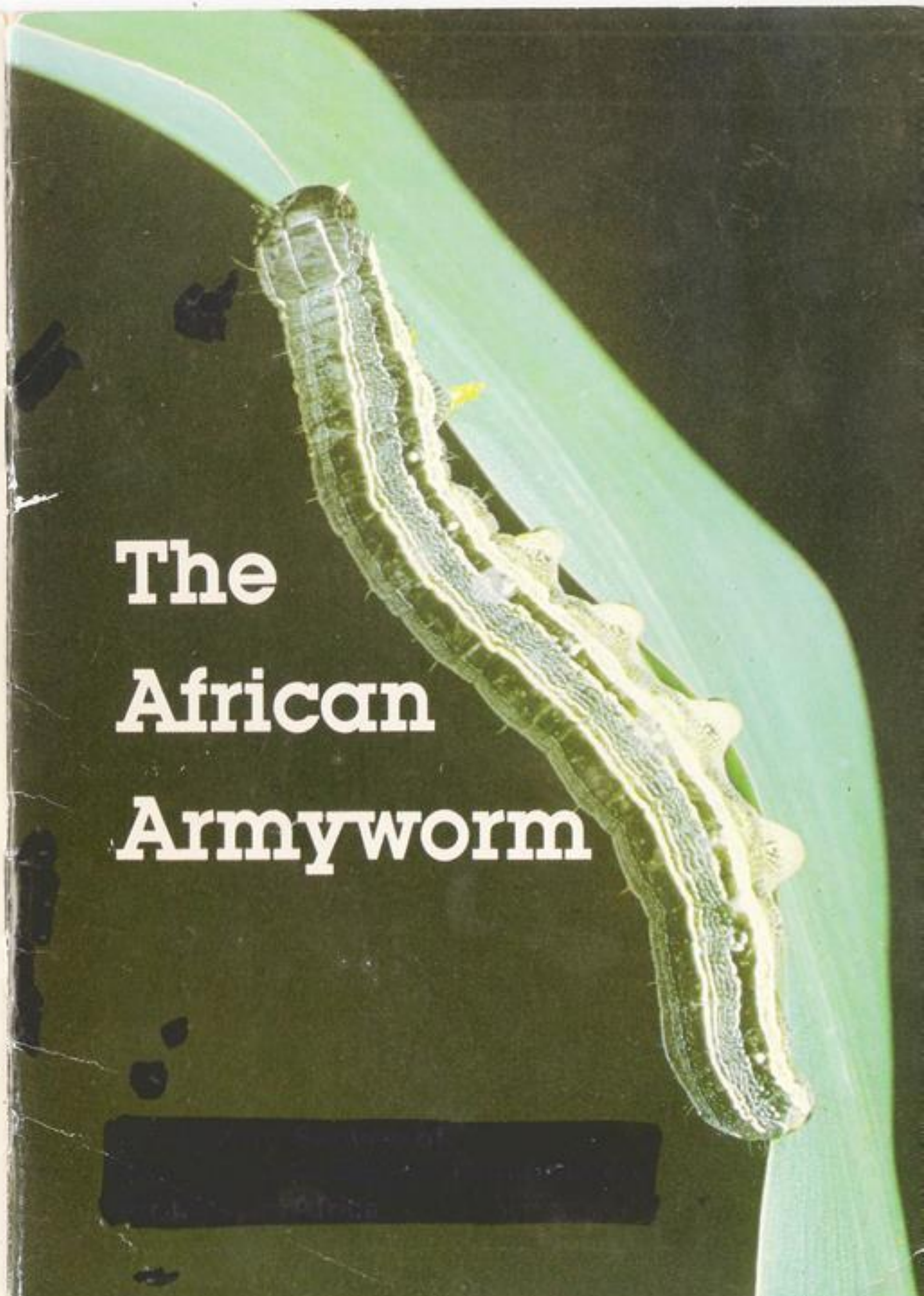

The African Armyworm

[redacted]

Index

Acknowledgements

The material in this pamphlet was prepared by W.W. Page and C.F. Dewhurst, Entomologists, DLCO-EA/TDRI/EEC Armyworm Project; J.L. Amisi, Armyworm Survey and Control Officer, DLCO-EA; P.O. Odiyo, Armyworm Forecasting Officer, DLCO-EA and Dr. N.R. Maslen, T.D.R.I. Further comment and editing was done by Dr.D.J.W. Rose, Team Leader, DLCO-EA/TDRI/EEC Armyworm Project and Dr. M.O.M. Nurein, Director of Scientific Research, DLCO-EA.

Acknowledgement is made to the late E.S. Brown who initiated armyworm research in eastern Africa.

We particularly thank D.G. Campbell for designing and organising the printing of this pamphlet.

Funds for printing this publication came from the European Community (EEC) Migrant Pest Control Programme in Eastern Africa.

First Published, Nairobi May 1987

Printed by Majestic Printing Works Ltd.,
P.O. Box 42466
Nairobi, Kenya.

Introduction

What do armyworm do?

The African armyworm is the larva (caterpillar) of a night flying moth *(Spodoptera exempta)* which, in large numbers, causes considerable damage to grasses (which include rangeland grasses, wheat, maize, rice, millet, sorghum, tef and sugarcane). They do not eat other plants such as vegetables, tea and coffee as has sometimes been reported in the past, although an isolated case of damage to palm seedlings has been observed.

What are the sizes of outbreaks?

It is a particularly serious pest in eastern, central and southern Africa where larval densities of sometimes over 1000 per square metre can be found damaging large areas of crops and rangeland. Such concentrations (which are called outbreaks) may cover tens or even hundreds of square kilometres *(see Plate 1)*.

Plate 1. Part of an armyworm outbreak on pasture

Nature of Damage

What damage is done?

The damage to grasses is almost entirely restricted to the leaves, although when food is scarce, the young stems or flowers (particularly of wild grasses) may be eaten.

The young larvae at first eat the upper and lower surface tissue of the leaves which results in the "skeletonisation" or "windowing" of the leaves *(see Plate 2)*. Armyworm larvae prefer young plants and recently germinated maize is a particular favourite *(see Plate 3)*. As the larvae become older and increase in size, they are able to chew through the entire leaf thickness starting from the edges and usually eating all but the mid-rib *(see Plate 4)*. Between two and four big larvae on a young maize plant can strip all the leaves.

Heavy infestations may result in a total loss of leaves often leading to severe crop loss or necessitating resowing.

Plate 2. Windowing effect on maize produced by young larvae. Note the small green larvae on the leaf.

Plate 3. Damage to young maize.

Plate 4. Damage to grasses showing the mid-rib being left.

Life Cycle and Recognition

The life cycle of armyworm is typical of that found among moths and butterflies *(Lepidoptera)*.

Moth (adult)

Pupa (chrysalis) **Ova (egg)**

Larva (caterpillar)

How long is the life cycle? The whole life cycle takes about one month under normal outbreak conditions.

The moths

How big are the moths? The adult moths have wing spans in the range of 20-37 mm although most are between 29-32 mm. The females tend to be larger than the males.

How do I identify armyworm moths? The major characteristics of armyworm moths are:
(i) An overall dull grey/brown appearance of the fore-wings.
(ii) White hind-wings with dark veins.

Any moth which has any colour on the hind-wings or which does not have dark veins on the hind-wings cannot be armyworm.

The following features will help separate the two sexes:-

Plate 5. Male armyworm moth

Plate 6. Female armyworm moth

Males *(see Plate 5)*
(i) Size with wings spread 20-35 mm.
(ii) Fore-wings greyish brown with lighter patches.
(iii) Inner (orbicular) spot on the fore-wing elongated and pale.
(iv) Outer (reniform) spot on the fore-wing arrow or kidney shaped.
(v) Tip of body (inside) with slate grey racket shaped scales.

Females *(see Plate 6)*
Size with wings spread 22-37 mm.
Fore-wings uniform dark brown.
Orbicular spot distinctly elongated and pale.
Reniform spot often difficult to see but is present.
Tip of body with black hair scales.

Sexes can also be distinguished by the number of bristles on the mechanism which couples the fore- and hind-wings (the frenulum) which are single in males and multiple in females.

The racket shaped scales in males (which can be seen with a hand lens) and the black scales on the tip of the body of females are characteristic of the African armyworm and can be used as a provisional identification when the wing patterns are not recognised due to wing damage or wear.

When in doubt of the correct identification, specimens should be put into envelopes (or "papers"), fully labelled with the place and date caught and sent to one of the addresses given on the last pages of this leaflet.

The eggs

What is the number of eggs each moth lays?

One female usually lays between 100 and 400 eggs in a mass, one mass being laid every night for several nights until she has laid up to 1000 eggs. The eggs may be laid in single or multi-layers and are covered by black hair scales from the tip of the female's body *(see Plate 7)*. They are small (about 0.5 mm in diameter) and yellowish when they are laid, turning black just prior to hatching.

The egg masses may be laid anywhere (in bushes, trees, wild plants and grasses) but are usually most easily found on grasses or on the leaves of cereal crops.

How quickly do the eggs hatch?

The eggs hatch 1-7 days after laying depending on temperature but usually between 2 and 4 days under conditions found during the time of the year when outbreaks occur.

Plate 7. Egg mass on grass showing the black hair scales.

The larvae

When the young larvae emerge from the eggs they eat part of the eggshell and then drop from the egg mass on silken threads. At this stage they may be blown by the wind and dispersed.

The newly hatched larvae are colourless or whitish with black heads, becoming green as they feed on the green plant tissue. As they grow, they cast their skins five times (moult). Each stage between moults is known as an instar and there are usually six instars (numbered i, ii, iii, iv, v and vi). The full grown larvae (vi instar) are approximately 25-35 mm long. During the iv-vi instars the larvae are voracious feeders and it is usually not until then that they cause serious damage to the crops or pastureland.

How do I identify the larvae?

Up until the third moult the larvae remain green. At this stage, depending on whether there are many together or a few, they will turn black or remain in various shades of green or brown.

If there are large numbers of larvae together ("gregarious" form), as in a typical outbreak, the larvae are characteristically velvety black on top with pale lines on each side and a greenish-yellow underside *(see Plate 8)*. They do not have any obvious hairs on them as in the American bollworm *(Heliothis armigera)*. The head is always shining black and there is a pale stripe along the top of the body always paler than the black area on either side of it. This is in contrast to the lesser armyworm *(Spodoptera exigua)*. The armyworm larvae may also be distinguished from the cotton leafworm *(Spodoptera littoralis)* because this has two dark spots on each segment, with those on abdominal 1 and 8 segments being much larger.

Plate 8. Gregarious larva.

What is the length of larval stage?

It is the gregarious form of the African armyworm which causes tremendous damage to cereal crops and rangeland. The larval stage of this form lasts 14-21 days depending on temperature.

On the other hand if larvae are not crowded, then the developing larvae instead of turning black remain one of many shades of green or brown and in contrast to black gregarious larvae they are sluggish living mostly at the bases of plants. These are the passive or "solitary" form *(see Plate 9)*. Most people, if shown this form, would not recognise them as armyworm larvae. The solitary larval forms are often difficult to distinguish from some other moth larvae. They generally have pale clear heads although some may have slight mottling. There is a "transiens" form in which the colouration is generally darker and the larvae may be more active, but for general purposes an understanding of the two extreme forms: gregarious (active and destructive) and solitary (sluggish and non-destructive) is all that is necessary.

It is now thought that the solitary form is the one which enables the populations to continue at a low level during the dry season when there are no outbreaks occurring. Therefore this form is very important in the survival of this pest.

Plate 9. Solitarious larva

The pupae

What is the length of pupal stage?

Once the larvae have reached full size they burrow into the ground forming chambers 2-3 cm below the surface. They become dull in colour and wrinkled (pre-pupa stage). They then moult into pupae one or two days after burrowing *(see Plate 10)*. The pupae usually remain underground for 7-12 days after which time, between dusk and midnight, the moths emerge. When temperatures are low (as in the cool season on high ground) the pupal stage may persist for as long as five weeks before the moths emerge.

Plate 10. Pupae in the ground

Why do the larvae disappear?

Burrowing into the ground is a critical phase in the armyworm life cycle. If the ground is dry the larvae have difficulty with burrowing and many may die. If it rains about the time of burrowing, the ground becomes soft and many larvae will take advantage of this. Thus when it rains at this stage the outbreak suddenly "disappears", leading some farmers to believe that the rain has eliminated the outbreak by killing and washing away the larvae.

Natural Enemies

All stages of the armyworm are subject to attack by natural enemies which range in size from microscopic viruses to birds.

Virus

There are two viruses which can kill armyworm:-

(i) The Nuclear Polyhedrosis Virus (NPV), which is an effective killer of armyworm larvae. When it occurs in a population of larvae it has been known to kill up to 90% of them. However, the larvae are not normally killed until they are in the last instar when considerable crop or pasture damage may have already occurred.

(ii) The Cytoplasmic Virus (CPV) which only seems to kill the pre-pupal or pupal stages of the armyworm. Most virus attacks appear to be brought on by stress i.e. poor food, low temperatures and/or little sunlight.

Fungus

The commonest fungus found attacking armyworm larvae is *Normuraea rileyi*. Once infected a larva climbs to the top of a grass blade where it becomes covered with white strands of fungus. Fungi require conditions of high humidity and temperature in order to survive. They seldom control outbreaks completely.

Insects

A great number of insects parasitise armyworm, particularly in the larval stage; these may be divided into the flies *(Diptera)* and wasps *(Hymenoptera)*.

Among the flies there are some 28 different species which attack the larvae. The fly larvae develop inside the armyworm larvae (endoparasitoids), finally killing their host.

Of the wasps, about 25 types have been recorded from all stages. One type is an egg parasitoid (so far only recorded from southern Tanzania), another type is an egg-larval parasitoid and the remainder are either larval or larval-pupal parasitoids. Two types live on the outside of armyworm larvae (ectoparasitoids) and the rest are endoparasitoids. As with many biological systems, there are also a number of other insects which parasitise the parasitoids!

Ants *(Formicidae)* may play an important part in the destruction of both the egg and larval stages and even newly emerged moths. The armyworm larvae are also preyed on by certain beetles.

Vertebrates

Most obvious predators are the birds, very many types feed on the larvae particularly during outbreaks. Sometimes the outbreaks themselves may be recognised by looking for concentrations of birds such as White Storks, Abdim's Storks or Marabou Storks. Such concentrations of birds may well play an important part in the regulation or even control of smaller outbreaks.

There is little information on other animal predators of armyworm larvae although baboons have been seen feeding on them. Shrews and other small mammals are likely to feed on emerging moths during the night.

Do natural enemies control armyworm?

Natural enemies may sometimes have a significant effect in controlling small, medium or even large outbreaks, especially if the latter are the result of continued breeding in the same area thus permitting a build up of parasitoid and predator populations. This is particularly true in the case of virus. As the moths are migratory (see below) and outbreaks are usually tens or even hundreds of kilometres apart, this type of control by natural enemies is normally unlikely.

Migration

How do armyworm move from one place to another?

African armyworm moths are able to fly tens or even hundreds of kilometres downwind during the hours of darkness. This migration may in some moths, last several successive nights before they land and lay eggs.

Within an armyworm outbreak area moths emerge from their pupae in large numbers over a period of up to twelve nights. The newly emerged moths quickly climb up nearby vegetation where they expand and dry their wings. It takes between one and two hours from emergence for the wings to be fully dry, thus allowing the moths to fly. Some moths may fly off directly on migratory flight although, in general, most will move into nearby trees causing the trees within an outbreak area to fill up with many thousands of moths by midnight on each night during the emergence period. For the rest of the night (from midnight to dawn) small numbers of moths may leave the trees at different times. Those moths which are still in the trees at dawn all take off together and hide themselves in dark, cool places within the area (such as under the bark of trees, clumps of grass and dry cow dung) for the duration of daylight. The moths that hide themselves this way will come out the following evening, briefly move into trees and then fly off on migration. Because of this behaviour of flying off on migration at different times of the night and emerging over a period of up to 12 nights, the moths are dispersed in time thus not forming swarms as can be seen with locusts.

When the moths take off on migration they may reach a height of several hundred metres above the ground where they meet winds which, because they are weak flyers, carry the moths off in a downwind direction. At this time the moths are further dispersed in the winds. The distance that the moths may travel on migration depends on several factors:-

(i) the speed of the winds
(ii) the length of time the moths fly in the winds on any one night
(iii) the number of nights individual moths fly before stopping to mate and lay eggs
(iv) the weather, particularly rainfall and wind conditions which may not allow the moths to travel any further.

Why are outbreaks associated with the rains? Because moths disperse in space and time downwind, for further outbreaks to be caused the moths need to be concentrated so that they may lay many eggs in one place. This concentration is achieved mainly by the moths being brought together in the air by wind convergences or eddies often associated with rain storms or the lee side of hills.

Although a proportion of moths migrating out from an outbreak emergence area may be re-concentrated, large numbers of moths will still be dispersed over a wide area producing low density populations of larvae which, because they are solitary form colouration, are not seen by the farmers. The moths resulting from these low densities may contribute to the next generation of outbreaks if they are concentrated later on.

First Outbreaks of the Season

Where do the outbreaks start? Armyworm, in low densities, survive and breed during the dry season in areas where grasses remain green, such as in the highland areas and, more especially, the coastal areas of Kenya, Tanzania and possibly, Somalia where it is hot and there are periodic showers during the dry season. These low density populations form the source for the first outbreaks (called "primary" outbreaks) when the rains arrive at the end of the dry season. The size of armyworm populations may increase rapidly particularly through a high rate of survival of young larvae on new flushes of grasses. Female moths may lay a thousand eggs each and, with generations approximately one month apart, populations may increase 10,000 fold in two months even whilst suffering a 90% mortality per generation. This level of mortality is similar to that found in the laboratory and it shows the potential for rapid population increase in grasslands from one solitary larva in one thousand square metres to ten gregarious larvae in one square metre within the span of two generations.

What favours bad armyworm outbreaks? Within eastern Africa, armyworm populations are at their lowest numbers in October. Poor rains during the short wet season from October to December in eastern Africa favour a subsequent population increase and first outbreaks of the season often occur in Tanzania or Kenya during November, December and January, frequently downwind from the coast by the first hills and high ground where early seasonal rainfall occurs and moths are concentrated. Moths which emerge in large numbers from these outbreaks are carried downwind and contribute to the spread of infestations causing further outbreaks (called "secondary" outbreaks) in subsequent generations at roughly monthly intervals.

Seasonal Movements

Since the armyworm moths are carried by the winds, the direction of spread of outbreaks is influenced by the seasonal prevailing winds as these are dominant for most nights that the moths are flying. The areas in which further outbreaks occur are usually places downwind

from the emergence areas where rain is falling at the time the moths arrive. Since the long rains in East Africa gradually move northwards through Tanzania, then Kenya, Ethiopia, Somalia and even reaching the Yemen, the monthly generations of armyworm outbreaks tend to show a gradual northward movement. Thus outbreaks may start in November in Kenya or Somalia or, more commonly, December in Tanzania and begin in the Yemen in June or July the following year, seven or eight generations later.

What time of the year are armyworm causing problems? The times of year outbreaks are regularly reported in the different DLCO member countries are as follows (full range of times shown in brackets):

Tanzania:	December-May (October-June)
Kenya:	November-June (October-August)
Uganda:	February-May (January-July)
Somalia:	November-December, May-June
Ethiopia:	April-September (March-November)
Sudan:	April-July (February-October)
Djibouti:	No confirmed outbreaks have been reported

Strategic Control

Can the spread of outbreaks be stopped? Strategic control is the name given to measures to prevent the spread of armyworm, particularly outbreaks, from one region or country to another. It is mainly directed against primary outbreaks which are critical with regard to their location and timing so that they are likely to be of major threat to early rainfall regions downwind.

It is now known that the spread of armyworm infestations through successive generations principally, or wholly, derives from the primary outbreaks of the season. By effectively controlling these outbreaks it may be possible to suppress the large upsurges of armyworm which ravage eastern Africa, thus considerably reducing both crop and pasture losses. Historically the majority of primary outbreaks occur in central Tanzania (usually in December) although the eastern side of the Kenyan highlands (Meru, Embu, Kitui) and sometimes on the coast of Kenya, can be of major importance (usually in November). Primary outbreaks have also occasionally been recorded in southern Somalia and southern Ethiopia. By recognising the areas where primary outbreaks are most likely to occur it is possible to monitor moth arrivals into these areas using pheromone traps which gives an early warning of outbreaks and improves the efficiency of control measures.

How can you help? However, quick reporting of outbreaks by farmers and agricultural staff is of major importance in being able to find and destroy the primary outbreaks.

Forecasting

Is there any warning of outbreaks? By understanding seasonal migrations of armyworm, their underlying causes and factors which lead up to outbreaks, it is possible to issue long- and short-term forecasts with warnings of the areas in which armyworm outbreaks are likely to occur.

Forecasts are based on information from a number of sources, the most important being networks of light and pheromone traps distributed over eastern Africa and operated nightly under the supervision of a trap operator. The records of the nightly catches are sent each week to the National Armyworm Co-ordinator and these trap catches indicate the current distribution and numbers of the moth population. To issue a forecast various other factors are taken into account, such as the incidence and extent of recent outbreaks of larvae (likely to give rise to further generations) and the current weather conditions, particularly the wind-fields which influence the direction of moth migration. In order to improve the accuracy of forecasts it is important that all outbreaks of larvae are reported without delay to one of the addresses given on the last pages of this pamphlet and to the local Agricultural Officer. Information required includes the exact locality, date the larvae were first seen, the area covered, the estimated average density (e.g. the number of larvae per square metre, square yard or per crop plant), crop attacked and whether controlled with insecticides. It is also important to collect a sample of not less than 50 larvae (pick up all larvae, not just the big ones), preserve them in methylated spirits or another preservative and put a label, written in pencil, inside the container giving the date collected, the locality and host plant. Send the sample by the quickest possible means to one of the addresses on the last pages of this pamphlet. Such samples are used in estimating the age of populations in the field and the probable date of emergence of the new generation of moths. Any observations on the presence of dead larvae (due mainly to viruses), predators (birds, flies, etc) or moths seen flying at night in large numbers, are also of value. Such information will do much to increase the efficiency of the forecast service and thus the effectiveness of control measures to save cereal crops, sugarcane and pasture grasses.

How can you help?

Control

How can they be controlled?

A number of different insecticides, in a variety of formulations, can be used effectively against armyworms. The choice of the material to be used will vary with the extent of the outbreak to be treated, with the equipment available for applying the insecticides and with the availability of the recommended insecticide(s). While DDT is still used in the control of armyworm outbreaks in parts of eastern Africa, there is the world-wide concern expressed in recent years about contamination of the environment by this very stable and persistent insecticide. Its use must therefore be limited. Similarly persistent compounds (e.g. dieldrin and endrin) have been used and are known to be effective against the armyworm but are also not recommended on account of their high mammalian toxicity. Other safer and faster acting materials (e.g. fenitrothion and cypermethrin) are increasingly being used.

Recent research on possible alternative insecticides to DDT has permitted identification of a variety of new compounds which are very effective against armyworms, safe to handle and of reasonable cost to the farmer. Some of these compounds are shown in Table 1.

The table lists the common trade name(s) and formulations of each insecticide, the recommended application rates and minimum safety period which must elapse between the time of application and harvesting or grazing by livestock.

What insecticide and equipment can be used by farmers?

Dusts

Small armyworm outbreaks can be controlled with dusts. For example, formulations of fenitrothion (3%), trichlorphon (5%), or other chemicals, applied without dilution to individual plants through the meshes of a small sack beaten with a stick or from a tin with a perforated lid. Pump, bellows or centrifugal dusters of different sizes may be purchased from local dealers.

Water dispersed insecticides

Larger scale outbreaks should normally be controlled using liquid insecticides. Emulsifiable concentrate (EC) formulations are usually diluted as Knapsack sprayers are used to apply the recommended quantity of insecticide per hectare (see Table 1). On a larger scale, these formulations may also be applied using vehicle or aircraft mounted boom and nozzle equipment.

ULV insecticides

Substantial improvements in speed and economy of operation and in reduced environmental contamination are now possible with ultra low volume (ULV) spraying methods. Special concentrated and non-volatile formulations are applied without dilution as very fine sprays using the wind for distribution and penetration of the crop. ULV spraying is usually carried out cross-wind to the target area. Some ULV formulations which may be available are listed in Table 1.

ULV spray equipment

ULV spray equipment which has been used successfully for armyworm control includes the following:

Handsprayers: ULVA (Micron and Turbair) battery operated hand-sprayer, capable of achieving an effective swathwidth of about 30 metres.

What other ways of spraying are there?

Vehicle mounted sprayers: The exhaust nozzle sprayer (ENS) mounted on a fourwheel drive vehicle utilises exhaust pressure to atomise and disperse the spray. It is capable of an effective swath-width of 60 (40-80) metres. It is not easily damaged, requires no additional power units or fuel and is moderately priced. Its lack of portability, fixed droplet-size range and alleged tendency to accelerate engine wear is considered a disadvantage by some. Recently, powered fan sprayers, utilising spinning discs or cages have been subjected to preliminary tests with a view to using them as an alternative to the ENS. These sprayers are more portable, do not affect engine wear and offer a greater choice of droplet size than the ENS. They are, however, more easily damaged, more expensive to buy and also to run since they require additional power units to drive the pump, fan and controls.

Aircraft spray equipment: DLCO-EA spray aircraft are fitted with rotary atomisers (Micronair) for ULV spraying. Effective swath widths achieved with these atomisers are in the range 100-200 metres.

Size of infestation and control equipment

Armyworm infestations vary greatly in size, from less than one hectare to several hundred square kilometres. Larvae feed rapidly and once they turn black they are readily noticed. Control measures have to be applied speedily to prevent serious crop and pasture losses. Table 2 provides a guide to the time needed to treat infested areas with the control equipment available. Dusters and knapsack sprayers are only recommended for small farms. Wherever possible drift spraying with ULV insecticide application is recommended.

Table 2

Size of outbreak	Control equipment	Estimated coverage per unit
<1-5 ha. Small plots, patchy outbreaks	Dusting tins Knapsack sprayers	1-5 ha/day 5 ha/day
Small and medium size farms 1-100 ha	ULVA sprayers	6 ha/h (30 ha/day)
>100 ha. Medium and large farms/rangeland	ENS mounted on landrover Aircraft	70-140 ha/h 1000 ha/h

Which equipment do I use?

The hand held ULVA is very versatile as several operators working together can treat a hundred hectares a day. A mobile unit consisting of Land Rover, several trained personnel, ULVA hand sprayers and insecticide, has been found most suitable for search and strike control operations in areas of mixed crops and pastures.

The exhaust nozzle sprayer is used primarily for pastures and rangeland grasses, and aircraft for large areas of cereal crops and rangeland. Some private farmers, control operators and state farms may have vehicle or aircraft mounted boom and nozzle sprayers used in conjunction with water dispersible insecticides. These require large volumes of clean water, regular maintenance and are slower and less economical than comparable ULV sprayers.

Control of outbreaks of armyworm is generally the responsibility of the national Ministry of Agriculture or, in some countries, the farmer himself. However, the Desert Locust Control Organisation for Eastern Africa (DLCO-EA), if requested by the government, assists in large-scale control campaigns by making available a spray aircraft and some exhaust-nozzle sprayers.

What level of infestation should be controlled?

As a rough guide, control should be applied where larval infestations exceed 2 per plant on crops up to 1m in height or 15 larvae per square metre on rangeland.

Marking of spray areas

In most ULV control operations it is necessary to have points of reference within or around the spray area to assist in spraying the

infestation evenly, and therefore economically. This can be done by marking the beginning and end of each intended swath run to give a series of parallel strips along which the spray is applied (drifted). This is relatively simple in most cases. However, in aerial spraying it is important that distinct markers are used. Ideally, there should be radio contact between the ground personnel and the pilot in order to resolve any misunderstandings as they occur. It is recommended that, at the beginning (downwind) of an infestation, a white flag is erected at each extremity, accompanied by pegged out squares of similar material measuring about 2 x 2 metres and placed horizontally on the ground. At the end of the infestation, yellow flags and squares of material should be positioned parallel to the white ones. The pilot can then distinguish the start from the finish and can use his aircraft guidance equipment to spray at the correct swath width starting from the 'white' line.

Safety

The following safety precautions should be observed when you are involved in any control operation:-

1. Store all insecticides under lock and key in their original packing and away from foodstuffs, living quarters and children.
2. Follow the instructions on the label or literature supplied with the insecticide:-
   a) for dilution and application
   b) for first aid and medical advice, if needed.
3. Wear gumboots, gloves, a hat or cap and overall for all spray operations. Thoroughly wash them at the end of each day.
4. Wash all exposed skin with soap and water immediately after spraying. Then take a bath or shower as soon as possible.
5. Avoid inhalation of any insecticide, whether liquid or dust. If insecticide is spilled on any part of the body, wash off immediately with plenty of soap and water.
6. Burn or bury empty containers. Avoid contaminating ditches, ponds or waterways. Do not smoke or feed while spraying and keep food well away from possible contamination.
7. Blood cholinesterase tests are recommended for operators engaged in large-scale control campaigns using organophosphate and carbamate insecticides which inhibit the activity of the enzyme cholinesterase. They should be carried out at the start of any large-scale or protracted period(s) of application work and be repeated at regular intervals, depending on the intensity of operations and handling exposure. The depression of blood cholinesterase enzyme is a valuable indicator of the degree of exposure to inhibiting substances, provided that the "normal" personal level of an operator is determined before exposure. It should be borne in mind that it is possible to have a depression of activity in the complete absence of external symptoms.

Addresses

Who should be informed?

Regional Armyworm Forecasting Officer
DLCO-EA,
P.O. Box 30023,
Nairobi.
Tel: 501719/04/94.
Telegrams: DESLOC NAIROBI.
Telex: 25510.

Djibouti

Ministere de L'Agriculture et du Developpement Rural,
B.P. 224,
Djibouti.
Tel: 351496, 351774.

or

DLCO-EA,
B.P. 1987,
Djibouti.
Tel: 353271

Ethiopia

Crop Protection and Regulatory Department,
Ministry of Agriculture,
P.O. Box 62347,
Addis Ababa.
Tel: 448040

or

DLCO-EA,
P.O. Box 4255
Addis Ababa.
Tel: 181475/77/64

Kenya

Armyworm Forcasting Service,
Kenya Agricultural Research Institute,
P.O. Box 30148,
Nairobi.
Tel: Karuri 32880/1-6.

or

Crop Protection Branch,
National Agricultural Laboratories,
P.O. Box 14733,
Nairobi.
Tel: 48474 or 48202.

Somalia

Plant Protection and Locust Control,
Ministry of Agriculture,
Mogadiscio.
Tel: 80157.

or

DLCO-EA,
P.O. Box 412,
Mogadiscio.
Tel: 80900.

Sudan

Plant Protection Department,
Ministry of Agriculture,
P.O. Box 14,
Khartoum North.
Tel: 33466.

or

DLCO-EA,
P.O. Box 328,
Khartoum North.
Tel: 33844/33862/34516.

Tanzania

Pest Control Services,
P.O. Box 7473,
Arusha.
Tel: Duluti 47 or Arusha 3855.
(TENGERU).

or

DLCO-EA,
P.O. Box 593,
Arusha.
Tel: Duluti 72.

Manager: Mr. Mika Ngalala
Res. Tel. 7926

Uganda

Chief Research Officer,
Ministry of Agriculture and Forestry,
P.O. Box 2,
Entebbe.
Tel: 20918.

or

DLCO-EA,
P.O. Box 9134,
Kampala.
Tel: 259907, 233107.

Table 1: A guide to some insecticides and their recommended application rates for armyworm control.

Insecticide		Water Dispersible Formulations		Ultra Low Volume Formulations		Minimum Safety Period
Common Name	Trade Name	Formulation & Concentration	Volume (litres) of formulation in 300 litres* of water	Formulation & Concentration	Volume (litres) of formulation per Ha	Weeks (w) or days (d)
Organophosphates						
Malathion	Kilpest	50% m.l. or	1.3-3.0	95% Techn.	1.25	1 w
	Cythion	50% e.c.	1.3-3.0	95% Techn.	1.25	1 w
Fenitrothion	Accothion	50% e.c.	1.3	96% Techn.	1.0	7-10d
	Agrothion	50% e.c.	1.3	96% Techn.	1.0	7-10d
	Folithion	50% e.c.	1.3	96% Techn.	1.0	7-10d
	Simbathion	50% e.c.	1.3	96% Techn.	1.0	7-10d
	Sumithion	50% e.c.	1.3	96% Techn.	1.0	7-10d
Trichlorphon	Dipterex	50% e.c.	1.0-2.0	250 ulv	2.0-2.5	7-10d
Phoxim	Volaton	50% e.c.	1.3	900 ulv	1.0	2 w
Chlorpyriphos	Dursban	48% e.c.	0.5	24% ulv	1.0	2 w
Quinalphos	Ekalux	25% e.c.	2.0	30% ulv	1.5	2 w
Tetrachlorvinphos	Gardona	24% e.c.	3.0	35% ulv	2.0	1 w
Pirimiphos methyl	Actellic	25% e.c.	3.0-4.0	500 ulv	1.5-2.0	1 w
Dichlorvos	Vapona	50% e.c.	1.5	-	-	1 d
	Nogos	50% e.c.	1.5	-	-	1 d
Carbamates						
Carbaryl	Sevin	85% w.p.	1.2	sulv-25%	2.5	1 w
Synthetic Pyrethroids						
Cypermethrin	Ambush CY	5% e.c.	1.0	2.5% ulv	1.0	2 d
	Ripcord	6% e.c.	0.85	2.5% ulv	1.0	2 d
	Sherpa	6% e.c.	0.85	2.5% ulv	1.0	2 d
Deltamethrin	Decis	2.5% e.c.	0.4	0.5% ulv	1.5	2 d
Fenvalerate	Sumicidin	7% e.c.	1.0	3.0% ulv	2.0	2 d
Permethrin	Ambush	10% e.c.	0.6	4.0% ulv	1.0	2 d

e.c. = emulsifiable concentrate;

w.p. = wettable powder;

m.l. = miscible liquid;

ulv = ultra low volume;

Techn. = Technical material

* This is the approximate volume of spray per hectare, in practice target spraying may enable the area covered to be increased.