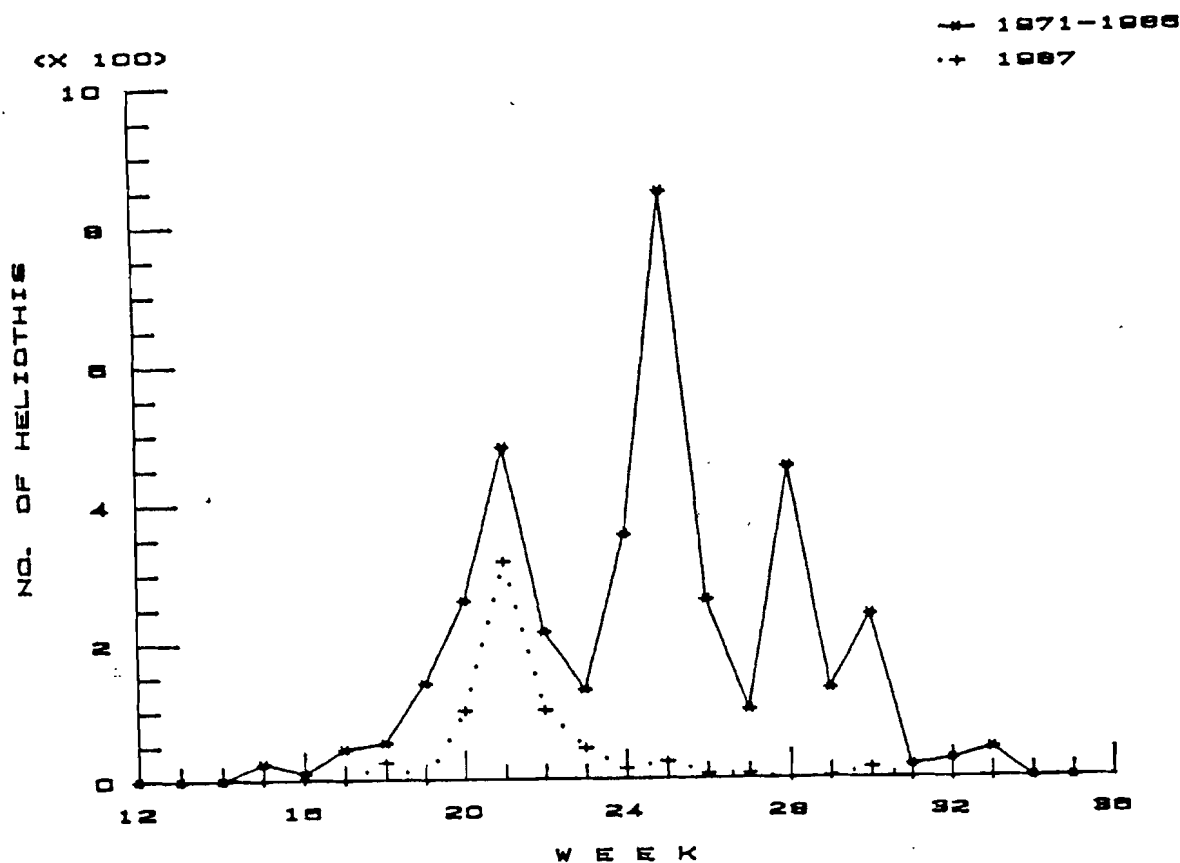


Figure 1. Weekly light trap catches at CIBC, Muguga, Kenya, of H. armigera during the last 15 years as compared to catches in 1987.

No field work was then appropriate until the short rains in November-December, which were unfortunately uncharacteristically sparse and absent altogether in some areas. Surveys were started again in the main rainy season during the last month of the project. Here we present results of these samples, surveys of possible field sites for Phase II and information on light-trapping and H. armigera rearing work undertaken to date.

The Kenya programme has been hampered by delays recruiting and posting the project entomologist (Mr Van den Berg) and by confusion between CIBC and KARI about CIBC's terms of operation, such that Mr Van den Berg was not able to enter Kenya during Phase I. These difficulties are now resolved and Mr Van den Berg has joined the CIBC Kenya Station at the start of Phase II.

3.1. Surveys

Crop plants were examined visually for damage by H. armigera, paying particular attention to the susceptible portions, e.g.

tomatoes	boring into fruit
cotton	open young squares and holes in side of squares
cleome	holes in pods
pigeon pea	holes in pods
peas/beans	damage to pods/flowers
maize	male inflorescence and cobs
sorghum	inflorescence
sunflower	flowers
peppers	holes in fruit, etc.

Larvae were collected individually into prepared diet containers so as to minimise chances of cross infection of pathogens. The individual diet containers were kept in cool boxes to and from the field and reared to maturity in the laboratory.

Preliminary surveys were made by Dr Cock in cooperation with KARI research stations at Kisii, Kibos, Mtwapa and Msabaha. Results are summarised in Table 1 below.

Table 1. Summary of field collections of *Helicoverpa armigera* in Kenya

Area	Date	Site	Crop	Man hours	No. of larvae found	No. of moths reared	No. of parasitoids reared	
BUNGOMA	25.iii.88	I	Cleome	0.5	3	3	0	
			Tomato	1.0	3	3	0	
			Maize	4.0	0			
			Beans	2.0	0			
GARASHI	3.xii.87	I	Maize	1.0	0			
			Maize	1.0	0			
KAKAMEGA	11.iii.88	I	Maize	3.0	0			
			Tomato	2.0	3	1	1	
			Cleome	2.0	0			
			Maize	1.5	0			
KISII	28.x.87	I	Tomato	3.0	2	0	1	
			Cleome	2.0	7	6	1	
			Maize	1.5	0			
			Peas	1.0	0			
			Sorghum	1.5	0			
			Beans	1.0	0			
			Tomato	2.0	4	3	0	
	10.iii.88	II	Sorghum	1.5	1	1	0	
			Cowpea	0.5	0			
			Beans	0.5	0			
		IV	Cleome	2.5	10	7	0	
			I	Cleome	3.0	12	4	0
				Tomato	1.0	2	1	0
				Maize	2.0			
23.iii.88	I	Sorghum	1.0					
		Beans	1.0					
		Cleome	1.0	7	7	0		
		Maize	3.0					
KISUMU	6.xi.87	I	Sorghum	1.0				
			Tomato	2.0				
			Cotton	3.0	7	3	0	
			II	Cotton	1.5	0		
				Cleome	2.0	4	3	0
			III	Maize	0.5	0		
Sorghum	0.5	0						
Pigeon pea	2.5	0						
MTWAPA	2.xii.87	I	Tomato	1.5	0			
			Cleome	2.0	0			
			Capsicum	1.5	0			
			Okra	1.5	0			
		II	Chillies	1.0	0			
			Tomato	1.0	0			
		III	Amaranthus	2.0	0			
			Pigeon pea	2.0	0			
			Maize	0.5	0			
MSABAHA	3.xii.87	I	Pigeon pea	2.0	0			
			Maize	0.5	0			
TOTAL				74.	65	38	3	

Kisii. A selection of farms within a 10 km radius of Kisii were visited in October 1987, with a manpower of 3-4. Rainfall had been reasonable and a selection of crops were available for inspection. H. armigera was found on tomato and cleome but parasitism was low. Similarly, during two visits in March 1988, H. armigera was found on tomato and cleome, but not maize, sorghum or beans; no parasitism was recorded in March.

Kisumu, and the area to the south of Ahero (II). In November 1987, rains had been below expectation and almost no crops planted. H. armigera larvae were found on cotton and cleome, but no parasitoids reared.

Kakamega. H. armigera was found on tomato, but not maize or cleome in March 1988. A tachinid parasitoid was reared.

Bungoma. In March 1988, H. armigera was found on cleome and tomato but not maize or beans.

Coast. The short rains had failed and no seasonal crops planted. Pigeon pea was inspected at Mtwapa and Msabaha and although extensively damaged by Maruca testulalis, Lampides boeticus and a pterophorid, no evidence of H. armigera was found. A small selection of mainly horticultural crops were being grown under irrigation around Mtwapa and Msabaha but none showed signs of H. armigera damage. North of the Sabaki River (Garashi) two small areas of rain fed maize were located. They had recently been harvested and there was no sign of H. armigera in the residues, although stem borers (?Chilo sp.) were present in unharvested cobs. It seems likely that with the failure of the rains at the Coast, H. armigera has remained in diapause and will not emerge until the long rains start.

As can be seen in Table 1, these modest surveys produced few H. armigera larvae and very few parasitoids: a tachinid from tomato at Kisii and Kakamega, and an ichneumonid from Cleome at Kisii. No indications of pathogens were found in field collected larvae.

3.2. Culture

A strong culture of H. armigera has been established at the CIBC Kenya Station. The sources are adult moths from light traps run at Muguga and at Dr Cock's residence at Kyuna Estate, North-west Nairobi, and adults reared from field collected larvae.

The adults are held in a plastic oviposition cage 20cm high, 15cm diameter, lined with grease proof paper and covered with muslin cloth on which is placed a pad of damp cotton wool. Honey diluted with water (50%) is provided.

The eggs are removed daily and kept for emergence. The larvae are reared on an semi-synthetic diet used at CIBC Kenya Station for rearing graminaceous stem borers (Chilo spp.). The ingredients are:

1. Rose coco beans powder	109.6 g
2. Maize/sorghum leaves powder	40.0 g
3. Brewers yeast	8.0 g
4. Ascorbic acid	2.6 g
5. Sorbic acid	1.0 g
6. Methyl para-hydroxy-benzoate (dissolved in 100% ethanol)	1.6 g
7. Agar No. 3 (Technical)	10.2 g
8. Vitamin E (one capsule)	147.0 mg
9. 36% Formalin solution	900 ml

Ingredients 1-6 are mixed in a commercial blender with 500 ml hot boiled distilled water. The agar is dissolved in 400 ml boiled distilled water, and the vitamin E capsule and formalin solution added. These ingredients are then blended together until homogenised before being poured into the sterilised rearing containers under a lamina flow cabinet.

The rearing containers are 1 fluid oz. clear plastic cups, 2.5cm diameter at the base, 4cm diameter at the top and 4.5cm high with push in cardboard lids. These imported cups will be replaced by a locally available "poly-jar", somewhat squatter with a plastic snap-on lid.

The jars are surface sterilised with diluted domestic bleach (10%) for 24 hours and the lids heat sterilised in a drying oven. They are filled approximately half full with diet.

Neonate larvae are kept five per container until the fourth instar, when they are transferred to individual containers, to prevent cannibalism which is otherwise prevalent. At this stage obviously backward larvae are discarded. The larvae pupate within the diet and pupae are separated out for emergence. For the present the culture is being stabilised at about 200 adults/week, but this will be increased once experimental material is needed.

3.3. Light trap monitoring

The use of light traps provides, potentially, an effective monitoring system for H. armigera. KARI runs an "armyworm unit" which monitors Spodoptera exempta on a national basis by means of a network of light traps and pheromone traps. We have arranged for a selection of these traps to start monitoring H. armigera as well.

One of the light traps is at the CIBC compound at Muguga, near Nairobi. At this site H. armigera has already been recorded since 1971. Fifteen years' data has been averaged and plotted as Figure 1. This shows large numbers of H. armigera from early May to the end of July. In contrast the catches for 1987 show a small peak in mid May tailing off to low numbers from mid June onwards. The pattern of H. armigera catches appears to follow that of the rainfall quite closely, but delayed by about three weeks. This will be investigated in more detail. The single principal peak suggests that around Muguga there is at most one brood of H. armigera larvae, probably in late May-June, the pupae from which went into diapause.

3.4. Choice of field sites

Without doubt field sites will be simplest to operate if they are on one of the KARI research stations or sub-stations. KARI is now responsible for all agricultural research that used to come under the Ministry of Agriculture and has a nation-wide network of stations involved in research. Any such field trials should be operated in close collaboration with KARI and could form part of KARI's own national crop protection programme. The opportunities for interaction and collaboration between CIBC and KARI over methods for studying natural enemies will be of direct benefit to Kenya.

In planning Phase II, Dr Cock visited a selection of KARI stations on a rough transect from western Kenya through Nairobi to the coast. He talked with crop protection personnel and/or station directors and discussed the incidence of H. armigera, cropping patterns in the area, weather patterns, willingness to collaborate, etc. Notes from these visits which were made to Kitale, Kakamega, Kibos (Kisumu), Kisii, Njoro, Thika, Katumani, Kiboko, Msabaha, Mtwapa and Matuga, are given in Annex 1.

In Kenya, H. armigera is currently considered the most important pest of cotton and sunflower, important on pigeon pea, cowpea, beans and tomatoes, but generally less important on maize, sorghum, brinjals, citrus and other crops. In view of the importance to cotton, which is often grown as a small holder crop in Kenya, the field sites could beneficially be linked to stations in cotton growing areas. On such a basis, Kibos which has cotton as its prime mandate, Msabaha in the coastal cotton growing area, and Mwea Tabere stand out as suitable. CIBC and KARI already have ongoing collaborative studies on cassava green mite at Kibos and Msabaha, so that staff at these stations have some familiarity with working on natural enemies. Msabaha is disadvantaged in that it has no electricity supply to run a light trap or fridge/freezer to preserve samples.

Another site that merits consideration is Kakamega. This has the advantage of the most continuous rainfall in Kenya, likely to lead to the richest and stablest natural enemy complex.

Accordingly for Phase II we propose five main centres for intensive sampling during the 1988 long and short rains, Kibos, Kakamega, Msabaha, Makueni (sub-station of Katumani) and Mwea Tabere, and two additional sites for less intensive sampling, Kisii and Mtwapa. This would reduce to one or two sites for intensive studies starting from the 1989 long rains, based probably at Kakamega and Kibos.

4. Research Links with Other Projects and Organisations

Contacts with ODA funded projects on H. armigera and its microbial control (Professors Haskell and Claridge, Cardiff) have been maintained and plans for field sites in Phase II have been discussed. The course of development of our project and that of the ODNRI H. armigera project in Sudan have been such that close collaboration in 1988 was not appropriate. Natural enemies collected in this project will be provided to CIBC for use in our ongoing taxonomic research.

CIBC scientists have made contact with ongoing H. armigera research programmes in Tanzania, Ethiopia, Chad, Malawi and South Africa. Particularly close links are established with Dr B T Nyambo, Tanzanian Agricultural Research Organisation (TARO) Ukiriguru, who has provided for our analysis her long term field data on parasitoids and diseases of H. armigera (Nyambo 1986). We have also had meetings with Dr P J Guest, lately of the Plant Protection Research Institute, Pretoria, to discuss their unpublished two year field study on natural enemies of H. armigera in South Africa. From this collaboration, field methods for predator assessment and their results have been discussed and a plan for our studies in Phase II devised.

We have arranged that an ongoing project on H. armigera on cotton and maize in Malawi (Dr G A Matthews, Imperial College) collect natural enemies for identification by CIE and inclusion in our ongoing taxonomic research.

Discussions on methodology have been held with H. armigera biological control specialists in the US and Australia.

5. Work in UK

As part of Phase I, an in depth study was made of existing knowledge of natural enemies of H. armigera. This was undertaken by Mr Van den Berg, while awaiting posting to Kenya, and Dr Waage. A survey of literature records was made with the assistance of the CIE, and a detailed survey of museum specimens was made by Mr Van den Berg with cooperation of specialists at CIE and in the Department of Entomology, British Museum (Natural History) (BMNH).

In the absence of the opportunity to begin collecting field data in Kenya (see Section 1), unanalysed data-sets on natural enemies of H. armigera were assembled at Silwood Park from collaborators in Africa, and a detailed analysis was made in particular of a 4-year data-set from Dr Nyambo (see Section 5.2). This is the most complete data-set available for East Africa which considers H. armigera on different small farmer crops.

5.1. Review of natural enemies of H. armigera in Africa

A review of the natural enemies of H. armigera in Africa has been prepared and is being issued separately. It contains all natural enemy records of H. armigera from Africa to date (300 records), including 80 parasitoids identified to species and 90 identified only to genus. The biology, taxonomy, distribution, alternative hosts or prey, host-plant associations, and secondary natural enemies are detailed for all recorded natural enemies, and the different aspects are summarized and evaluated for the total natural enemy complex. Furthermore, methods for sampling natural enemies are discussed, and suggestions are made for accurately estimating parasitism rates for the different types of parasitoids attacking H. armigera. Aspects identified as needing particular attention in Phase II include egg/larval predation and egg parasitism.

5.2. Analysis of field data

Four years' data on H. armigera larval parasitoids on small holder crops in North-western Tanzania was provided for analysis by Dr Nyambo (see Nyambo 1986). From analysis of these data it is apparent that some major larval parasitoids show close associations to certain host plants. Some parasitoids, for example, are only important on H. armigera on sorghum, whereas others are restricted to cotton. In view of this, the data set was analysed, concentrating on crop associations of the parasitoids, thereby eliminating variances due to temporal factors. The analysis of parasitism levels was based on log odds of data with a binomial error distribution (GLIM, Payne 1986). Results show highly significant effects of the interaction parasitoid-crop, which means that clear differences in crop associations between parasitoids do exist in the data set. Regressions were then made for the individual parasitoid species. All parasitoids show a significant crop-effect, which is particularly large for Palexorista laxa, Cardiochiles spp. and Charops sp., as for those species the crop-effect explains as much as 50% of their total deviance in parasitism levels. Parasitism rates on different crops are presented for the five commonest parasitoids in Figure 2. It is apparent that on sorghum H. armigera suffers higher mortality due to parasitism than any other crop. This can be attributed mainly to the parasitoids Apanteles diparopsidis, Chelonus curvimaculatus and P. laxa, which are in some way associated with this crop. The first two are only common after flowering of the crop, the last mainly occurs in the period after flowering, up to July. In times of absence of other crops the weed cleome is commonly kept for consumption in East Africa and seems to be an alternative host plant for the pest and some of its natural enemies alike. Charops sp. is mainly associated with this weed. Cardiochiles spp., which may be H. armigera specialists, are also commonly found on this weed, but when cotton is available parasitism on cleome drops sharply suggesting a recruitment of Cardiochiles spp. parasitoids onto cotton cleome. This association with cotton is supported by previous data from Africa (Parsons 1940; Coaker 1959).

These parasitoid-crop associations have two important implications for biological control of H. armigera in Africa. Firstly, important natural enemies on one crop should not be assumed to be important on all. As most work to date has concentrated on cotton, more attention should be paid to natural

enemies of H. armigera on food crops in order to elucidate the natural enemies there. Secondly, insofar as all parasitoids studied attacked H. armigera on all crops, there is scope to enhance parasitoid activity on one crop by growing it adjacent or contemporary to another.

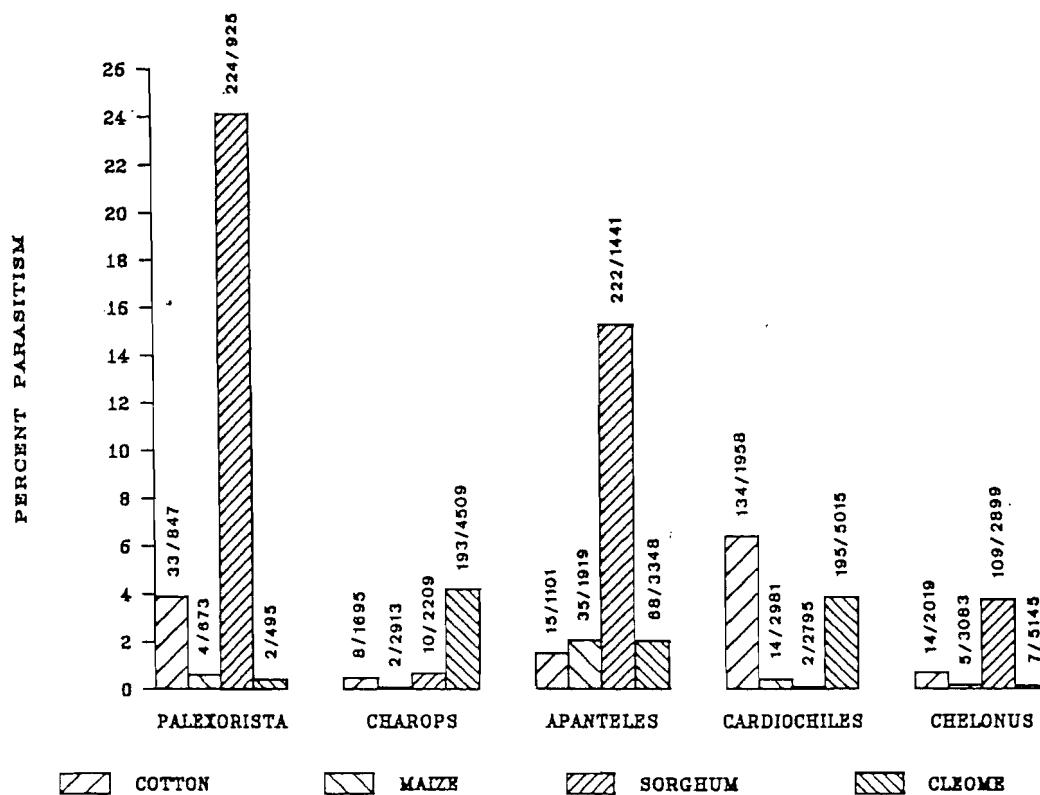


Figure 2. Average percentage parasitism of H. armigera by its main parasitoids on different crops. Data for the period 1982-1985, collected at Ukiriguru, Tanzania by Dr Nyambo. Numbers of parasitoids and numbers of host larvae of the appropriate stage are given.

5.3. Taxonomic Research

Museum and literature surveys of H. armigera natural enemies identified parasitoid groups in need of further taxonomic studies. Priorities for this were identified as the braconid genus Cardiochiles and the tachinid Palexorista laxa, both possible specialists in East Africa, and the ichneumonid genus Charops. Work has started on extending a CIE-BMNH revision of West African Cardiochiles to East Africa, and on a study of P. laxa material to determine if there are in fact more than one species from H. armigera and if specimens not from H. armigera are truly P. laxa. Work on Charops will need to be carried out in Phase II.

6. SAMPLING METHODS FOR FIELD WORK

Because of logistic problems discussed above, work in this area was directed at discussions with collaborators in ongoing H. armigera projects in Africa and elsewhere. On the basis on this collaboration, previous work by Mr Van den Berg on predator assessment at the International Rice Research Institute and a review of the literature, a sampling plan was developed. Here, a brief survey of the sampling methods is given.

6.1. Sampling host stages

Regular (weekly) field samples of egg and larvae will permit phenology and seasonal age structure changes to be assessed. Larvae must be isolated on diet and head capsules checked to determine age at collection. Head capsule size per instar may differ between crops. This will be studied in more detail.

Crops will be sampled destructively for accurate density estimates of field populations. Particular attention will be paid to H. armigera egg densities.

Regular sampling of eggs and larvae and measurement of developmental duration for each stage will permit a calculation of a "seasonal life table" (i.e. total of all stages over all generations) to determine the life stages at which greatest mortality occurs.

In order to investigate more closely the components of mortality (see next section), cohort studies, involving eggs, larvae or pupae placed in the field, will be made. This will require substantial and dependable production of the culture.

6.2. Natural enemies

Demonstrating the impact of natural enemies on the pest requires a thorough knowledge of the phenology of individual species of natural enemies and, also, how species interact or compete with each other.

For parasitoids, therefore, the percent parasitism needs to be adjusted to the individual parasitoid species involved. To determine percent parasitism by a certain parasitoid one has to consider a specific stage of the host. For example, to determine percent parasitism by Apanteles diparopsidis only 2nd instar larvae should be collected, because this parasitoid emerges from the late 2nd or 3rd instar. On the other hand tachinids attack only old larvae and mostly emerge from pupae. Unfortunately, some parasitoids are not very consistent but can attack several host stages and emerge from several. The literature gives some information on the host stages attacked by these parasitoids and the host stage from which parasitoids emerge (see van den Berg, Waage & Cock 1988). Some parasitoid species must be studied more closely in this regard. In general, we will sample the different guilds of parasitoids in the following manner.

Egg parasitism will be studied largely by field exposing marked host eggs on the crops. Here, competitive interactions with egg predators will be considered, since parasitised eggs generally remain 3 or more times longer exposed to predators than do unparasitised eggs. Just before eclosion, the eggs are put in vials until emergence of larvae or parasitoids.

In order to assess percent parasitism by larval parasitoids only certain host instars will be considered, depending on the parasitoid species involved. Thus, for some braconids, 2nd instar larvae will be sampled, whereas late 3rd or early 4th instars are appropriate for certain ichneumonids, and 6th instars for specific tachinids.

Recently, intensive studies in South Africa have indicated a high impact of natural enemies (mainly predators) on the pupal stage of the pest. For this reason we will expose marked pupae in the field by burying them in the soil.

An accurate assessment of predation is more difficult than the assessment of parasitism, hence the paucity of work in this area. Experimental methods (Luck, Shepard & Kenmore 1988) will be needed to determine the role of

individual predator species.

In addition to parasitism and predation, the mortality in the field due to diseases (bacterial, viral, fungal) will be assessed.

Acknowledgements

The work carried out in Kenya was based at the CIBC Kenya Station at KARI's National Agricultural Research Centre, Muguga. We thank Dr B N Majisu (Director, KARI) Dr B W Ngundo (Director, NARC) and Dr A M Mailu (Head, Entomology and Biocontrol Division, KARI) for their support and cooperation.

We are also much indebted to the officers-in-charge and staff of the field stations of KARI: Mr Orodho (Western Agricultural Research Station, Kakamega), Mr O Karuru (Kiboko Station), Mr Macharia (Nyanza Agricultural Research Station, Kisi), Dr Malinga (Cotton Research Sub-Centre, Kibos), Mr D K Muthoka (National Agricultural Research Station, Kitale), Mr Muli (Sub-Station Matuga), Mr A Aziz (Coast Research Station, Mtwapa), Mr Githunguri (Sub-Station Msabaha), Dr M W Ogema (National Plant Breeding Station, Njoro) and Dr M S K Njuguna (National Horticultural Research Station, Thika), for co-operation and discussions.

Mr P Odiyo (KARI armyworm unit) is thanked for valuable co-operation in the light trap studies, and for making available the data set on H. armigera.

The Kenyan staff working in the project were Mr P Chege Ng'ang'a, technologist, and Mr J Obiero, sub-ordinate (KARI).

Part of the literature survey was conducted at the C.A.B International Institute of Entomology and the British Museum (Natural History). We wish to thank Dr Z Bouček, A Polaszek and A K Walker of CIE, and R W Crosskey, I D Gauld and T Huddleston of BMNH who helped in the search of museum material and made valuable contributions to the review with their taxonomic comments on the parasitoid species/records. Especially, thanks are due to Dr K M Harris, Director CIE, for his co-operation; he and Dr L Mound, (Keeper of Entomology, BMNH) have organised the taxonomic studies being undertaken on Cardiochiles spp. and the Palexorista laxa complex.

Thanks are also due to Dr B T Nyambo (Agricultural Research Institute Ilonga, Tanzania), Dr P J Guest (Jealotts Hill Research Station, Bracknell, UK) and Dr N J Mills (CIBC UK Station) for providing useful information for the review, and to Mr D J Girling (CIBC) and Ms K Howard (CIE) for their assistance in the literature search.

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ANNEX I. Summaries of information on KARI research stations.

KAKAMEGA Western Agricultural Research Station

Officer in Charge: Dr Orodho

Crops on Station: Maize, beans, sorghum, oil crops, horticulture, citrus, papaya, potato, onion etc.

Local crops: Small farmers mostly grow maize and beans intercropped with no rotation. Little or no pesticides.

Rains: Long rains late January/February - June; short rains August - November.

Seasons: Harvest December and June - July; land preparation immediately afterwards.

Elevation: 5000 ft.

KATUMANI National Dryland Farming Research Station

Director: Mr Kusewa

Crop protection: Mrs J Songa (entomologist)

Mandate: Dryland crops including maize for dryland areas.

Crops on station: Maize, cowpea, pigeon pea, cassava, sorghum, millet, beans.

Local farmers: Maize-beans intercrop predominates, but also pigeon pea-maize intercrop and cotton as a cash crop.

Rains: Long rains March - May; short rains November - December but erratic.

Seasons: Land preparation just before rains in September - October and January - February; planting at the beginning of the rains and harvest in May - June (beans) and June - July (maize) for long rains and February - March for the short rains.

H. armigera: Third most important pest on pigeon pea.

Elevation: 6000 ft.

KIBOKO Out station of Katumani

Officer in Charge: Omari Karuru; no crop protection

Crops on Station: Pigeon pea, cowpea, soya, maize, sorghum etc. Irrigation available.

Local Crops: Small farmers: maize and beans dominant, both as intercrop and monoculture; little rotation; also cowpea, green gram, sorghum. By river: cash crops under irrigation: okra, tomato, kale, peppers.

Rains: Short: mid October - November or even December; long: March - April. Rain somewhat inconsistent.

Seasons: Two crops per annum; harvest at end of long rains (August - September) and prepare land September - October; harvest again at end of short rains (January - February) and prepare land February - March.

Chemicals: On station pigeon pea, cowpea and other legumes sprayed during flowering.

Extent of cultivation: Away from river minimal.

Elevation: 3000 ft.

KIBOS Cotton Research Sub-Centre

Officer in Charge: Dr Malinga

Crop Protection: Mr A Mambiri

Station mandate: Cotton and cotton systems.

Crops on station: Cotton and some intercrop systems.

Local crops: Maize and beans usually intercropped; also cassava and sweet potato.

Rains: Long rains March - June, short rains August - October; usually poorly defined but reliable.

Seasons: Planting cotton at beginning of long rains (March), harvest August - September for about one month in 3 pickings; after harvest plants cut and burnt, and land left fallow for rest of year as short rains adequate. Land preparation December - January.

H. armigera: No. 1 pest on cotton; recommended to use insecticides (Pyrethroids) 2 months after planting and then every 2 weeks until bolls mature, i.e. 5 - 6 sprays. In practice farmers economise with sub-standard doses and less frequent sprays.

Elevation: 4000 ft.

KISII Nyanza Agricultural Research Station

Officer in Charge: Mr Macharia

Crop Protection: Mr J Otieno (entomologist), + 1 pathologist.

Crops on Station: Maize, soya, beans, potato, cabbage, bananas, onion, tomato, groundnut.

Local Crops: Small farmers: maize and beans predominate, mostly as intercrop; cash crops coffee, tea, pyrethrum.

Rains: Long rains: late February to late May or early June; short rains - late August to early November.

Seasons: Harvest January and August and prepare land immediately afterwards.

H. armigera: Not considered common.

Elevation: 6000 ft.

KITALE National Agricultural Research Station

Officer in Charge: Mr D K Muthoka

Crop Protection: Mr T Ochur (Pathologist), Mr Maaka (New Entomologist).

Crops on Station: Mandate: Maize and pasture (including forage legumes).

Local crops: Small farmers: maize - bean intercrop mostly, some monoculture. Large farmers predominate and grow maize with pesticides for stem borer control.

Rains: Long rains late March to September, more or less predictable.

Seasons: Harvest December; harrow with first rains January, February, or mostly March; plant with rains late March, April.

H. armigera: Not considered important; more important in lower areas where cotton grown; probably less than 1% plants attacked.

Elevation: 6000 ft.

MATUGA Sub Station Matuga of Coast Research Station

Officer in Charge: Mr Muli

Crop Protection: Mr V Keya (entomologist)

Mandate: Regional sub centre for coastal crops; citrus.

Local Crops: Cashew and coconut; further South sugar cane, bixa. Coconut under-planted with food crops: maize, cowpea, green gram, cassava and some simsim - mostly intercropped, but not maize on clay soils. Tomato under irrigation.

Rains: Long rains mid March - July; short rains mid - October to November, but not reliable just around Matuga.

Seasons: Maize principally grown in long rains, simsim and cowpeas in the short rains.

Farmers: don't use insecticides.

South of Mtwapa: More rain; continuous cultivation throughout year.

H. armigera: Worst on tomato and brinjal.

MTWAPA Coast Research Station

Officer in Charge: Mr Abubakar Aziz

Crop Protection: Mr Kiarie Mwangi (entomologist)

Crops on Station/Mandate: Coconut, cashew, root and tuber crops.

Local Crops: Maize, cassava, simsim and to lesser extent cowpea and tomato.

Rains: Long rains May to July followed by showers and the short rains October to the beginning of December.

Seasons: Maize planted April - May and harvested July; simsim planted end of July and harvested September/October and harvested December giving three crops a year. Maize is intercropped with cassava (one year cycle), cowpea etc. Simsim is often inter-planted rather than clear the land.

H. armigera: Mainly on tomato and cotton, very few farmers use pesticides.

Elevation: Sea level.

MSABAHA Msabaha Research Station (Sub Station of Mtwapa)

Officer in Charge: Mr Githunguri

Crop Protection: Mr Gitonga (entomologist)

Mandate: All crops in area, especially cassava, maize, cotton, legumes (pigeon pea, cowpea, green gram).

Local Crops: Small farmers grow maize, cowpea, green gram, pigeon pea, simsim, cassava about equally; some tomato under irrigation; cotton as cash crop.

Rains: Long rains April to mid June and short rains October - November.

Seasons: Maize and cassava planted at start of long rains; the former is harvested towards the end of the rains and replanted with simsim or green gram which is harvested December. Pigeon pea also planted in April for harvest in September. Land preparation: burn and plant - no tillage. Cotton is planted in April, harvested at the end of October and replanted with legumes.

Elevation: Sea level.

NJORO National Plant Breeding Station (NPBS)

Officer in Charge: Dr M W Ogema

Crop Protection: Entomologist Dr J K Wanjama (Head)

Crops on Station: Wheat, maize, sunflower, soya, lupin etc.

Local crops: Maize - bean intercrop dominant; some wheat, and a bit of horticulture: cabbage, carrot, tomato, kale.

Rains: April - May and usually July - August (but not July 1987).

Seasons: Planting end of March/beginning of April 'until June, for harvest August to November. Of Molo - plant later and harvest 'until February; Narok plant February onwards.

Cultivation: Soil doesn't hold water for long. New land is ploughed in December; old fields are harrowed after harvest; both are harrowed again before planting.

H. armigera: Normally present, but not epidemic. An outbreak on wheat in 1981 possibly due to army worm spraying. Light trap catches negligible in dry periods, small numbers in wet.

Elevation: 7000 ft.

THIKA National Horticultural Research Station

Director: M S K Njuguna

Crop Protection: Mr G K Kinyua, Mrs Waiganjo

Crops on Station: All horticultural crops, notably priority fruits (mango, citrus, avocado, passion fruit, papaya, apricot, banana, apples, peaches, pears, grapes, strawberry), vegetables (cabbage, kale, lettuce, capsicum, tomato, brinjal, carrot, onion, cucumber, courgette, water melon), and Asian vegetables (okra, papri, valore, chora (cowpea) etc.).

Local crops: Small farms grow maize - beans usually as an intercrop; cash crops include french beans, tomato, potato.

Rains: Long rains mid March - end May, short rains October - November. Not very reliable, but horticulture under irrigation anyway.

H. armigera: Most noticed on tomato, brinjal, capsicum, okra, papri, valore chora etc.

Elevation: 5000 ft.

Distribution

ODA-NRE (3)

CABI - DSS
Director, CIE
Head, CDS

CIBC - Director
Stations & Units (6)
Information Officer

Dr T Abate, Institute of Agricultural Research, Ethiopia
Prof M F Claridge, University College, Cardiff, UK
Dr P J Guest, Jealotts Hill Research Station, UK
Prof P T Haskell, University College, Cardiff, UK
Dr A B S King, ICRISAT, India
Prof J C van Lenteren, Agricultural University Wageningen, Netherlands
Dr G A Matthews, Imperial College, UK
Dr B T Nyambo, Ilonga Research Institute, Tanzania
Dr D E Pedgeley, ODNRI, UK
Dr P Silvie, Institute de Recherches du Coton et des Textiles Exotiques, Chad
Dr P A Stam, FAO, Sudan

Kenya - Director of Agriculture, Ministry of Agriculture

KARI - Director
Director of Research
Director, National Agricultural Research Centre, Muguga
Director, Cotton Research Station, Kibos
Director, Western Agricultural Research Station, Kakamega
Director, National Dryland Farming Research Station, Katumani
Director, Coast Research Station, Mtwapa
Director, Nyanza Agricultural Research Station, Kisii
Director, Mwea Tabere Research Station
Officer in Charge, Msabaha sub-station
Head, Division of Entomology and Biocontrol, NARC
Senior Entomologist, National Agricultural Laboratories
Librarian, National Agricultural Research Centre
Chairman, CIBC Kenya Station, Research Advisory Committee
ICIPE - Head of Biocontrol Sub-programme
IPM Co-ordinator, PESTNET
Secretary, National Council for Science and Technology
Head of Entomology, National Museums of Kenya
Chairman, Department of Zoology, University of Nairobi
Chairman, Department of Zoology, Kenyatta University
Chairman, Department of Biology, Egerton University
Chairman, Department of Zoology, Moi University

Spare (2)

Total 50