Crops — Plant Biotechnology

CEE PROCEEDINGS

PROCEEDINGS OF THE 10th ANNUAL MEETING OF THE COMMITEE OF ETHIOPIAN ENTOMOLOGISTS

FEB. 7 — 9, 1990
ADDIS ABABA
ETHIOPIA

COMMITEE OF ETHIOPIAN ENTOMOLOGISTS

FORWARD

The annual meeting of the Committee of Ethiopian Entomologists (CEE) serves as a forum for concerned experts to share their experience, accrued through research and field work, in agricultural and medical entomology.

The 10th annual meeting of the CEE attracted quite a large audience from all corners of the country. Presentation of papers which had relevance to public health and insect pest control on crops such as cotton, barley, maize, pulses - etc. formed the major part of the meeting. Full texts of papers presented in the meeting is contained in this proceeding with the inclussion of comments and replies made for questions raised after each presentation.

Information contained in this proceeding is reckoned to provide vital indications for those who are interested in the aforementioned fields of work.

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* Ato Kassahun Bekele, Chairman, CEE.

ACKNOWLEDGEMENTS

The CEE would like to extend its heart felt gratitude to Agro-Industrial Inputs (AII) for making the 10th annual meeting a success through provision of the following:

a) renting and arranging a hall for the annual meeting,

b) providing refreshements to the participants during coffee break, and

c) organizing a get-together reception at the end of the meeting which fostered an informal discussion between members and other invited guests.

- The CEE would like to express its gratitude to the Crop Protection Department of the Ministry of Agriculture for duplicating this proceeding & Newsletter Volume II and for covering expenses associated with the printing of the cover of the proceeding & binding.

- The CEE would like to thank the Ministry of Coffee & Tea Development for donating 500 Birr. in response to a letter addressed to them.

- The CEE also extends its thanks to W/t Tadelech Petros for typing the original manuscript.

The Executive Committee of the CEE

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Ato Adugna Haile	-	Vice Chairman
Ato Fulassa Sori	-	Secretary
Ato Berhane G/Yohannes	-	Treasurer

CONTENTS

OPENING ADDRESS*

CEE 10^{th} Annual Meeting

Mr. Chairman,
Members of the Committee of Ethiopian Entomologists (CEE) and Invited Guests.

It is a great honour for me to be invited to give an opening speech to this annual event of the CEE., to which I am also a member. Thus, I would like to welcome you all to the 10^{th} annual meeting of the CEE.

As you all are aware, the CEE is a professional committee which embraces experts involved in the fields of agricultural and medical entomology. The main aim of this committee was and still is to enhance the knowledge of entomology among entomologists who are engaged in research, teaching, agricultural developments and others. Exchange of ideas, practical experiences, etc. among interested members through such forums will undoubtedly be of immense help in bringing to light some of the entomological problems which are known to hinder successful production of crops & in alleviating human ailments known to be caused by vectors.

Ladies & Gentlemen,

It has been mentioned, time and again, by concerned officials that the major bottleneck in an under-developed countries like Ethiopia is the growing disparity between food production and population increase. Any attempt made to narrow the gap between these factors would undoubtedly have an immense social and economic impact. The CEE has a lot to contribute in this direction, especially in alleviating production problems which reckoned to be limiting in boosting productivity.

Mr. Chairman,

May I take this opportunity to express my heart felt gratitude to those members who made their utmost effort to strengthen the CEE and reach to this stage.

I am highly confident that pertinent information which precipitate from such a meeting will eventually be channeled to the agricultural community to help in raising agricultural productivity or alleviate other problems.

Ladies & Gentlemen,

As you well know, initiation was made to merge the CEE with the Phytopathological Committee and the Ethiopian Weed Science Committee and form the Crop Protection Society. I, firmly, believe that this kind of trend should be encouraged by all concerned and every effort should be placed towards making the Crop Protection Society a reality.

With this brief remark, wishing you a practically worthy delibrations and successful annual meeting, I declare this 10th annual meeting open.

Thank you.

" Ethiopia Tikdem "

* Ato Bisrat Gebrekal
Research & Advisory Department Head
Ministry of State Farms Development
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SANDFLY VECTORS (DIPTERA: PSYCHODIDAE, PHLEBOTOMINAE) OF CUTANEOUS LEISHMANIASIS IN THE HIGHLANDS OF ETHIOPIA.

by

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INTRODUCTION

Cutaneous leishmaniasis (CL) is mainly a disease of the skin. (may visceralize in some species) which is brought about by a protozoan parasite belonging to the genus Leishmania. The aethiologic agent of CL in the highlands of Ethiopia is Leishmania aethiopica (Bray et al., 1973). The same species is also responsible for CL in the Mount Elgon region of Kenya (Kaddu and Mutinga, 1981; Mutinga and Odhiambo, 1986a, b).

Cutaneous leishmaniasis due to L. aethiopica has been recorded from Sebeta (Shoa), Aleku (Wollega), Kutaber and Wurgessa (Wollo) and Ochollo (Gamo Gofa) (Lemma et al., 1969; Ashford et al., 1973). Cases coming to the Armanuer Hansen Research Institute (AHRI) for treatment indicate that CL prevails in many highland areas of Ethiopia (Sarojini et al., 1984).

The phlebotomine sandflies incriminated as vectors of CL in Ethiopia are P. longipes and P. pedifer while in Kenya it is only P. pedifer. Preliminary studies indicate that P. pedifer is the sole vector of CL in Ochollo while P. longipes is presumably the vector in most of the other highland areas of Ethiopia (Lemma et al., 1969; Ashford et al., 1973; Gemetchu, 1977; Gemetchu, et al., in press).

MATERIALS AND METHODS

This paper resorts to previous data (e.g., Lemma et al., 1969; Foster et al., 1972; Foster, 1972, b; Ashford et al., 1973; Gemetchu, 1977) as well as to data obtained during three investigations carried out in 1980, 1989 and 1990 in Ochollo by Gemetchu et al. (in press) and on an extended study in Sebeta by Worku Negash (1988).

The materials and methods used in previous and recent studies are to a large extent similar.

Sandflies were collected from their resting habitats such as rock holes, buttresses of trees and inside houses using simple suction aspirator, CDC light trap and sticky plates. Human bait was used to catch anthropophilic species. In previous as well as in recent studies Sebeta, Aleku, Kutaber and Ochollo were the main study areas (Figure 1) where CL due to *L. aethiopica* is known to be endemic or hyperendemic.

Sandflies were dissected in the field or brought back to the laboratory in Addis when situations permitted. In both cases live sandflies were transferred into small nylon Barraud's cage and were kept in humid atmosphere until they were dissected. Those collected on sticky plates and all males trapped by other methods were first preserved in 70% alcohol and later processed and mounted for the determination of species composition and seasonal distribution.

Using aspirator, female sandflies were transferred individually from Barraud's cage into a vial or petri dish containing 2% detergent (e.g. Savlon) to wash away the dirt or the oil from the cuticle prior to dissection. The specimen was then washed in two changes of sterile physiological saline. The specimen was then dissected in a drop of sterile saline, on a clean slide, with fine dissecting needle under a stereoscopic dissecting microscope. A female sandfly was first examined for the appearance or condition of the accessory glands and the ovaries to determine whether the fly is parous or nulliparous. Subsequently the alimentary canal was examined to determine the presence or absence of promastigotes and their distribution and approximate abundance in the midgut, if present. If promastigotes are present, the gut is then teased to release some of the flagellates into the sterile saline. Some of the fluid is then removed with a syringe and needle and injected into Novy-Nicolle-MacNeal (NNN) culture media or a laboratory animal such as hamster. The rest of the gut together with the promastigotes are squashed onto a nylon hybridization membrane for DNA probe analysis.

Culture media are checked every day or as required for the development of promastigotes. Some of this material have been sent, on several occasions, to the London School of Hygiene and Tropical Medicine or the Liverpool School of Tropical Medicine for isoenzyme characterization of the isolates.

During dissection, the head, the terminalia and the rest of the body are mounted in Gum Chloral mountant, on a slide, for identification. Preserved specimen are also processed and mounted on a slide to be identified later using standard keys (Abonnenc and Miniter, 1965; Abonnenc, 1972).

RESULTS AND DISCUSSION

Studies carried out so far, in Ethiopia, suggest the existence of several foci of cutaneous leishmaniasis (CL) due to *L. aethiopica*. The four important foci in which some degree of epidemiological studies have been done are Sebeta (or Meta Abo), Aleku, Kutaber and Ochollo. All are above 1500 m in altitude (Figure 1). It is presumed that CL is quite prevalent in many of the highland regions of Ethiopia. It has been also observed that the distribution of CL coincides with the distribution of the vectors, namely, Phlebotomus longipes and P. pedifer (Ashford and Smith, 1985).

The prevalence rate of CL has been observed to vary from area to area, the highest being recorded in Ochollo (Table 1). Prevalence rates also varied between villages of a known focus (e.g., Ochollo) as well as with the proximity of huts to the natural habitats of sandflies and hyraxes (Ashford et al., 1973). The causitive agent in all the endemic areas is known to be L. aethiopica (Bray et al., 1973; Ashford et al., 1973). Both active lesions and characteristic scars have been successfully used in determining the prevalence rate of CL.

The habitat in which L. aethiopica and its phlebotomine vectors (i.e., P. longipes and P. pedifer) exist is within the altitude range (1500 - 2700m) in which the hyrax reservoirs are also found (Ashford et al., 1973; Ashford and Smith, 1985). In all regions of Africa where L. aethiopica is known to act as the agent of CL four species of hyraxes, namely, Procavia capensis, P. johnstoni, Heterohyrax brucei and Dendrohyrax arboreus, have been recorded to serve as the natural reservoir hosts of L.aethiopica. P. capensis and H. brucei are the reservoir hosts in Ethiopia (Ashford et al., 1973) while P. johnstoni and D. arboreus are the reservoir host in Kenya(Mutinga, 1986). Even in Ethiopia, H. brucei is more prevalent and important than P. capensis (Table 2). Both P. longipes and P.pedifer probably have hyrax habitats (e.g., rock cracks, rock holes, etc) as their natural breeding and resting places. It appears that the decomposed organic matter provided by the food and faces of hyraxes may be a suitable breeding area for the larvae (Mutinga and Odhiambo, 1986a). It also sounds logical that hyraxes would provide blood source for egg development in P. longipes and P. pedifer. Blood-meal analysis carried out on 5 fed P. pedifer collected from hyrax cracks showed that all were from hyraxes (Ashford et al., 1973). Also a similar analysis carried out by the same authors on 11 fed P. pedifer collected from houses in Ochollo showed that all were from man. This suggests that P. pedifer feeds readily both on man and hyraxes thus ensuring the transmission of L. aethiopica from hyraxes to man as well as between man. The data also shows that P. pedifer may primarily maintain the transmission of L. aethiopica between hyraxes in hyrax cracks.

2In situations such as Ochollo where villages are actually built on hyrax habitat it is taken that both zoonotic and anthroponotic transmission of L. aethiopica may take place with out difficulty.

Studies carried out in L. aethiopica endemic areas, so far indicate, the existence of 8 species of phlebotomine sandflies belonging to two genera, namely, Phlebotomus and Sergentomyia (Table 3). They are P. aculeatus (=P. elgonensis), P. longipes, P. pedifer, S. affinis vorax, S. africana magna, S. bedfordi, S. schwetzi and S. serratus. P. longipes is the most prevalent and the only anthropophilic sandfly species in most of the CL endemic areas of Ethiopia. On the other hand P. pedifer is the dominant and possibly the only anthropophilic species in Ochollo. However, the existence of P. pedifer with P. aculeatus in Ochollo (Ethiopia) and Mt. Elgon (Kenya) pose some question as to the role of P. aculeatus. The degree of anthropophily of P. aculeatus has not been determined so far, although in caves in Kenya, where large number of P. aculeatus occurred, very few, if any, came to bite man (Rogo, 1983; Mutinga, 1986). The highly insignificant number of male P. aculeatus collected from Ochollo by Gemetchu et al., (in press) suggest that this species may not be important here. Sergentomyia species are normally lizard feeders and are not considered important in the transmission of mammalian leishmaniasis.

Investigations carried out on different occasions to determine natural infection in sandflies, in CL endemic areas of Ethiopia, have revealed that both P. longipes and P. pedifer are found naturally infected with L. aethiopica. The infection rate in sandflies of these areas varied from 0.16% to 5.4% (infection rate of sublocalities can go as 6.5% both in Kutaber and Ochollo).

The distribution of promastigotes in the thoracic and abdominal midgut regions suggest the normal distribution of mammalian Leishmania in the gut of vector species. The density of promastigotes in the gut (e.g., 300 to several thousand) also confirm the importance of the above two sandfly species in the maintenance and transmission of L. aethiopica between hyraxes, from hyrax to man or between man (Table 4).

Laboratory infection experiment carried out by Foster (197:b)showed 12 out of 20 (60%) of P. longipes that fed on CL and DCL (diffuse cutaneous leishmaniasis) cases developed a high anterior infection with promastigotes. This also confirms the suitability of P. longipes to serve as a vector of L. aethiopica in nature. A similar laboratory infection experiment using P. pedifer also showed 2.5 to 35.1% anterior infection (Mutinga and Odhiabo, 1986b) indicating the importance of P. pedifer in the transmission of L. aethiopica in endemic areas of Kenya.

From what is known in Ethiopia, P. pedifer is the only vector of CL in Ochollo while P. longipes is the only vector in the remaining end endemic foci of CL due to L. aethiopica. On the other hand, P. longipes is unknown from Kenya and it is only P. pedifer that is important here.

Although in the past, dissection had been solely used to positively determine natural infection in sandflies, nowadays, specific DNA probe technique has proved more efficient (Gemetchu et al., in press) in detecting and determining Leishmania infection in the gut of sand-flies, detecting even those that are not seen with the compound microscope. In addition, both isoenzyme electophoresis and DNA probe have been efficiently used in determining L. aethiopica from sandflies and the vertebrate hosts during studies carried out in CL endemic foci of Ethiopia and Kenya.

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Table 1. Prevalence rates of cutaneous leishmaniasis in four endemic foci in highland Ethiopia.

STUDY AREA	REFERENCE	NO. OF LESIONS	NO. OF SCARS	TOTAL STUDIED	PERCENT AFFECTED
Aleku	Lemma *et al.* (1969)	5	4	55	16.4
Sebeta	"	5	25	185	16.2
(Meta Abo)	Worku Negash (1988 MSc thesis)	13	43	1129	4.96
Kutaber	Ashford *et al.* (1973)	13	3	1439	1.1*
Ochollo	"	96	272	895	41.1
"	David Humber and Genene Mengistu 1986/87 (Unpublished)	90-150	600-1200	3000	22-41**

* Percent increased (6.5) in compounds nearer to the natural resting places of *P. longipes* and hyraxes.

** Prevalence varied with villages.

Table 2. Reservoir hosts of Leishmania aethiopica in cutaneous leishmaniasis endemic foci in highland Ethiopia

STUDY AREA	REFERENCE	SPECIES OF HOST	POSITIVES FOR L. AETHIOPICA
Aleku	Ashford _et_ _al_. (1973)	_Heterohyrax bruoei_	6 out of 22
Sebeta (Meta Abo)	Worku Negash (1988 MSc thesis)	" "	Undetermined*
Kutaber	Ashford _et_ _al_. (1973)	" "	1 out of 5
		Procavia capensis	9 out of 115
Ochollo	"	_Heterohyrax bruoei_	4 out of 19

* Flemings (1970) unpublished report states the finding of infected hyraxes in Sebeta.

Table 3. *Phlebotomus* and *Sergentomyia* sandfly species, their relative abundance and feeding habits as seen in endemic foci of cutaneous leishmaniasis.

STUDY AREA	REFERENCE	SPECIES	RELATIVE ABUNDANCE	FEEDING HABITS (A OR Z)*
Aleku	Lemma *et al.* (1969)	*P. longipes*	Dominant	A
		S. bedfordi		Z
		S. schwetzi		Z
		S. serratus		Z
Sebeta (Meta Abo)	" Foster *et al.* (1972)	*P. longipes*	Dominant	A
		S. bedfordi		
Kutaber	Ashford *et al.* (1973)	*P. longipes*	Dominant	A
		S. africana magna		Z
		S. befordi		Z
Ochollo	"	*P. pedifer*	Dominant	A
		S. bedfordi		Z
"	Gemetchu *et al.* (1990, in press)	*P. aculeatus*		?
		P. pedifer	Dominant	A
		S. affinis Vorax		Z
		S. africana magna		Z
		S. bedfordi		Z
		S. schwetzi		Z

* A = Anthropophilic; B = Zoophilic(specially lizards)

? = Unknown

Table 4. Natural infection in *Phlebotomus longipes* and *P. pedifer* with *Leishmania aethiopica*.

STUDY AREA	REFERENCE	SPECIES DISSECTED	NUMBER DISSECTED	POSITIVES NO.	POSITIVES RATE(%)	DISTRI-BUTION	DENSITY OF PARASITIES
Sebeta (Meta Abo)	Lemma *et al*. (1969)	*P. longipes*	?	2	?	Midgut	?
"	Foster (1972)*	"	1216	2	0.16	Thora-cic and abdomi-nal mid-gut	300-500
"	Worku Negash (1988 MSc thesis)	"	616 parous (total 990)	1	0.16	Abdomi-nal midgut	Dense
Kutaber	Ashford *et al*. (1973)	"	3730 (computed)	138	3.7 6.5(of parous or fed	Thoracic & Abdomi-nal midgut	?
Ochollo	"	*P. pedifer*	37	2	5.4	?	?
"	Gemetchu *et al*	"	118 r parous (total 359)	5(6)**	4.2 (5.1)**	Thoracic & Abdominal midgut	Dense

? = Not determined

* = In lab infection experiment Foster observed infection rate of 60% (12/20) using *P. longipes* and infected human cases.

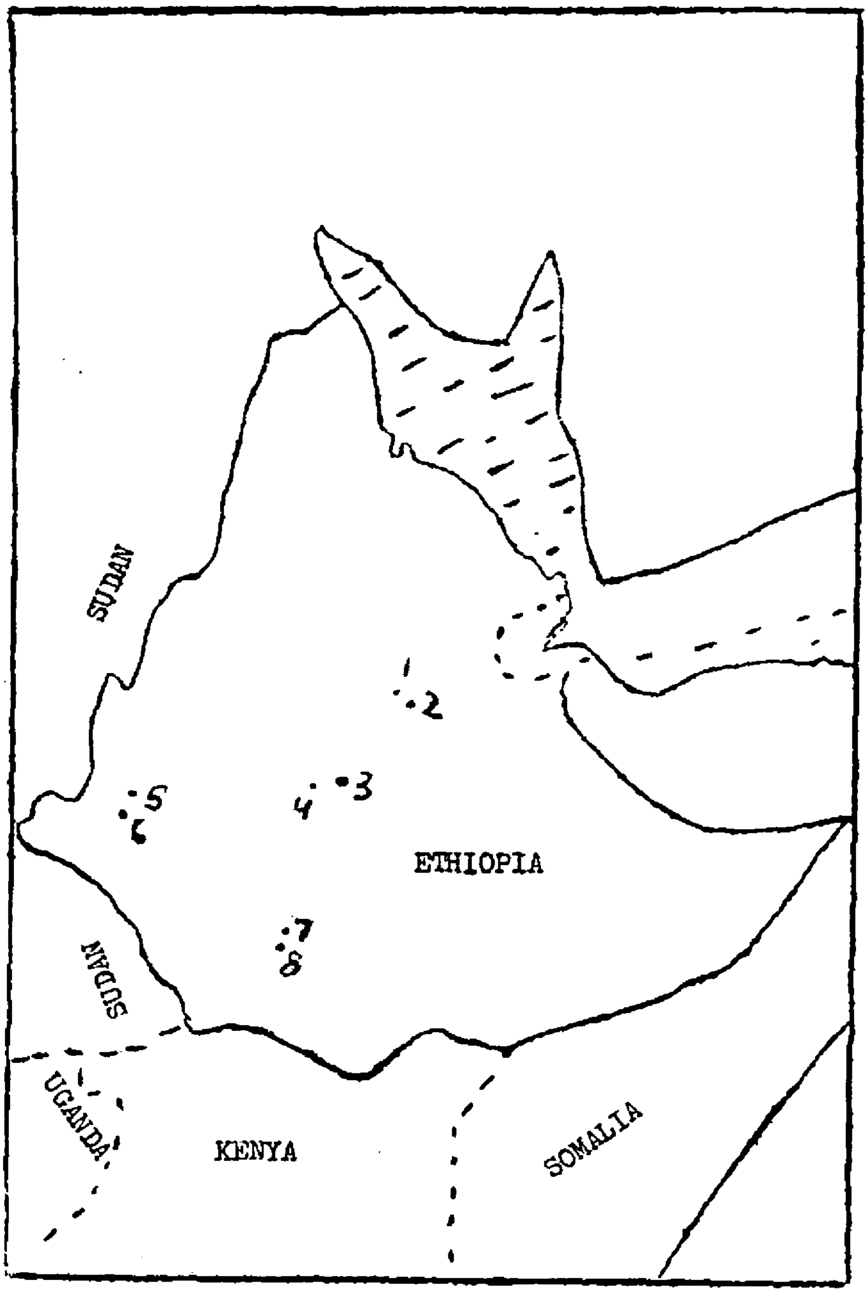
** = One more *P. pedifer* showed positive with the DNA probe.

Fig. 1. Map of Ethiopia showing foci* of cutaneous leishmaniasis.

1. Kutaber*, 2. Dessie, 3. Addis Abeba

4. Sebeta*, 5. Aleku*, 6. Dembidolo,

7. Ochollo*, 8. Arba Minch.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SOMALIA

RESIDUE ANALYSIS OF SOME CHLORINATED INSECTICIDES IN MILK SAMPLES

by
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INTRODUCTION

Environmental pollution with insecticides has become the world's primary concern, because they are potentially hazardous for human health.

The sources of residues of insecticides are many. The two main routes of contamination are direct applications of insecticides to crops and drift sprays from aerial applications. This is particularly true where the insecticides are applied on a crop intended for animal feed. Insecticides are transported by air and through soil and water movements, to be later on concentrated in food chain. Inadequate disposal of unwanted insecticides have also greatly contributed to the accumulation of residues in the environment.

Most of the organochlorine insecticides have been banned or their use is restricted in many developed countries because of their persistent nature in the environment and their accumulation in fatty tissues in organisms. The persistence of these insecticides has greatly necessitated monitoring of the residues in a wide variety of foods, including milk. Data collected from reporting countries for the ten years period (1976-1985) showed the trend of residues in dairy milk. In Japan, data showed gradual decline of dieldrin residues, whereas in Canada and the U.S.A. values have remained constant but fairly well below the extraneous residue limits. DDT residues have markedly declined through the ten years period in Japan, Canada and US.A. data for samples from India indicate a high degree of contamination with DDT. As far as heptachlor + heptachlor epoxide residues in milk are concerned, values have been reported to be below the limits of determination in Canada and the U.S.A. Prior to 1980, some high values were recorded in the Netherlands, but recent data indicate a low level of residues. Data for HCB residue levels in milk in the U.S.A. and Canada remained below determination limits, whereas in Japan and F. R.G. levels have increased and show no evidence of declining. Although developing countries are still the major users of organochlorine insecticides, adequate studies have not been conducted to assess the trend of these insecticides, and the information available is small, often nil.

In Ethiopia, so far, significant study has not been undertaken to indicate the level of residues in food especially in dairy milk. Hence, the purpose of this preliminary study, is to assess the extent of contamination of milk by these insecticides.

Materials and Methods

58 samples were randomly collected from different milk collection centres around Addis Ababa and these are Mullo, Sululta, Shola and other individual farms.

Gas Chromatograph fitted with electron capture detection system has been used for the analysis of the samples. Chromatographic conditions were, 2mts glass column packed with 1.5% OV - 17 + 1.95% OV - 202, with temperatures of injector 250°C detector 300°C and column 200°C. carrier gas flow was at 20 - 25ml/min, and mode of calibration was external standard method or absolute calibration curve method.

10gm from each milk sample was taken into a mortar and mixed with 15gms of silica gelnormal. This mixture was transferred to a clean-up column packed with 10% silica gel. This was eluted with 170ml of 4:1 petroleum benzene: dichloromethane. The solution collected was evaporated to 3-5ul to get rid of the excess dichloromethane and volume was made up to 10ul with hexane. 2ul was injected to the chromatograph.

The organochlorine insecticides are fat soluble and the normal processing of milk and dairy products doesn't change the residue levels in milk fat. Hence, results of residues in milk and dairy products are usually reported on a fat basis. Following the same principle, results obtained are based on pre-determined percentage of fat quantities in each sample.

Table 1. Types of Insecticides Detected in 58 Milk Samples

	Pesticides detected	Positive samples Out of 58	Mean + STd. Devia.	Maximum Residue Limit (PPM)	No. of Samples Exceeded the limit
1.	HCB	23	0.0057±.0095	0.5	0
2.	Total HCH (2,B,2 isomers)	47	0.036±0.266	0.01	39
3.	Heptachlor + Heptachlor epoxide	21	0.043±0.87	0.006	15
4.	Dieldrin	31	0.0484±0.124	0.006	21
5.	DDT isomers (PP-DDE+PP-DDD+ OP-DDT+PP-DDT)	51	0.129±0.307	0.05	16
6.	Cis + Trans Chlordane	24	0.105±002	0.002	34

Results obtained were compared with the maxium residue limits given by FAO/WHO codex Alimentarius Commission, 1986.

As summarized on table 1, the HCB residue values detected in 23 samples are within the permissible limit. Out of the 47 samples which are positive for HCH isomers, 39 samples or 83% of the total have exceeded the maximum residue limit. Heptachlor + Heptachlor epoxide residues were detected in 21 samples out of which 15 samples or 71.4% have exceeded the limit given. Among the 31 samples in which dieldrin residues were detected, 21 samples or 67.7% of the total exceeded the maximum residue limit. Out of the 51 samples which were positive for residues of DDT isomers, 16 samples or 31.3% have exceeded the given limit. All the 34 samples which were positive for cis + trans chlordane residues have exceeded the maximum residue limit.

Discussion and Conclusion

This preliminary study doesn't fully indicate the extent of contamination of dairy milk by the persistent insecticides. However, it is intended merely to draw attention to the problems which exist and at the same time to promote further studies in the field.

At the moment, it is difficult to draw conclusions regarding the sources of contamination in the samples. Hence, the research is still in progress so that the residue sources could be traced.

It is obviously believed that much more interesting results could be obtained if more representative samples are analysed at regular intervals from areas where large quantities of pesticides are frequently sprayed.

The non-restricted usage of persistent insecticides and the resulting residues in the environment should mobilize the attention of all who have a genuine concern for the welfare of man-kind.

MAIZE STALK BORER RESEARCH IN ETHIOPIA

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Ethiopia

ABSTRACT

In a survey of lepidopterous stalk borers, three species, namely, Busseola fusoa, Chilo partellus and sesamia calamistis were identified. B.fusca and C. partellus were found to be the major species in Ethiopia.

In an attempt to develop integrated management methods for B. fusoa various studies were undertaken.

Phenology of B. fusoa has shown that there are three generations a year in Southern Ethiopia. The first generation occurs during the wet season (April - July). The second generation occurs in July but majority of the larvae diapaused from mid September until the end of dry season. A samll proportion of the larvae pupated without diapause to give rise to a third generation.

Diapause larvae have two distinct development periods, namely diapause maintenance and post-diapause periods. Water did not enhance pupation of the larvae during the diapause maintenance period. On the other hand pupation time was influenced by amount of rainfall during the post-diapause period. Delay of pupation was observed when amount of rain was less than 80mm during this period in the field.

Pennisetum purpureum and sorghum verticilliflorum were found to be major wild host plants in Ethiopia. In addition, study on the potential of crop residues indicates that the diapause larvae were observed in all

sizes of maize stalk left in the field but significantly more larvae occurred in longer stalks. The conventional method of storing stalks upright after harvest constituted a major source of carry over populations.

On the other hand, horizontal placement of infested maize stalks for four weeks was effective in reducing larval populations. The relationship between planting dates and B.fusca showed that maize planted early in the season had significantly lower infestation. Yield loss due to the pest showed a significant increase in late planted maize.

INTRODUCTION

Maize (Zea mays) and sorghum (Sorghum bicolor) are the major cereal crops in Ethiopia. The potential yields of these crops, however, are hardly realized especially under peasant system of production where the bulk of the country's crops are raised. Among the major factors causing low yields is the damage by the lepidopterous stalk borers, Busseola fusca(Fuller) and Chilo partellus (swin.) (Assefa, 1981, 1985).

Although the damage by lepidopterous stalk borers has long been recognized, research data on these pests and their impact on yields of crops were not available in Ethiopia. However, in 1979 crop season maize stalk borer research was initiated by the Awassa College of Agriculture in Southern Ethiopia. The main objectives of the stalk borer research were to determine stalk borer species and their distribution in the country. The second aim was to gain a better understanding on the biology and ecology of the major species (B.fusca) and to develop integrated management methods for the pest.

RESULTS AND DISCUSSION

Stalk borer species

Three stalk species, namely, Busseola fusca, Chilo partellus and Sesamia calamistis were recorded in Ethiopia (Table 1). B. fusca and C. partellus were found to be the important species in the country. B. fusca was the dominant species at higher altitude (1160 - 2500m) and in cooler areas whereas C. partellus was important at lower altitude (510 - 1700m) and in warm areas of the country.

This study has also shown that there were differences in populations of B. fusca and C. partellus at similar altitudes but different regions in the West, South and Eastern Ethiopia. Swaine (1957) states that the main factor limiting B. fusca distribution is the high temperature at low altitude. Hence, the distribution of stalk borers based on only altitudinal differences appears misleading.

Phenology of Maize Stalk Borer, B. Fusca

Observations on the phenology of B. fusca showed that there are three generations a year in the Awassa area (Southern Ethiopia) (Fig. 1). The number of generations was variously reported from different African countries. Three generations were observed by Swaine (1957)and Harris (1962) in Tanzania and Nigeria respectively. From Uganda (Ingram, 1958) and Zimbabwe (Smithers, 1959) two and 2-3 generations were reported. Furthermore, a report from South-Western Nigeria showed four generation during a growing season (Usua, 1968a). The difference in the number of generation per year between countries probably due to different climate conditions, vegetations and cropping patterns.

The first generation eggs were laid in April in the Awassa area. Pupation of the first generation larvae was recorded early June to late August with a peak in late June. Second generation eggs were laid in July. The high density of second generation eggs in the middle of July indicates the peak flight period of the first generation moths.

Second generation consisted of two groups of larvae (diapause and non-diapause) in the field. The non-diapause larvae constituted a small proportion of the total larval populations and pupated from September to October to give rise to third generation eggs.

Diapause larvae constituted the great majority of the second generation. These larvae spent nearly six months of the dry season in dry maize stalks.

Termination of diapause in the larvae of <u>B. fusca</u>.

Laboratory studies

Application of water to stimulate pupation in diapause larvae of <u>B. fusca</u> indicates the presence of diapause maintenance and the post-diapause periods during the dry season (Fig 2).

The diapause maintenance period lasted until the end of February in the study area. It was observed that wetting of the diapause larvae had very little influence on pupation during the diapause maintenance period (December, January or February).

Water appeared to be essential for successful and timely pupation of the larvae during the post-diapause period (starting from early March). This was shown by an immediate pupation (within **ten days**) of the larvae when they had access to water in March, April or May. On the other hand delay or access to water once the larvae entered post-diapause dormancy increased days to pupation.

Diapause larvae of <u>B. fusca</u> probably require a certain length of dry period during the early part of the diapause development. Access to water in December, January or early part of February resulted in higher percent larvae mortality. Larvae held in dry jars until late April or May also showed a remarkable increase in the larval mortality.

Field Studies

In the Awassa area, fifty percent cumulative field pupation of diapause larvae of <u>B. fusca</u> occurred from 17 to 26 April in four out of five years (Table 2). Although the larvae showed immediate response in terms of pupation to contact water during the post-diapause period in the lab the indicated pupation time appeared to have been influenced by amounts of rainfall during this period.

Details study on the relationship between pupation and the weather factors in the Awassa area indicates that cumulative rainfall of 80 mm (from the 1st of March) is necessary for induction of pupation of a substantial proportion of the larvae in April. The indicated cumulative rainfall appeared to be necessary to wet the stalks and the larvae contained so that pupation is induced. Inadequate rainfall (less 80 mm) during the post-diapause period resulted in a delayed pupation. Thus, this study suggests the possibility of predicting the time of pupation of the diapause generation using rainfall data.

Development of B. fusca in wild host Plants

The potential of various wild host species, Sorghum verticilliflorum (thick and thin stemmed), Pennisetum purpureum and Snowdema spp and cultivated Saccharum officinarum to support development of B. fusca was assessed both under laboratory and field conditions.

The laboratory study confirmed B. fusca development through adult stages in all host tested.

Sorghum verticilliflorum (thick-stemmed) and P.purpureum were identified as major host of B.fusca (Table 3). In many cases, these two species were comparable with main host (maize and Sorghum) in terms of development and populations. The two wild host plants species supported a substantial number of insects. Interestingly, S.verticilliflorum (thick stemmed) was superior to the main host plants in terms of populations. In addition, proportion of pupae in the population was markedly higher in these two hosts compared with other wild host plants and S. officinarum. The higher populations of pupae in the sample indicates faster rate of larvae development in the host. On the other hand Snowdenia spp did not support B. fusca larvae to pupation.

Fewer number of immature stages of B. fusca in S.verticilliflorum (thin stemmed) and S. officinarum are probably due to decreased preference by female moths for oviposition.

In addition, remarkably low percentages of pupae in these two host species indicate a low rate of larval development. In general S. officinarum and S.verticilliflorum (thin stemmed) were not found to be of minor importance. On the other hand S. verticilliflorum (thick-stemmed) and P. purpureum were identified as major wild host species of B. fusca in Ethiopia.

Female moths developed on various host plants were able to lay a substantial number of eggs with the exception of S. verticilliflorum (thin stemmed) in which many of the larvae and/or pupae died before emergence.

Non-Insecticide Management Practices for B.fusca

The potential of crop residues as sources of carry over population of B. fusca.

The fully grown larvae of B. fusca diapause in tunnels in dry maize and sorghum residues during the dry season. Importance of these crop residues as sources of carry-over populations was assessed in Southern Ethiopia.

Stalks of various lengths (ranging from 10 to 100ms) were left in the farmers field when removing the major part for use. Diapause larvae were found irrespective of stalk size but more larvae occurred in longer stalks (Table 4). The potential of maize and sorghum stalks kept in an upright position immediately after grain harvest contained the highest number of live larvae and pupae. This method of storing stalks would therefore be important in increasing survival of the diapause generation during the dry season.

Manipulation of Crop Residues

Destruction of diapausing larvae has long been regarded as an important means of B. fusca control (Mally, 1920, Deurden, 1953, Blaire, 1971). Collection and complete burning of stalks after harvest (Deurden, 1953) or spreading them thinly in the field throughout the dry season was recommended (Harris, 1962). However, these recommendations are seldom followed by farmers because the crop residues are kept for construction of houses, fences for use as fuel and for grazing (Adesiyum and Ajayi, 1980, Assefa 1981). Therefore, an alternative method which would reduce carry-over populations of the insect without affecting the normal use of crop residues was sought. Effect of horizontal placement of infested stalks in the sun in reducing populations of diapause larvae was tested. This study showed that horizontal placement of infested maize stalks for weeks or sorghum stalks for two weeks was effective in reducing carry-over populations of the insect(Table 5 and 6). Thus, the recommended practive of spreading stalks in the field throughout the dry season or burning them completely is not necessary in the Awassa area. Furthermore, when the stalks of maize or sorghum are removed, they should be cut at soil level so as to remove most larvae.

Manipulation of Planting Dates

Although heavy infestation and damage are often observed, quantitative data on yield loss of maize crop due to B. fusca are not available in Ethiopia. Consequently B. fusoa attack rate and corresponding yield loss of maize in ten successive planting dates were studied in Awassa. To obtain an estimate of yield loss due to the insect, two sets of planting dates were used. One set was treated with insecticide against B. fusca.

Infestation rates on maize planted on different planting dates showed two peaks representing two generations (Table 7). The first peak, which represents 1st generation was recorded on the first planting dates (April 10). Infestation by the second generation larvae started on the six planting (30 May) reaching a peak in June plantings.

The first generation larvae caused a lower rate of infestation than those from the second generation. This appears to be due to high mortality of diapause larvae in the dry season reducing the number moths emerging at the end of the season (Assefa, unpublished, Usua, 1970). In addition, the diapause generation moths laid fewer eggs than those of the non-diapause generation (Smighers, 1959, Usua, 1967, Assefa, 1989 b.)

On the other hand infestation by the second generation larvae was significantly higher on late plantings. The increased infestation levels by this generation appeared to be due to:

1. an increased fecundity of the moths

2. low mortablity of the larvae in the generation

3. oviposition preference to late planted maize young maize

Impact of infestation by the first and second generation larvae on maize yield was assessed (Table 9). The low rate of infestation by the first generation larvae did not have a significant influence on the yield. On the other hand delayed plantings resulted in significantly higher yield losses due to the second generation larval infestation.

In conclusion although conflicting reports were made by various workers with regard to the relationship between planting time and the maize stalk borer, B.Fusca and other stem borers the current study clearly shows that planting time has a strong influence on the damage caused by the pest in Awassa.

Therefore to obtain better yields without application of insecticides against B.fusca the study suggests that maize planting should not be extended later than April in the study area. An addition, similar studies are necessary in other areas where B. fusca is considered to be in important pest.

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Table 2. Time of induction and pupation of diapause generation of *B. fusca*, in the field in relation to cumulative rainfall during the post-diapause period.

YEAR	SUPPOSED DATE OF INDUCTION OF PUPATION	CUMULATIVE RAINFALL (MM) FROM 1 MARCH UNTIL DATE OF INDUCTION	DATE OF 50% CUMULATIVE PUPATION IN THE FIELD	CUMULATIVE RAINFALL (MM) FROM 1 MARCH UNTIL 50% PUPATION
1983	7 April	81.3	18 April	124.7
1984	5 May	57.0	16 May	93.1
1985	13 April	169.4	23 April	204.7
1986	16 April	139.4	26 April	154.2
1987	6 April	125.4	17 April	189.8
	$\bar{x} \pm s.e$	114.3 ± 20.2		153.3 ± 20.5

* Dates of induction of pupation were obtained from Figure 1.

$\bar{x} \pm s.e$: mean cumulative rainfall (mm) $\pm$ standard error of the mean. (Assefa, 1989b).

Table 1. Distribution of stem borer species attacking maize and sorghum in Ethiopia.

ADMINISTRATIVE REGION	SPECIES RECORDED	ALTITUDE (M)
Gamo Gofa	*Busseola fusca**	1200 — 2200
	*Chilo pertellus**	1200 - 1690
	Sesamia calamistis	1200 - 1600
Harerge	*B. fusca**	1520 - 2500
	*C. partellus**	750 - 1690
	*S. calamistis**	1200 - 1690
Illubabor	*B. fusca*	1590 - 2000
	C. partellus	1160
Sidamo	*B. fusca**	1470 - 2450
	*C. partellus**	1470 - 1700
	S. calamistis	1550 - 1750
Wellega	*B. fusca**	1480 - 1950
	S. calamistis	1490

* Principal Species

Source: Assefa, 1985

Table 3. Development and population of Busseola fusca in various host plants in the field.

HOST PLANT	MEAN NO IMMATURE STAGES IN 20 PLANTS	PROPORTION OF PUPAE IN THE SAMPLE(%)	MEAN FRESH LARVAL WT (MG/IND.)	MEAN FRESH PUPAL WT (MG/IND.)
		1985		
S.officinarum	9.3 b	7.5	94.8 c	-
S.verticilliflorum I	52.0 ab	26.3	284.0 ab	279.8 a
S.verticilliflorum II	12.7 b	5.5	172.7 c	-
P.purpureum	12.3 b	29.1	246.1 bc	275.0 a
S.bicolor	43.0 b	23.2	355.8 a	294.0 a
Zea mays	80.3 a	63.1	309.5 ab	310.0 a
		1986		
S.officinarum	3.7 b	12.5	342.7 a	-
S.verticilliflorum I	23.7 a	56.9	312.9 a	253.3 a
S.verticilliflorum II	4.7 b	20.0	179.1 a	-
P.purpureum	12.7 ab	35.7	219.7 a	304.5 a
S.bicolor	13.0 ab	52.5	308.4 a	295.1 a
Zea mays	12.3 ab	61.1	277.4 a	287.4 a

Means followed by the same letter are not significantly different according to student New-man Keuls multiple range test at p=0.05 (Assefa, 1988 b).

Table 4. Proportion of maize stalks left in the field containing diapause larvae of Busseola fusca in the dry season. Awassa 1984 and 1985.

STALK LENGTH (CM)	NUMBER OF STALKS RECORDED	NUMBER OF STALKS CONTAINING LARVAE	PERCENT(%) STALKS CONTAINED LARVAE
10	39	3	7.7
10 - 20	516	95	18.4
21 - 30	434	74	17.1
31 - 40	226	62	27.4
41 - 50	133	38	28.6
51 - 60	72	15	20.8
61 - 70	29	10	34.5
71 -101	24	12	50.0

Assefa,1988 a.

Table 5. Survival and mortality of *Busseola fusca* in 100 maize stalks following hortizontal placement in the sun at Awassa.

TIME OF HORIZONTAL PLACEMENT (WEEKS)	NUMBER OF LIVE LARVA AND PUPA	NUMBER OF DEAD LARVA	PERCENT % MORTALITY
		1983	
0	45	51	53.1
2	13	118	90.1
4	9	72	88.9
6	4	94	95.9
8	1	73	98.7
		1984	
0	68	139	67.2
2	21	109	83.9
4	1	108	99.1
6	1	113	99.1
8	1	115	99.1
		1987	
0	43	74	63.3
2	7	68	90.7
4	3	103	97.2
6	8	94	92.2
8	2	49	96.1

Assefa, 1988 a.

Table 6. Survival and mortality of *Busseola fusca* in 100 sorghum stalks following horizontal placement in the sun at Awassa.

TIME OF HORIZONTAL PLACEMENT (WEEKS)	NUMBER OF LIVE LARVA AND PUPA	NUMBER OF DEAD LARVA	PERCENT % MORTALITY
	1983		
0	9	39	81.3
2	2	68	97.1
4	0	48	100
6	2	60	96.8
8	1	69	98.6
	1984		
0	34	13	27.7
2	3	32	91.4
4	0	32	100
6	0	30	100
8	0	23	100

Assefa, 1988 a.

Table 7. Levels of infestation by *Busseola fusca* on maize following different planting dates, Awassa (Ethiopia)

PLANTING DATE	PERCENT (%)			
	LEAVES INFESTED	DEADHEART INJURY	STALKS BORED	COBS INFESTED
		1985		
10/4	42.0 a	17.3 bcd	63.3 b	14.4 a
20/4	32.9 a	2.3 de	41.4 cd	16.3 a
30/4	13.7 b	1.3 e	8.9 e	25.3 b
10/5	9.2 b	1.9 de	8.4 e	38.0 b
20/5	3.2 b	2.7 de	26.3 d	46.0 b
30/5	7.9 b	11.4 cde	54.7 bc	99.6 c
9/6	65.1 c	35.3 a	85.0 a	100 c
19/6	99.7 d	25.3 abc	100 a	100 c
29/6	96.8 d	32.5 ab	100 a	100 c
9/7	97.1 d	14.3 cde	100 a	77.3 c
		1986		
10/4	8.9 a	2.0 a	23.4 a	14.3 a
20/4	1.1 b	0.8 a	7.5 b	47.9 b
30/4	3.2 ab	0.4 a	15.0 a	82.4 c
10/5	4.7 ab	0.5 a	16.0 a	82.2 c
20/5	9.0 a	1.3 a	20.9 a	90.0 c
30/5	45.6 c	11.4 b	67.1 c	96.6 c
9/6	93.7 d	24.2 c	92.1 d	92.5 c
19/6	94.9 d	32.6 c	100 d	100
29/6	100 d	30.8 c	100 d	82.9 c
9/7	100 d	23.8 c	100 d	39.0 b

Means followed by the same letter are not significantly different according to the Duncan's Multiple Range Test at P=0.05.
(Assefa, et al.,1989).

Table 8. Yield (Quintals/ha) of maize with insecticide and percent yield loss due to *Busseola fusca* following different dates of planting, Awassa (Ethiopia).

PLANTING DATE	YIELD(Q/HA) B.FUSCA CONTROLLED	YIELD(Q/HA) WITHOUT CONTROLLING B. FUSCA	YIELD LOSS DUE TO B. FUSCA INFESTATION	
			Q/HA	PERCENT(%)
		1985		
10/4	74.9 ab	67.6 ab	7.3	9.8
20/4	80.4 a	77.3 a	3.1	3.9
30/4	75.7 ab	79.7 a	-	-
10/5	79.6 a	64.7 ab	14.9	18.7
20/5	65.4 b	58.0 b	7.4	11.3
30/5	49.5 c	18.2 c	31.3	63.2
9/6	40.0 cd	3.2 c	36.8	92.0
19/6	33.0 de	1.7 c	31.3	94.9
29/6	24.2 ef	d	24.2	100.0
9/7	14.8 f	4.9 c	9.9	66.9
		1986		
10/4	88.1 a	68.2 ab	19.9	22.6
20/4	89.2 a	82.7 a	6.5	7.3
30/4	73.3 b	67.3 b	6.0	8.2
10/5	74.6 b	57.8 bc	16.8	22.5
20/5	70.0 bc	47.0 cd	23.0	32.9
30/5	51.6 cd	38.8 d	12.8	24.8
9/6	61.2 cd	17.7 e	43.5	71.1
19/6	45.5 e	3.3 e	42.2	92.8
29/6	49.9 e	4.1 e	45.8	91.8
9/7	36.3 e	6.7 e	29.6	81.5

Means followed by the same letter are not significantly di different according to the Duncan's Multiple Range Test at P=0.05. (Assefa, *et al.*, 1989).

DISCUSSION

Dr. Tadesse Gebre-Medhin

You have identified suitable planting dates to escape the damaging generation of the stalk borer; if the planting dates coincide with the first rains well and good, but if it doesn't would you recommend dry planting?

Dr. Assefa Gebre-Amlak

April planting doesnot coincide with the first generation infestation because eggs of this generation are laid around the middle of April and by the time maize plants in the recommended plantings do not reach preferable stage for oviposition.

Ato Abraham Tadesse

The color of maize leaves in your transparency looks as if it has changed to yellow. How can one conclude that this changes are only due to borers? How practical would horizontal spreading be since it may take up land for cultivation? Insecticide application as dusts is not practical specially on large scale, what alternative method of application do you think of?

Dr. Assefa Gebre-Amlak

1. It is not the color changes that showed borer infestation but there are damage (eaten up) symptoms.
2. Yes, it takes up land but spreading horizontally only for four weeks.
3. E.C. application at early stage of crop growth would solve the problem of pinch application which is tedious.

Dr. Mengistu Hulluka

Qestions on Phenology of insects:

1. the methodology used in determining the different stages?

2. in the abseenoe of crop what do the larvae feed on during the dry season?

3. the occurrence of 3 generations, does it hold true under all ecological conditions?

Dr. Assefa Gebre-Amlak

1. Various generations of B.fusca determined by:

   (a) Inspection of plants for eggs

   (b) Dissecting infested plants from different plantings and recording, larvae and pupae

   (c) Use of Pheromone traps.

2. During the dry season, B.fusca larvae go into a state of diapause in dry stalks of maize or sorghum where there is no feeding activity.

3. There could be different number of generations under different ecological conditions. We will soon start similar observations in various regions where the pest is important.

Ato Kumssa Yirgie

Large farms like the state farms are forced to sow out of recommended date due to shortage of facilities. In this case such farms are forced to use insecticide application. How can we assess eggs to determine infestation?

Dr. Assefa Gebre-Amlak

Eggs of B.fusca are laid on the underside of the leaf sheaths of maize and sorghum plants. These egg masses are visible through leaf sheath for an experienced field workers.

In addition we are conducting a research on oviposition pattern and behavior of B.fusca. I believe results of the current study will be very useful for field inspection of eggs of the pest.

Ato Adugna Haile

You have mentioned that stalk borers have many host plants is wheat one of these host plants. I have seen many wheat fields infested by worms (similar to stalk borer) are they stalk borers if so what is your suggestion to control them?

Dr. Assefa Gebre-Amlak

Yes, wheat can be infested by stalk borer. We observed such infestation at Arsi-Neghle. However, wheat is not an important host plant for B. *fusca* because its stems are not thick enough for larval development.

TERMITES: THEIR DAMAGE AND CONTROL ON MAIZE, TEF AND HOT PEPPER IN ASSOSA AREA

by

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Assosa

INTRODUCTION

Termites (*Macrotermes subhyalinus*) are either primary pests of the crops concerned or their occurrence as secondary pests is of such regularity as to be of interest to the grower (2). Prevalent problem of termite damage to crop plants at Assosa is said to start at Bafeno Korecho farmers association back in 1938(Personal Communication). The infestation has expanded then on at an alarming rate. Consequently, farmers around Menesibu are currently forced to abandon their crop fields solely because of termite damage.

According to Wood (1986) total losses exceeding 20% and lodging more than 50% due to termites on maize were recorded in the country. On millet and tef Macroterm were observed (by farmers and extension workers) foraging with estimates of heavy losses commonly over 20% locally; more than 50% on pepper and groundnut. Microterms attack on roots approach 20-25% in Wollega. According to Adugna and Kemal (1985) several trials were carried out by EPID and IAR against termites on tef at Bako and Mendi. It was shown that satisfactory control could be obtained with all doses 2.5 to 12.5gm aldrin 40% WPB per kilo of tef (1). Besides, local observations indicated that soyabean at maturity, hot pepper at green pod stage, maize at seedling and maturity, tef at maturity were found to be attacked by termites around Assosa.

Therefore, because of the potential importance of termites in affecting crop production, verification studies on chemical control of maize, tef and hot pepper using aldrin 40% wettable powder was under taken to update information on the level of termite damage and control at Assosa.

Materials and Methods

Experiments were conducted for two years (1987 and 1988) on maize and tef and for ono year (1987) on hot pepper in the main season at Assosa Research Center (Western Ethiopia).

Single observation of treated and untreated plots with 40% Aldrin WP were compared. Plot sizes used were 20 X 20 m gross and 10 x 10 m net in 1987 both for maize and hot pepper but 42 x 42m gross and 22 x 22m net in 1987 for tef and 1988 maize respectively. Tef was simply broadcasted while hot pepper and maize were row planted. Plots were fertilized with 100/100, 80/80, 40/40kg/ha N/P_2O_5 as urea and DAP for hot pepper, maize and tef respectively.

Tef and maize seeds were dressed with 40gm aldrin per 10kg seed while hot pepper bare root and soil intact seedlings were dipped in 200gm per 10 litre water suspension of 40% aldrin wettable powder.

Termite attack in tef was determined by counting numbers of attacked plants using 0.5 x 0.5m quadrat at four different growth stages (early tillering, first flowering, full heading and at maturity). Attacked maize and hot pepper plants were recorded by pulling out from the root and scrutinize for infested roots. Whereas effects of termites in lodging was considered by direct observation whether they are due to termite or not. Observation for maize were after thinning, at knee high, attasseling, at grain filling and at maturity; for hot pepper three weeks after transplanting, at flowering, at pod formation, at green maturity and at red ripe. Visual observations were supported by yield comparisons.

RESULTS

Maize: Vegetative performance upto tasseling in 1987 were markedly vigour in treated plots. Besides, over the two years untreated plots had more termite attacks. Nevertheless the infestation of 1987 was serious to 1988. There was 19% attack and 5.3 lodging of maize in 1987 while 8.7% attack and no lodging in 1988. 40.27q/ha mean yield was obtained from treated plots while the untreated gave 29.72q/ha (table 2).

The heaviest infestation of termite in maize was observed at maturity but lodging was important after tasseling. Microterms was usually severe at seedling stage while macro terms get access of infestation at maturity especially when stalks are lodged due to various eases along with delay in harvest.

Tef: Same as maize. Aldrin treated plots were shown. In 1987 treated plots had more infestations of termite, while, in 1988 the untreated plots were relatively more infested. The heaviest infestation in 1987 was 45 days after sowing (at stem elongation) but in 1988 the attack was serious at maturity (94 days) after sowing. Yield results were not consistent over the two years(table 2). This was attributed to the interference of other pests like Teffly, unknown larvae, Tef epilacna, leaf rust and wild pest damages. Especially in 1988 there was severe damage by unknown larvae, which in 1-6 scale a 6 level damage on treated and a 5 level on untreated plots was observed.

Hotpepper: Like the previous crops dipped seedling showed better vegetation after green maturity stage than the non-treated one. The peak termite attack on hotpepper was recorded at flowering. Both bare root and soil intact treated seedlings gave high yields and have less termite damage as opposed to untreated check. The soil intact dipped seedlings gave the highest yield 4.61 q/ha and bare root dipped gave the next high yield 4.36 q/ha. However the number of plants damaged by termite were higher in soil intact dipped plots than the bare root.

DISCUSSION

Maize: According to different workers in various countries (2) maize is subject to termite attack more in drier areas and poor soils. Treating seeds of maize with aldrin 40% WP has shown better protection and sometimes gave good yield (2). Therefore the outcome of this experiment agrees with above mentioned statements.

Tef: Termite damage except in some stages had escaped detection and after completion has been attributed to other causes (2). In this experiment there was confusing results where the termite attack and yield loss differences were masked by the infestation of other pests. Thus the outcome of the experiment disagree with that of Adugna and Kemal (1985) which says that satisfactory control was obtained with all doses (2.5 to 12.5gm) aldrin 40% WP per kg of tef.

Hotpepper: Other factors such as leaf blight and spots, pods drop due to wind storm and bacterial soft rot, wild pest attack contributed to the low dry pod yield. There was clear difference of termite damage between treated and untreated plots. Hence, the results of this experiment agreed with that of Tsedeke (1985) which says that a suspension of 200gm 40% WP aldrin in 10 litre water was enough for dipping 600-9600 hotpepper seedlings to manage termites.

CONCLUSSION

The yield and infestation level differences between treated and untreated plots expressed that one can get better maize yield by dressing 10kg seeds with 40gm aldrin 40% WP.

Dipping both bare root and soil intact hotpepper seedling; with 200gm 40% WP aldrin in 10 litre water suspension for 600-9600 seedlings will be enough to manage termites and increase pod yield.

By and large most of the termite damages around Assosa are caused by under ground mound builders and which forage near or on surface. The level of damage is deliterous year after year. Therefore, detail study on the significance, seasonal attack on major crops with emphasis on maize and hotpepper should be done.

Table 1. Number of Termite attacked plants V_s crop growth stages of maize Hotpepper and Teff at Assosa.

	MAIZE						HOT PEPPER						TEF				
	34d	44d	90d	138d	167d	Total	21d	39d	69d	104d	139d	Total	38d	53d	67d	100d	Total
Treated	11	15	2	12	13	53	-	-	-	-	-	-	24	35	53	11	123
Bare root	-	-	-	-	-	-	6	16	0	3	6	31	-	-	-	-	-
Soil intact	-	-	-	-	-	-	8	18	0	12	10	48	-	-	-	-	-
Untreated	24	11	10	26	48	118	0	53	39	18	35	145	23	61	55	30	169
Mean	17.5	13	6	19	40	85.5	7	29	13	11	17	74.6	23.5	48	54	20.3	546

d = days after sowing

Growth stages: Maize	Hotpepper	Tef
After thinning	Three weeks after transplanting	at tillering
at Knee height	Flowering	at first flowering
at tasseling	Pod formation	at full heading
at grain filling	Green maturity	at maturity
at maturity	Red ripe	

Table 2. Effect of Termite damage on the yields of Maize, Tef and Hotpepper at Assosa.

	MAIZE				HOTPEPPER				TEF					
	1987		1988		1987		1987		1988		MEAN			
	Damage percent	Yield q/ha	Damage percent	Yield q/ha	Mean damage percent	Yield q/ha	Damage percent	Yield q/ha	Damage no.of plants	Yield q/ha	Damage no.of plants	Yield q/ha	Mean damage no.pl.	Yield q/ha
Treated	4.99	45.19	7.79	35.34	6.39	40.27	-	-	201	4.0	44	1.66	122.5	2.83
Bare root	-	-	-	-	-	-	7.38	4.36	-	-	-	-	-	-
Soil intact	-	-	-	-	-	-	11.85	4.61	-	-	-	-	-	-
Untreated	24.91	30.20	9.71	29.21	17.31	29.71	34.20	2.25	194	3.85	143	2.56	168.5	3.21
Mean	19.92	37.70	8.75	32.28	11.85	34.96	17.81	3.74	197.5	3.93	93.5	2.11	145.5	3.02

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TERMITES: PROBLEMS AND POSSIBLE METHODS OF CONTROL IN AGRICULTURE WITH REFERENCE TO ETHIOPIAN CONDITION[1]

by

Abraham Tadesse

SUMMARY

Termites belong to the order Ispotera, widely separated from the Hymenoptera which contains the only other true social insects. Some can build very large size, complex in structure and long lasting nests. In some species the physogastric queen can produce millions of individuals.

Up to 2200 termite species have been described, the majority being found within the tropics. In the Ethiopian Region, 570 species in 89 genera have been recognized. Within their geographical boundaries termites are a threat to structural timbers, manufactured goods of wood, plantations of trees and a number of crops. In Ethiopia, the majority of termite damage reports come from Wellega, Illubabor, Sidamo, Gemo Goffa, Shewa, Keffa and Harargae regions.

Biological, chemical, and cultural methods have been reported to control termites; however, chemical method is the most effective. Mound poisoning with 10g aldrin 40% W.P in 9 l of water, broadcasting aldrin as dust or W.P formulations and working into the soil or application together with fertilizers, into planting hole or furrow treatments at a rate of 250g a.i aldrin/ha, seed dressing with 25-50g a.i/10kg seed, have been recommended. Potting soil treatment(50g a.i/m^3) with aldrin followed by correct transplanting of seedlings are reported to be important in forest seedlings and plantations while stocking rate management is recommended for termite control in rangeland.

Detailed survey works, studies on the biology of termites, development of alternative control methods etc. are some of the suggestions made for future research on termite problems.

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INTRODUCTION

Termites used to be called termes. According to weidner(1955), Linnaeus originally gave the name termes to the deathwatch beetle and a true termite on the basis of the tapping sound they produce in wood and the tapping of the deathwatch is often held in folklore to signify the approach of death within the household. Hence the name termes, from the Greek word TEN & meaning' the end' (Howse, 1970).

Much to the distress of entomologists, 'white ants' is, in many languages, the common name for termites. Itiis quite true that in their habits termites show more similarities to ants than to any other insects, but in other features they have great affinities with cockroaches, and it has even been suggested that they should be placed in the same order as cockroaches(Howse, 1970). They are, however, placed in a separate order of their own, the Isoptera, widely separated from the Hymenoptera which contains the only other true social insects: the bees, wasps and ants.

There are a number of easily recognizable differences between ants and termites. The color of ants is generally much darker as a result of their much thicker and harder cuticle. Unlike termites, ants have a very slender waist, and may carry a sting at the end of the abdomen(Howse, 1970). Ants have elbowed antennae, hind-and fore-wings are different in size and are held some what raised above the abdomen; while in termites wings are equal in size(hence 'Isoptera')which are held flat on the abdomen. A very fundamental difference between ants and termites lies in their development. Like in cockroaches, young termites hatch from the eggs as active, six-legged creatures and not as helpless grubs (as in other social insects) that have to be fed by adult insects through out the development period. Young termites at quite an early age seek out food for the community, and tend both the very young and their parents.(Harris, 1969 and Howse, 1970).

Like ants, bees and wasps, termites are social insects living in closely knit communities. The behavior of the individuals is coordinaed, so that cooperative activities like foraging and nest building are possible. This is helped by a certain degree of division of labour: different castes of individuals are present, each specialized for particular funtions. In termite societies these are are workers, soldiers, and reproductive forms of various kinds (Howse, 1970).

According to Howse(1970) the nest of termites includes many remarkable, intricate and complex structures that are without parallel any where in the animal kingdom. Lee and Wood (1971) indicated that the mounds range in size from small domed or conical structures only a few cm, in height and diameter to the colossal mounds built by some species of African Macrotermitinae which reach nine meters or more in height and 20-30m. in diameter at the base. Harris (1955) illustrated a mound of Macrotermes species of approximately this height in Ethiopia. Mounds can exist for great lengths of time. The record for longevity appears to be held by a mound in southern Rhodesia in which was an iron-age burial mound found to be about 700 years old (Watson, 1967). Many other termites build subterranean nests (Schmutterer, 1969) and from there they tunnel through the soil to roots of plants, poles, and other wooden materials.

A point of great interest is that termites are able to regulate their microclimate-the humidity, temperature, Co_2 and other factors suited to the needs of the individual species. It is this ability which contributes largely to their success in surviving in the intense competition of the tropics besides other insects which appear so much more aggressive and strong (Harris, 1961; Lee and Wood, 1971).

Colonies numbering millions of individuals have been reported for Macrotermes darwiniensis (Howse, 1970). Termite colonies, however large generally have only one parent couple: the king and queen, which are the founders of the colony. In species which develop very large colonies the queen tends to have a very large abdomen (physogastry as it is called in the entomological world), an adaptation for the continous production of large numbers of eggs. Physogastry is not marked in termites that live in wood, where it would obviously be disadvantageous since the colony is not static in position and has to move when the wood is eaten out. Physogastry is most marked in the mound building termites, where the king and queen are confined in a thick-walled 'queen cell' in the heart of the nest. The queen of M.natalensis has been known to increase her length from 35 mm to 140 mm as a result of hypertrophy of the abdomen, increasing her weight 125 times in the process(Bouillon, 1958).

There is a general correlation between evolutionary complexity and fecundity (Lee & Wood, 1971). According to Grasse(1949) the relatively primitive Kalotermitidae and Termopsinae lay 200-300 eggs per year, Rhinotermitidae lay some thousands of eggs per year and Termitidae lay up to several millions per year (Cubitermes exiguus lays 185 per day; M.bellicosus lays 40,000 eggs per day; Bouillon, 1970).

According to Hegh (1972) the queen of Odontotermes badius lays eggs at the rate of 4000 a day, which would result in 1,460,000 in a year and the queen of M.natalensis can produce 36,000 eggs in a day which amounts to one every seconds (on average) or 13,000,000 in a year. But nothing is known of the age to which a queen normally lives (Howse, 1970).

As far as the distribution of termites goes, various workers have reported that the great majority of termites live in tropical and sub-tropical regions, although they extend into the temperate zone to about 45° N & S latitudes other than on high mountains where it is too cold and in deserts where there is no food (Harris,1969) or 48° N & S latitudes (Emerson, 1955). Between these latitudes lie about two thirds of the Earth's land surface (Kranz, et.al., 1977; Lee & Wood, 1971). According to Harris (1961) both the number of species and individual termites present fall rapidly outside the tropics, or where the elevation of the land leads to low minimum temperatures.

Between 1500 to 2000(Krishna, 1969), species of termites have been described the majority being found within the tropics (Schmutterer, 1969 and Lee ' Wood, 1971). The greatest number of species is in the Ethiopian Region where Bouillon (1970) recognized 570 species in 89 genera.

The above number of termite species belongs to six families (Table 1). The first five families are known collectively as the lower termites and the sixth family, termitidae, which includes approximately 75% of the known species, as the higher termites (Lee & wood, 1971 and Howse, 1970) because of their greater specializations for a social life (Howse, 1970), The higher termite do not depend on symbiotic protozoa and have solved the problem of cellulose conversion in a variety of ways. For example, some extract nutrients from humus-rich earth which they eat in large quantities and which is then used for building nests of great complexity. Others feed on wood already infested with moulds and wood-rotting fungus and digest this with the aid of bacteria(Harris, 1969).

Economic Importance

Termites constitute one of the most important groups of destructive arthropods in the tropical and subtropical regions of the world.

Within their geographical boundaries, termites are a threat to structural timbers, manufactured goods of wood, plantations of trees and a number of crops. Harris(1954) stated that the farmer in the tropics unless living at an altitude sufficient to produce a temperate climate, has to compete with termites for the timber work of his home and farm buildings, as well as for his fences and such parts of his implements as may be made of wood, and upon all of which his success depends. The indirect effects of termites on crops, due to the influence of mound building termites on soil fertility has been discussed by some researchers to be probably greater than that caused by direct destruction of stands. They affect cultivated land both because of the physical and chemical properties of their soil and by reason of their topography (pearson,1958), although some termite species perform a valuable function in increasing the aeration, drainage and mineral content of the soil (Howse, 1970).

During their long history the feeding habits of different species of termites have developed along many lines, thereby allowing them to take advantage of the many and varied sources of food available (Harris, 1969). Termites feed not only on cellulosic materials derived from plants, mainly wood, but also on stalks and leaves of herbaceous plants. They chew fabrics, plastics and the softer metals such as lead and aluminium (although they do not attempt to digest them) (Harris, 1969). It is said that our knowledge of the history of South America has been severely impoverished by termites, which have eaten most of the books more than a century old, Subterranean termites have been knon to make tubular galleries upto the second story of a house, where they attacked a box of candles. They have also been admired for a habit of eating the corks of stored wine bottles. In 1820 Napoleon's ship, Le Genois, had to be broken up because of the damage done by termites. According to Howse (1970) over $ 100,000,000 is spent annually in the U.S.A on the control of wood-eating termites, over $ one million is spent every year in repairing buildings in Hawaii that have been damaged by termites, and about $6 million in Australia.

In addition to their attack on buildings, termites attack all species of plants, cultivated or wild. But the amount of losses they cause depend on factors such as the species of termites involved, the species and growth stage of the plants attacked, season of the year, and other mangemental and environmental conditions under which the plants are grown. According to Harris (1969), trees and shrubs with their abundance of wood, offer facilities for the wood-boring Kalotermitidae that are not found in annual crops. In addition, crops with wide geographical distributions tend to have longer lists of termites.

Pearson (1958), Harris (1969) & Kranz, et.al. (1977) have indicated that temporary weakness in plants is likely to be exploited by one or more of the numerous termites present in most tropical countries. Such weakness is apparent after a variety of cultural operations, including transplanting, pruning and tapping, and in the natural course of maturity and senescence. One particular predisposing cause of termite attack on growing plants is drought, natural or physiological. Harris (1969) stated that in addition to old and sickly trees and shrubs, such herbaceous crops as maize sorghum sugercane, groundnuts, beans and chillies and the like are liable to attack particularly at a late season of ripening. Harris (1961) found in Nigeria that M. bellicosun and M. subhyalinus attack rice as the plant ripens and feeds on the fallen seed heads resulting in losses of from 15-20% of crop on observation plots. He further indicated that maize in Rhodesia is subject to attack more in drier areas and poor soils.

Generally, the damage by termites is greater in exotic plants, rainfed crops than irrigated crops, in dry periods than in periods of regular rainfall, plants under stress than healthy and vigorous ones, in lowland areas than highlands and savanna regions than forest regions (Hickin, 1971 & wood, 1986).

In the tropics and subtropics most of the common agricultural crops suffer a certain amount of damage by termites (Table 2). In many cases this damage passes unrecognized, or is so usual that it is ignored. The amount of crop which must be lost before the farmer begins to worry depends largely on the level of agricultural development in a particular area. Harris (1969) reported that loss of grazing due to harvester termite attack, for example, is of more immediate concern to South African or Australian farmers with fenced pastures than to the nomadic pasturalists of Afghanistan or Turkmenia. Reduced yields of sugarcane are more likely to be noticed on large estates than peasant farmers producing small amounts of cane for village jaggery mills. Moreover, termite attack on perennial crops is generally a matter of more immediate concern because the loss of a single tea bush, cacao tree or coconut palm represents the waste of considerable labour in tending it to maturity (Harris, 1969).

Termite Problems in Ethiopia

As a tropical country, Ethiopia suffers much from these notorious pests. The majority of reports of termite damage come from Wollega, Illubabor, Sidamo, Gamo Goffa, Shewa, Keffa and Hararghe where they cause damage to field crops, forage grasses, young and matured trees and all kinds of wooden buildings (Wood, 1986).

The problem is particularly prevalent in Western Ethiopia where it has been well known for many years and has received wide publicity. The problem has become so acute in this region that some farmers have been forced to abandon their land and move to less affected areas. The severity of the problem in Menesibu (Mendi) and Jarso reached a serious level; as a result a mound poisoning campaign was undertaken in 1983 by the MOA in collaboration with the Ethiopian Peasant Association and attempt was made to poison all visible mounds using aldrin in cultivated fields and rangeland. During the campaign 635,908 mounds were treated with 12078 kg of aldrin 40% WP, 202,638 man-days of labour and costed Birr 163,437. As a result of the campaign a certain degree of sucess was reported (Wood, 1986).

The issue of termite problem was repeatedly raised in several entomological conferences and it was decided that the problem should be considered at a national level. To this end, a consultant from the Tropical Development and Research Institute, London, was requested through the MOA in order to asses termite damage to crops, foresting trees and rangeland, particularly in Western Ethiopia.

As a result Dr.T.G wood with the assistance of the MOA personnel surveyed the Western, Southern and Eastern regions of the country. According to the report of this survey work, maize, tef, groundnut, pepper, pasture and Eucalyptus plants in Wellega, Illubabor, Keffa, Sidamo, Gamo-Goffa, Shewa and Hararghae were significantly damaged by the pest(Table 3).

The damage to maize is more serious when termite attack is severe enough to cause lodging or when the attack occurs after the crop is already lodged. Wood (1986) reported that in some localities in Sidamo and Gamo Goffa farmers had ceased to grow improved varieties of maize and had reverted to local varieties which yielded less, but sustained lodging. In Wollega claims of 30-40% lodging and great damage to maize seedlings have been substantiated. Damage to tef was claimed to be upto 20% in Sidamo and Gamo Goffa and upto 100% in Wollega Peasant Farms.

The heavy losses observed in the forestry plantations were reported to be due lack of prior treatment of the seedling bed and careful transplanting. During the course of discussion with the local MOA representative and visits to forest nurseries it was found that there was a viable use of aldrin to protect nursery seedlings and that no where was the correct transplanting technique being adopted. Moreover, after transplanting forestry tree seedlings can suffer severely from moisture stress, the roots begin to dryout and termites can cause losses(Wood, 1986).

Significant damage to rangeland appears to be mainly in the Western part of the country and the problem seems to be aggravated by over grazing by livestock. This conclusion is suggested by observation on an area of rangeland near Mendi, IAR trial site. In part of this area various forage grasses had been planted; live-stock had been keptout on the order of research workers and there was complete cover of grass. On the adjacent area where grazing had been permitted, the grass had been grazed to ground level and many areas were bare. This idea was supported by the consulting entomologist during his visit to the region.

According to the report of the consulting entomologist, although there was some evidence of significant losses in some of the fields visited, losses due to termites were exaggerated by farmers in some localities. The problem, according to the report, is that it is difficult to differentiate between the significance of termites feeding on dead plants or crop residues and termites feeding on living plants resulting in yield losses. A common concept was that if termites were present then they must be causing damage, particularly if mounds were obvious.

Lists of termite species collected by the consultant during his visit to the various regions of Ethiopia are given in Table 4. A total of 25-30 species of termites, were collected and most of these were found to be harmless, feeding on dead plant tissues, dung or soil. Species with deep subterranean nests and with the ability to survive on living crops and crop residues can cause serious losses. Such species recorded from the regions visited were Macrotermes, Microtermes, Ancistrotermes, Odontotermes and Pseudacanthotermes.

CONTROL MEASURES

1. BIOLOGICAL METHODS

Naturally there are very many animals which prey on ter termites. Some attack termites in their mounds, some feed on foraging termites, and very many make a banquet of flying termites. Such predators include predatory ants, *Dorylus dentifrons*, which can break open termite mounds deep into the queen cell; ant-eaters of South America and their counterparts in the Ethiopian zoogeographical region; the pangolins[1], and ant-bears and the spiny ant-bears of Australia. These are all equipped with powerful fossorial front legs and long sticky tongues which will whip up hundreds of termites at a time. Chimpanzees occasionally feed on termites and a point of great interest is that they use twigs as a tool to collect the insects. The twigs are put into holes prepared for emergence of the winged forms and then withdrawn with soldiers clinging to them. Birds are important predators of termite swarms. Man himself is also a predator on termites (Howse, 1970).

Biological methods of termite control have not proved to be possible to date (Harris, 1969). Despite certain claims for the prospects of biological control by controlling their symbionts (Termitomyces on the fungus combs of Macrotermitinae), the use of juvenile hormones, poison baits or parasitic nematodes, prospects for biological control are purely experimental at present. The development of their potential can only be carried out effectively in well-equipped laboratories and effective control will depend on the use of persistent insecticides for some years (Wood, 1986). In various parts of African and Asia the persistent organochlorine insecticides have been shown to be effective. However, the human health and environmental hazards of these compounds are well documented and therefore their use should be made in restricted and supervised termite control.

1, The pangozin, or scaley Ant-eater (*Manis temmincki*), an African edentate mammal.

2. Chemical Methods

2.1. Mound Poisoning

In some parts of Ethiopia mechanical destruction of mounds and queen removal are common practices in fighting against termites. But they were not successful because mound destruction in itself does not necessarily destroy the termite colony (Harris, 1961). Moreover, mound destruction will not prevent termite damage to crops because many species of termites do not build mounds. Likewise, queen removal does not guarantee the death of the community unless ants and other enemies gain access to the nest through the breaches made in its outer defences, or insecticides are used further to reduce the population or to poison the fungus combs and induce starvation, there is always the possibility that the colony will produce substitute reporductives. After a period of quiescence, during which the termite nest is recovering from loss in egg production, the trouble would then start all over again (Harries, 1961).

Destruction of termite mounds should only be done if they obstruct cultivation or take up land for other purposes. the mechnical treatment should be supplemented with insecticides. The chlorinated hydrocarbon insecticides, aldrin, dieldrin, chlordane and the like in the form of water missible emulsions proved effective for nest destruction(Harris, 1971; sands, 1962; wood, 1986). The recommended technique is (Fig.1) using a screw auger three to five holes, depending on the size of the mound, are made in the side of the mound from about two-third height down into the base of the hive. A plastic hose is inserted into the hole to reach the centre of the nest. Using a watering can 10 g. aldrin 40% W.P in nine litres of water is poured down each hole and the holes closed with soil (Wood, 1986).

2.2. General application of insecticides to soils

8 Termites in the topsoil can also be controlled by broadcasting a dust or wettable powder formulation and working into the soil(sands, 1962) 10 to 20 cm. deep about two weeks

before sowing (Bohlen, 1973) or 5 to 10cm. deep before sowing (I.A.R., 1978). Since aldrin is stable in alkaline materials application together with fertilizer was also found to be effective (Schmutterer, 1969). Application of aldrin together with fertilizer was found to be equally effective to seed dressing on tef at Bako Research centre. However, it has been suggested (Sands, 1962) that in view of the importance of termites in facilitating aeration and water penetration in tropical savannah soils and of the likelihood of quite long persistence of insecticides, the large-scale use of general applications of these insecticides to soils should be approached with caution until more is known of their effects on the termite populations.

2.3. Planting hole and furrow treatment

Planting hole and furrow treatments are effective (Lee & wood, 1971) and economical as compared with the general application of insecticides to soils, since the quantities of insecticides used are greatly reduced (Sands, 1962). Planting hole and furrow treatments at a rate of 250 gram a.i aldrin/ha was reported to be effective (Wood, 1986). Bigger(1966) found that aldrin worked into the soil of the planting ridge at a rate of 0.5kg a.i/ha increased maize yield by 200 to 400 kg/ha in Tanzania.

2.4. Seed dressing

Seed dressings offer the best and most economical method for reducing losses (Kranz, et.al., 1977; wood, 1986). However, it is reported to be less effective than planting hole or furrow treatments. The recommended rate is 25 to 50 gram a.i with 10kg seed (I.A.R., 1978; wood, 1986). The seeds must be mixed well until the chemical sticks to the seeds.

Seed dressing with aldrin gave relatively good results in maize and tef at Bako and Didessa research sites. Moreover, dipping seedlings of pepper, with or without the intact soil, in aldrin solution before transplanting was found to be effective against termite damage both at Didessa and Bako. The recommended rate was 200 gram a.i aldrin in 10 litres of water for 600-9600 seedlings of pepper.

Control in forest nurseries and plantations

1. Soil used for seedling bed preparation or potting soil is mixed with aldrin dust at a rate of 50 gram a.i/m^3 soil. If 40% dust is to be used it is advisable to dilute it to 10% with dry, finely seived soil or sand (Wood, 1986).

2. If the above method was not applied, the bed can be treated with a sprayer or watering can at a rate of 10 gram a.i in 5ml. water/m^2 soil.

3. Correct transplanting in the field the technique which has proved to be successful is to retain a collar of plastic (about 4cm.) around the top to keep the treated soil in place and to plant so that 2cm of treated soil is above ground level(Fig.2). The base of the plant should not be covered by untreated soil during transplanting or by erosion.

4. Treatment of field established trees-if it is important to save trees irrespective of cost, several holes, 10-15cm. deep, can be made close to the base of each tree and drench with one litre of 0.5% aldrin (Wood, 1986). If the major damage to established seedlings is from mound building macrotermes mound poisoning can be effective.

Control in Rangeland

It is neither feasible nor economical to attempt control measures in rangeland. However, since it has been observed that grass eating termites are often numerous particularly in grass lands over grazed by stock, it appears that prevention is largely a question of stock management.

3. Cultural Methods

As in the case of most other crop pests, cultural practices that result in vigorous crop growth contribute much to the control of termites. Kranz, e.al(1977) reported that termite damage is pronounced on plants which are stressed or weakened and dried. It therefore, follows that one of the best method of averting losses due to termites is to maintain the young plants at their optimum growth rate as far as this is possible. Attack by termites on cotton have been countered by close spacing on the seedlings(Pearson, 1958), following (Crowther & Barlow, 1943), and by growing different varieties(Harris, 1954), Pearson (1958) reported that termites seem to be most active in land that has been cultivated without rest. According to Macgregor (1950) in Somalia damage to crops is not serious if the soil is well cultivated, and in general cultivation would appear to be effective mainly by destroying subterranean gallery-systems. It has also been reported by Lee & Wood (1971) that large populations of some termite species occur only on land of poor quality. Where the level of nutrient exceeded 280kg/ha there was no termite mounds. Harris (1954) found that in East African gardens the risk of termite damage to growing crops could be markedly reduced if the humus content of the soil was maintained at a high level by the addition of well rotted compost. The emphasis here would be on well composted material as the addition of row plant debris would attract the species of termite likely to attack growing plants.

As cellulose feeding insects, termites prefer older plants (Harris, 1961 & 1969; schmutterer, 1969; Kranz, e.al., 1977) and delay in harvesting crops like maize give ample oportunity for subterranean termites to cause damage (Lee & Wood, 1971). Stubble removal, use of lodging resistant varieties, indigenous crops and frequent irrigation practices were reported to be beneficial (Wood, 1986).

In tree crops pruning of dead branches, cutting out heavily infested stems, and protection of plantation from injury by fires, with a view to eliminating a major predisposing cause of termite attack are some of the recommendations given by Harris (1969).

FUTURE NEEDS

Termite problem is becoming more important now than it was in the past and it will continue to be important in the future unless more effective, economical, safe and easily applicable methods of control are workedout.

Although the problem is wide spread and serious in most parts of the country, its significance varies with place and time. Moreover, among the numerous termite species described to date only a few are reported to be of economic importance. However, so little is known about the species present locally that we do not know whether their presence is harmful or beneficial. Before designing any method for the control measure knowledge about the pest species, economic significance, pest distribution, pest status etc. of any crop pest of primary importance. Thus detailed survey of termites in place and time, identification of termite species that cause crop losses and their abundance, loss assessment studies and relation of losses to economic threshold etc. are some of the prerequisites to the control attempt.

Furthermore, effective control of injurious insects usually depends on knowledge of the life history and habits of each one individually, and in general, this information on termites is lacking.

The growth of crops on termite mounds, or on areas where mounds have been leveled, depends on the properties of the crop, the mounds and the soils. Doop (1938) reported that sisal, for example, grew better on the mounds than the intervening flat land and that leveling of the mounds increased productivity on the intervening area. On the other hand Nye (1955) indicated that annual crops such as maize grew relatively poorly on leveled or colapsed mounds of Macrotermes bellicosus in Nigeria. It appears that certain instances of soil toxicity could possibily be related to the accumulation in the soil of inhibitory substances from the nest system of termites. The differences in susceptibility or tolerance to termite damage have been observed during visits to various localities and crop fields in the Western part of the country. It, therefore, appears that evaluation of crops and varieties for their tolerance to termite damage can be one of the alternative approaches to the problem of termite control.

As it has been reported by various researchers and cited in this review the control of termites can be effected by employing various cultural practices that lead to sound crop hasbundary. However, the effects of these cultural methods on termite infestation have not been tested locally and require due attention. Seed dressing is the only method reported to be cheaper & safe as compared to other methods of insecticide application againest termites. But it gives no complete protection for seedlings and is especially advisable only on newly opened land where it can be used successfully on tef, barley, maize and cotton (I.A.R;)1978). Moreover, the persistent organochlorine insecticides recommended for termite control are hazardous to man, animals and the environment. Therefore, it necessitates that application methods that can give better protection to all crop plants liable to termite attack be searched for together with screening of more effective, ecomomical and less hazardious chemicals.

Table 1. Termite families, number of genera & species known to cause damage to economic plant species.

FAMILY	GENERA	NO. OF SPECIES
1. Mastotermitidae+		
2. Kalotermitidae (Dry wood Termites)	Kalotermes Neotermes Postelectrotermes Rugitermes Paraneotermes Glyptotermes Epicalotermes Incisitermes Bifiditermes Cryptotermes	29
3. Hodotermitidae (Harvester termites)		4
4. Termopside (Damp wood termites)		1
5. Rhinotermitidae (Subterranean or moist wood termites)	Heterotermes Reticulitermes Coptotermes Schedorhinotermes	31
6. Termitidae(mound building termites)	Anoplotermes(Soldierless) Drepanotermes Amitermes Globitermes Eremotermes Microcerotermes	28
Termitinae	Termes Procapritermes Capritermes	6
*Macrotermitinae (restricted to Asia and Africa)	Pseudacanthotermes Allodontermes Macrotermes Odontotermes Ancistrotermes Microtermes	47
Nasutitermitinae		29

After Harris (1969)

+ Mastotermitidae has no living representative outside Australia though fossile records show that it has been widely distributed in earlier times.

Table 2. The significance of Termites in some parts of the world

CROPS	% YIELD LOSS OR PLANT MORTALITY	COUNTRY	NO. OF SPECIES RECORDED
Cacao	20	W.Af., Ind. & Ceyl	18
Date palm	22	S. America	26
Cocount	50	E. Africa	28
Sugarcane	33-35	Indi & Paks. C&S.Amer.	58
Tea	15-100	India	19
Vine	80		2
Cotton	31-80	Ind. Africa	17
Coffee			6
Fruit trees			26
Rubber			6
Groundnut	10		17
Rice	15-100	Africa	9
Wheat	25-100	Asia, Africa	6
Maize	22-27	Ind., Africa	
Cassava	40	Africa	18
Yam	70	Africa	
Tobacco			
Pasture	20-60	Asia-Africa	
Plantations			
Eucalyptus			18
Saligna	100	Africa	
E. robusta	50	Africa	
Other spp.	60-80	Africa	
Forest trees			44

(Modified after Harris, 1969)

W.Af = West Africa
Ind. = India
Ceyl. = Ceylon
Paks. = Pakistan
Amer. = America

Table 3. The significance of Termites in some Regions of Ethiopia

	ADMINISTRATIVE REGIONS				REMARK
	SDM. & G.GOFA	WOLLO. & ILLUB.	SHOA & KEF.	HARARGE	
Maize	25-50%	30-50%	***	**	
Tef	0-20%	0-100%	***		
Fingermillet		25-50%			
Peanut	**	20%	**	***	
Wheat			**		
Pepper		25%	**		
Cotton				***	
Others	*	*	*	*	
Nurseries & Plantations					
Eucalyptus	***	***	***	***	Seedlings in beds and Seedling
Casuarina	**	**	**	**	Transplanted in plastic tubes
Grevillia	**	**	**	**	
Rangeland & grazing		***			

(Modified from Wood(1986)

*** Significant damage
** Damage present
* Infestation present
% Percent yield loss of plant mortality.

Table 4. Summary of Termite species collected from some Regions of Ethiopia 1

(After T.G Wood, 1986)

Family: Termitidae	No. of Spp.	
Macrotermitinae		
Macrotermes subhyalinus (Rambur)		
Macrotermes	2	*
Pseudacanthotermes militaris (Hagen)		*
Odonotermes	5-6	
Ancistrotermes	1-2	* ▲
Microtermes	4-6	* ▲
Synacanthotermes		▲
Pseudacanthotermes	1-2	
Apicotermitinane		
Soldierless genera	4-5	
Termitinae		
Amitermes	1-2	
Microcerotermes	2	
Angulitermes	1	
Masutitermitiane		
Trinervitermes	2	
Afrosubulitermes	1	▲

1) Wollega, Illubabor, Keffa, Sidamo, Gamo Goffa, Shoa, Harargae.

* More damaging in administrative regions visited

▲ Species that have not been recorded previously from Ethiopia.

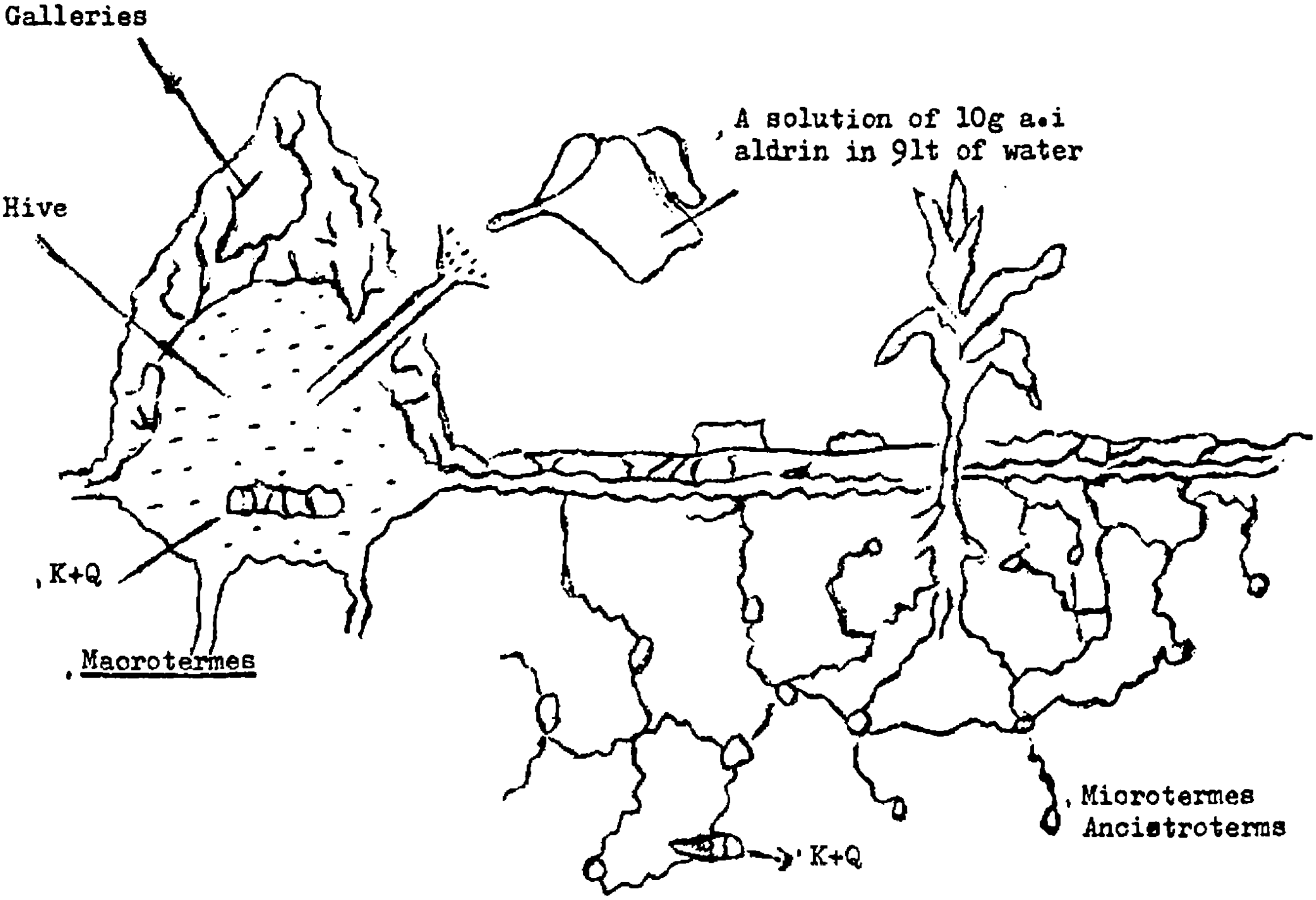

Fig.1 Diagramitic representation of nesting system of mound building and subterranean termites and the application of of mound poisoning technique.

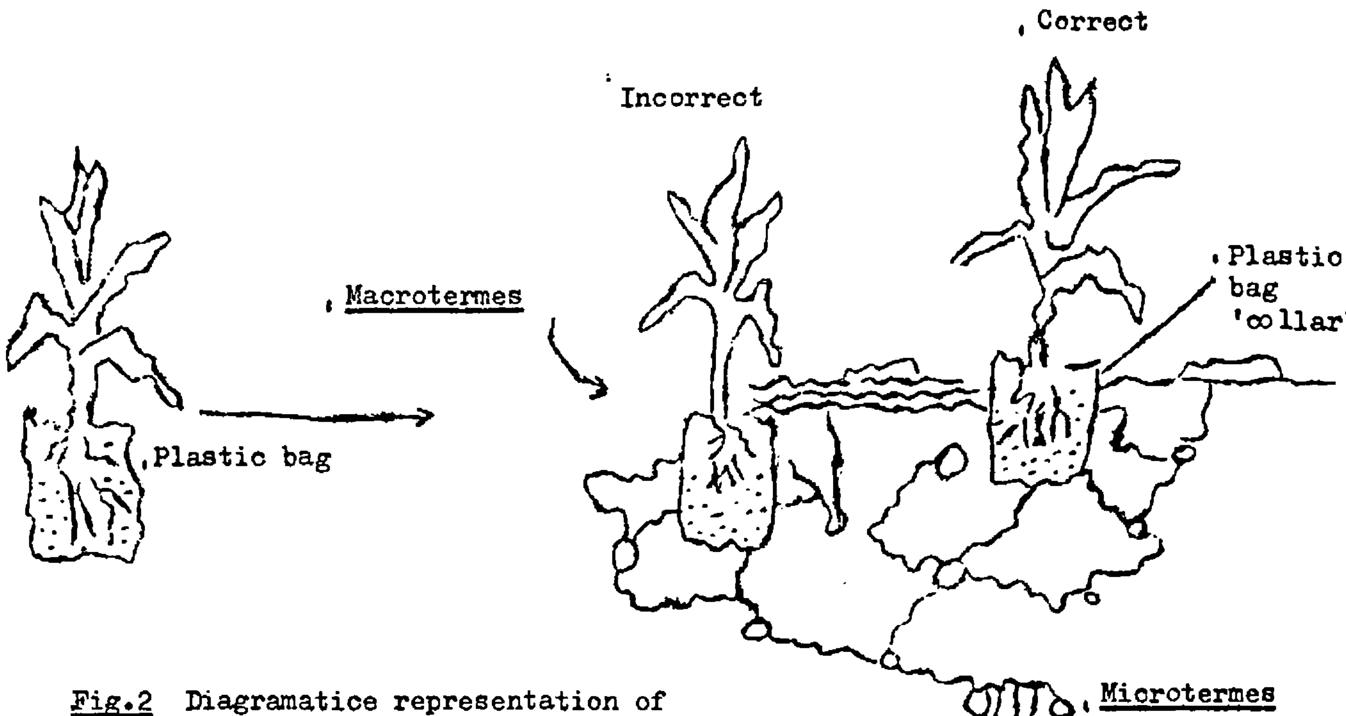

Fig.2 Diagramatice representation of transplanting techniques(correct and incorrect) of seedlings in plastic tubes.

(After Wood, 1986)

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DISCUSSION

Ato Ababu Demessie

Broadcasting for control of termites seemed very expensive. Did you consider the price of chemical when you recommend this?

Ato Abraham Tadesse

Not only the cost, but also it may affect beneficial termites. Therefore for both reasons, that is for the cost and environmental hazards, the general application to the soil is not recommended unless we are forced to do so and it must be done under close supervision.

Ato Sebsibie Alebe

Ato Abraham, you mentioned that termite damage an overgrazed land is more than fenced field. To the contrary the termites are better feed on fenced land as there is no competetion with the animals for food.

Ato Abraham Tadesse

Termites prefer week and dried stalks of plants rather than health plants.

Ato Tassew Mekuria

1. The severity of termite damage was observed to be higher in larger plantation area compared to the smaller planted areas.
2. Since Aldrin is already banned, what alternative products do we have for future use?

Ato Abraham Tadesse

This is due to better observation in a larger planted area rather than to smaller one not to severity of damage.

Research will continue to look for alternative product.

Comment

Dr. Hailu Kassa

At the moment there is no pesticide registration scheme. Hence the organochlorine are not actually banned. But as soon as the registration is passed these chemicals will be banned. One of the staff member of the MOA is completing his PHD and hopefully. We will get a general overview of the problem in Ethiopia and alternative chemicals.

LOSS ASSESSEMENT STUDY FOR PEA APHID (ACYRTHOSIPHON PISUM) (HARRIS) INFESTATION ON FIELD PEA

by

Tadesse Gebremedhin

IAR, Box 2003, A.A.

INTRODUCTION

Field pea (*Pisum sativum*) is one of the important pulse crops grown in the highlands and medium altitudes of Ethiopia. It provides protein supplement in the diet of the people, particularly in the rural and urban areas of the highlands in the country. However, production per unit area is very low (about 0.83 ton/ha) (1). This low productivity of the crop is due to many production limiting factors among which insect pests are one of the major constraints.

Some eight years ago the predominant insect pest on field pea was *Heliocoverpa armigera* (3), but in the past few years the most important pest of this crop was and still is the pea aphid (*A. pisum*) (2). Therefore, it was deemed necessary to conduct a loss assessment study to evaluate the impact of infestation by this insect pest on the yield of field pea and also to select effective insecticides for its control.

Materials and Methods

The experiment was conducted between 1985 and 1987 at the Holetta Agric. Research Center and at Denbi research site near Debre-Zeit during the main seasons. The design was randomized complete block with four replications and plot size of 5 by 3.2 m. The cultivars used were SC 436 and Mohandefer at the rates of 200 and 180 kg/ha for Holetta and Denbi respectively. Urea at 40 kg and DAP at 100 kg/ha were applied only at Holetta. Sowing was done on 30 cm. row spacing and planting dates were June 24 to 27 for Holetta and June 28 to July 12 for Denbi.

The insecticide treatments were dimethoate 40% EC, primicarb 50% WP, oxydemeton-methyl 25% EC, primiphos-methyl 50% EC, heptenophos 25% EC, chlorpyriphos 48% EC, triazophos 40% EC, thiometon 25% EC and untreated check applied at the rates of 400, 500, 250, 250, 250, 960, 250, 175 g.a.i./ha respectively with knapsack sprayers.

Pre-spray and post-spray aphid counts were taken on ten plants per plot picked at random. Spray application was made if an average infestation exceeded 20 percent. Pods/plant and seeds/pod were recorded. Finally, yield was taken and loss calculated by comparing treated and untreated plots.

Results and Discussion

A. Holetta

The loss assessment experiment at Holetta was carried out for two seasons, 1985 and 1986. Sufficient aphid infestation was recorded in both seasons that warranted insecticide application. For each spray application, there were one pre-spray and one post-spray aphid counts made. One to two spray applications were made in one season.

Post-spray aphid counts showed significant differences among treatments. There was also statistical yield difference between treatments in both years (Table 1). Better yields were obtained from plots treated with pirimiphos-methyl, pirimicarb, oxydemeton-methyl and chlorpyriphos; dimethoate was weak in its effect on aphids at Holetta. The average yield loss for both years at this site was 18.8 percent. There was no significant difference in the number of pods per plant and seeds per pod.

B. Denbi

The trial at Denbi was conducted in the 1986 and 1987 seasons. Very high aphid infestation was recorded, particularly in the 1987 season because of the erratic rainfall and drier periods that occurred during that season. The number of aphid counts and spray applications were the same as that of Holetta.

Post-spray aphid counts indicated significant differences among treatments with all insecticide treatments being different from the check, but dimethoate treatment gave slightly higher aphid count (Table 2). There was no appreciable difference in the number of pods per plant and number of seeds per pod. Yields were statistically different at the 5% level of significance. All insecticide treatments were different from the untreated check and better yields were obtained from heptenophos, chlorpyriphos, pirimiphos-methyl and pirimicarb treated plots. The overall mean yield loss for both years at Denbi was 37 percent.

Conclusion

In conclusion, it is clear that pea aphid has caused an economic loss of yield in field pea both at Holetta and Denbi areas. Serious infestations that warrant the application of control measures have occurred, particularly in the 1987 season. Therefore, one of the effective insecticides indicated here can be used for the control of this pest if in general about 20 percent of the plants are found infested.

No adequate crop improvement has been made in field pea yet, as a result yields are very low. Hence, the overall management of the crop should be improved so that it would be possible to have a field pea crop worth protecting from devastating pests such as the pea aphid. Otherwise, it would be wasteful to spend more resources on a meagre crop.

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Table 1. Mean pre-spray and post-spray aphid counts per plant, yield and yield loss at Holetta - 1985 & 1986.

TREATMENTS	DOSAGE g.a.i/ha	PRE-SPRAY APHID COUNT	POST-SPRAY APHID COUNT	PODS/ PLANT	SEEDS/ POD	GRAIN YIELD KG/HA	% YIELD LOSS
Dimethoate 40% EC	400	8.9	10.1b	8.3	4.2	1126.0bc	
Pirimicarb 50% WP	500	11.9	1.9ab	8.5	4.5	1321.5a	
Oxydemeton-methyl 25%EC	250	12.2	1.6a	7.9	4.3	1380.0a	
Pirimiphos-methyl 50% EC	250	12.0	3.6ab	7.8	4.5	1431.0a	
Heptenophos 25% EC	250	10.8	4.5ab	7.7	4.2	1288.0ab	
Chlorpyriphos 48% EC	960	9.8	5.4ab	8.2	4.4	1312.0a	
Untreated check	-	12.5	19.2c	7.7	4.5	1063.0c	18.8
S.E.	±	0.48	2.36	0.12	0.05	50.29	

Table 2. Mean pre-spray and post-spray aphid counts per plant, yield and yield loss at Denbi - 1986 & 1987.

TREATMENTS	DOSAGE g.a.i/ha	PRE-SPRAY APHID COUNT	POST-SPRAY APHID COUNT	PODS/PLANT	SEEDS/POD	GRAIN YIELD KG/HA	% YIELD LOSS
Dimethoate 40% EC	400	43.3	10.0a	5.8	4.0	1268.9b	
Pirimicarb 50% WP	500	27.3	2.7a	6.2	3.5	1322.0b	
Pirimiphos-methyl 50% EC	250	47.8	7.3a	7.0	5.0	1508.5ab	
Heptenophos 25% EC	250	18.5	3.2a	8.1	3.7	1800.0a	
Triazophos 40% EC	250	60.8	3.0a	7.6	4.1	1210.0b	
Chlorpyriphos 48% EC	960	15.0	2.0a	6.5	3.6	1790.3a	
Thiometon 25% EC	175	35.4	1.8a	8.2	3.8	1130.0b	
Untreated check	-	47.9	26.6b	7.3	4.2	903.2c	37.0
S.E. ±		5.61	2.98	0.31	0.17	111.34	

DISCUSSION

Ato Bisrat Gebre-Kal

What was the impact of other pests in the yield since some products are selective and some are non selective?

Dr. Tadesse Gebre-Medhin

Since there was no any observable interference from other pests, there was no any impact from to cause an appreciable yield difference.

Dr. Assefa Gebre-Amlak

Why did you have a reduced aphid counts on untreated checks?

Dr. Tadesse Gebre-Medhin

There could be two reasons for the reduction of aphid counts in the untreated check in post-spray counts: (1) A small drift of the aphicides applied might have gone to the untreated plots. (2) The effect of natural enemies, especially predators might have been involved.

Ato Ababu Demessie

Why the yield is not parallel to the post-spray counts in some of the treatments?

Dr. Tadesse Gebre-Medhin

Yield doesnot always correspond to the reduction of aphid numbers. Some aphicides knock down the aphids very quickly compared to others so less damage is incurred; in other cases the damage to plants may have been already done though the heavy infestation is put under control. However, if the treated and untreated plots are compared, one can see the advantage of aphicide application in order to control the aphids and come up with statistically different yields.

Ato Kassahun Bekele

You have said that the action threshold used for applying the treatment was that when the samples show an infestation level of 20%. Does this mean that 20% of the sampled crop stand should show aphid infestation to receive the treatment disregarding the number of colonies observed on each plant.

Dr. Tadesse Gebremedhin

The threshold level considered was 20% of sample plants regardless of the number of aphid colonies. Infact, there was not free sample plant without any aphid in the plots; so infestation was readily available during the experimental seasons.

Ato Ferdu Azerefegne

If there is a prevalence of other insects, The African ballworm, what types of methods one has to use to make loss assessment?

Dr. Tadesse Gebremedhin

One can use blanket spray for the insect which appeared with the target insect and then continue the treatment for the target insect species, depending on the period of appearance of such non-target pests.

Ato Abraham Tadesse

1. Why do you think Heliothis is renamed to be Helicoverpa when the initial name is more familiar?
2. What was your basis for insecticide rates?

Dr. Tadesse Gebremedhin

1. Insect taxonomists revise scientific or biological names and in the process if they come across a name of an insect which they think is wrongly named or misplaced, they give it an appropriate scientific name. I think, this situation must have happened with regard to Heliothis.

2. Insecticide rates for the loss assessment study were taken from an earlier preliminary study that was carried out on the same pest.

Ato Teshome Lemma

The pre-spray aphid count under the different chemical treatments were very variable. Wouldn't that mean that the insecticides were not evaluated under the same infestation level?

Dr. Tadesse Gebremedhin

The infestation level in every plot or treatment does not have to be the same; What matters is that there should be adequate infestation in order to carry out the experiment.

Ato Adhowm Negasi

Pods/plant and seeds/pod are components for yield, but did not show any difference among the treatments. What could be the reason for the yield difference if the yield components did not show difference?

Dr. Tadesse Gebremedhin

As pointed out number of pods/plant and number of seeds/pod did not show any significant difference; however, though not measured or recorded the size of pods/plant and seeds/pod might have been bigger in the treated plots compared to the untreated plots because statistically significant yield differences have been recorded.

MANAGEMENT OF THE RUSSIAN WHEAT APHID (DIURAPHIS NOXIA MORDV.) OF BARLEY

by

Adugna Haile
Holetta Agri. Res. Center, P.O.Box 2003,
Addis Abeba, Ethiopia

ABSTRACT

Management of the Russian wheat aphid (Diuraphis noxia Mordv.) based on host preference, effect of fertilizer, sowing dates and screening of barley resistant varieties were studied for three seasons at Chaoha (Shewa). Among the host plants studied, Bromus pectinatus L., barley and wheat were the most preferred ones with 241.5, 227.4 and 156.3 aphids per tiller respectively. Lower aphid counts were recorded on tef 10.7, cultivated oat 7.7 and wild oat 28.7.

Fertilizer had no effect on the population of the aphid. Studies on the sowing dates showed that the population of the aphid was higher on early plantings while the rest of the sowing dates encountered no infestation. In screening of barley landraces, the population of the aphid varied widely among the enteries; the lowest and highest population per tiller was recorded on enteries PGRC/E 03250 and 00255 respectively.

INTRODUCTION

The Russian wheat aphid (Diuraphis noxia Mordv.) is a serious pest of barley and wheat in the Ethipian highlands. It was first recorded during the drought period of 1973/74 in some parts of Tigrai and Wello (Hadera pers. com). Its distribution includes major barley and wheat growing areas of the country, especially at altitudes above 2400m (1,2). It has been observed that population of D.noxius increases during the dry season (3).

Loss assessment with help of insecticides show that the pest causes 41-71% yield reduction (Adugna H. unpublished). Although it can be effectively controlled by some insecticides, it would be worth-while to find other methods that require minimum inputs for insecticides are not appropriate for small farmers because of their ever increasing price and undesirable effects on the environment.

Therefore, work on host preference, effect of fertilizer sowing dates and screening of resistant lines were conducted to find efficient and safe control method of this pest.

MATERIALS AND METHODS

Experiment 1: Host Preference

The laboratory and field studies on host preference were conducted from 1983 to 1985 at Holetta and Chacha.

The host plants tested included tef, barley, wheat, bromus, cultivated and wild oats.

In the laboratory the host plants were planted in pots using complete randomized design in three replication. After germination, the seedlings were thinned to 3 plants per pot for infestation. Three weeks after germination each tiller was infested with 3 aphids (approximately the same age) and covered with plastic cylinder. The top of the cylinder was covered with muslin cloth to avoid any aphid escape. Twenty four hrs after infestation, the presence of aphid was checked and plants without aphids absent were re-infested. Four weeks after infestation (when barley seedlings started to die), the aphid pregenies were counted and recorded. Under field conditions, the host plants were planted in an un replicated plots of 2 x 3m. Three aphid counts were taken at 20, 40 and 60 days after emergence from 20 plants selected at random.

Experiment 2: Effect of Fertilizer

This trial was conducted at Chacha from 1983 to 1985. The barley variety, Sheno local was planted at the rate of 100 kg/ha. The plot size was 1.2 m X 2.5m and the design used randomized complete block with three replications. The treatments used were urea, urea and diamonium phosphate (DAP), DAP and unfertilized check with N and P_2O_5 of 57, 57/57, 57 and zero respectively. The fertilizers were applied to the soil at sowing. Aphid counts were made 20, 40 and 60 days after emergence on 10 randomly selected plants.

Experiment 3: Effect of Sowing Dates

The trial site, barley cultivar used, seed rate and plot size used were the same as experiment 2. Split-plot design in four replications was used. The main-plot, and sub-plot constituted sowing dates and insecticide treatments respectively. There were 5 sowing dates at 15 day intervals starting May 11 in each season. Throughout the study period, dimethoate 40 L at 1 liter/ha (400 gm a.i/ha) was used. The data collected were aphid counts from 20 plants selected at random and yield per plot.

Experiment 4: Preliminary barley landrace screening for their resistance to D.noxia.

The trial was conducted at Chacha in 1984 and 1985 cropping seasons. In the study, 14 enteries that showed lower aphid counts during 1983 and 2 susceptible checks were used. These enteries were planted in plots of 1.2m X 2.5m using randomized complete block 3 design in three replications. The spacing between rows was 20 cm. Aphid counts were made at 25-30 and 45-50 days after emergence from 20 plants selected at random. However, in 1984 lack of rain in June was caused high aphid population build-up and a third count was taken 75-80 days afteremergence. Data on aphid counts were statistically analysed.

RESULTS AND DISCUSSION

1. Host Perferneoe

Aphid counts on the host plants are given in Table 1. In the laboratory study, barley had significantly higher number of aphids per tiller and followed by Bromus pectinatus and wheat respectively. Tef and oats (cultivated and wild) were least preferred with 9.85, 6.6, and 8.8 aphids per tiller respectively.

In the field studies B.pectinatus and barley were the most preferred host plants with 241.6 and 227.4 aphids per tiller respectively. Wheat was the second important host plant with 156.3 aphids per tiller. Field study shows that aphid populations on tef and oats were similar to the laboratory observations (Table 1).

At present, farmers around the study site show more tendency to produce oats than barley because of aphid population.

2. Effect of Fertilizer

Aphids counts on the fertilized and unfertilized plots are given in Table 2. There was no significant difference in aphid counts among the treatments (Table 2). However, DAP and DAP + Urea fertilized plots produced higher number of aphids per tiller respectively.

Table 1. Mean number of aphids (*D. Noxia*) on different host plants under laboratory and field conditions 1983 to 1985.

HOST PLANTS	NUMBER OF APHIDS PER TILLER						
	LABORATORY			FIELD			
	1983	1984	MEAN	1983	1984	1985	MEAN
Tef (*Eragrostis tef*)	12.7 c	7.0	9.85 d	16.0	8.0	8.0	10.7 c
Wheat (*Triticum spp*)	28.0 b	33.9	30.95 bc	303.0	57.0	103.3	156.3 b
Barley (*Hordeum Vulgare* L.)	56.7 a	39.4	40.1 a	528.0	74.0	79.7	227.4 a
Bromus pectinatus L.	37.7 b	40.3	39.0 ab	493.0	90.0	141.7	241.6 a
Cultivated oat (*Avena sativa* L.)	10.0 c	3.2	6.6 d	16.0	5.0	2.0	7.7 c
Wild oat (*Avena fatua* L.)	11.3 c	6.4	8.8 d	59.0	21.0	5.7	28.7 c

[a] means followed by the same letter do not differ significantly at the 5% level according to Duncan's multiple range test.

Table 2. Aphid population (D. noxia M.) on barley following fertilizer application 1983 to 1985.

TREATMENTS	N/P_2O_5 KG/HA	AVERAGE NUMBER OF APHID/TILLER			
		1983	1984	1985	MEAN
Diamonium phosphate (DAP)	0/57	25.1 a	108.0 a	35.8 a	56.8 a
Urea (N)	57/0	21.5 a	93.3 a	30.9 a	48.6 a
Diamonium phosphate+ Urea	57/57	25.3 a	122.7 a	25.6 a	57.9 a
Control	0	16.8 a	110.8 a	29.3 a	52.3 a

[a] Mean followed by the same letter are not different significantly at the 5% level according Duncan's multiple range test.

Effect of Sowing Dates

Aphid counts and yield of barley following different planting dates are presented in Table 3.

In 1983, aphid counts were taken only from the first sowing date. Sowing date II, III and IV germinated together with the last sowing date, due to shortage of rainfall from mid-May to the last week of June. There were no aphid infestation in all the plots of the above plantings. The mean aphid counts per tiller in the treated and untreated plots of the first sowing dates were 8.7 and 39.2 respectively.

During in 1984 cropping season again aphid counts were taken only from the first sowing date. The rest of the sowing dates (II, III, IV & V) germinated at the same time due to the reason as above. The mean aphid counts per tiller in the treated and untreated plots of sowing date I were 2.7 and 48 respectively.

In 1985, aphid counts were taken from sowing dates I and II. sowing II and IV germinated at the same time after the mid-June rainfall. No aphid counts were taken from the sowing dates III, IV and V due to the continous rain after mid-June that might have caused few or no aphid infestation. The highest aphid counts were recorded from the untreated plots of sowing dates of I and II with a mean of 42.3 and 23.0 aphids per tiller respectively. These results are similar to the previous study on D.noxia, where its population increases during the dry period and decreases during the rainy seasons (2).

Grain Yield

During the three seasons, lower yields were obtained from sowing date I untreated plots with a yield reduction of %. In 1985 season, lower yields were also obtained from sowing date II untreated plot. Insecticide treatment did not produce yield difference between the treated and untreated plots in sowing dates III, IV and V. This shows that with the shortage of rainfall the population of D.noxia increases and causes yield reduction.

Table 3. Mean aphid count/tiller on the effect of sowing date on Diuraphis noxia Mordv. at Chacha 1983 to 1985.

SOWING DATE	NUMBER OF APHID/TILLER					
	1983		1984		1985	
	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED
11/5	8.7	39.2	6.7	48.0	14.5	12.6
26/5	0	0	0	0	0	23.0
10/6	0	0	0	0	0	0
25/6	0	0	0	0	0	0
10/7	0	0	0	0	0	0

Table 4. Mean grain yield(Q/ha) on the effect of sowing date on D.noxia at Chacha.

SOWING DATE	GRAIN YIELD IN Q/HA					
	1983		1984		1985	
	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED
11/5	39.2	16.5	24.0	12.3	42.3	17.5
26/5	41.5	42.5	35.0	32.7	48.2	45.6
10/6	43.6	41.7	29.5	28.2	40.4	40.0
25/6	40.4	39.5	27.2	28.0	37.2	38.3
10/7	40.2	39.8	22.1	20.6	35.1	38.0

Varietal Resistance against D.noxia

All the enteries were infested by the aphid. However, the level of infestation varies widely, among the enteries PGRC/E 03250 and 03325 showed significantly lower aphid count followed by Maichew Coll #20 with a mean of 15.3, 17.8 and 25.9 respectively. Higher aphid counts were recorded on enteries PGRC/E 02746 and 00255 with a mean of 56.8 and 60.6 respectively. The infestation of the aphids on the rest of the enteries ranged from 27.1 to 31.1 aphid/tiller. In both years of observation the number of the aphids on PGRC/E 03250 and 03325 remained low. This may suggest that the pest was unable to multiply in these enteries. However, further testing of the entries both under laboratory & field conitions would be necessary.

Table 5. Mean number of aphids/tiller on 16 barley landraoes at Chacha.

BARLEY LANDRACES	NUMBER OF APHIDS/TILLER		
	1984	1985	MEAN
PGRC/E 03238	30.6	28.5	29.5
" 03250	15.6	15.0	15.3
" 03291	30.9	27.2	29.1
" 03325	18.1	17.5	17.8
" 03252	30.8	26.7	28.7
" 04387	29.9	24.8	27.3
" 03284	26.2	27.9	27.1
Atsbi Coll.#12	29.8	26.5	28.2
Holetta Coll.#13	31.6	25.0	28.3
" " 14	26.2	30.0	28.1
" " 20	29.8	25.2	27.5
Adigrate Coll.10	27.8	28.3	28.1
Maichew Coll. 16	32.6	29.5	31.1
" " 20	25.9	25.9	25.9
PGRC/E 02746	62.5	59.2	60.6
	31.3	29.9	
LSD 5%	16.4	16.7	4.40
1%	22.1	23.1	6.10
CV %	30.1	26.3	4.134

CONCLUSION

The Russian wheat aphid (Diuraphis noxia Mordv.) is an important pest of barley and wheat in the highlands of Ethiopia. It survives throughout the year because of its wide host plants. Among these, the important ones are Bromus pectinatus L. and wild oats. These host plants serve as a reservoir of the aphid throughout the year. One method of controlling this pest could be avoiding these host plants from the area. Besides, barley and wheat should not be considered for crop rotation one after another as both of them are hosts of the pest and would provide continuous food supply to the pest.

During the study it has been found that fertilizer has no effect on the population of D. noxia. However, at higher altitudes, where barley is planted in April and May, there is high infestation of the crop during late May and early June. To avoid crop damage by this pest, barley should not be planted during this time unless it is protected by insecticides. In screening of resistant enteries, the results showed that PGRC/E 03250 and 03325 gave lower aphid counts in both years. Research on this line has to continue as resistant varieties are the cheapest means of pest management.

DISCUSSION

Ato Fikre Eshete

As you all know there is a complexioity of pest in the field so, how do you determine the loss of one pest from the other?

Ato Adugna Haile

The loss of yield due to one pest and another can be determined:

(1) By blanket spray of one insecticide that evoids the un-wanted pest and leaves the target pest.

(2) The un-wanted pest can also uniform for all the treatments and the spray will only treat the target pest, so in this case you can find the loss due to the targeted pest.

Ato Ferdu Azerefegne

Does *D.noxia* have any significant importance in transmitting virus diseases?

Ato Adugna Haile

The symptom of *D.noxia* (Mordv.) on barley looks like Barley yellow Dwarf virus (BYDV). On this base a preliminary test was whether it is a virus or saliva toxicity. However, the test showed that it is not BYDV. The other test was done by spraying of insecticides to kill the aphids. After spray, the young leaves that out come showed yellow leaves. Had it been a virus the symptom should appeared as before the spray. Both testes showed that (atleast to day) that *D.noxia* does not transmit.virus. Studies in other parts of the world showed that it does not transmit a virus.

Ato Kassahun Bekele

It is very well known that aphids do debilitate the crop and affect the eventual yield. With this in mind, have you tried to assess the effect of the onset period of aphid infestation in relation the crop growth stage. This is to say effect of aphid infestation which occurs at early, mid and late growth stage.

Ato Adugna Haile

The Russian wheat aphid (D.noxia) affect the yield of barley at all stages provided that the rainfall is low and when the aphid infestation per tiller is over 30. However, sever yield loss occurs at early stage 30-60 days after germination.

Ato Kassahun Bekele

In what ways do aphids affect the crop yield. Is it by reducing thousand kernel weight, number of grains per spike-etc?

Ato Adugna Haile

Aphids cause yield loss by causing stunt growth. In some cases the plant fails to set grains and the number of seeds per head is reduced. It also affects the number of tillers. In general it affects both the number of grain per ears and 1000 seed weights.

Dr. Assefa Gebre-Amlak

What is the distribution pattern of the insect in the field? I believe such knowledge would contribute to the assessment and management of the pest.

Ato Adugna Haile

The infestation of the aphids distributed throughout the field.observation on the distribution of the aphids starting from the edge of the field at 10 meters interval. In the observation the aphid infestation was found uniformly distributed throughout the field.

Ato Kassahun Yitaferu

Have you ever tried to identify and measure the impact of any natural enemies?

Ato Adugna Haile

During the ecological survey of D.noxia in parts of Shewa, Welo and Tigrai about 10 predators and 2 parasitoids were collected as natural enemies of D. noxia. Among these Adonia variegata Goez from the predators and Aphidins hortenes Marshall from the parasitoids were the most important. However, their efficiency in reducing of the aphids is very negligible. A.variegata efficiency was 9% and A.hootensis was 0.1%. This is because of their population increases very late after the damage is already done by the pest.

Diapause Study of African Bollworm, *Heliothis armigera*, and Pink Bollworm, *Pectinophora Gossypiella*, in Middle Awash Valley.

by

Ababu Demessie[1] and Girma Kifle[2]

ABSTRACT

The purpose of the study was to investigate whether african and pink bollworms diapause occurs or not in Middle Awash Valley, and to formulate effective control measures accordingly. In the study for african bollworm (ABW) soil sieving and pupation cages and for pink bollworm (PBW) cotton seed examination and pupation cage techniques were used.

In this investigation, diapausing african bollworm pupae were not encountered in all years. However, in both cotton seed examination and cage emergence study, diapausing larvae of pink bollworms were recorded at Melkawerer conditions.

INTRODUCTION

Diapause enables insects to survive when environments do not favour them all the year round and is an important factor determining insect distribution (Jones and Jones, 1974). It is a suspended activity that can occur at any stage in the life cycle but is most common in the larval or pupal stage (Fenemore, 1982).

Some species undergo a nymphal diapause that enables them to survive the summer, when streams become to warm or dry up. Sometimes diapausing eggs are laid (Richard and Danies, 1977). Diapause is particularly frequent in temperate latitudes where the cold winter is unsuitable for insect growth. But it may also occur in parts of the tropics where there is a dry season that must be survived (Wigglesworth, 1966).

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In any one species diapause is limited to a single stage of development: egg, larva, pupa or adult. In some species diapause occurs automatically in each generation. In others induced environmentally that precedes unfavourable conditions, such as short hours of day light, falling temperatures or scarcity of food (Jones and Jones, 1974; Schmutterer, 1969). Certain species will not breed continously throughout the year, even under favourable conditions, but at a certain times will go into dormancy before conditions become unfavourable (Borror and Delong, 1964).

Thus the occurance of diapause of different key pests would affect crop production in raising cost of control. Infestation will start early and subsequent generations will damage the crop if not controlled effectively. In Middle Awash conditions, regardless of effective close season at least for two and half months, african bollworm and pink bollworm will appear every season, and cause a measurable yield loss on cotton production. The source of ABW and PBW is not well known. The source could be local migration or facultative diapause. Knowing the initial source of infestation will facilitate to formulate a practical means of control. For instance, in case of pink bollworm else-where, study showed that adjusting planting date exposed 85% of emerging adults to succidal emergence. Therefore, diapause study of ABW and PBW in the Middle Awash would have a great impact in order to formulate effective management strategies.

MATERIALS AND METHODS

For ABW:- (1) recently cotton planted and ploughed fields were selected. Random sites in the field were chosen, and soil samples up to six centimeter deep were sieved to expose if any diapausing pupae existed. (2) cages were placed in randomly selected sites in previously ABW infested cotton fields. Observation was made for adult emergence.

For PBW:- 5,000 - 10,000 cotton seeds were examined from November to June for the presence of diapausing pink bollowrm larvae. (2) 2,000 - 3,000 susceptible bolls were collected in October and November. After drying the bolls in open air were deposited in pupation trough at the depth of six centimeter. Date of adult emergence was recorded. (3) Infested bolls with PBW larvae were kept in perpex cages in laboratory, and emergence dates were followed. (4) Cages placed in the field for ABW were also observed for PBW adult emergence.

RESULTS AND DISCUSSION

Afrioan Bollworm (ABW):- Fields which were planted to cotton the previous year were observed for the presence of diapausing pupae by sieving the soil at different random sites within a depth of 4-6cm. Only few exuviae were recorded. In addition in all years (1986, 1987 and 1988), adults did not emerge from cages which were placed at random in formerly ABW infested cotton fields.

Pink Bollworm (PBW):- Susceptible bolls were kept under pupation cages. Adult emergence was followed in all years. Few were emerged within fourteen days.

Examination of cotton seed from previous year harvest reaveled diapausing larvae in one year (Table 1). In addition, from the susceptible bolls that were kept in perpex cages adult emergence continued over six months (Table 2). However, PBW adults did not emerge from cages placed in previous infested cotton fields.

In case of ABW, since the duration of diapausing pupae is much longer, two and half to six months (Pearson, 1958), it can be concluded that no diapausing pupae were encountered during the present investigation. However, the study confirmed that PBW could diapause in Middle Awash Valley.

CONCLUSION

African bollworm population appears in June and threatens the cotton production till September over the last Twenty years. The source of infestation is not known. Light trap catch at Melkawerer center did not indicate a sign of immigration since 1969. Therefore, since the source of infestation is still a mystery, devising a proper methodology for further

Table 1. Result of examining cotton seeds from previous year's harvest.

DATE COTTON HARVESTED	DURATION OF SEEDS IN STORE (MONTHS)	NO.OF SEEDS EXAMINED	NO.OF DIAPAUSING PBW LARVAE
Oct., 1986	9	10,000	33
Oct., 1987	11	10,000	0
Oct., 1988	8	10,000	0

Table 2. Pink bollworm adults emerged throughout the season from perpex cages.

1987		1988		1989	
LARVAL RESTING DAYS	NO.OF PBW ADULT EMERGED	LARVAL RESTING DAYS	NO.OF PBW ADULT EMERGED	LARVAL RESTING DAYS	NO.OF PBW ADULT EMERGED
18	182	16	95	22	2,381
39	156	47	1061	53	22
70	7	75	19	84	11
98	20	106	56	114	55
129	28	136	93	145	39
159	6	167	63	175	38
190	14	197	49	178	1
220	1	228	73		
251	4	259	34		
		289	9		
		320	8		

- 1987 emergence extended from November to July
- 1988 " " " December to October
- 1989 " " " January to July.

investigation is essential for efficient management of ABW.

According to the study, Pink bollworm diapause occurs in Middle Awash Valley. In order to manage the pest, effective close(dead) season should be implemented for two and half months starting mid-February till early May. During this time cotton stores, temporary stoving places should be free of piles of seed cotton.

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THE EFFECT OF CLOSE SEASON ON THE POPULATION OF PINK BOLLWORM, PECTINOPHORA GOSSYPEILLA (SOUND) IN MIDDLE AWASH COTTON FARMS

*by

Girma Wayou

INTRODUCTIONS

Cotton is one of the main cash crops grown for its fiber. The amount of lint on a seed varies considerably among commercial varieties. In most upland cottons it is from 30 - 40%.(2)

In Ethiopia cotton is grown on about 60,000 hectars. In early 1960's growing cotton started in Middle Awash. Since then cotton production has been treated as monoculture. At present, cotton production covers an area close to 13,000 hectares, in which three different varieties are grown. The varieties are Acala 1517/70, Acala SJ - 2 and Worer 1 - 84. Acala 1517/70 is the main variety grown in the state farms.

Cotton suffers a great damage from different insect pests. Cotton bollworms and sucking insect pests are the major groups which cause loss in yield. African bollworm, Heliothis armegera, from bollworms and cotton aphids, Aphids gossypii, from sucking pests are economically important pests.

Pink bollworms, peotinophora gossypiella, which was not an economical pest, is now getting very important in Middle Awash state farms. Pink bollworm is one of the world's most destructive pests of cotton. Uncontrolled, high infestations may reduce yield 50 - 80%.(1)

Pink bollworm larvae cut and stain the lint as they walk their way to the seeds, where they do most of their feeding. Infested bolls are vulnerable to fungal contamination.

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Cotton is the main host plant for pink bollworm. Although, the population of pink bollworm is not as high as on cotton, fruits of Hibiscus diangolensis could be another source of infestation.(3)

The best way to reduce the survival of the larvae is to eliminate the food supply by maintaining an effective close season.(1)

In Middle Awash there was an early infestation of pink bollworm in 1971 - 1973. However, effective close season suppressed pink bollworm population starting 1977, and its population did not reach an economic threshold level. Since 1985, labour shortage has made the cotton not to be picked with in the planned schedule. Late picking and delayed slashing shortened the duration of effeotive close season.

In 1987 pink bollworm attack was observed in September at Gewane and Melka Sedi Farms. The previous year trace infestation was recorded at Gewane in which the source of infestation is considered to be from the neighbouring settler farms located 10 - 15 kms. The patches of cotton fields planted by farmers were not slashed and underploughed during the dead season. In 1984, 1985 and 1986 farmers cotton was not slashed till July and row cotton was kept in stores for a year round. In 1987 upto 75 adults were caught in one night per phermon trap at the farmers site. Late irrigation, after 126 days, initiates cotton plant to produce green bolls. These late bolls are unproductive and they are a good food source for development and carryover of the pest.

Materials and Methods

From 1983 - 1989 number of days in the close season for the five state farms was recorded (Table 1).

To detect the population and infestation of the pest bolls were sampled and larval instars were catagorized. From 1986 - 1989 in October and November, a total of 300 bolls were collected randomly, from which only 100 bolls were sampled. The sampled bolls were dissected using knife. Larvae and infested bolls were counted and recorded (Table 2).

From 1987 - 1989 Phermon traps were used to monitor pink bollworm adults. From early June to the end of October 100 - 150 phermon traps were tied on a wooden stick at the plant level. Traps were supervised every morning and adult catch was recorded. (Table 3).

Table 1. Number of days in the close maintained in each state farm for 7 years.

STATE FARMS	1983	1984	1985	1986	1987	1988	1989
Melka Sedi	104	92	83	48	24	32	34
Melka Worer	102	97	81	52	18	46	22
Amibara Angelele	93	92	63	47	25	35	30
Doffen Bolhamo	85	105	74	40	36	29	15
Gewane	95	99	92	55	46	22	32
Average days	96	97	79	48	30	33	27

Table 2. Number of pink bollworm larvae in the sampled bolls.

YEAR	SAMPLING DATE	NUMBER OF BOLLS SAMPLED	P B W INSTRARS				TOTAL INSTARES	NUMBER OF INFESTED BOLLS
			1	2	3	4		
1986	Oct. 25 - 30	100	5	-	14	6	25	18
1987	Nov. 1 - 10	100	10	16	21	19	66	38
1988	Nov. 10 - 20	100	26	38	19	56	139	46
1989	Oct. 10 - 20	100	38	94	43	68	243	58

Table 3. Number of adult pink bollworm caught in a phermon trap from June - October.

MONTHS	1987	1988	1989	AVERAGE OF THE MONTH
June	25	76	582	228
July	74	88	531	231
August	89	120	652	287
September	126	218	517	287
October	129	262	313	235
Average	89	153	519	

Results and Discussion

In 1983, 1984 and 1985 the effective close season (2½ - months was maintained in all state farms. In the state farms, from 1986-1989 the close season was less than the minimum requirement (Table 1).

The larval population in the sampled bolls and the number of infested bolls are increasing from year to year. (Table 2) In Aguust and September of 1988 and 1989 similar boll sampling was carried in each farm, but the number of bolls infested and the larval population were very few.

In 1989 adult pink bollworm population is very high (Table-3). Larval infestation level seems low compared to the adult population. It may be due to frequent sprays against *Heliothis armegera* and other cotton pests carried in the months of July, August and September that lower the infestation level. In October, when most of the bolls get matured the need for frequent sprays is reduced, and this may create a favourable condition for the build up of the pest.

Since 1986, the number of days of effective close season is less than the minimum and in relation to this, the number of adult pink bollworm and the infestation level is getting high. Late harvesting and slashing cotton stalk caused by labour shortage, unnecessary late irrigation, unstriped cotton stalks stored for fire wood for the coming months in the camps and trashes of seed cotton left in the stores create better condition for the bollworm carryover.

Conclusion

Due to the biology and life history of pink bollworm, regular scouting may not reveal the presence of the pest as early as possible. Eggs and larvae are seldom exposed where insecticides can reach them, so mortality using the existing insecticides is minimal. Spraying the present broad spectrum insecticides may not give good control and it also leads to resistance and secondary pest out-break.

DISCUSSION

Dr. Assefa Gebre-Amlak

Have you ever noticed on yield difference between years of long close season (1983-1985) and years that had very short close season in the Middle Awash?

Ato Girma Wayou

There is a yield variation from 1983-1985 and 1986-1989. During the long close-season higher yields were obtained. But during the short close season lower yields were obtained. But it is difficult to say that lower yields are obtained due to PBW infestation. PBW may have a place in the yield loss.

Ato Kemal Ali

Any relationship between Moth catch and field infestation? Do you use phermone traps for spraying purposes if so, what is the threshold?

Ato Girma Wayou

Moth catch was by far greater than the infestation level. This is may be due to fequent sprays carried against Heliothis and sucking insect pests in July and August, this insecticides may decrease at the same time the PBW population. Adult PBW may die before they lay eggs. But late in the season, September and October, when frequent sprays against Heliothis is minimal PBW infestation is very high.

The Economic threshold level for PBW is 5 adults in the phermon trap are caught continuesly for 3 days. Phermon traps were used for spraying purpose. This sprays may also decrease the adult population, but due to the biology of the pest good control was not maintained.

Ato Fikru Haile

This days there is a tendency to use phermones for control to confuse insects there by avoiding mating. Is there a possibility of using pheromones for the control of pink boll-worm.

Ato Girma Wayou

We use phermon traps only for monitoring purpose. Phermone traps are available on the market and can be used for controlling PBW by confusing insects not to mate. But it is costy and there is a problem in applying it. The cheapest and simplest method is to maintain an effective close season atleast for 2-2½ months.

INTEGRATED APPROACH FOR THE CONTROL OF THE SWEET POTATO WEEVIL, CYLAS PUNCTICOLLIS BOH (COLEOPTERA: CURCULIONIDAE)[1/]

by

Emana Getu[2/]

ABSTRACT

The sweet potato weevil (SPW), *Cylas puncticollis* Boh is an important pest of sweet potato in Ethiopia. Crop Losses due to this pest range from 20% to 75%. Attempts were made to develop an integrated management methods of the pest. Varietal and insecticidal screening against the pest were conducted at Areka and Awassa(Southern Ethiopia). Observations were also made on some agronomic practices which help in reducing SPW. cypermethrin and primiphos methyl gave significantly better control of SPW. There was no significant difference between the varieties as far as mean percent infestation is concerned. Varieties which set their tubers deeper in the soil were found to be resistant and/or moderately resistant. Delayed harvesting and crop rotation played an important role in the levels of SPW infestation. As time of harvesting was delayed from 5 to 6 months infestation increased from 29% to 68% in Awassa. Sweet potato grown for four years continously on the same piece of land had remarkably higher infestation (over 70%) while less than 20% infestation was recorded on sweet potato grown on different land from year to year.

INTRODUCTION

In Ethiopia, sweet potato is extensively grown in the South, West, East and central part of the country. In an effort to combat drought at present the crop is grown in most parts of the country (Ministry of Agriculture, 1988 unpubl. data).

1/ Paper presented at 10th annual meeting of the committee of Ethiopian Entomologists (CEE), Feb.7-9, 1990, Addis Ababa.

2/ Entomologist, Awassa Research Center IAR, P.O.Box 6.

Insect pests are the major factors limiting sweet potato production in Ethiopia. Of the insect pests the most destructive one is the sweet potato weevil (SPW), Cylas puncticollis Boh(1,2). Female SPW search for exposed tubers through the cracks in the soil either due to very low moisture or enlargement of tubers for oviposition. Once SPW find tubers it makes a small hole in the tuber just underneath the epidermis and lays eggs. Then the egg cavity is sealed with a grey faecal plug that preserves moisture and protects the eggs from predators and parasitoids. White colored larvae developed from these eggs feed inside the tubers and leave dark stained tunnels. SPW female also lays eggs in the stems and developing larvae feed inside the stems resulting in wilting of the plant under severe condition(1,2). Besides, the adults that develop from the larvae in the stem increase weevil populations and chance of damage to the tubers(7). The adults of SPW also cause windowing to leaves of sweet potato. Losses due to SPW in Ethiopia ranges from 20% to 75% (1,2). Losses are considered to be higher in areas where harvesting is delayed and where crop rotation is not practised(2,8). Even partially damaged tubers are unsuitable for human consumption due to an off flavor that SPW damage imparts to the tubers(7). Some of the control methods for SPW include, foliar spray of insecticides and dipping of planting material in insecticide solution, crop rotation, use of resistant variety, destruction of infested crop material and crop residues(3). Integrated methods for SPW control have been developed by International Institute of Tropical Agriculture(IITA) and Asian Vegetable Research Development Center (AVRDC) (5,7). Villanueva (8) has also demonstrated use of agronomic practices for SPW control.

Despite the importance of SPW in Ethiopia very little information is available in its biology and management. Therefore, inorder to develop integrated methods for SPW control studies on varietal and insecticidal screening and agronomic practices such as crop rotation and delay harvesting were initiated in Southern Ethiopia.

MATERIALS AND METHODS

Varietal Screening

Thirty Four varieties of sweet potato at Areka and Twenty Nine varieties in Awassa were tested for SPW resistance between 1987 and 1989 using randomized complete block design in three replications. Spacing between rows and plants were 1.0 and 0.4m, respectively. Each variety was planted in a single row of 4 meters long. Tubers were harvested 6 months after planting. At harvest 30 tubers were randomly sampled from each variety and evaluated for SPW damage and levels of percent infestation were determined. Percent infestation was transformed to arcsine transformation and combined analyses were made. Varieties were rated as follows.

1. Varieties with no damage were considered as highly resistant (HR) and received a class rating of 1.

2. Varieties with 1-25% infestation were considered as resistant (R) and received a class rating of 2.

3. Varieties with 25-50% infestation were considered as moderately resistant (MR) and recived a class rating of 3.

4. Varieties with 50-75% infestation were considered as susceptible (S) and received a class rating of 4.

5. Varieties with 75-100% infestation as highly susceptible (HS) and received a class rating of 5.

Insectioidal Screening

Testing of various chemicals was carried out between 1987 and 1989 to control SPW both at Areka and Awasa. Sweet potato variety Koka 12 was used for the experiment. The plot size was 4m by 4m. Spacing between plants was 0.4m and that of between rows was 1m. Randomized complete block design in four replication was used. The studies include dipping treatments, foliar spray or the combination of dipping and foliar spray. Manually operated knapsack sprayer was used for the application of spray treatments.

Dipping Treatments

Diazinon 60% EC was used as dipping, dipping+foliar spray and spray treatments. Cuttings for dipping, and dipping+foliar spray treatments were kept submerged for 30 minutes in diazinon solution at the rate of 0.5 lt per 25,000 cuttings.

Spray Treatment

Spray treatments were started two months after planting and continued up to four months at fortnight intervals. The chemicals were:

1. Carbaryl 85% W.P., 1.5 kg/ha
2. Cypermethrin 10% EC, 150 g.a.i/ha
3. Endosulfan 39% EC, 700 g.a.i/ha
4. Primiphos methyl 50% E.C., 500 g.a.i/ha
5. Karate 5% E.C., 20 g.a.i/ha
6. Deltamethrin 2.5% E.C, 12.5 g.a.i/ha
7. Diazinon 60% EC, 0.5 lt/ha.

For comparison untreated check was used. Tubers were harvested 6 months after planting. At harvest, 80 tubers were randomly selected and evaluated for SPW damage. Moreover, marketable tubers were also assessed.

Effect of Time of Harvesting on SPW Infestation

Tubers harvested 5 months after planting were compared to tubers harvested 6 months after planting for percent SPW infestation. Forty tubers were evaluated at each harvesting period.

Effect of Crop Rotation on SPW Damage and Infestation

To study the effect of crop rotation sweet potato was grown on the same plot of land for four years. Tubers from this plot were compared with tubers harvested from a piece of land where crop rotation was practised every year.

RESULTS AND DISCUSSION

Varietal Screening

At Areka, 38% of the varieties were found to be resistant and the rest 62% was moderately resistant. In Awassa 55% of them found to be moderately resistant and 45% was susceptible (Table 2). The possible reason for the differences in the levels of resistance at both locations could be due to the low population pressure of SPW at Areka. The experimental field at Areka was under sweet potato cultivation not for more than three years. As SPW is a poor flying insect it needs source of infestation to establish itself and cause damage to the next crop. One of the most important source of SPW, infestation to the next crop is the sweet potato debris in and outside the field (2,7,8). The initial source of SPW which caused damage to sweet potato grown at Areka's experimental field could be planting materials that were moved from Awasa to Areka. The population of SPW in Awasa's experimental field was higher than that of Areka since the field was under sweet potato cultivation for decades. Some varieties that were resistant at Areka were found to be susceptible in Awasa. For example, Arbaminch I and IIs 8250 found to be resistant at Areka and susceptible in Awassa (Table 1). This could be again due to the high population pressure of SPW in Awassa and lesser ability of these varieties under Awassa condition. Metcalf and Luckmann (4) confirmed that the amount of injury caused by an insect pest to a crop plant depends on the size of the insect population and the ability of the plant to withstand injury.

Studies of Hill(3), munthali (5) and Raman (6) indicate that the presence of genes responsible for resistance to SPW in sweet potato varieties could be related to depth of tuber in the soil. The current study has also confirmed that those varieties with deeper tuber were resistant and/or moderately resistant to SPW in most cases.

Table 1. Mean percent infestation (Pl) of SPW and the class rating (CR) of the varieties.

VARIETIES	AREKA		AWASA	
	PI	CR	PI	CR
Wenago I	34.37	3	52.65	4
" II	32.43	3	48.35	3
" III	30.20	3	64.36	4
AJAC I	29.14	3	46.96	3
" II	30.81	3	42.41	3
" III	28.82	3	45.18	3
" IV	13.86	2	-	-
Koka 3	31.15	3	54.57	4
" 6	27.34	3	54.98	4
" 9	25.25	3	-	-
" 9A	23.42	2	46.08	3
" 9B	11.44	2	-	-
" 10	33.29	3	43.50	3
" 12	23.38	2	52.36	4
" 18	22.05	2	40.60	3
" 25	47.65	3	46.93	3
" 26	24.02	2	46.93	3
" 28	30.73	3	40.91	3
Arbaminch I	21.29	2	61.04	4
" II	28.52	3	50.62	4
" III	31.10	3	-	-
Wendogenet	27.36	3	55.76	4
Abosto	31.41	3	50.00	4
Melkasa I	31.52	3	42.24	3
" II	18.07	2	-	-
Cemesa	25.78	3	59.27	4
Variet A	27.38	3	46.36	3
Alemaya	15.05	2	-	-
Baracty	-	-	43.07	3
EPID	-	-	54.43	4
Bekule	22.86	2	-	-
TIS 2534	30.03	3	61.26	4
" 8250	22.89	2	50.41	4
" 70683	13.96	2	-	-
" 2544(28)	23.64	2	-	-
" 3270(74)	-	-	49.32	3
TIB 2 (26)	-	-	62.40	4
Rreka local	34.37	3	-	-
Awasa local	-	-	48.19	3
	NS		NS	

\- Varieties were not either established or did not set tubers

NS All means infestations withih a column are not significantly different at 5% probablity level (DMRT).

Table 2: Resistance levels of sweet potato varieties to SPW.

LEVELS	AREKA NO. OF VARIETIES	%	AWASSA NO. OF VAR.	%
HR	–	–	–	–
R	13	38.24	–	–
MR	21	61.76	16	55.17
S	–	–	13	44.83
HS	–	–	–	–

Insecticidal Screening

Cypermethrin and primiphos methyl gave better control of SPW at both locations producing significantly low percent infestation and higher marketable yield (Table 3).

Dipping treatment did not show good control which could be either due to inefficacy of the chemical or lack of SPW in the planting materials used. Dipping treatment kills all stages of SPW in the stems by contact action.

It will not prevent weevil reinfestation (7). In order to prevent the reinfestation foliar application is necessary. Foliar application reduces the population of SPW before it enters the tubers to cause damage and lay eggs.

In general chemical contol of SPW can be practical through dipping treatment when cuttings are harvested from SPW infested nursery and by foliar applications of insecticides to minimize the population of SPW adults on the leaves and stems. It is also possible to use systemic insecticides but most of them are costy and pose the risk of residual contamination of the tubers (parker, personal com.).

Table 3. Efficacy of Insecticides of on SPW control

INSECTICIDES	A R E K A		A W A S A	
	PERCENT INFESTATION(%)	MARKATABLE YIELD/16^{m2}	PERCENT INFESTATION(%)	MARKATABLE YIELD/16^{m2}
Carbaryl	29.94 ab	12.58 cd	46.30 b	7.00 a
Cypermethrin	23.94 a	26.35 a	36.67 a	8.47 a
Endosulfan	28.01 ab	13.15d	44.48 b	9.03 a
Primiphos-methyl	25.01 a	21.57 abc	32.46 a	9.13 a
Karate	33.01 ab	13.50 cd	50.67 b	7.23ab
Deltamethrin	23.54a	17.71bc	48.63 b	7.02 ab
Daznon-dipping	28.56 ab	10.89 d	53.72b	7.53ab
Diaznon-dipping+foliar Spray	31.28 ab	14.41 cd	48.06 b	6.04 ab
Diaznon-Spray	31.61 ab	10.87d	48.13 b	5.77 ab
Untreated check	41.13 b	8.16 d	53.46 b	2.12 b

All means followed by the same letter within a column are not significantly different from each other at 5% (DMRT).

Agronomic Practices

Time of harvesting and crop rotation played an important role in the prevention of SPW. Because of poor storage technology and planting material preservation farmers practice piecemeal harvesting. Although sweet potato reaches physilogical maturity within 3 to 5 months from planting it may be left un-harvested for more than 6 months. SPW infestation increases as time of harvesting delayed. It was observed in Awasa that as time of harvesting was delayed from 5 to 6 months the infestation of SPW increases from 29% to 68%. Villanueva (8) has also reported that as time of harvest delayed from 3 to 5 months from planting infestation of SPW increases from 25% to 50%.

Crop rotation is another important agronomic practice that helps control SPW. In Awasa sweet potato grown on the same pieve of land for four years continously showed over 70% tuber infestation whereas under normal rotation pattern less than 20% infestation was recorded. Farmers in Southern Ethiopia grow sweet potato on the same land for years because of shortage of land.

Entomologists working at AVRDC(7) indicated that in places where sweet potato is a staple food and where the crop is continously grown on the same field, all plant debris such as pieces of tubers and stems must be removed. They also recommended flooding of the field immediately after harvesting for several weeks. This can be done by farmers who produce sweet potato by irrigation. But if there are no limitation of land crop rotation can produce best method of SPW control.

CONCLUSION

Foliar spray of cypermethrin and primiphos methyl showed effective control of SPW but it is not economically feasible for farmers who grow sweet potato on very small piece of land. For small holdings use of agronomic practices such as appropriate time of harvesting crop rotation and destruction of sweet potato debris are practical methods of SPW control. Use of deeprrooted varieties is another method that might reduce losses due to SPW. The result obtained from varietal screening could servo as information for further screening work.

To make use of the recommended insecticides for large scale production economical and more effective rate and frequency of application should be determined.

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DISCUSSION

Ato Ferdu Azerefegne

That is the profile of this insect in storage and the effect of chemicals tested in the field on stored sweet potato tubers?

Ato Emana Getu

This question will be answered when rates and frequencies of the recommended chemicals are experimentally determined. But, the current findings serves for sweet potato that will be harvested 5-6 months from planting.

Ato Tesfu Mesfin

1. Total Area devoted to sweet potato in the country
2. Acceptability of sweet potato by the Ethiopian
3. Treated area with insecticides

Ato Emana Getu

1. Total area occupied by sweet potato is known but as of now I do not have the figure at hand.

2. The crop was under cultivation by farmers for years specially in the Eastern, Western, Southern and Central parts of the country. Thus, it is highly acceptable.

3. Treated area of the plot size used in the experiment was 4X4m = $16m^2$.

Ato Girma Wayou

1. What is the economic threshold for SPW?

2. Does the foliar spray control SPW in the tubers?

Ato Emana Getu

1. The economic threshold level for this pest has not been established but it will be one of our future interest as far as the sweet potato weevil management is concerned.

2. No, it does not control weevils in the tubers. By controlling the pest on leaves and stems by foliar spray the number of weevils infesting the tubers will be definitely reduced.

Ato Alemayehu Refera

In your discussion you have mentioned that feeding of sweet potato weevil produce toxic compounds.

(a) What type of toxic compound will be formed
(b) How toxic to human being.
(c) What is the real causal agent of this toxic compound, is it feeding of sweet potato weevil or due to secondary fungus infection.

Ato Emana Getu

These compounds have not been:
(a) Identified
(b) Since this is a recent information detail work was not done.
(c) It is due to secondary infection by fungus.

Ato Adugna Haile

In your transparency it has been indicated that in one area you found M.Resist to Susceptible, while in other site all the varieties were M.Susceptible to susceptible, in this line you said this is because of population pressure of the pest. But if it is due to population pressure then there should be some lies completely damaged and others slight, could you elaborate on this line?

Ato Emana Getu

When I say high populatioh pressure it is a relative terminology. This is in short to say the population pressure at Areka is lower than Awassa. However, if Awasa is compared to areas like chanodorga and lante the population pressure is low. So, the reason why some of the varieties did not completely die was that though the population pressure in Awasa was higher than Areka's this population level was not a maximum population to cause complete loss of any one of the varieties.

TOXICITY TESTS OF SOME INSECTICIDE AGAINST ADULTS AND NYMPHS OF THE DESERT LOCUST SCHISTOCERA GREGARIA

by

K. J. Musa & Alganesh Zarfu

INTRODUCTION

Laboratory testing and evaluation of new insecticides is an important research programme and a continuous project of the insecticides Research Unit following previous work by FAO/SIDA(1971/78). The objective is to identify the most effective, safe, and non-persistent insecticides as alternatives to organo-chlorine and the current standard fenitrothion used in the control of the desert locust.

The insecticides selected must be effective and or better than those already in use, have low mamalin toxicity and not harmful to the environment.

1. Laboratory Toxicity Tests

New insecticides are generally tested in laboratory in order to determine their toxicity against nymphs and adults of the desert locust by topical application and stomach action; the two methods most widely used in the control of the desert locust. The toxicity evaluations are made in comparison with well established insecticides already in use such as fenitrothion.

Promising insecticides are further investigated to evaluate their side effects against non-target organisms before a recommendation can be made for field trials.

DISCUSSION

Dr. Assefa Gebre-Amlak

How are you going to use phermone traps in desert control? If you think of mass trapping, some experience show that mass trapping is not efficient in controlling pests.

Mr. K. Musa

Mass trapping is one of the potential methods reported to have been used against some insects. As far as the desert locust is concerned, in protocol of field evaluation has to be investigated. I think pheromone may be used in direct control as mating disruptant of sexual communications of sexes. The delivery system will be developed to optimise the efficacy of the pheromones and protect it from UV light. Possibility controlled release dispensers may be developed and used. Pheromones may also be used in combination with insecticides.

Comment:

Dr. Hailu Kassa

Among its programmes, ICIPE will be involved in finding promising biological control agents for Desert Locust Control. DLCO-EA has a mandate also for the control of Desert Locust. In the past it has been using persistent insecticides which have now been banned will also be looking into the biological control of desert locust. Therefore, there will be a possibility for collaboration between DLCO-EA and ICIPE.

ICIPE has recently initiated a 5 years research programme(Phase 1) for alternative methods for the control of the desert locust. The programme will search for promising biocontrol agents eg. bacteria, fungi, viruses, as well as pheromones, kairomones and juvenile hormones. The DLCO-EA has been concerned with the continuing use of persistent insecticides in desert locust control because of widespread occurrence of their residues in the environment and non target organisms. The council of Minister of the DLCO-EA has recently directed the management to search for alternative non-chemical control methods. I persume that there will be ample opportunities for close cooperation between DLCO-EA and ICIPE in research & field work.

This report summarises the work carried out at the Organization's HQ Laboratory, Addis Ababa to obtain relative toxicity information on some available insecticides using the desert locust *S. gregaria.*

Materials & Methods

Insects Tested

Insects were from the stock of *S. gregaria* reared and maintained in the laboratory for several years. They were used in fifth instar at 2-5 days from their moulting and of two weeks old adult.

Insecticides Used

1. Alfa Cypermethrin (fastac)
2. Bendiocarb (ficam)
3. Carbosulfan (marshal)
4. Chlorpyrifos (dursban)
5. Cyhalothrin (Karate)
6. Deltamethrin (decis)
7. Fluvalinate (mavrik)
8. Profenofos (curacron)
9. Propoxur (Unden)
10. Pyridaphenthion (ofunac)
11. Sumi combi (sumicidin + fenitrothion)
12. Thiodan (endosulfan)

Results and Discussion

Table 1 summaries the results of LD50 (grapical methods) and the speed of action of the insecticides compared to dieldrin and fenitrothion.

The results show that most of the insecticides tested were comparable with fenitrothion and dieldrin and some are more toxic to locusts.

Profenofos and Thiodan were the least effective with LD50 about 30ug/g and slow acting. Bendiocarb, carbosulfan, deltamethrin, fluvalinate and propoxur are highly toxic to adults and nymphs and as nearly as twice toxic as fenitrothion. While chlorpyrifos, pyridaphenthion and sumicidin + fenitrothion were moderately toxic to nymphs and similar to fenitrothion against adults. Deltamethrin, alfacypermethrin, and cyhalothrin were highly toxic and quick acting to adults but of low toxicity to nymphs. It was observed that locusts were likely to recover from knock down doses.

Table 1. LD50 and speed of action of some insecticides to the Desert Locust S. *gregaria* by contact application compared with Dieldrin and Fenitrothion.

INSECTICIDES	INSTAR	LD50 ug/g	TIME FOR COMPLETION OF ACTION
Alfa cypermethrin	Fifth	6.50	3 days
	Adult	4.20	3-4 days
Bendiocarb	Fifth	2.70	24 hrs.
	Adult	2.40	24 hrs.
Carbosulfan	Fifth	3.10	24 hrs
	Adult	1.40	48 hrs
Chlopyrifos	Fifth	6.80	48 hrs
	Adult	3.90	3-4 days
Cyhalothrin	Fifth	5.40	3 days
	Adult	2.80	4 days
Table II			
Deltamethrin	Fifth	1 - 3.50	48 hrs
	Adult	0.50	3-4 days
Fluvalinate	Fifth	1.50	24 hrs.
	Adult	2.00	48 hrs.
Profenofos	Fifth	20	-
	Adult	20	-
Propoxur	Fifth	1.50	24 hrs
	Adult	3.70	48 hrs
Pyridaphenthion	Fifth	9.80	48 hrs
	Adult	3.90	48 hrs
Sumi combi	Fifth	6.80	48 hrs
	Adult	5.50	2 - 4 days
Thiodan	Fifth	20	-
	Adult	20	-
*Dieldrin	Fifth	1.90	4 - 10 days
	Adult	5.10	-
* Fenitrothion	Fifth	4.90-7.80	12-24 hrs
	Adult	3.70-8.40	1- 6 days

* Data from MacCuaig's Insecticide Index(1966)

Ato Sebsibie Abebe

Mr. Mussa, have you ever mentioned that Delthamethrin, karate and other synthetic pyrethroids have very high knock down, highly toxic to Desert Locust, but the insects recover later. Have every tried to find out or make study why the insects recover?

Mr. K. Mussa

The recovery could be from the effect of heat on the insect and also on the insecticide. We have observed at the Red sea costs that by the time we sprayed Delthamethrin, karate, ect., that the locust were knocked but as soon as they moved to shade they recovered the new generation of synthetic pyrethroids are better and the mixture of OPS or carbamates to the synthetic pyrethroid was found to be very effective.

Dr. Teferi Gemetchu

Both the DLCO-EA and ICIPE are planning to undertake research on biological control of locusts. What would the degree of cooperation be?

Mr. K.Mussa

I understand that there will be a collaborative research programme agreement where by DLCO-EA will offer its services in surveys and facilities for yield trials of pathogenic organisms and others _nst natural populations of the desert locust. DLCO-EA will also supply egg-pods, live insects and other materials for laboratory research work.
I presume the agreement will be signed soon.

SEASONAL DISTRIBUTION OF AFRICAN BOLL-WORM ON CHICKPEA AT DEBRE-ZEIT

by

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ABSTRACT

Seasonal activities and infestation of African boll-worm, Helicoverpa armigera (Hb) on chick pea were studied during 1988 and 1989 at Debrezeit using Pheromone traps. In both years highest number of moth catches by pheromone traps occurred during the drier months (December and January), while in April and August during the rainy season, lowest moth catches were recorded. It appears that such changes in the insect activity may have been influenced by the weather condition of the region and the availability of possible host plants in the field.

INTRODUCTION

The African boll-worm Helicoverpa armigera is the most important pest of many crops like cotton, sorghum, maize, tomato and most legumes in the semiarid tropics of the old world. In different regions of Ethiopia, this pest causes considerable damage to green pods of chickpea and accounts for a high percent yield loss. Survey results on pod damage in the highlands of Shoa showed 20.8 to 35.6% infestation.

This study was initated to monitor the moth population using three pheromone traps (Supplied by ICRISAT). The trap catches were related to rainfall and temperature data to develop effective pest management strategy in the longrun.

Materials and Methods

Three pheromone traps were placed around the corner chickpea fields at a distance of 100m from each other. All the pheromone traps were about away from electric lamps that operate at night. Each trap was put at 1.5m above the crop and insect catches were recorded every morning. The pheromone trap had a rubber septa impregnated with synthetic pheromone which was suspended above the surface of a plastic funnel and protected by a circular aluminium plate. A 'ploythene bag was fixed on the funnel to collect adult males attracted by the pheromone.

Results and Discussion

Seasonal fluctuations of H.armigera moth activity were observed at Debre-zeit. During the growing seasons sharp population increase was observed from November to January both in 1988 and 1989 (Fig 1). After January moth populations decreased and the lowest record was in(April-May). However, moth population increase was again observed in June (1989) and July (1988). After August the population went on declining. The pattern of moth activity for both years was similar, but the total moth catch of 1988 is greater than of 1989. From these observations it appears that H.armigera has two generations a year around Debre-Zeit area.

This population dynamics probably depends upon the weather conditions, particularly rain and temperature of the region, and the presence of possible host plants in the field. The low record of moths during the small rainy season (March to Mid-May) and the main rainy season, (Mid July to Sebtember). May be associated with higher moisture and relatively cooler temperatures of the area.

Observations on the life cycle of Afrioan boll-worm during the chickpea growing season may suggest that egg-laying occurred from late September to October, larval stage from Mid-October to November, the pupal stage from late November to early January, and the adult stage from December to January. The larval population can, therefore, be expected to build and cause damage to chickpea in October and November.

In 1989, larval of *H.armigera* appeared very late in the season i.e. at the end of October the level of larval populations and the damage caused on chickpea were found to be low.

Table - 1 The relationship between stage of chickpea and larval population.

DURATION	STAGE OF THE CROP	LARVAE/30 PLANTS
1st Week of November	50% flowering	1.12
2nd Week of November	Peak flowering	2.38
3rd Week of November	Mid-pod setting	2.98
4th Week of November	Full-pod setting	1.39

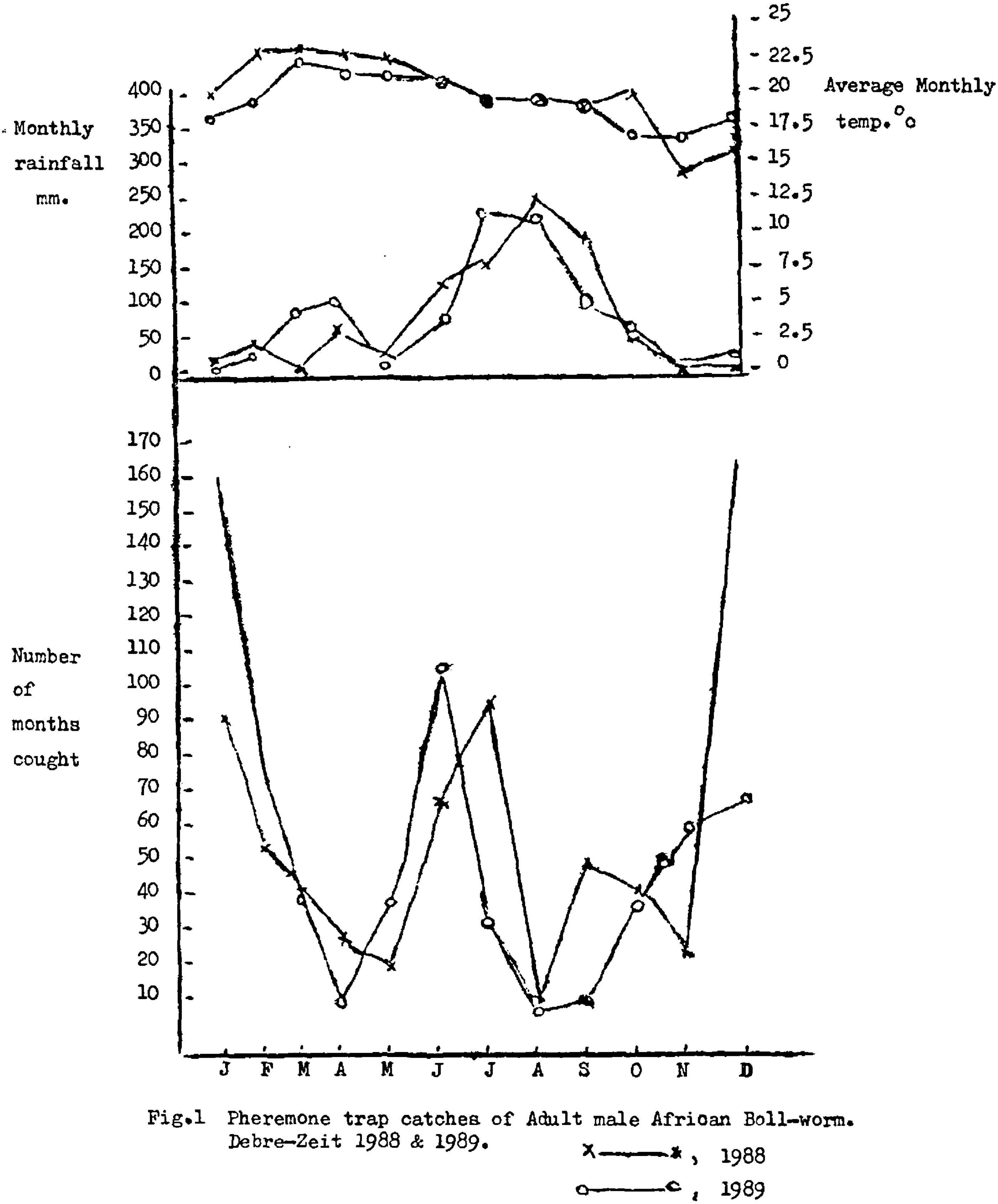

Fig.1 Pheremone trap catches of Adult male African Boll-worm.
Debre-Zeit 1988 & 1989.

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