FIELD AND LABORATORY EVALUATION OF SOME INSECTICIDES FOR THE CONTROL OF INSECT PESTS ON COTTON

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL
AHMADU BELLO UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF SCIENCE IN CROP PROTECTION

DEPARTMENT OF CROP PROTECTION
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AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

JUNE, 1998

DECLARATION

I HEREBY DECLARE THAT THIS THESIS HAS BEEN WRITTEN BY ME AND THAT IT IS THE RECORD OF MY OWN RESEARCH WORK. IT HAS NOT BEEN PRESENTED BEFORE IN ANY PREVIOUS APPLICATION FOR A HIGHER DEGREE.

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THE ABOVE DECLARATION IS CONFIRMED.

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CERTIFICATION

THIS THESIS ENTITLED "FIELD AND LABORATORY EVALUATION OF SOME INSECTICIDES FOR THE CONTROL OF INSECT PESTS ON COTTON" BY EUNICE ATTAH SATISFY THE REGULATIONS GOVERNING THE DEGREE OF MASTER OF SCIENCE OF AHMADU BELLO UNIVERSITY, ZARIA, AND IS APPROVED FOR ITS CONTRIBUTION TO SCIENCE KNOWLEDGE AND LITERARY PRESENTATION.

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DEDICATION

THIS THESIS IS DEDICATED TO MY DEAR HUSBAND WHOSE PRAYER AND ENCOURAGEMENT ENABLED ME TO COMPLETE THIS STUDY.

ACKNOWLEDGEMENT

I wish to express my profound gratitude to my Supervisors, Dr. I. Onu and Dr. M.C. Dike for their critical assessment of this research work.

I am grateful to Dr. A.D. Akpa, Professor V.B. Ogunlela, Professor A. Aduku, Dr. & Mrs. A. Adamu, Dr. L.E. Magani, Dr. & Mrs. J. Adeosun, Dr. Mrs. R.H. Daudu, Dr. A.A. Ojo, Mr. Emmanuel Aduku, Mrs. Afiniki Zarafi, Mrs. M.B. Balogun for their moral assistance.

My appreciation is also extented to all my coursemates and my office colleagues for their love and concern for this work. My thanks also to Mr. Bako Damina and Mr. Elias for their techincal assistance. My thanks also to the typist, Mrs Eriba for her kindness and sacrifice.

Gratitude is also expressed to my parents, Mr. & Mrs. J. Attah and my dear uncle and wife, Rev. & Mrs. D.M. Akwu and my dear sisters, Mrs. Franka Oduadu. Whose foresight, sacrifice and support has helped me to become what I am today.

Finally, my profound gratitude goes to my husband, Rev. Chimezie Okoroaofor for his patience, understanding and sacrifices throughout the long period of this study.

ABSTRACT

Experiments were conducted for two years (1992 and 1993) at Samaru (between 11° 11' N and 07° 38 'E); to:

1. evaluate the efficacy of different rates of insecticide application for the control of insect pests on cotton in the field and in the laboratory.
2. evaluate yield of seed cotton as affected by chemical control of insect pests.

The following insecticides were used: Polo 500 SE, Match 50% (insect growth regulator), Vertimec 1.8 e.c. (Avermectin) and Larvin 375 (thiodicarb).

All the insecticide treatments significantly reduced the insect pest population and percentage fruiting body damage compared with the control. Match, Larvin, and Match + Polo were found to be most effective in the control of insect pests of cotton - considered in this study. Vertimec treatments had more fruiting body damage during the spray-period (9-14 weeks after sowing) than Polo, Match, Larvin and Mixture of Match + Polo treatments.

Seed cotton yield was higher with Match and Larvin in 1992 and 1993 respectively.

The efficacy of four insecticides was evaluated in the laboratory at two rates on Dysdercus volkeri at 5 hrs, 24hrs, 48hrs and 72 hrs after spraying. Among the insecticide treatments, Polo, Match, Larvin were most effective on Dysdercus volkeri at 24hrs after spraying than Polytrin. Effectiveness of the insecticide rates evaluated commenced at 24 hrs after spraying with the exception of polytrin (Cypermethrin + Profenofos) which showed effectiveness at 48 hrs after spraying.

There was a significant difference (P = 0.05) between the insecticide rates screened at 5 hrs and 24 hrs after spraying.

Polo treatments had the highest mortality rate at 24hrs after spray while polytrin treatments had the least mortality. Match and Larvin treatments induced the same level of mortality in Dysdercus volkeri at 48 hrs but at 72 hrs, that of Match became higher than Larvin alhough the difference in their mortality rate was not satisfically significant (P = 0.05).

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ABBREVIATIONS AND SYMBOLS

WAS	-	Weeks after Sowing
ANOVA	-	Analysis of variance
LSD	-	Least Significant Difference
N.S.	-	Not Significant

Chemicals *(Field trial)*

C1	-	Polo
C2	-	Match
C3	-	Vertimec
C4	-	Larvin
C5	-	Match + Polo

Treatments

T1	-	Concentration 1
T2	-	Concentration 2
T3	-	Concentration 3
T4	-	Concentration 4
T5	-	Concentration 5 (Control)

Chemical *(Laboratory Trial)*

C1	-	Polo
C2	-	Polytrin
C3	-	Larvin
C4	-	Match

T1	-	Concentration 1
T2	-	Concentration 2
T3	-	Control

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CHAPTER 1

INTRODUCTION

Cotton (Gossypium hirsutum L) is the world's most important fibre crop, and is grown on more than 30 million hectares of land in some 80 countries (Huffaker, 1980). Cotton is grown in almost every country between Latitude 40° N and 30° S. However, the majority of cotton crop (over 80% of total production) are grown between Latitude 40° N and 20° N (Rosier, 1990). This belt includes the principal producing areas of China, India, Pakistan, the U.S.A. and Russia. These five countries and Brazil account for a little over 75% of the global cotton crop.

In Nigeria, cotton is grown mostly in the North of Latitude 7° 30' North. Areas where cotton is produced in the Northern states include:- Niger, Borno, Kaduna, Kano and Kwara. Faulkner (1973) reported that the Northern zone produces about 60% of the cotton crop, while the eastern zone produces about 40%. Cotton is an important raw material for textile industries.

It is also an important contributor to the economy of many developing countries. The yield of cotton per unit area in 1980 and 1270 kg/ha in the world; 888kg/ha in Africa and 189kg/ha Nigeria (Anon, 1980). A number of factors are responsible for the low production levels of cotton in Nigeria. These include late planting, inadequate fertilization, insects, disease, weeds and management problems. Thus, the textiles are faced with problems because as the cost of man-made fibres continues to rise, the demand for cotton will continue to be on the increase.

The domestic demand for cotton exceeds theaggregate production, and the estimated consumption for 1981-1982 season was 938,090 tonnes whereas

the production for that year was only 260,000 tonnes with a net deficit of 678,090 tonnes (Gusau, 1981). Until recently, Nigeria was an important exporter of seed cotton but production has progressively declined from 185,000 tonnes in 1971 to 90,000 tonnes in 1980. Areas devoted to the production of this crop has also decreased from 0.6 million to 0.3 million hectares (Gusau, 1981). Rosier (1990) reported that cotton lint is a basic raw material for textiles while cotton seed yields an edible oil which is used in salad, cooking oil, and in margarine production. The residual oil cake is a source of high protein for animal feeds.

The cotton plant is attacked by many pests including insects, bacteria, fungi, nematodes and weeds. In areas of the world where cotton is produced, there are major insect problems and the technology for control of these pests in most areas depend on heavy use of costly insecticides. The major factor affecting agro-chemical use will continue to be insect resistance problems. Therefore, controls will be introduced to limit over use of insecticides and to encourage the adoption of Integrated Pest Management (IPM) programmes.

The use of natural synthetic insecticides and insect growth regulators may help solve the problems of resistance in insects in the future if they are judiciously used. Various chemical trials have been carried out on cotton insect pest. This study was designed with the following broad objectives:-

(1) To evaluate the efficacy of different rates of insecticides for the control of insect pests on cotton in the field and in the laboratory.

(2) To evaluate yield of seed cotton as affected by chemical control of insect pests.

CHAPTER 2

LITERATURE REVIEW

2.1 Area of Production in Nigeria

Cotton belongs to the family malvaceae and is the world's most important fibre crop (Huffaker. 1980). Commercially cultivated cotton in Africa is belived to have originated from introduction of the new world species as well as from the development of Barbadense cotton in Egypt in the 19th Century (Pearson. 1958).

In Nigeria, the Ishan type of cotton, G. barbadense is grown in the South, while the upland cotton, G. hirsutum is grown in the North (Hayward. 1967: Irvine, 1969). In Nigeria only 0.5% of the country's total acreage is devoted to cotton growing (Rene,1988). The bulk of the cotton crop grown in Nigeria is under rain fed (Faulkner, 1974).

The main centres of cotton production Nigeria are located North of latitude 7^0 North, a region characterized by pronounced fluctuations in seasonal rainfall distribution (Anon, 1976). The rainfall lasts from May to September with a rainfall of 600-750 mm per annum.

2.2 Factors Limiting Cotton production in Nigeria

Many reason have been advanced for the low cotton yield and declining production in Nigeria. These include damage by insect pests. Insects reduce cotton yield and transmit rot causing organisms (bacteria and fungi) (Choyce, 1966; Hayward. 1967). Another factor is the non adoption of recommended practices such as use of fertilizer and insecticide for cotton production (Anon, 1976; Kumar and Ogunlela, 1991). Finally, cotton competes for farmers time

with food crops such as millet, cowpea, sorghum and groundnut during the growing season (Faulkner, 1973, Anon, 1976).

2.3 Arthropod Pests of Cotton

Cotton is susceptible to attack by a wide range of insect pests (Hargreaves, 1948). Hargreaves listed 1,326 species of insects as pests of cotton, 482 of which were recorded in African. Out of the 482 insect species. Only 150 are pests of significance on cotton (pearson, 1958). Pearson reported Helopeltis sp and Dysdercus spp., Bemisia spp., Diparopsis spp., Cryptohlebia spp., Helicoverpa spp., as the principal pests of cotton in the most equatorial region to which Nigeria belongs. Libby (1968) reported about 20 insect species as pests of cotton in Nigeira, and regarded the mirids (Helopeltis spp.), the cotton stainers (Dysdercus spp.) and the bollworms as the major pests.

Helopeltis schoutedeni Reut, Cryptohlebia leucotreta Mayr and Dysdercus spp. are the major pests to the more humid South, while Diparopsis watersi Roths and Dysdercus spp. are the most important insect pests to the North (Libby, 1968; Caswell and Raheja, 1977). Although Helicoverpa armigera and Cryptophlebis leucotreta have also been reported to be of increasing important in Nigeria (Annon, (1983). Based on the phenology of the cotton plant, insect pests of cotton could be conviniently catagorized as pests of vegetative phase and reproductive phase, although some pests in the absence of their preferred feeding parts may utilize the available plant parts.

2.3.1 Pests of the Vegetative Phase

Pests that feed on the young seedlings and leaves of cotton at the early vegetative growth period are known as the pests of the vegetative phase although these pests extend their feeding on the leaves even at the reproductive phase of cotton plant. These pests can affect the establishment of the crop and the basic framework of individual plants and so control of these can be important otherwise subsequent fruiting may be restricted. Matthews (1989) reported that the severity of these pests varies considerably between seasons and localities. The vegetative stage of cotton is characterised by luxuriant growth of plants that render them attractive to certain categories of insect pests that include the following: Cotton leaf roller (Sylepta derogata), the cotton whitefly (Bemisia tabaci), aphids (Aphis gossypii), jassid (Empoasca facialis), leaf beetles (Podagrica spp and Syagrus spp.) Mirids (Campyloma subflava) (Libby, 1968; anon 1976; Mathews, 1989).

(i) Sylepta derogata F. (Cotton leaf roller:) (Lipidoptera, Pyralidae) which caused leaf rolling, is caused by the gregarious larvae which are light green with dark head capsule and two dark brown spots on the thoracic. The larva lives within the rolled cotton leaf and feeds on the epidermis from within (Libby, 1968). Heavy infestation on plants causes defolation which results in premature boll ripening and impaired bud formation. It is also attacks okra, tomato and egg plants.

(ii) Bemisia tabaci Genn (Cotton whitefly). The whitefly B. tabaci (Homoptera: Aleyrodidae) affects cotton production by transmitting the leaf curl virus dieases and they may also produce honey dew which

contaminates the lints, decreasing plant growth. The leaf curl disease is more severe on G barbadense (Ripper and George. 1965).

(iii) Aphis gossypii Glover (Homoptera: Aphididae): Aphids attack cotton as early and late season pests in Nigeria (Libby, 1968; Raheja, 1981). Aphis gossypii is the main aphid pest of cotton. Nymph and adult colonies develop on new growth of shoots and leaves. Feeding on them and causing curling of the leaves and stunted plant growth. Aphids secrete some honey of dew, which apart from staining the lint. also enhance fungal growth and makes picking operation messy (Usenbo, 1980 and Raheja, 1981). Natural enemies of Aphis gossypii include the lady bird bettle, Platynaspsis ferruginea (Coleopetra: Coccinelidae), spiders (Usenbo, 1977) and ants, Camponotus acvapimensis Mayer (Hymenoptera: formicidae) (Anon, 1983).

(iv) Jacobiella Fascialis Jacobi (Jassids (Hemiptera: Cicadellidae). Two common cicadellids, Empoasca dolichi Jacobi are important pests of cotton in Africa (Pearson, 1958). The genus Empoasca of the family Cicadellidae, has been revised so the most species in Southern, Equatorial and West African, Empoasca Fascialis (Jacobi), is now Jacobiella Fascialis Jacobi as reported by Matthews (1989). The Nymphs and adults attack seedlings and feed on the leaves as they suck out the sap. In addition to sap loss. They cause the hopper burn sympotom on leaves. Attacked leaves show pale yellow margins which turn red colour and roll downward. Turning brown as if scorched. In severe cases leaves and buds are shed (Libby,

1968) and the bolls may be shed or produce immature lint (Matthews, 1989).

(v) Leaf Beetles (Coleoptera- Chrysomelidae): The leaf beetles include. Podagrica sjostedti (Jacobi) commonly refered to as the flea beetles and Syagrus calcaratus F. all of which are early season pests of cotton. The adults make feeding holes in the leaves. While the larvae feed on the roots. Egg plants and okra are also hosts of these pests (Libby, 1968; Anon, 1976).

(vi) Mirids (Heteroptera: Miridae:) Mirid pests of cotton include Lygus voselleri Popp., Campyloma subflava Odhiambo and C. anguistor Poppius (Pearson, 1958; Lyon, 1972). Campylomma spp. are prevalent on cotton fields in Nigeria, where the adults and nymphs feed on the growing point and new growth tissues of cotton plants, causing leaf tattering and flower bud shedding during the reproductive phase of its growth. Plants with heavy infestations are notably tall with poorly developed sympodial branches (Lyon 1972; Raheja, 1981). Peak population occur between August and September.

(vii) Other important foliage pests include the grasshoppers (Orthoptera: Acrididae) which damage young seedlings and cause complete defoliation that can reduce the number of plants in the field by over 50 percent: Thrips (Thysanoptera) which feed on the growing points of young seedlings causing the upper surface of leaves to turn brown. The cutworms. Spodoptera littoralis (Boisduval) Lepidoptera; Noctuidae cause damage to young seedlings.

2.3.2 Pests of the Reproductive phase

The reproductive phase of cotton plant starts at flowerings and extends to boll formation and maturation. The reproductive phase in cotton growth such as the flowering, square and boll formation stages are the most critical stages in cotton pest management (Lyon, 1972; Caswell and Raheja, 1977). Insect pests of this phase are the bollworms and plant bugs. Dysdercus volkeri Fabricius and - Dysdercus fasciatus Signoret. Ridgeway (1984) reported that the principal pests of cotton are the bollworms.

Bollworms: The term bollworm is applied to a number of moth species, the larvae of which damage the developing cotton squares and bolls. The fruiting bodies (flower buds or squares, flowers and bolls) are attacked by bollworm in Nigeria (Choyce, 1966; Lyon, 1972). The bollworm insect pest are - Diparopsis watersi Roth (Lepidoptera; Noctuidae); Pectinophora gossypiella Saund (Lepidoptera; Gelechidae), Cryptophlebia leucotreta Meyr, Earias insulana Boisd, E. biplaga Walk (Lepidoptera: Noctuidae). The spiny bollworm attack the squares and the red bollworm attack young bolls. They both occur earlier in the season than the other bollworms.

(i) Diparopsis watersi Roths (Red bollworm): D. watersi is a major pest of cotton in the cotton growing areas of the world (Pearson, 1958). It is the most important bollworm in terms of population, incidence and level of damage of cotton in northern Nigeria (Caswell and Raheja. 1977), although recent pest surveys have indicated the increasing importance of H. armigera and Cryptophlebia leucotreta (Anon, 1983).

Damage to the cotton crop is caused by the larvae, which fed on flower buds and bolls, or occasionally on mature bolls, which are consequently shed (Libby, 1968: Matthews. 1989). The larva completely enters the buds and green bolls. Using the excrement to block the entrance hole from within, while it feeds on the contents of the buds and bolls. The larvae are red, later becoming green with red markings. It has a red head capsule and a black prothoracic shield.

Its natural enemies in the field include: Carcelia evolans Wied (Diptera: Tachnidae). Apanteles spp and Bracon brevicornis Wesm (Hymenoptera: Braconidae) (Pearson. 1958; Libby, 1968).

(ii) Pectinophora gossypiella (Pink bollworm) Pectinophora gossypiella is a primary pest of cotton growing area of the world (Pearson., 1958). Damage to the green boll is caused by the larvae, which feed on the seeds, eating out the kernel and damaging the immature lint. In heavily infested field, many bolls are damaged and they may fail to open or at best open prematurely with very dirty lint. Athough a major pest of cotton, it is only of primary importance in more humid cotton fieLds of Southern Nigeria (Libby, 1968; Raheja, 1981).

(iii) Helicoverpa armigera (American bollworm): Damage to cotton plants is caused by the larva which feeds on the buds and flowers and consumes their contents. H. armigera is one of the major pests of maize, tomato, tabacco, citrus and vegetable (libby, 1968). The larvae vary in colour from green to brown or black, with alternating dark stripes and a mid-dorsal line

which runs the length of the body. Attacked buds and young bolls are shed with neat round entrance holes (pearson. 1958: Libby. 1968).

The larvae is a polyphagous feeder which moves about the cotton plant considerably, thus damaging many fruiting bodies (Ripper and George. 1965). H. armigera infestations originate from alternative dry season hosts as it has no diapausing pupae (Lyon. 1972).

(iv) Cryptophlebia leucotreta (False codling moth): Cryptophlebia leucotreta is one of the major pests of cotton in Africa (pearson. 1958). In Nigeria, it is a late season pest and occurs at the end of the rainy season in the main cotton growing areas (Anon. 1976). In the more humid southern cotton fields, it is the most injurious bollworm (Libby, 1968). The insect attacks the mature green bolls. The body of the larva is green coloured with shinning dark spots which give it a spotted appearance. The younger larvae feed almost entirely inside the boll wall, while the older ones penetrate the boll cavity to feed on the developing seeds and lint.

(v) Earias spp. (Spiny bollworm): Two species, Earias biplaga Wlk and E. insulana Boisd are recorded as being major pests of cotton in Nigeria. Earias insulana is common in the north while E. biplaga is commonly found on cotton plants in the southen part of Nigeria where it is a also found as pest of cocoa (Libby,1968). Raheja (1981) reported E. biplaga as an early season pest which occurs at the beginning of the wet season and E.insulana as a late season pest which occurs at the end of the wet season. The larvae which does the damage is stout, spindle shaped, with characteristic long hairs and two pairs of fleshly spines on each segment. It attackes buds,

flowers and unripe fruits (Libby, 1968; Raheja, 1989). Unlike other bollworms, its lavae has a marked propensity for stem boring, resulting in the wilting of growing point and poor plant growth (Ripper and George 1965). Attacked buds and unripe bolls are shed. Its population on the field are attacked by parasites and predators like Apanteles diparopsidis Cyle. Phanerotoma hendecasisella cam. (Hymenoptera: Braconidae) and Rygchium Ventrale Sauss (Hymenoptera: Eumenidae) (Pearson, 1958)

COTTON PLANT BUGS:

(1) Cotton Plant Bugs: Dysdercus volkeri (F) (Cotton stainer) (hemiptera: pyrhocoridae): there are about ten species of the genus Dysdercus in Africa nine of which are pests of cotton (Pearson.1958). However. D. volkeri and D. faciatus are the only spices recorded as pests of cotton in Nigeria (Libby, 1968). The cotton strainers also feed on maize, millet, sorghum, rice, cowpea, sugar-cane, tomato and okra(Libby, 1968).The nymph and adult with a reddish body, marked with white, responsible for the damage which may be direct. and indirect. The main damage which is direct, is the injury done to the developing seeds.

Secondary damage, which is indirect, is the transmission of nematospora fungus which causes boll rot and lint staining. Dysdercus spp feed on the sap of cotton bolls which results in bud shedding and abortion of young boll (Lyon, 1972). C otton stainers breed profusely on the later stages of the cotton crop. The young nymphs feed on seeds in newly opened bolls, while the older nymphs and adults feed on both green and open bolls (Libby, 1968; Lyon, 1972). Natural enemies of Dysdercus spp. on the field

are Apantelles diparopidis Lyle; Bogosia helva Wied (Hemiptera: Sarcophagidae) Phonoctonus lutescens (Hemiptera; Reduvidae) (Pearson, 1958).

(2) Helopeltis schoutedeni R. (Hemiptera: Miridae) is an important pest of cotton in most areas of the tropics. They are slender insects, the nymphs and adults resembles mosquitoes. With long legs and antennae that are twice as long as the body, the nymphs and adults attack the shoots, and green bolls. The shoots became disturbed while attacked bolls open prematurely. It was reported to be a major and common pest of cotton in the more humid south but not commonly found on cotton in northern Nigeria (Libby, 1968, Anon, 1983).

2.4 Strategies for the Control of Insect Pests on Cotton

The range of pests damaging cotton crops is so extensive that farmers must use more than one tactics to reduce their economic effect. Each tactic has to be as compatible as possible with their control measures and integrated into a pest management programme (Matthews, 1989). Many farmers have relied almost entirely on chemical control but problems of pesticide resistance and concern about environmental pollution have led to a reappraisal of the benefit of cultural and biological controls, and the need for integrated pest management (Kumar,1984). Chant (1964) defines strategy as "general approach to control, including decisions on which method should be used. In Nigeria, control strategies implored include the use of chemicals, cultural and varietal resistance control.

2.4.1. Varietal Resistance:

Pubescent varieties are resistant to Jassid and Pink-bollworm (Smith et al, 1975). Smooth-leaf variety that is resistant to Jassid would be advantageous, especially in areas prone to both Jassid and Whitefly infestation (Agarwal et al, 1978). Glabrous leaf combinedd with the absence of extra-floral nectaries was shown to have an additive effect and reduce the numbers of pink-bollworm larvae found on cotton plants (Wilson and Wilson, 1976). The nectariless character is also a source of resistance to Helicoverpa armigera (Lukefahr et al, 1975). However, resistance to Helicoverpa spp. is probably more effective with varieties containing high levels of gossypol and tanin (Lukefahr, 1982). Varietal selection need to be carried out in periods of the season. appropriate to the pest being condidered without insecticide protection.

2.4.2 Cultural Control:

Cultural Control of insect pests is effected by the mainpulation of the enviroment in such a way as to render it unfavourable to the pest (Dent, 1977). Cultural pratices include close season, use of trap crops, intercropping, cotton date of sowing and harvesting, use of quarantine zone, good husbandry, cropping system, plant density, destruction of alternnative host and volunteer plants. But of these, close season is the most important and widely used (Matthews, 1989). Close season should last at least two months between harvesting and showing of next crop.

Outbreak of pink bolloworm (pectinophora gossypiella in Malawi when close season was not observed was reported (Matthews et al., 1965). while in

Zimbabwe it checked Diparopsis infestations and also prevented the establishment of pink-bollworm. In Nigeria, the close season is practised to check diapausing bollworm complex (Apeji, 1992; Kumar, 1984). In U.S.A, it was reported that 76 -83% of the pink -bollworm larvae in infested cotton debris are killed by burying the material (Adikisson et al, 1964). Crop rotation prevents the build up of insect pests. Generally crop rotation is most effective against insect that have a narrow host range (Wright, 1984). A new generation of an insect pest that may have overwintered in the vicinity of its host crop will be faced with different non-host crop plant in subsequent season. Sowing data may play an important role in cultural control varying the planting time of crops works as a means of cultural control by creating a synchrony which can retard the rate of colonization (Ferro, 1987) reported by Dent (1991) or that the pest fails to coincide with critical crop growth stage. Ripper and George (1965) reported that early planting helps decrease the incidence of pink boll-worm and the spiny bollworm.

Plant density has influence on population of insects. In general, an increase in plant density i.e a reduction in plant spacing, reduces insect pest numbers (Farrell, 1976) but not in all cased (Mayse, 1978). Crops in intercropping system reduce the incidence of insect pest attack (Tingey and Lamont, 1988) and thereby maintain lower pest control costs. In Nigera, cotton is intercropping with cereals like millet and sorghum in the North (Baker, 1979) while in the South, it is intercropped with maize (Usenbo, 1977).

The use of trap crops in cottton field reduces insect pest population. Robinson et al (1972) reported in Oklahoma that sorghum appears to be the

crop with good potential for strip cropping with cotton as the predators were more frequent on sorghum. In china, maize is planted along the edge of cotton fieLSD to attract second generation Helicvoerpa month, while in the Philippines signle rows of maize or tobacco have been recommended in integrated control programmes (Hasse, 1986).

2.4.3 Biological Control

A very large number of parasitoids and predators have been recorded in cotton fieLds (Frisbie 1983) and often significantly reduce the pest populations or prevent insects causing economic damage. Ants, conccinellids, syrphids, lace wings, and spiders are particularly important, predators, but their populations are often not adequate, especially at the time of peak of flowering which coincide with periods of rainfall (Leigh, 1985; Matthews, 1989). In consequence, yieLds are generally very low if farmers rely entirely on natural controls.

Biological control is more likely to succeed by augumentation of natural enemies each season either once or by several release referred to as the inundation technique (Ridgeway and Vinson; 1977). Natural enemies such as Green lacewing, Chroysopa carnea is a main predator of white-flies. According to Butler & Henneberry (1988) the larvae feed on the whitefly nymphs. There are also a number of natural enemies of Aphis gossypii. Aphis gossypii is preyed on by Coccinella septempuncata Bruckii (Coleoptera: Coccinellidae), (Nozato & Toshio, 1988) and Coccinella undecimpuncta (Belikova & Kosaev, 1985).

Sex pheromone as traps has been used in biological control. Pheromone mixed with insecticide, lure the insects into the trap (Matthews, 1989). This is used for monitoring moth population. The number of insecticide treatments was significantly less when pink bollworm control was based on pheromone trap data (Toscano et al., 1974). An alternative to pheromone trap is the oil trap. This trap can hold up to 2000 months. Spraying is recommended 1 - 2 days after catching eight moths per trap per night (Taneja and Jayaswal, 1981). Five traps per hectare reduced the mean number of egg masses by 77 percent (Campion, 1983). Boll infestation due to Earias have been reduced using five traps per hectare (Meveigh et al., 1979).

Another strategy of control is the confusion technique. The aim is to permeate the atmosphere with a significiently high concentration of the pheromone from many point sources over a period of several weeks to confuse the insects. This has led to the development of micro-capsules (Campion, 1976). The main advantage of the micro-capsules is that they can be applied with conventional sprayers. Micro-encapsulated formulation at 5 - kg / ha disrupted Pectinophora gossypiella mating for 2 - 3 weeks (Hall et al., 1982). Where labour is readily available, hand tying large plastic dispensers containing two or more pheromone is another possible way of using this control technique (Critchley, et al., 1987). Using 1000 dispensers per hectare containing 78 mg gossyplure enabled the number of insecticide treatments to be reduced by 41 percent compared with neighbouring plots (Staten, et al., 1987).

Disruption with pheromone is most likely to be successful with insects that have restricted host range plants e.g. P. gossypiella, Diparopsis watersi, Earias insulana (Marks et al., 1978, 1981; Campion, 1984) and also a restricted flight range. The use of pheromone mixed with a relatively low rate of insecticide usually, a pyrethroid has been reported effective in California. Male pink bollworm moths attracted by the pheromone are killed by contact with the insecticide (Anon, 1984), a technique referred to as 'lure and kill'. In Nigeria, the use of light trap for catching of cotton stainer and adult red bollworm was reported by Hayward and Beeden (1973). Mating disruption with pheromone or mass trapping is important in IPM programmes because beneficial insects are more numerous compared with areas treated with insecticdes.

2.4.4 Chemical Control:

High yield can only be sustained in majority of cotton producing contries if there is also judicious use of insecticides. Maximum protection is now possible with a considerable reduction in the amount of insecticide required (Watson and Fullerton 1969). Timing of insecticide applications could be achieved by considering scouting of insects in cotton field. Cotton crop should be inspected at least weekly prior to first flower buds to ensure that Jassid infestations are not suppressing plant development. In Pakistan, 2 Jassid per leaf is regarded as the economic threshold (Ahmad et al., 1986). In Sri Lanka, an action threshold of 5 damaged flower buds (squares) per 30 plant 7 - 10 WAS and then 6 damaged bolls per 30 plants for the same period 11-18 "WAS" was proposed by Keerthisinge (1982). Economic threshold

needs to be as high as possible to minimise the risk of too many apoplications each season, and reduce selection of populations resistant to insecticides and acaricide. Some insecticides are developed to reduce the problem of resistance. Such insecticides include avermectins, pyrethroids, thiodicarb, insect growth regulators.

Chemical Insecticides:

The majority of chemical insecticides consist of an active ingredient (the actual poison) and a variety of additives which improve the efficacy of its application and action.

Organo-phosphates:

The fast breakdown of organo-phosphate inseticides is an advantage and it means that the timing of application is critical to ensure an efficient kill (Dent, 1991). They therefore require an effective monitoring of action threshold strategy in order to ensure timely application and maximum economic return. A large number of organo-phosphate insecticides have systemic action that is particularly effective against phloem feeding insects, many also have effective contact and stomach action. The organo-phosphate includes parathion, malathion dimethoate, dichlorves, phorate, monocrotophos, prefenofos.

Pyrethroids:

The most effective and safe natural insecticides are those drived from the flowers of Pyrethrin cinearaefolium and their synthetic anatogues, the pyrethroids (Barlow, 1985). Synthetic prythroids have extremely high contact activity and are particularly effective against Lepidopterous Larvae (Kings and Sanders, 1984) as reported by Dent (1991). They have low persiistence and

hence require appropriately timed application. They are also effective at very low doses. Most of the pyrethroid but not all have a very low mammalian toxicity (Elliott et al; 1978). Examples of pyrethroid are cypermethrin, *permethrin, fenvalerte, deltamethrine*.

Insect growth Regulator:

The majority of compounds that make up the new class of insecticides known as insect growth regulators are the result of research on insect juvenile honrmones (Staal, 1975). Some growth regulators produce only or mainly juvenile honrmone type responses. The juvenile hormone are present during the larval stages at each moult to prevent the insect maturing (Bowers, 1971). The juvenile hormones have proved to be eminently suitable as insecticides. Examples of insect growth regulators are TUREX and MATCH.

Microbial insecticides:

Microbial insecticides tend not to have an immediate effect. Nevertheless the entomopathogens that are used in microbial insecticides are classed as quick damage pathogens (Fuxa, 1987). They are capable of inhibiting further feeding by the insect within a short time, often within 24 hours of uptake, although the insect may actually take a few days to die. Most microbial insecticides are host specific unlike broad spectrum insecticide. Attention has now been focused on the avermectins which are extremely active compounds derived from the mycelia of streptomycetes avermitilis (Picket, 1984).

However, the avermectins are toxic to mammals. The avermectin is an active ingredient of vertimec. Vertimec (avermectin) is a new and unique product for cotton harmful mites and selected insects on a veriety of crops. It is highly effective as a contact and residual acaricide against tetranychid spider mites. Avermectin provides long residual activity (usually up to 30 days or more).

Thiodicarb:

Larvin brand thiodicarb insecticide is a highly effective oxime carbamate insecticide that can provide outstanding control of most economically signifficant lepidoptera, coleoptera and certain diptera and homotera insect pests attacking cotton, soybean, corn (maize), grapes, fruits, vegetables and many other crops. Thiodicarb has a relatively narrow spectrum of activity which makes it ideally suited to insect pest management prorammes. There is minimal adverse impact on benedicial arthropods, parasites and predators. Thiodicarb has outsttanding ovicidal action against the eggs ;of many insect pests and also larvicidal activities with proper application and timing. It acts as stomach toxicant with complementary contact action.

Several compounds are reported to exert good control of whitefly. These include fenpropathrin, cypermethrin, pirimiphosmethyl, decis (Nazer & Sharaf, 1986). These compounds are more effecti ve when used in conjuction with another compund, a synergist. Ishaaya & Ascher (1984) used Cypermethrin synergised with monocrotophos to control whiteflyon cotton. Debra & Hodkinson (1989) reported that the successful insecticides against cotton

whitefly and aphids are characterised by moderate to long term chemical stability. They have low stability but systemic action. Examples are mevinphos, aldicarb, carbaryl, chlorfenrinphos, endosultan. These systemic chemicals are applied to the soil and taken up by the plants and translocated to the leaves. Ground application of insecticides usually achieves a much greater degree of whitefly control.

Aldicarb (Temiks (s) , a relatively expensive soil applied granular systemic insecticide with a relatively long efficacy period has been widely used with success against whitefly (chaudhary et al. 1981; Reynolds et al. 1983). Carlson & Mohammed (1986) showed that switch to aldicarb use in Sudan reduced whitefly population, increased cotton quality, increased yield and decreased the need to use other insecticides.

Bodhade et al. (1987) examined the residual toxicity of nine synthetic insecticides against Aphis gosssypii. Monocrotophos, dimethoate and formothion were found to be most effective. He also reported that emulsions and foliar sprays of soybean and cotton seed oils in green house studies reduced both adults and nymphs of aphid and whitefly. Vertimec (avermetin) has been evaluated as cotton insecticide at the rate of 11 - 33 gai/ha and was shown to be active against Helicoverpa and Tetrancychus (wright, et al. 1985)

Synthetic pyrethroid has been used to control insects on cotton. Judicious use of this group of insecticides will avoid resistance by cottton insects. Hasse (1986) reported that only one generation of bollworm is exposed to this group of insecticides as strategy to reduce selection of resistant population. The pyrethriod/organophosphate mixture were selected to control both

bollworms and sucking pests (All et al., 1977), Ishaaya and Ascher (1984) used Cypermethrin synergised with monocroptophos to control whitlefly on cotton Insect growth regulators as insecticides have little impact on natural enemies They interfere with the moulting process by inhibiting the biosynthesis of Chitin (Bull et al, 1983). Application of insect growth regulator mixed with an organophosphate insecticide controlled Bemisia nymphs. Reports have shown that chemical protection of cotton crop using insecticides has remained an important component of pest management programmes geared towards increased cotton production. Kumar and Ogunlela (1982) observed that yield increases resulting from early planting. , use of fertilizers and herbicides are dependant to a large extent on the efficiency of pest control

Investigations into the use of insecticides for the control of insect pest of cotton in Nigeria date back to 1949 (Choyce, 1957). Such early trials in main cotton growing areas of Nigeria were designed to control the Bollworms, particulary the red Bollworms, (diparopsis watersi), a major pests of cotton which passed the dry season as a dispausing pupa (Lyon, 1972). Insecticides used in Nigeria for cotton insect pest control include DDT, BHC DDT/BHC mixture, aldrin, chlordane (Choyce, 1957 and 1966; caswell, 1973). Others are endosulfan, carbaryl, monocroptohos and synthetic pyrethroid like cypermethrin and decamethrin (Caswell and Raheja, 1977). Six sprays at weekly intervals, stating from the 9 - 10th week after planting with 5.6 litres of DDT or BHC and 1.1kg of carbary wetteable power in 225 litres of water per hectare have been recommeded and use to control insect pests of cotton

in Nigeria (Anon 1976, Raheja. 1981). Chaudry (1982) observed that monocrotophos and endosulfan at 3 litres/ha were effective against some of the Bollworms, and had no marked effect on the incidence of cotton stainer and Helicoverpa armigera. Due to the high mammalian tocicity and persistence of the early insecticides such as DDT and Lindane. The trend in pesticide usage in Nigeria is geared towards the use of the relatively safe synthetic pyrethroid combine and Decamethrin (Caswell and Raheja, 1977). Synthetic pyrethroid combine high insecticidal activity with low mammalian toxicity. They have an additional advantage of a rapid knockdown effect. Compared with DDT, BH and Carbaryl, 5% cypermethrin at 2.5 litres/ha has been reported to give a better control and a resultant increased yield which is about three times that of the un-sprayed plots (kumar and Ogunlela; 1982). Cypermethrin at 100 gai/ha and Decamethrin at 10gai/ha in 200 litres of water are recommeded as e.c formulations, while 2.5 litres and 1 -2 litres of ULV/ha respectively are recommended for ULV application (Raheja, 1981; Anon. 1983.

Onu (1991) reported that the bollworms, complex was adequately controlled by cymbush (75 gai/ha), Larvin 375 - (282 gai/ha), Karate (12.5 gai/ha), Talstar (10 gai/ha) while the sapsuckers - were controlled by cymbush, polytrin (30g + 300g/ha) and Talstar, Larvin 375, Talster (75 gai/ha), Karate. He concluded that the seed cotton yield obtained from plants treated with karate, talstar, larvin 80 DF, Sherpa plus and CGA 184699 compared favourably well with each other. Seed cotton yield from the plants treated with CGA 194699 (insect growth regulator) compared well with those from

plants treated with the standard insecticides. He also reported that at low dosages, Polo at 100 gai/ha and Karate at 5 gai/ha gave good control of all categories of insect pests attacking fruiting bodies.

CGA 194699 at 40 gai/ha gave similar protection of the fruiting bodies as the lower rates of Polo and Karate. The ULV formulations of Karate 0.8%, Sherpa plus, Polytrin 166 and Cymbush 1.8% applied each at the rate of 2.5 gai/ha and three spray regimes at forth nightly intervals at 10 weeks after sowing adequately controlled bollworms and sap sucking insects (Onu, 1990). The degrees of insect control by Cymbush, Sherpa plus, and Polytrin were similar, but the level of insect control achieved by Karate was rather very remarkable. It indicated that fairly good control of bollworms was achieved in the plots treated with e. c formulations at the rate of 0.7 - 1.0 l/ha of Polytrin, Fastac, Larvin 80 DF and cymbush while the sap suckers were effectively controlled by Karate.

CHAPTER 3

MATERIALS AND METHODS

3.1 Experimental site:

The research work was carried out in the1992 and 1993 cropping seasons in the agronomy field and plots L/12 in Institute for Agricultural Research Farm Samaru, Zaria (Lat 11° 11. N, Long 07° 38'E, 686 m above sea level) in the Northern Guinea Savanna Ecological Zone of Nigeria.

3.2.1 Crop Variety, Fertilizer Application and planting

Cotton variety SAMCOT 10 was used for the study. Fertilizer used included CAN and BOSUPA at the rate of 250 kg/ha respectively. The crop was sown at the second week of June in 1992 and 1993 on ridges spaced 90 cm apart and with an intra-row spacing of 45 cm. (Fig 1). At four weeks after sowing (WAS), cotton seedlings were thinned to two plants per stand. In all, 75 plots were used for the trial and each plot was made up of four ridges of four metres long and 90 cm wide (fig 1). In 1992 and 1993 cropping seasons, the replicates were separated by two guard rows on which maize was sown, to minimise insecticide drift from adjoining plots. Yield were specifically taken from the two middle ridges at harvest (Fig. 1). Out of the 75 plots, 15 plot served as control plots (Fig.3). In both years, about 0.25 hectare of land was used for the trials. Throughout the research period, normal agronomic operations such as thinning, weeding, molding were carried out manually as necessary.

3.2.2 Insecticides and their Application

Insecticides:

Four insecticides were used. These include Polo (pyrethroid/ organo-phosphate) Match (growth regulator), Vertimec (Microbial insecticide) and Larvin (Thiodicarb) The mixtue of Match and Polo was also used in the study. Polo and Match are products of CIBA - GEIGY LTD. Basle Switzerland. Vertimec is a product of Merck and Co. Inc., Pathway, New Jersey, USA. Larvin is a product of Union Carbide Agricultural products company INC P. O. Box 120414. T. W. Alexander Drive Research Triangle Park NC 27709 USA.

Field Trials

There were five treatments completely randomised with three replications. Thus the randomised complete block design was used for the trials. The treatmens were applied at 9 and 10 WAS, and the application was three sprays at two weeks interval. A knapsack sprayer (CP-3), Cooper Pegler), was used for the spray treatment. Insecticide spraying was on the 21/ 8/ 92 [10 WAS] for 1992 cropping season and 19/ 8/ 93 (9 WAS) for 1993 cropping season when 40-50% plants had flowered.

Laboratory Trial

Four insecticides were screened on the test insect, Dysdercus volkeri in the Laboratory. These include Polo 500 SE, Polytrin 440 ec, Larvin 375, and Match 50% applied at different rates. Each insecticide treatment was replicated three times in a complete Randomised Design (C R D)

Adult Dysdercus volkeri were collected from the experimental plots that served as no-spray plots (control) in this research. The insects were hand picked from the field,and the grren bolls on which they fed were also collected from the no-spray plots. Seven adult Dysdercus volkeri were introduced into each kilner jar with perforated cover where they fed on the green cotton boll sap. The insects were sprayed with the insecticides using a hand sprayer as they fed on the cotton sap.

The experiment was performed between the hour of 8.00 8.30 a m and observation on the insects was made at hourly intervals until 6.30 p.m. Mortality records of the insects were taken. The final observation was at 24 hrs, 48 hrs and 72 hrs. The mortality of Dysdercus volkeri was first observed at 5 hours and subsequently at 24, 48, 72 hours after spraying. The mortality records were taken against the various rates of the insecticides sprayed.

3.3.1 **Polo 500 SE:**

Polo e.c formulation was applied at the rates of 500 ml/ha (250g), 600ml/ha (300 g), 800 ml/ha (400g), 1000 ml/ha (500g) in 400 litres of water respectively was sprayed in the field, and 2 ml (1.0g); 4ml (2.0g) mixed with 400 ml (0.4 litres) of water was used in the laboratory.

3.3.2 Match 50% EC : Match e. c. formulation was applied at the liquid rates of 200 ml/ha (100g), 300ml (150g), 400ml (200g), 600ml (300g) mixed with 400 litres of water respectively was applied in the field. 2ml (1.0g) and 4ml (2.0g) mixed in 400ml (0.4 litre) of water was applied in the laboratory.

3.3.3 Vertimec 1.8 EC: Vertimec e.c formulation was applied at the rate of 277.7 ml/ha (5g), 555ml/ha (10g), 1000ml/ha (18g), 1111ml/ha (20g) mixed with 400litres of water respectively

3.3.4 Larvin 375: Larvin aqueous flowable formulation was applied at the rate of 800 ml/ha (300g) 933ml/ha (350g), 1066ml (400g), 1025ml/ha (475g) mixed with 400litres of water respectively was applied in the field. 2.66ml (1.0g) and 5.33ml (2.0g) mixed in 400ml of water was applied in the laboratory.

3.3.5 Match + Polo: The mixture of Match + Polo was applied at the rate of 200ml + 400ml (100g + 200), 300ml + 800ml/ha (150g + 400g), 400ml +1000ml/ha (200g + 500g) and 600ml + 800ml/ha (300g + 400g) mixed with 400 litres of water respectively.

3.3.6 Polytrin 440 EC: Polytrin e.c formulation at the rate of 0.4ml (1.0g) and 0.8ml (2.0g) mixed in 400 ml of water was applied in the laboratory.

3.4 Sampling Methods for Insect Incidence and Assessment of Damage:
The Population trend of some insect pests of cotton were studied from 4 – 9 weeks after sowing (WAS), until bolls opened up at 16 WAS.

Emphasis were on;

Bemisia tabaci Genn

Empoasca facialis (Jacobi)

Aphis gossypii (Glover)

Sylepta derogata F

Dysdercus volkeri Fab

The boll-worn complex.

Some other insects studied were ants, ladybird beetle and spiders. The following methods were used in collecting data on the insects:

i) Hand picking (cotton stainer, coccinellids).

ii) Use of polythene bags (aphids, cicadellids).

iii) Direct physical count (lead roller, whitefly, cotton stainer, Aphids).

iv) Use of damage indices (bollworms and sucking pests).

The insect counts were done randomly on the front ridges as sample rows. In each plot, three stands of cotton were randomly selected from the sample rows and the numbers of each insect present were recorded. The insect count commenced at 10 WAS and ended at 14 WAS in 1992 while it commenced at 9 WAS and ended at 13 WAS in 1993. The Diparopsis egg count commenced at 8 weeks after sowing in 1992 and 1993 respectively.

3.4.1 Bemisia tabaci (Whiteflies): The direct count method was used after gently raising the leaves to expose the undersurfaces of the leaves on which the whiteflies fed.

3.4.2. Empoasca facialis (Jassid) Cicadellids: The cicadellids which rested on the undersurface of the leaves were counted directly.

3.4.3. Aphis gossypii (Aphids): Aphids were physically counted using the colony method (Usenbo, 1980). Nymphs were mostly counted in this study.

3.4.4 Sylepta derogata (Cotton leaf roller): The number of rolled leaves per stand was used as an index for assessing leaf roller incidence and rolled leaves were occasionally opened up to see if the larvae were present. The rolled leaves were randomly selected and in this study and population of Sylepta larvae were assessed

3.4.5 Dysdercus volkeri (Cotton stainer): The nymphs and adult cotton stainer were counted by direct physical count.

3.5 Fruiting Body Damage Assessement: Damage to the fruiting bodies (flowers, squares and green bolls) was estimated from 9 and 10 WAS by counting the total number of fruiting bodies produced as well as the number damaged by insects. Damage indices (sucking points and feeding holes) were grouped into;

a (a) those caused by the piercing & sucki g insect pests and

(b) those caused by the bollworms.

The number of damaged fruiting bodies was expressed as a percentage of the total fruiting bodies produced. At 14 WAS, three stands / plot were randomly selected and their fruiting bodies were stripped, bagged and labelled. In the laboratory, the fruiting bodies were cut open and holes on bolls, mum bolls, bollworm larvae were counted. Stained lint (yellow) or boll rot with piercing points indicated sucking pest damage while feeding holes and tunnelling indicated bollworm attack. Live bollworm larvae when found were collected and identified. From the data obtained, the efficacy of the insecticides was determined.

Assessment of boll on the plant was carried out and the total flower number, total square (bud) and green bolls were randomly counted on sample rows per plot. The number of damaged squares, flowers and green bolls were also recorded.

3.6 Yield Data: Data on number of fruiting bodies was taken as they were assessed in three stands per plot starting from 9-14 WAS. Harvesting

commenced when the bolls were split exposing the seed-cotton. The weight of seed cotton, and seeds (ginned) were recorded per plot. The weight of clean lint and stained lint were also recorded. The yield data was expressed in kg per hectare.

3.7 Statistical Analysis: The data collected were subjected to the analysis of variance and where F test showed significant difference, the means of such treatments were compared using Least Significant Difference Test.

Treatment Symbols for Field Application

C1 = Polo, C2 = Match (C GA 184699)

C3 = Vertimec, C4 = Larvin, C5 = Match + Polo

T1 = Concentration 1, T2 = Concentration 2

T3 = Concentration 3, T4 = Concentration 4

T5 = (Control).

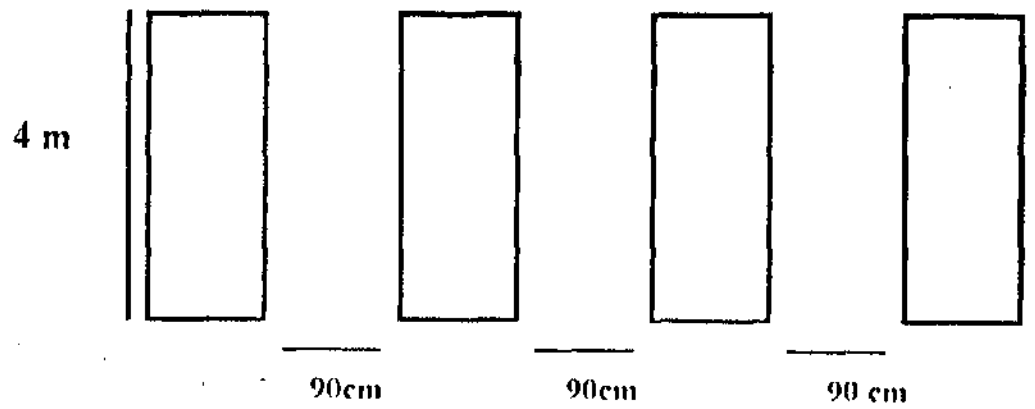


Figure 1: Diagrammatic representation of a plot showing the rows used for sampling and recorded yield data.

TREATMENT		PLOT NUMBERS		
C1T1		1	16	15
C1T2		2	19	52
C1T3		3	18	54
C1T4		4	17	55
C1T5	CONTROL	5	20	53
C2T1		28	11	67
C2T2		30	12	66
C2T3		29	13	68
C2T4		26	14	69
C2T5	CONTROL	27	15	70
C3T1		34	24	50
C3T2		33	23	49
C3T3		35	21	48
C3T4		32	22	47
C3T5	CONTROL	31	25	46
C4T1		38	60	73
C4T2		37	56	71
C4T3		39	59	75
C4T4		36	58	72
C4T5	CONTROL	40	57	74
C5T1		6	41	62
C5T2		8	42	63
C5T3		10	43	64
C5T4		9	44	65
C5T5	CONTROL	7	45	67

FIGURE 2: Treatment Allocation to Plots Key: C = Chemicals T = Concentration

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15	16	45	46	REP
14	17	44	47	
13	18	43	48	
12	19	42	49	III
11	20	41	50	
10	21	40	51	
9	22	39	52	
8	23	38	53	
7	24	37	54	
6	25	36	55	II
5	26	35	56	
4	27	34	57	
3	28	33	58	
2	29	32	59	I
1	30	31	60	
				3 m

75 plots (300 Ridges) 4 Rows

Figure 3: General Layout of the field showing random allocation of treatments.

CHAPTER 4

RESULTS

4.1 Effect of Different Rate of four Insecticides on the Population of Whitefly on cotton in 1992 and 1993.

Results in respect of the performance of spray treatments on whiteflies in 1992 and 1993 are presented in Table 1 to 5. The mean population of whietfly from the four insecticides evaluated showed that in each of the parameters shown in Table 1 there were significant differences (P = 0.05) among the insecticides. The population of whitefly were more in 1992 than in 1993 cropping season (Table 2) but was effectively reduced after the second spray (Table 3). All the insecticides were effective but Match, Match + Polo were most effective on B. tabaci in 1992 while Larvin was most effective in 1993 and was closely followed by Match

In 1992 at 10 WAS, there was no significant difference (P = 0.5) in the population of whitefly controlled by Match 50% from Polo 500 SE, Larvin 375, at 24 hours after spraying. However, Match+ Polo and Match had lower population At 48 hours after spraying Match, Match + Polo also had significantly low pouplation of whitefly. Although there was no significa t difference (P = 0.05) in the number of whiteflies controlled by Match, Match + Polo from Polo and Larvin, the population of whitefly was significantly higher with Vertimec 1.8 e.c (Table 1)

TABLE 1: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF WHITEFLY ON COTTON IN 1992

MEAN NUMBER OF WHITEFLY ON COTTON PER THREE STANDS

		at tent (10) WAS		at twelve (12) WAS		at fourteen (14) WAS	
CHEMICAL	RATES (g/ha)	24 HPS	48 HPS	24 HPS	48 HPS	24 HPS	47 HPS
POLO	250 - 500	1.27b	0.97ab	5.57c	553c	0.43	0.43
MATCH	100 - 300	0.9bc	0.60b	11.10a	10.60a	0.43	0.43
VERTIMEC	5 - 20	2.3a	1.67a	6.73c	5.87c	1.17	1.17
LARVIN	300 - 475	1.37b	1.17ab	7.83b	5.60b	1.33	1.33
MATCH + POLO	100 - 300 + 200 - 500	0.63c	0.67b	7.70b	7.70b	0.57	0.57
LSD (P = 0.05)		0.81*	0.72*	3.50*	3.5*	0.93 NS	0.93 NS

Values followed by the same letter (s) are not significantly different at P = 0.05

HPS = Hour Post Spray; * = Significant at 5% level; NS = Not Significant.

At 12 WAS, plots treated with Polo had significantly lower population of whitefly compared with the other insecticide treatments. There was no significant difference (P = 0.05) in the number of whitefly controlled by Larvin and Match + Polo at 24 hours and 48 hours after spray respectively (Table 1). At 14 WAS, Polo and Match had the least pouplation of whiteflies (Table 1). The population of whitefly in 1992 & 1993 before spraying is represented in Table 2. In 1992, Polo at the rate of 300g reduced the population of whitefly from 15.33 to 0.33 per six plants at 72 hours after third spray (Table 3). Match at the rate of 100g and 150g reduced the pouplation from 23.33 & 22.33 to 0.00-per six plants respectively while Vertimec at the rate of 10g and 20g reduced the population from 11.00 and 8.67 to 0.00 respectively and Larvin at the rate of 475g reduced the population from 19.33 - 0.00 at 72 hours after the third spray. Mixture of Match + Polo at rates of 200 + 500g and 300g + 400g reduced the population of whitefly from 9.00 and 4.00 to 0.00 respectively after the second spray. Match at 200g/ha, Polo at the rate of 500g/ha, and mixture of Match + Polo at the rate of 150 + 400g/ha controlled whiteflies at two sprays. In 1993, at 13 WAS, the plot treated with Larvin had significantly low population of whitefly and this was closely followed by Match. There was no significant difference (P = 0.05) in number of whiteflies controlled by Match and Vertimec (Table, 4). Larvin at the rate of 475g/ha, Match at the rate of 300g/ha and Polo at the rate of 500g/ha were most effective on whiteflies (Table 5).

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4.2 Effect of Different Rates of four Insecticides on the Population of Jassid on Cotton in 1992 and 1993:

Results of the performance of spray treatments on Jassids in 1992 and 1993 are presented in Table 6 -11. The means of Jassid population from the four insecticides evaluted showed that in each of the parameters shown in Table 6 and 9 there were significant differences (P = 0.05) among the insecticides. All the insecticides were effective but Match + Polo was most effective on Jassid at 10 WAS, and 12 WAS, in 1992 (Table 6) and also most effective at 11 WAS and 13 WAS in 1993 (Table, 9).

In 1992, at 10 WAS, there was no significant difference (P =0.05) in the population of Jassids controlled by Polo and Match at 24 hours and 48 hours after spray. Match + Polo had significantly low population of Jassids. Vertimec gave a siginificant higher population of Jassid than other insecticides used in this study (Table 6). At 12 WAS, Match + Polo had significantly low population of Jassid at 24 hours and 48 hours after spray. There was no significant difference (P = 0.05) in the population of Jassids controlled by Match and Polo. Vertimec gave significantly higher number of Jassids at 48 hours after spray (Table, 6) . At 14 WAS, there was no significant difference (P =0.05) in the population of Jassids controlled by Larvin and Match + Polo at 24 hours after spray but at 48 hours, Match + Polo gave the least population of Jassids (Table, 6).

The effect of different rates of four insecticides on population of Jassids in 1992 is represented on (Table 7 & 8). Polo at the rate of 400g and 500g reduced Jassid population from 10.00 - 0.03 and 6.67 - 0.50 per six plants respectively. Vertimec at the rate of 18g reduced Jassid population from

11.00 - 0.33 per six plants at 72 hours after the third spray. Match at the rate of 100g/ha reduce Jassid population from 10.33 - 1.33 and at 150g/ha reduced Jassids from 15.00 -00 per six plants. While Larvin at the rate of 350g reduced the population from 9.00 - 0.63 and at 475g/ha from 10.33 - 0.67 per six plants respectively. Match + Polo at the rate of 200 + 500g/ha reduced the population from 12.33 - 0.50 per six plants at 72 hours after the third spray (Tables 7 & 8).

In 1993, at 11 WAS, there were no significant differences (P = 0.05) in the population of Jassids controlled by Polo, Match + Polo from Larvin. However, Match + Polo and Larvin had the least population of Jassid at 24 hours after spray (Table 9). At 13 WAS, there was no significant difference (P = 0.05) in the population of Jassids controlled by Match from Vertimec at 24 hours after spray but at 48 hours, Match had lower population of jassids than Vertimec. Larvin and Match + Polo had the least population at 24 hours after spray but at 48 hours spray, the least population was obtained with Match + Polo and polo (Table 9). The performance of the different rates of four insecticides on jassid population in 1993 is presented on Tables 10 & 11. Polo at the rate of 500g/ha controlled Jassids at two spray regimes

4.3 Effect of Different Rates of Four Insecticides on the Population of Aphids on Cotton in 1992 and 1993:

Result of respect of the performance of spray treatments on Aphids in 1992 and 1993 are presented in Table 12 - 17. The mean population of Aphids from the four insecticides showed that, in each of the parameters shown in Table 12 -17, there were significant differences (P = 0.05) among the insecticides. All the insecticides were effective on Aphid but Polo 500SE and

Vertimec 1.8 E.C were most effective in 1992 while in 1993, Vertimec 1.8 e.c and Larvin 375 were most effective. The population of Aphids was low in 1993 compared to that of 1992. In 1992, at 10 WAS, there were no signifiant difference (P = 0.05) among the various insecticide treatments at 24 hours spray (Table 12).

At 12 WAS, the lowest population of Aphid was obtained with Vertimec at 24 and 48 hours after spray. There was no significant difference in the population controlled with Larvin and Match + Polo. The population of Aphids controlled by Larvin was comparable to that controlled by Vertimec at 24 hours after spray. There was no significant difference (P = 0.05) in the population of Aphids controlled by Polo and Match (Table 12).

The effect of different rates of four insecticides on the population of Aphids at 10 and 14 WAS in 1992 is represented in Table 13 & 14. Vertimec at the rate of 18g/ha resulted in 90% reduction of Aphids population after the third spray while Larvin at the rate of 400g/ha reduced Aphid population by 95% at the end of three sprays . This observation was made considering the population before the first spray and after the third spray. Match + Polo at the rate of 150g + 400g/ha reduced aphid population by 83% at the end of spraying. Polo at the rate of 500g/ha effectively reduced the population of aphids at the end of spraying.

In 1993, at 9 WAS, there was no significant difference (P=0.05) in the number of aphids controlled by Vertimec and Match + Polo, and that of Larvin from Vertimec at 48 hours after spray. However, Larvin had significantly lower population of aphids and this was closely followed by

Vertimec. There was no siginificant difference (P = 0.05) in the control of aphid by Polo and Match (Table 15). At 11 WAS, Larvin had the lowest population of aphids at 24 and 48 hours after spray and this was closely followed by Match + Polo (Table, 15).

At 13 WAS, Vertimec had the lowest population and this was closely followed by Larvin at 48 hours after spray (Table 15). The effect of different rates of four insecticides on population of aphids at 9 and 13 WAS in 1993 is represented in Table 16 and 17. Vertimec 1.8 e.c at the rate of 5g and 20g/ha resulted to 50% & 95% reduction of aphid population respectively. Larvin 375 at the rate of 475g/ha effectively prevented the aphid colony at one spray while Vertimec at the rate of 20g/ha prevented aphid at two sprays..

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TABLE 2: POPULATION OF WHITEFLIES BEFORE SPRAY ON COTTON AT 10 and 9 "WAS" IN 1992 & RESPECTIVELY

		Mean population of whitefly per three stands of cotton	
		1992	1993
TREATMENTS	RATES(g/ha)	24 HBS	24 HBS
POLO	250	2.33	3.67
	300	15.33	1.33
	400	9.67	0
	500	8	2
CONTROL	0	10.33	3
MATCH	100	23.33	2.33
	150	22.33	3
	200	24	1.33
	300	15.33	1
CONTROL	0	12.33	2
VERTIMEC	5	13.33	4
	10	11	1
	18	9.33	2.67
	20	8.67	3.33
CONTROL	0	12	2.33
LARVIN	300	6.33	3.67
	350	18.67	4
	400	26	1.33
	475	1933	0.67
CONTROL	0	9.33	2.67
MATCH + POLO	100 + 200	15.67	2.67
	150 + 400	18.67	0.67
	200 + 500	15	0.33
	300 + 400	9	0.67
CONTROL	0	4	3

HBS = Hour before spray, HPS = Hour after spray NS = Not significant at P = 0.05

TABLE 3: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF WHITEFLIES ON COTTON AT 14 "WAS" IN 1992

		Mean Population of whiteflies in three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	0.67	0.33	0.17	0.33
	300	2	1	0.17	0.33
	400	0.33	0.17	0.33	0.33
	500	0.33	0.33	0.33	0.17
CONTROL	0	0.33	0.33	0.17	1.33
MATCH	100	0.33	0.17	0	0
	150	0.33	0.17	0	0
	200	0	0	0	0.17
	300	1.67	0.03	2.5	0.03
CONTROL	0	0.33	0.17	0.67	0
VERTIMEC	5	0	0	0	0.17
	10	2	1.17	0.67	0
	18	1.33	1.03	0.5	0.33
	20	9	0	0	0
CONTROL	0	1.33	0	1	0.67
LARVIN	300	0.33	0.17	0.17	0.17
	350	2.67	1.07	0.67	0.5
	400	4	2.33	0.33	0.33
	475	1	0.07	0.17	0
CONTROL	0	2.67	1.03	2	1.67
MATCH + POLO	100 + 200	1.67	1.33	0.03	1
	150 + 400	2	1	1.17	1
	200 + 500	0	0	0.3	0
	300 + 400	0	0	0.17	0
CONTROL	0	0.67	0.5	0.33	0.5
LSD			2.19NS	1.48NS	1.52NS

HBS = Hour before spray, HPS = Hour after spray, NS = Not Significant at P = 0.05

TABLE 4: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF WHITEFLIES ON COTTON AT 9, 11 AND 13 WEEKS AFTER SOWING IN 1993.

CHEM*	Polo	Match	Vertimec	Larvin	Match + Polo	LSD = 0.05
g/HA	250-500	100-300	5 -20	300-475	100-300 + 200-500	
9 WAS						
24 HPS	1.27	1.27	1.67	1.43	0.87	0.98
48 HPS	1.27	1.27	1.67	1.43	0.87	0.98
11.WAS						
24 HPS	4.37	2.03	2.07	1.13d	2.97b	0.95*
48 HPS	4.37a	2.03c	2.07c	1.13d	2.97b	0.95*
13 HPS						
24 HPS	1.07	1.10	1.03	1.47	0.77	0.79
48 HPS	1.07	1.10	1.03	1.47	0.77	0.79

Values followed by the same letter(s) are not significantly different at P = 0.05

* = Significant at P = 0.05, NS = Not Siginificant at P = 0.05

Note : CHEM. * = Chemicals used in the experiment.

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TABLÆ 5: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF WHITEFLIES ON COTTON AT 13 "WAS" IN 1993

		Mean Population of whiteflies /three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	3	1.67	1.5	1.5
	300	4	2.33	2.33	2
	400	0.33	0.17	0.17	0.17
	500	0	0	0	0
CONTROL	0	3.67	3.5	2.67	3.17
MATCH	100	3.67	2.5	2	1.83
	150	3	2.17	1.67	1.5
	200	2.67	1.83	2.33	1.5
	300	0	0	0	0
CONTROL	0	7	6.33	5.17	4.33
VERTIMEC	5	3	1.83	2	1.5
	10	3	1.5	1.5	1.67
	18	0.33	0.17	0.17	0.5
	20	1.67	0.83	0.83	1
CONTROL	0	6.33	5.17	5.5	6.17
LARVIN	300	6.66	3.67	4.5	3.33
	350	3	1.5	1.5	1.83
	400	2	1	1	1
	475	0	0	0	0
CONTROL	0	11	7.5	8.5	7.5
MATCH + POLO	100 + 200	3	1.5	1.5	1.5
	150 + 400	2.33	1.17	1.33	1.17
	200 + 500	0.33	0.17	0.17	0.17
	300 + 400	0.33	0.17	0.17	0.17
CONTROL	0	6	5.17	4.67	4.67
LSD			2.13 NS	2.09 NS	3.22 NS

HBS = Hour before Spray ; HPS = Hour after Spray

Table 6: **EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF JASSIDS ON COTTON IN 1992**

		Mean Population of Jassids in three stands					
		10 WAS		12 WAS		14 WAS	
CHEMICALS	RATES (g/ha)	24 HPS	48 HPS	24 HPS	48 HPS	24 HPS	48 HPS
POLO	250 - 500	2.53b	1.90bc	4.60b	4.53bc	2.77a	1.53
MATCH	100 - 300	2.50b	2.83b	4.60b	4.53bc	2.77a	1.53
VERTIMEC	5 - 20	3.80a	4.13a	5.27a	5.13a	2.20a	1.13
LARVIN	300 - 475	1.70c	1.73bc	5.40a	4.87a	1.03b	1.23
MATCH + POLO	100 - 300 + 200 - 500	1.87c	1.33c	3.87c	4.23c	2.07b	0.53
LSD (P=0.05)		1.09*	1.18*	2.07*	2.06*	1.30*	0.87*

Value followed by the same letter(s) are not significantly different at P = 0.05

PS = Hour post spray; * = Significant at 5% level; NS = Not significant at P = 0.05

TABLE 7: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF JASSIDS ON COTTON AT 10 "WAS" IN 1992

		Mean Population of Jassids / .. three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	5.67	2.67	1.5	1.17
	300	11.33	2.83	2.5	2.33
	400	10	2.83	2.17	2.17
	500	6.67	1	0.83	0.83
CONTROL	0	8.33	3.33	2.5	2.83
MATCH	100	10.23	0.67	0.83	1
	150	15	2.33	2.33	2
	200	11.67	3.33	2.67	1.83
	300	15	3.83	3.5	3.5
CONTROL	0	14	2.67	4.83	2.83
VERTIMEC	5	8.33	2.83	2.5	2.33
	10	10	5	4.83	4.33
	18	11	2	1.83	1.83
	20	8.33	3.33	2.67	2.5
CONTROL	0	10.67	5.83	8.83	4.67
LARVIN	300	5.67	2.67	2.67	2.33
	350	9	1.5	1.5	1.5
	400	6.67	0.67	0.83	0.83
	475	10.33	0.83	0.83	0.83
CONTROL	0	13..33	2.83	2.83	1.67
MATCH + POLO	100 + 200	6.33	1.83	1.5	1.83
	150 + 400	9	1	1	1
	200 + 500	12.33	0.67	0.67	0.67
	300 + 400	3	1.5	1.5	1.5
CONTROL	0	7	4.33	2	3.17
LSD			2.43 NS	2.63 NS	2.13 NS

HBS = Hour before Spray = Hour after Spray ; & NS = Not significant at P = 0.05

TABLE 8: EFTFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF JASSIDS ON COTTON AT 14 "WAS" IN 1992

		Mean Population of Jassids in three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	2.67	2	1.67	1.5
	300	5	3	1.33	1.5
	400	5.67	4.33	0.67	0.03
	500	2.67	1.33	0.5	0.5
CONTROL	0	4.67	3.17	0.5	2.03
MATCH	100	2.33	1.67	1.33	1.33
	150	6	3.33	0.3	1
	200	2	1	1	1
	300	1.67	0	0.67	0.67
CONTROL	0	4.67	2.03	3.17	1
LARVIN	300	4.67	3	0.3	0.03
	350	3.67	2.17	0.63	0.06
	400	1	0.5	0.63	0.67
	475	1.33	0.87	0.67	0.67
CONTROL	0	4.67	2.03	3	3
MATCH + POLO	100 + 200	4.33	3	1.67	1.33
	150 + 400	3.33	1.67	2	1.63
	200 + 500	1	0.5	0.5	0.5
	300 + 400	2	1	1	1
CONTROL	0	4.33	4.17	2.5	2.17
LSD			2.67 NS	1.52 NS	1.52 NS

HBS = Hour before Spray = HPS Hour after Spray ; & NS = Not significant at P = 0.05

TABLE 9: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF JASSIDS ON COTTON IN 1993

		Mean Population of Jassids on Cotton per three stands at					
		10 WAS		11 WAS		13 WAS	
CHEMICALS	RATES (g/ha)	24 HPS	48 HPS	24 HPS	48 HPS	24 HPS	48 HPS
POLO	250 - 500	2.93	2.6	1.70b	1.87	4.73a	1.33c
MATCH	100 - 300	2.92b	2.6	2.93a	2.6	2.67b	2.40b
VERTIMEC	5 - 20	1.6	1.53	3.17a	3.3	2.73b	4.53a
LARVIN	300 - 475	2.1	1.77	1.18b	2.23	1.50c	2.33b
MATCH + POLO	100 - 300 + 200 - 500	1.97	1.63	1.70b	1.93	1.73c	1.50
LSD (P=0.05)		1.24 NS	1.18*	1.15*	2.64*	1.40*	1.02*

Value followed by the same letter(s) are not significantly different at P = 0.05

HPS = Hour post spray; * = Significant at 5% level; NS = Not significant at P = 0.05

TABLE 10: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF JASSIDS ON COTTON AT 9 "WAS" IN 1993

		Mean Population of Jassids per three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	3.67	2	2.33	2.33
	300	3	1.83	1.67	1.67
	400	5.33	3.17	2.67	3
	500	4.33	3.5	2.33	2.17
CONTROL	0	5.33	4.17	4	4.3
MATCH	100	3	2.33	1.83	1.5
	150	2.33	2	1.33	1.33
	200	3	2	1.5	1.5
	300	2.33	1.17	1.17	1.17
CONTROL	0	4	2.67	2.67	3.83
VERTIMEC	5	2.33	1.33	1.33	1.33
	10	1.67	0.83	0.83	1
	18	0.33	0.33	0.17	0.17
	20	3	2.33	1.5	1.17
CONTROL	0	3.67	3.17	3.83	1
LARVIN	300	3	1.67	1.67	1.67
	350	3.67	2.67	2.17	2
	400	4.33	3	2.5	2.17
	475	2.33	1.5	1.17	1.17
CONTROL	0	1.33	1.67	1.33	3
MATCH + POLO	100 + 200	4	2.17	2	2
	150 + 400	2.33	1.5	1.33	1.5
	200 + 500	2.33	1.17	1.17	1.17
	300 + 400	2.33	1.33	1.17	1.17
CONTROL	0	3.67	3.67	2.5	3.0
LSD			2.77 NS	2.55 NS	2.65NS

HBS = Hour before Spray = HPS Hour after Spray ; NS = Not significant at P = 0.05

TABLE 11: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF JASSIDS ON COTTON AT 13 "WAS" IN 1993

		Mean Population of Jassids per three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	6.33	3.17	3.33	4.5
	300	2.67	2.17	1.67	1.67
	400	1	1	0.83	0.67
	500	0	0	0	0
CONTROL	0	7.3	7	6.67	7.17
MATCH	100	6.	4.5	4.17	3.33
	150	0.67	6.67	0.5	0.33
	200	3	1.83	2.33	1.83
	300	067	0.5	0.33	0.33
CONTROL	0	8.67	5.83	5.67	3.5
VERTIMEC	5	3.33	1.67	2	1.83
	10	5.67	3.5	4	3.33
	18	2.67	1.83	2.17	1.5
	20	1	0.5	0.83	0.5
CONTROL	0	15	12.83	13.67	12
LARVIN	300	2	1.17	1.17	1.67
	350	3.33	1.67	2	2
	400	2	1	1.33	2.17
	475	1	0.5	0.5	1.17
CONTROL	0	7.67	6.5	6.67	6.5
MATCH + POLO	100 + 200	2.33	1.33	1.33	1.17
	150 + 400	0.67	0.33	0.33	0.33
	200 + 500	1.67	1	0.83	1
	300 + 400	0.67	0.33	0.5	0.33
CONTROL	0	5.67	5.5	5.17	4.5
LSD			3.16 NS	1.64 NS	2.45 NS

HBS = Hour before Spray; = Hour after Spray; NS = Not significant at P = 0.05

TABLE 12. EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF APHIDS ON COTTON IN 1992

		Mean Population of Aphid per three stands of Cotton					
		at 10 WAS		at 12 WAS		at 14 WAS:	
CHEMICALS	RATES (g/ha)	24 HPS	48 HPS	24 HPS	48 HPS	24 HPS	48 HPS
POLO	250 - 500	0.75b	0.63	4.07a	3.53a	0	0.5
MATCH	100 - 300	1.40ab	1.35	4.07a	3.53a	0.4	0.5
VERTIMEC	5 - 20	19.0a	1.55	2.82c	2.45c	0.4	0.7
LARVIN	300 - 475	0.85b	0.97	3.32bc	3.10b	0.07	0.66
MATCH + POLO	100 - 300 + 200 - 500	0.77b	0.88	3.50b	3.17b	0.65	0.66
LSD (P=0.05)		0.73* NS	0.79*	0.87*	0.97	0.35 NS*	0.49 NS*

Value followed by the same letter(s) are not significantly different at P = 0.05 Significant at 5% level;

TABLE 13: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF APHIDS ON COTTON AT 10 "WAS" IN 1992

		Mean Population of Aphids per three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	4.0	0.77	0.75	0.83
	300	7.33	0.42	0.42	0.42
	400	6.66	1	0.58	0.42
	500	6.66	0.5	0.25	0.17
CONTROL	0	7.33	1.08	1.77	1.08
MATCH	100	7.33	0.58	0.67	0.75
	150	8.67	1.08	1.08	1.08
	200	6.67	2.33	2.08	2.17
	300	7.67	1.08	1	0.92
CONTROL	0	5.33	1.92	1.92	3.58
VERTIMEC	5	4.67	2.24	2.33	2.27
	10	4.33	1.08	1.08	1.08
	18	5.0	2.17	2.08	0.83
	20	4.0	1.17	1	1
CONTROL	0	4.0	2.67	1.92	2.25
LARVIN	300	3.0	0.67	1.25	0.92
	350	5.67	0.42	0.42	0.42
	400	8	0.92	0.83	0.83
	475	5.67	0.5	0.75	0.75
CONTROL	0	4.33	1.75	1.58	1.25
MATCH + POLO	100 + 200	5.0	0.75	0.67	0.58
	150 + 400	6.67	1.17	0.83	1
	200 + 500	5.67	0.25	0.5	0.42
	300 + 400	4.33	0.42	0.83	0.42
CONTROL	0	7	1.25	1.58	1.33
LSD			1.64 NS	1.50 NS	1.60 NS

HBS = Hour before Spray; = Hours after Spray; NS = Not significant at P = 0.05

TABLE 14: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF APHIDS ON COTTON AT 14 "WAS" IN 1994

		Mean Population of Aphids per three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	0.67	0.42	0	0
	300	0.67	0.33	0.43	0.33
	400	2.5	1.42	0.5	0.5
	500	0.17	0	0.00	0
CONTROL	0	2.5	1.73	1.33	71.0
MATCH	100	0.33	0.5	0.42	0.42
	150	1.67	0.03	0.03	0.03
	200	1.67	1	0.72	0.03
	300	1.67	0.03	0.33	0.03
CONTROL	0	3.17	2	1.72	1.72
VERTIMEC	5	1.17	0.5	0.42	0.42
	10	1.17	0.5	0.5	0.67
	18	0.6	0.42	0.42	0.42
	20	2.5	1.25	1.33	1.25
CONTROL	0	2.33	1.67	0.75	0.67
LARVIN	300	1	0.5	0.03	0.03
	350	2.67	1.5	0.5	0.5
	400	1.17	0.5	0.03	0.03
	475	1	0.5	0.92	0.92
CONTROL	0	2.5	1.25	1.25	1
MATCH + POLO	100 + 200	0.67	0.33	0.33	0.33
	150 + 400	2.67	1.5	1.42	1.33
	200 + 500	0.33	0.17	0.17	0.25
	300 + 400	0.33	0.17	0.17	0.17
CONTROL	0	1.03	1	1.05	1
LSD			1.38 NS	1.12 NS	1.12 NS

HBS = Hour before Spray; = Hours after Spray; NS = Not significant at P = 0.05

TABLE 15. EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF APHIDS ON COTTON IN 1993

		Mean Population of Aphid per three stands of Cotton:					
		at 9 WAS		at 11 WAS		at 13 WAS	
CHEMICALS	RATES (g/ha)	24 HPS	48 HPS	24 HPS	48 HPS	24 HPS	48 HPS
POLO	250 - 500	0.55	0.63a	0.30b	0.35c	0.60c	0.5
MATCH	100 - 300	0.55	0.63a	0.60a	0.78a	1.70a	0.5
VERTIMEC	5 - 20	0.26	0.13bc	0.45ab	0.50b	1.00	0.7
LARVIN	300 - 475	0.28	0.16c	0.13c	0.15d	0.93c	0.66
MATCH + POLO	100 - 300 + 200 - 500	0.46	0.46ab	0.18c	0.30c	1.00b	0.66
LSD (P=0.05)		0.36 NS	0.36 NS	0.33*	0.33*	0.63*	0.79 NS*

Value followed by the same letter(s) are not *significantly different at P = 0.05

Significant at 5% level;

TABLE 16: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF APHIDS ON COTTON AT 9 WAS" IN 1993

		Mean Population of Aphids per three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	0.83	0.41	0.75	0.41
	300	0.83	0.58	0.5	0.58
	400	0.83	0.41	0.41	0.41
	500	0.66	0.41	0.33	0.33
	'0'	1.5	0.91	1.16	1
	100	1	0.66	0.5	0.5
MATCH	150	0.16	0.25	0.25	0.08
	200	1.16	0.58	0.58	0.66
	300	1.16	0.66	0.58	0.58
	'0'	1.83	1.25	1.91	1.33
	5	1.16	0	0.88	0
VERTIMEC	10	0.66	0.33	0.41	0.41
	18	0.5	0.25	0.25	0.25
	20	0	0.08	0	0
	'0'	0.83	0.66	0.83	0.5
	300	0.66	0.33	0.03	0.03
LARVIN	350	0.33	0.16	0.16	0.16
	400	0	0	0	0
	475	.16	0.08	0.80	0.80
	'0'	16	0.83	0.25	0.25
	100 + 200	0.33	0.33	0.16	0.16
MATCH + POLO	150 + 400	1.16	0.75	0.58	0.85
	200 + 500	1	0.5	0.5	0.58
	300 + 400	0.5	0.25	0.25	0.26
	'0'	0.66	0.5	0.83	0.25
					0.33
		1.20NS	0.81 NS	0.85 NS	0.77 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

TABLE 17: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF APHIDS ON COTTON AT 13 "WAS" IN 1993

		Mean Population of Aphids per three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	2.17	1.58	1.25	1.33
	300	1.33	1.08	1.17	0.67
	400	0.5	0.33	0.25	0.33
	500	0.67	0.42	0.58	0.33
	'0'	3	2.58	2.67	1.58
	100	2.5	2.08	1.67	1.25
MATCH	150	2.17	1.08	2	1.33
	200	0.5	0.42	0.25	0.25
	300	2	1.42	1.67	1.08
	'0'	4.17	3.67	5.42	2.33
	5	0.67	0.67	0.67	0.33
VERTIMEC	10	0.5	0.25	0.33	0.25
	18	1.33	0.67	0.83	0.83
	20	0.33	0.17	0.17	0.17
	'0'	2.4	2.08	2.33	1.83
	300	1.5	1.08	0.92	1
LARVIN	350	1	0.667	0.67	0.83
	400	2.33	1.17	1.17	1.42
	475	0	0	0	0
	'0'	3.5	3.08	2.58	3.08
	100 + 200	1	0.5	0.92	0.5
MATCH + POLO	150 + 400	1.67	1.17	1.08	1.42
	200 + 500	1.5	0.75	0.12	1
	300 + 400	0.33	0.25	0.25	0.25
	'0'	3.67	2.42	3.42	3.17
LSD = (P=0.05)		146 NS	1.36 NS	1.36 NS	1.48 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

4.4 Effect of Different Rates of Four Insecticides on the Population of Dysdercus on Cotton in 1992 & 1993:

Result in respect of the performance of spray treatments on Dysdercus in 1992 and in 1993 are presented in Tables 18 - 22. Larvin (Thiodicarb), and Vertimec were most effective on Dysdercus in 1992 while Larvin, Vertimec in 1993. The population of Dysdercus was generall low in both years in 1992. At 12 WAS, the least population of Dysdercus was obtained with Larvin 375 at 48 hours after spray and this was closely followed by Match + Polo. There was no significant difference (P = 0.05) in the population of Dysdercus controlled by Polo, and Match. Vertimec was comparable with Polo and Match at 48 hours after spray (Table 18)

At 14 WAS, the mean population of Dysdercus controlled by the insecticides were not statistically different (P = 0.05) but the trend indicated that the least population of Dysdercus was obtained with Larvin and this was closely followed by Match + Polo treatment (Table 18). The effect of different rates of the four insecticides on Dysdercus in 1992 is presented in Table 19 & 20. Larvin at the rate of 475g effectively controlled Dysdercus at 72 hours after the first spray (Table 19). However, Larvin at the rate of 300g, 350g and 400g prevented Dysdercus from the Cotton plants at the end of spraying (Table 20). Polo at the rate of 300g, 400g, 500g effectively controlled Dysdercus from the sprayed plots, and Vertimec at the rate of 200g on Dysdercus at two sprays.

In 1993 the mean population of Dysdercus controlled by the insecticides at 13 WAS were statisfically different (P = 0.05) at 48HPS. The least population of Dysdercus was obtained with Larvin, Polo, and Vertimec (Table 21). The effect of different rates of the four insecticides on Dysdercus in 1993 is presented in Table 21 Polo at the rate of 250g/hq and 300g/hq controlled Dysdercus at three spray regimes while Larvin at the rate of 400g/hg and 475g/hq, and Vertimec at the rate of 5g/hq and 19g/hq were effective on Dysdercus at three spray regimes (Table 22)

TABLE 18. EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF DYSDERCUS ON COTTON IN 1992

		Mean Number of Dysdercus per three stands of Cotton					
		at 10 WAS:		at 12 Was		at14 WAS	
CHEMICALS	RATES (g/ha)	24 HPS	48 HPS	24 HPS	48 HPS	24 HPS	48 HPS
POLO	250 - 500	0.53	0.63	0.43	0.63ab	0.67	0.6
MATCH	100 - 300	0.26	0.16	0.43	0.63ab	0.67	0.6
VERTIMEC	5 - 20	0.53	0.3	0	0.70a	0	0.7
LARVIN	300 - 475	033	0.26	0.16	0.10c	0.13	0.13
MATCH + POLO	100 - 300 + 200 - 500	0.36	0.33	0.66	0.56b	0.3	0.27
LSD (P=0.05)		0.33 NS	0.27 NS	0.49 NS	0.33*	0.37 NS	0.65 NS

*= Significantly at P = 0.05; NS = Not significant at the same level of probability . HPS = Hour after spray
Values followed by the same letter (s) is /are not significantly different at P= 0.05 Significant

TABLE 19 EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF DYSDERCUS ON COTTON AT 10 "WAS" IN 1992

		Mean population of Dysdercus per three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	1	0.5	0.33	0.5
	300	0.66	0.66	0.5	0.33
	400	1	0.83	0.16	0.16
	500	0.66	0.16	0.33	0.16
	'0'	1.33	0.5	0.53	0.5
	100	0.66	0.66	0.33	0.16
MATCH	150	0.66	0.16	0.16	0.16
	200	0.66	0.16	0.16	0.33
	300	0.33	0.16	0.16	0
	'0'	0.67	0.16	0	0.5
	5	0.33	0.5	0.67	0.33
VERTIMEC	10	1.33	1.16	0.33	0.6
	18	0.33	0	0.83	0
	20	1	1	0.17	0
	'0'	1		2.33	0.5
	300	0.33	0.83	0.3	0.83
LARVIN	350	0.33	0.16	0.16	0.33
	400	0.33	0.33	0.16	0.33
	475	0.6	0	0.00	0
	'0'	0	0.33	0.33	0
	100 + 200	0	0.33	0	0
MATCH + POLO	150 + 400	1	0.16	0.16	0.33
	200 + 500	0.66	0	0.33	0.16
	300 + 400	1.66	0.83	0.33	0.83
	'0'	1.33	0.5	0.83	0.66
LSD			0.73 NS	0.59 NS	0.61 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

TABLE 20 EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF DYSDERCUS ON AT 14 "WAS" IN 1992

		Mean population of Dysdercus per three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	2.67	1.03	1.67	0.17
	300	1.33	0.03	0.03	0
	400	0.33	0.17	0.17	0
	500	0.33	0.17	0.17	0
	'0' (Control)	0.33	0.33	0.17	0.67
MATCH	100	0.67	0.5	0.33	0
	150	000	0	0	0
	200	0	0	0	0
	300	4.67	2.33	2.33	0
	'0' (Conttol)	5.50	2.55	2.50	0
VERTIMEC	5	0.33	0.17	0	0
	10	0	0	0	0
	18	0	0	0	0
	20	0	0	0	0
	'0' (Control)	0.33	0.33	0.17	0
LARVIN	300	0	0	0	0
	350	0	0	0	0
	400	67	0.33	0	0
	475	0	0	0	0
	'0' (Control)	0.67	0.33	0.33	0
MATCH + POLO	100 + 200	1	0.5	0.5	0
	150 + 400	0.33	0.17	0.17	0.83
	200 + 500	0.33	0.17	0.17	0.17
	300 + 400	0.67	0.5	0.33	0
	'0' (Control)	0.33	0.17	0.17	0.33
LSD			1.52 NS	1.48 NS	0.27 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

TABLE 21: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF DYSDERCUS ON COTTON IN 1993

		Mean Number of Dysdercus per three stands of Cotton					
		at 9 WAS:		at 11 WAS		at13 WAS	
CHEMICALS	RATES (g/ha)	24 HPS	48 HPS	24 HPS	48 HPS	24 HPS	48 HPS
POLO	250 - 500	0.06	0.46	0.2	0.13	0	0.00b
MATCH	100 - 300	0.06	0.46	0.6	0.6	0	0.30a
VERTIMEC	5 - 20	0	0.4	0	0	0.16	0.00b
LARVIN	300 - 475	0	0.4	0	0	0.03	0.00b
MATCH + POLO	100 - 300 + 200 - 500	0.1	0.4	0.26	0.3	0.	0.26a
LSD (P=0.05)		0.14 NS	0.27 NS	0.23 NS	0.24NS	0.12 NS	0.27*

*= significantly at P = 0.05; NS = Not significant at the same level of probability . HPS = Hour after spray
Values followed by the same letter (s) is /are not significantly different at P= 0.05 Significant

TABLE 22 EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF DYSDERCUS ON COTTON AT 13 "WAS" IN 1993

		Mean Population of Dysercus three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	0.33	0.33	0.33	0.00
	300	0.60	0.60	0.60	0.00
	400	0.00	0.00	0.00	0.00
	500	0.00	0.00	0.00	0.00
	'0' (Control)	0.60	0.60	0.60	0.67
MATCH	100	0.00	0.00	0.00	0.00
	150	0.33	0.17	0.00	0.00
	200	1.00	0.50	0.50	0.00
	300	0.00	0.00	0.67	0.00
	'0' (Conttol)	2.33	1.67	0.33	0.75
VERTIMEC	5	0.63	0.10	0.00	0.00
	10	0.20	0.16	0.00	0.00
	18	0.00	0.06	0.00	0.00
	20	0.06	0.00	0.00	0.00
	'0' (Control)	0.06	0.06	0.00	0.00
LARVIN	300	0.00	0.00	0.00	0.00
	350	0.60	0.00	0.00	0.00
	400	0.06	0.03	0.00	0.00
	475	0.03	0.00	0.00	0.00
	'0' (Control)	0.33	2.00	0.30	0.06
MATCH + POLO	100 + 200	0.00	0.00	0.00	0.00
	150 + 400	1.00	0.50	0.50	0.83
	200 + 500	0.33	0.17	0.17	0.17
	300 + 400	0.00	0.00	0.00	0.00
	'0' (Control)	2.66	1.33	0.67	0.33
LSD			0.87 NS	0.27 NS	0.27 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

4.5 Effect of different Rates of Four Insecticides on the population of sylepta on Cotton in 1992 and 1993

Results of the performance of spray treatments on Sylepta Larvae in 1992, and 1993 are presented in Tables 23-28. All the insecticides used were effective on the Larvae but Larvin 375 (thiodicarb), Vertimec 1.8 ec (Avermectin) and the mixture of Match + Polo were most effective. In 1992, there were significant differences (P = 0.05) among the insecticides evaluated on Sylepta Larvae at 10 WAS (Table 23). The results in Table 23 showed that, there wes no significant difference (P = 0.05) in the Control of Sylepta Larvae by Polo, Vertimec, Larvin and Match + Polo at 24 hours after spray with exception of Match that showed significantly higher population of Larvae.

Vertimec at the rate of 5g, 10, 18g, 20g/ha reduced the Larvae at the same level. At these rates, the Larvae were effectively controlled at three sprays (Table 25), mixture of Match + Polo at the rate of 200g/ha and Vertimec at the rate of 5g/ha reduced the Larvae effectively at one spray (Table 24) In 1993, the effect of the insecticides on Sylepta larvae was not statistically significant (P = 0.05) at 9 WAS, 11WAS, and 13WAS (Table 26). Results on the Table 27 showed that, there was no occurence of Sylepta Larvae in the plots treated with Larvin before spraying operation at 9 WAS, but at 13 WAS, Sylepta Larvae were recorded. Larvin at the ratte of 350, 475g /ha effectively controlled the Larvae while Vertimec at the rate of 5g/ha 10g/ha controlled Sylepta Larvae at three sprays (Table 28).

4.6 Effect of Different Rates of Four Insecticides on some Athropods in 1992 and 1993

Results on the performancee of spray treatments on biocontrol agents in 1992 and 1993 are presented on Table 29-41.

i ANTS (Camponotus Perris for.)

From the result prewsented in Table 29, there were significant differences (P=0.05) among the insecticides evaluated on Ants at 10 WAS and 9 WAS respectively. Application of Match (growth regulator) Showed significantly high population of ants at 24 hours and 72 hours after spraying in 1992 and at 48 hours after spraying in 1993. While vertimec (Avermectin) adversely reduced the population at 24 hours after spraying (Table, 29).

The application of Match att the rate of 150g/ha on insect pests of cotton favoured the population of ants on cotton plants. At this application rate, ant population is reduced by 50% (Tables, 30 & 31). Vertimec applied at the rates of 18g/ha & 20g/ha eliminated the ants at two spray regime (Tables, 31 & 33) while the application at the rates of 5g/ha and 10g/ha eliminated ants at three spray regime (Tables, 30 & 31). Applicattion of Mixture of Match + Polo at 150g +4000g/ha eliminated ants at one spray (Table 32).

TABLE 23. EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF SYLEPTA ON COTTON IN 1992.

		Mean Number of sylepta per three stands of Cotton					
		at 10 WAS		at 12 WAS		at 14 WAS	
CHEMICALS	RATES (g/ha)	24 HPS	48 HPS	24 HPS	48 HPS	24 HPS	48 HPS
POLO	250 - 500	1.30	1.3	3.5	3.5	0.57	0.6
MATCH	100 - 300	2.77a	1.8	3.5	3.5	0.57	0.6
VERTIMEC	5 - 20	0.77b	0.57	2.13	2.13	0.03	0.1
LARVIN	300 - 475	0.67b	0.87	3.8	3.27	0.63	0.2
MATCH + POLO	100 - 300 + 200 - 500	0.97b	1	1.4	1.17	0.3	0.53
LSD (P=0.05)		1.24 *	1.09 NS	3.28	2.69	0.41 NS	0.52 NS

*= significantly at P = 0.05; NS = Not significant at the same level of probability . HPS = Hour after spray
Values followed by the same letter (s) is /are not significantly different at P= 0.05 Significant

TABLE 24: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF SYLEPTA ON COTTON AT 10 WEEKS AFTER SPRAYING (WAS) IN 1992

TREATMENTS	RATES (g/ha)	Mean Population of Sylepta Larvae/ three stands of cotton 24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	16.00	1.17	0.67	0.67
	300	6.67	0.67	0.50	0.83
	400	4.33	1.67	1.17	1.00
	500	2.00	1.83	2.00	1.33
	0	1.00	0.50	1.00	0.50
MATCH	100	16.00	1.33	1.00	0.83
	150	6.67	0.67	0.83	0.50
	200	4.33	2.00	1.50	1.17
	300	2.00	2.17	1.33	1.33
	0	1.33	0.33	0.33	0.33
VERTIMEC	5	4.64	0.17	0.17	0.00
	10	3.33	1.50	1.50	1.83
	18	5.67	1.67	1.17	1.17
	20	7.33	0.67	0.67	0.67
	0	3.33	0.33	0.33	0.33
LARVIN	300	4.33	1.00	0.83	0.50
	350	4.00	0.33	0.50	0.67
	400	9.00	1.00	0.83	0.50
	475	10.00	1.67	1.50	1.00
	0	3.33	0.67	0.33	0.50
MATCH + POLO	100 + 200	1.67	1.50	1.50	1.50
	150 + 400	1.33	1 17	1.00	1.83
	200 + 500	2.33	0.00	0.00	0.00
	300 + 400	3.67	1.500	1.00	1.00
	0	1.67	0.67	0.67	0.67
LSD			1.78 NS	1.64 NS	1.56 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

TABLE 25: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF SYLEPTA ON COTTON AT 14 WEEKS AFTER SOWING (WAS) IN 1992

		Mean Population of Sylepta/three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	3.00	2.00	1.67	1.50
	300	0.00	0.00	0.00	0.00
	400	0.33	0.17	0.67	0.17
	500	1.00	0.50	0.50	0.50
	'0' (Control)	0.33	0.17	0.17	0.17
MATCH	100	1.00	0.50	0.00	0.00
	150	2.00	1.17	0.00	0.00
	200	2.33	1.33	0.50	1.00
	300	2.00	1.50	1.00	1.00
	'0' (Control)	0.33	1.17	0.00	0.50
VERTIMEC	5	1.67	0.03	0.00	0.00
	10	2.00	1.03	0.50	0.17
	18	1.33	0.67	0.00	0.00
	20	1.67	0.03	0.00	0.00
	'0' (Control)	0.00	0.00	0.00	0.00
LARVIN	300	1.00	0.50	0.00	0.00
	350	0.67	0.67	0.13	0.33
	400	1.00	0.67	0.17	0.17
	475	1.00	0.50	0.50	0.50
	'0' (Control)	1.67	0.03	0.00	0.00
MATCH + POLO	100 + 200	1.00	0.50	0.50	0.50
	150 + 400	0.33	0.17	0.17	0.17
	200 + 500	0.00	0.00	0.00	0.00
	300 + 400	0.67	0.33	0.33	0.33
	'0' (Control)	1.00	0.50	0.33	1.00
LSD			0.27 NS	0.72 NS	0.80 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

TABLE 26. EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON POPULATION OF SYLEPTA ON COTTON IN 1993.

		Mean Number of sylepta per three stands at Cotton					
		at 9 WAS:		at 11 WAS		at 13 WAS	
CHEMICALS	RATES (g/ha)	24 HPS	48 HPS	24 HPS	48 HPS	24 HPS	48 HPS
POLO	250 - 500	0.46	0.46	0.53	0.53	0.53	0.73
MATCH	100 - 300	0.46	0.46	0.8	0.8	0.26	0.4
VERTIMEC	5 - 20	0.4	0.4	0.73	0.73	0.26	0.77
LARVIN	300 - 475	0	0.4	0.73	0	0.4	0
MATCH + POLO	100 - 300 +						
	200 - 500	0.4	0.4	0.33	0.33	0	0.37
LSD (P=0.05)		1.27 NS	0.27 NS	0.67 NS	0.67 NS	0.36 NS	0.66 NS

*= significantly at P = 0.05; NS = Not significant at the same level of probability . HPS = Hour after spray
Values followed by the same letter (s) is /are not significantly different at P= 0.05 Significant

TABLE 27: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF SYLEPTA ON COTTON AT 9 (WAS) IN 1993

		Mean Population of SyleptaLarvae/ three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	0.66	0.33	0.33	0.00
	300	0.00	0.00	0.00	0.00
	400	0.67	0.66	0.66	0.00
	500	1.00	0.66	0.66	0.33
	'0' (Control)	0.00	0.00	0.00	0.00
MATCH	100	0.00	0.00	0.00	0.00
	150	0.00	0.00	0.00	0.00
	200	0.00	0.00	0.00	0.00
	300	0.33	0.33	0.33	0.00
	'0' (Control)	0.00	0.00	0.00	1.00
VERTIMEC	5	0.88	0.00	0.60	0.60
	10	2.00	064	0.04	0.03
	18	0.60	0.04	0.00	0.03
	20	0.00	0.00	0.00	0.00
	'0' (Control)	2.00	1.00	1.00	0.00
LARVIN	300	0.00	0.00	0.00	0.00
	350	0.00	0.00	0.00	0.00
	400	0.00	0.00	0.00	0.00
	475	0.00	0.00	0.00	0.00
	'0' (Control)	0.00	0.00	0.00	0.00
MATCH + POLO	100 + 200	0.00	0.00	0.00	0.00
	150 + 400	0.00	0.00	0.00	0.00
	200 + 500	0.00	0.00	0.00	0.00
	300 + 400	1.00	1.00	1.00	1.00
	'0' (Control)	1.00	1.00	1.00	1.00
LSD		1.50 NS	0.77 NS	0.77 NS	0.74 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

TABLE 28: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPLATION OF SYLEPTA ON COTTON AT 13 (WAS) IN 1993

		Mean Population of SyleptaLarvae/ three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	0.00	0.00	0.00	0.00
	300	2.00	1.33	2.00	2.00
	400	2.00	1.50	1.00	2.00
	500	0.70	0.67	0.67	0.67
	'0' (Control)	0.00	0.00	0.00	0.00
	100	0.00	0.00	0.00	0.00
MATCH	150	1.33	0.67	1.33	0.67
	200	0.00	0.00	0.00	1.33
	300	3.00	1.50	0.00	0.00
	'0' (Control)	1.00	1.00	0.67	0.50
	5	0.60	0.60	0.00	0.00
VERTIMEC	10	0.30	0.00	0.00	0.00
	18	1.00	1.00	0.83	0.50
	20	3.00	0.30	0.00	0.00
	'0' (Control)	3.00	3.00	3.00	3.17
LARVIN	300	0.00	0.00	0.00	0.00
	350	0.60	0.37	0.00	0.00
	400	0.00	0.00	0.00	0.00
	475	0.60	0.03	0.00	0.00
	'0' (Control)	0.66	0.60	0.00	0.00
MATCH + POLO	100 + 200	00.67	0.67	0.33	0.33
	150 + 400	0.00	0.00	0.50	0.50
	200 + 500	0.00	0.00	0.00	0.00
	300 + 400	0.00	0.00	0.00	0.50
	'0' (Control)	1.00	1.00	1.00	0.50
LSD			1.60 NS	0.56 NS	0.79 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

TABLE 29: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF ANTS ON COTTON AT 10 AND 9 (WAS) IN 1992 AND 1993

Mean Number of Ants/3stands of Cotton

CHEM*	POLO	MATCH	VERTIMEC	LARVIN	MATCH+ POLO	LSD P =0.05
9/ha	250 - 500	100 - 300	5 - 20	300 - 475	100 - 300 200 - 500	
10 WAS In 1992						
24 HPS	0.60d	0.37a	1.10c	1.80b	1.10c	1.10*
48 HPS	0.60	1.73	0.97	1.73	1.00	0.98NS
72 HPS	0.77c	1.60a	0.83c	1.50ab	1.07b	0.85*
9 WAS in 1993						
24 HPS	6.30a	2.10c	1.77c	1.43c	2.83b	2.08*
48 HPS	3.83a	2.73b	2.10b	1.07c	3.93a	2.21*
72 HPS	5.93a	2.13b	2.03b	1.07c	2.70b	1.91*

Values followed by the same letters(s) are not significantly different at P = 0.05 ** = Significant at P = 0.05 ; NS = Not significnat at P =0.05

Note: CHEM.* = Chemicals Used in the expriment.

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TABLE 30: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF ANTS ON COTTON AT 10 WEEKS AFTER SOWING (WAS) IN 1992

		Mean Population of Ants/ three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	7.00	10.00	6.00	6.67
	300	7.00	4.00	4.00	2.83
	400	6.67	5.50	7.33	5.33
	500	7.33	3.83	4.83	4.00
	'0' (Control)	6.00	8.17	11.33	1083
	100	4.67	0.83	1.67	1.17
MATCH	150	1.67	0.00	0.50	0.17
	200	2.00	0.83	3.00	1.17
	300	6.67	3.33	2.17	2.50
	'0' (Control)	7.67	5.50	6.33	5.67
	5	2.00	2.67	1.33	1.17
VERTIMEC	10	2.33	2.17	1.67	1.50
	18	6.00	1.17	0.83	1.83
	20	4.67	0.67	1.50	1.00
	'0' (Control)	4.00	2.17	4.67	4.67
LARVIN	300	1.67	1.17	1.33	1.00
	350	4.33	2.17	3.50	1.83
	400	1.67	1.50	1.33	1.17
	475	1.33	0.33	0.50	0.67
	'0' (Control)	5.00	0.17	0.50	0.67
MATCH + POLO	100 + 200	7.00	3.50	5.33	3.17
	150 + 400	0.00	2.33	2.50	2.33
	200 + 500	9.00	3.83	2.00	3.17
	300 + 400	3.00	3.17	4.33	2.67
	'0' (Control)	6.67	1.53	5.50	2.17
LSD			1.51 NS	1.72 NS	2.21 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

TABLE 31: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON *THE POPULATION OF ANTS ON COTTON AT 14 (WAS) IN 1992*

	Mean Population of Ant/ three stands of cotton				
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	0.33	0.17	0.17	0.17
	300	0.67	0.33	0.00	0.33
	400	0.00	0.00	0.00	0.00
	500	0.33	0.17	0.17	0.17
	'0' (Control)	0.60	0.00	0.17	0.00
	100	1.00	0.50	0.50	0.50
MATCH	150	1.33	0.67	0.67	0.67
	200	0.00	0.00	0.00	0.00
	300	0.67	0.50	0.33	0.33
	'0' (Control)	1.66	0.03	0.03	003
	5	0.33	0.17	0.00	0.00
VERTIMEC	10	0.33	0.17	0.00	0.00
	18	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
	'0' (Control)	0.00	0.00	0.00	0.03
	300	0.66	0.33	0.33	0.33
LARVIN	350	0.66	0.33	0.33	0.33
	400	0.33	0.17	0.17	0.33
	475	0.66	0.33	0.50	0.33
	'0' (Control)	1.66	0.33	0.03	0.33
	100 + 200	0.00	0.00	0.00	0.00
MATCH + POLO	150 + 400	1.66	1.17	0.33	0.33
	200 + 500	0.67	0.67	0.33	0.50
	300 + 400	0.33	0.17	0.17	0.17
	'0' (Control)	0.66	0.33	0.33	0.33
LSD			0.83 NS	0.73 NS	0.08 NS

HBS = Hour before Spray, HPS = Hours after Spray, NS = Not significant at P = 0.05

TABLE 32: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF ANTS ON COTTON AT 9 (WAS) IN 1993

		Mean Population of Ant/ three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	11.00	3.67	4.00	3.67
	300	5.00	4.50	4.33	4.33
	400	7.67	3.33	4.33	3.67
	500	7.67	3.67	4.17	4.17
	'0' (Control)	13.00	3.50	4.33	3.33
MATCH	100	2.33	3.67	3.50	2.83
	150	0.33	4.50	2.17	1.83
	200	2.33	3.33	1.33	1.83
	300	2.67	3.67	4.83	4.00
	'0' (Control)	4.67	4.50	4.83	1.67
VERTIMEC	5	2.33	3.50	3.00	1.67
	10	3.00	4.00	2.83	2.67
	18	2.33	3.83	3.17	3.67
	20	1.33	2.83	3.17	3.67
	'0' (Control)	4.33	2.00	3.00	1.33
LARVIN	300	1.63	1.83	1.67	0.83
	350	2.33	2.67	3.67	3.17
	400	2.33	1.67	1.83	1.00
	475	0.67	0.67	2.17	0.67
	'0' (Control)	0.33	2.50	3.67	2.33
MATCH + POLO	100 + 200	4.67	3.33	1.50	1.00
	150 + 400	4.67	0.17	0.50	0.00
	200 + 500	3.67	0.67	1.17	0.83
	300 + 400	5.00	1.83	2.50	2.33
	'0' (Control)	2.67	2.33	5.33	2.83
LSD			6.05 NS	2.47 NS	1.92 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

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TABLE 33: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF ANTS ON COTTON AT 13 (WAS) IN 1993

		Mean Population of Ant/ three stands of cotton			
TREATMENTS	RATES (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
POLO	250	3.67	0.00	0.00	0.00
	300	0.33	0.50	0.67	0.33
	400	0.00	0.17	0.17	0.00
	500	0.33	0.33	0.00	0.17
	'0' (Control)	1.33	0.00	0.17	0.00
MATCH	100	2.00	0.00	0.00	0.00
	150	1.00	0.00	0.00	0.00
	200	0.67	0.00	0.00	0.00
	300	1.33	2.17	2.33	1.33
	'0' (Control)	1.00	0.83	0.83	1.33
VERTIMEC	5	3.33	0.33	0.33	0.50
	10	0.33	0.17	0.17	0.17
	18	0.00	0.17	0.33	0.67
	20	0.00	0.00	0.33	0.00
	'0' (Control)	0.67	2.33	0.67	0.67
LARVIN	300	0.00	0.00	0.00	0.00
	350	0.00	0.17	0.00	0.00
	400	0.00	0.00	0.00	0.00
	475	0.67	0.50	0.50	0.50
	'0' (Control)	1.33	1.17	1.17	0.00
MATCH + POLO	100 + 200	0.33	0.83	0.67	0.83
	150 + 400	0.33	0.00	0.00	0.50
	200 + 500	1.00	0.00	0.00	0.00
	300 + 400	1.33	1.33	1.67	2.33
	'0' (Control)	1.33	1.33	0.50	0.33
LSD			1.48 NS	1.34 NS	1.34 NS

HBS = Hour before Spray; HPS = Hours after Spray; NS = Not significant at P = 0.05

(ii) Laybird Beetle (Cheilmones spp):

Conccinellids. Although, the population of Ladybird beetle was quite low in both years, the result presented on Table 34 showed that, application of Match (growth regulator) significantly favoured the Ladybird beetle while the mixture of Match + Polo adversely reduced their population.

Application of Match at the rate of 100g/ha for the control of cotton insect pests had little impact on the Ladybird. The population of Ladybird beetle was reduced by 50% (Tables, 35-37). The application of Polo at the rates of 300g/ha and 400g/ha; Match + Polo at the rate of 300g + 400g/ha eliminated Ladybird beettes at two sprays while Match + Polo at the rate of 150 + 400g/ha eliminated Ladybird beettes at three sprays (Table 36).

(iii) Spiders (Tetranychus spp).

The application of Match + Polo favoured the population of spiders in cotton plants at 9 WAS (Table 38). Application of Match + Polo at the rates of 100g +200g/ha reduced spider population by 50% at 72 hours after spray (Table,39 & 40). At the end of spraying, Vertimec at the rate of 5g/ha reduced the population by 30% at 72 hours after spray (Table 40), but the rate of 10g/ha eliminated spiders at one spray regime (Table 41)

4.7 Effect of different rates of four insecticides on population of Diparopsis Eggs on Cotton in 1992 and 1993

Results of the performance of different rates of insecticides on Disparopsis eggs in 1992 and 1993 is presented in Tables 42 and 43. Following the application of insectides in 1992, the number of eggs reduced in the sprayed plots when campared with the data before spray (Tables, 42 & 43).

Polo at the rate of 400g/ha controlled the eggs at 12 WAS by 90% while 500g/ha prevented the eggs from the cotton plant at 14 WAS (Table, 42). Match at the rate of 200g/ha resulted to 90% reduction in the eggs population at 14 WAS, 70% at 12 WAS, and 50% at 10 WAS. Vertimec at the rate of 18g/ha resulted in reduction of the eggs by 70% at 14 WAS, 60% at 12 WAS, and 40% at 10 WAS. Larvin at the rate of 400g/ha & 475g/ha resulted 95% reduction of egg population at 14 WAS and 80% reduction at 10 & 12 WAS, while mixture of Match + Polo at the rate of 200 + 500g/ha and 300 + 400g/ha reduced the egg population by 80% at 10 WAS (Table 42).

In 1993, Vertimec at the rate of 18g/ha reduced the population by 70% at 14 WAS and 60% at 12 WAS, while Larvin at the rate of 400g/ha reduced the egg population by 95% at 14 WAS (Table, 43). Difference between the means of all the egg population controlled by the insecticide rates were not statistically significant (P 0.05).

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The eggs were deposited appreciably at 10 WAS in 1992, but in 1993 only few eggs were deposited at 9 WAS but the deposit increased at 11 WAS & 13 WAS. In both years, Vertimec at 18g/ha & Larvin at the rate of 400g/ha gave similar control of Diparopsis egg.

4.8 Effect of different rates of Four insecticides on Insect damage to Cotton fruiting point in 1992 and 1993

The result in respect to assessment of insect damage to cotton boll in 1992 and 1993 is shown in Tables 44 – 47. In 1992, Polo at the rate of 500g/ha reduced insect damage to cotton bolls but the least damage was recorded in plants treated with Larvin at the rate of 350g/ha and Vertimec at 18g/ha. The least damage to the buds (Squares) was recorded with Larvin at the rate of 300g/ha whereas the least damage to flowers was recorded on plants treated with Larvin at 300g/ha and Match + Polo at the rate of 300 + 400g/ha (Table 44). In 1993, the least damage to green-bolls was recorded on plants treated with Larvin at the rate of 350g/ha while the least damage to the buds (squares) and flowers was obtained with Larvin at the rate of 475g/ha (Table 45).

The effect of different insecticide treatments on damage to fruiting bodies in 1992 and 1993 are presented in tables 46 and 47. In 1992, Polo at the rate of 300g/ha gave good control of sap suckers. Whereas Match at the rate of 200g/ha and 300g/ha gave good control of bollworms and suckers. Match at these rates reduced insect damage to 23% and 20% compared with 37% damage in the unsprayed plots. Larvin at the rate of 400g/ha and 475g/ha gave a better control of bollworms and sapsukers and resulted to 19% fruiting body damage by bollworms and sapsuckers compared with 30% damage in the unsprayed plots.

Generally, plants treated with Larvin had the least insect damage to fruiting points and this was closely followed by Match treatments (Table 46)

In 1993, Polo at the rate of 500g/ha reduced the insect damage to fruiting points to 23% compared with the 45% damage in the unsprayed plots. Match at the rate of 300g/ha gave good control of bollworms. Larvin at the rate of 400g/ha controlled bollworms and reduced insect damage to 29% compared with the 41% in the unsprayed plots. The mixture of Match + Polo at the rate of 100+200g/ha reduced insect damage to 24% and 25% respectively compared with the 43% damage in the unsprayed plots (Table 47). In both years, the least green boll damage was recorded on plants treated with Larvin at the of 350g/ha but the least square and flower damage was recorded with Larvin at the rate of 300g/ha and 475g/ha respectively. In both years Match at the rate of 300g/ha controlled bollworms and sapsuckers and Larvin at the rate of 400g/ha gave good control of bollworms.

Table 34: **EFFECT DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF LADY BEETLE ON COTTON IN 1992 AND 1993.**

		Mean Number of Lady bird beetles per three stands of cotton					
		1992			1993		
Chemicals	Rates(g/ha)	24HPS	48HPS	72HPS	24HPS	48 HPS	72 HPS
		10 WAS			9 WAS		
Polo	250-500	0.143	0.06	0.1	0.00c	0.33b	0.00c
Match	100-300	0.46	0.43	0.3	0.63a	0.70a	0.70a
Vertimec	5.20	0.46	0.73	0.46	0c	0c	0.00c
Larvin	300-475	0.46	0.56	0.5	0.06bc	0.13b	0.13b
Match + Polo	100-300 + 200-500	0.13	0.1	0.13	0.13b	0.13b	0.13b
LSD(0.05)		0.13 NS	0.35 NS	0.31 NS	0.39 *	0.43*	0.43*

*= Significant at P=0.05 NS=Not significant at the same level of probability.

Values followed by the same letter (s) is are not signifcantly different at P = 0.05 HPS = Hour after 8 spray.

Table 35: **EFFECT DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF LADY BEETLE ON COTTON AT 10 (WAS) IN 1992.**

Mean Population of lady Bird Beetles per three stands of cotton

Treatment	Rate (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
Polo	250	0.66	0.33	1.16	0.33
	300	1.33	0.83	0.66	0.16
	400	0.33	0.33	0.50	0.16
	500	1.33	0.66	1.00	0.66
	0	1.00	0.50	0.66	0.50
Match	100	0.66	0.50	0.83	0.33
	150	1.00	1.00	0.00	0.16
	200	0.66	0.33	0.50	0.16
	300	1.33	0.83	0.33	0.16
	0	0.66	0.50	0.50	0.33
Vertimec	5	0.66	0.50	0.33	0.33
	10	0.66	0.50	0.50	0.33
	18	1.00	0.60	0.66	0.66
	20	0.33	0.16	0.66	0.16
	0	0.66	0.50	0.66	0.83
Match+ Polo	100+200	0.66	0.33	0.33	0.00
	150+400	1.00	0.50	1.16	0.66
	200+500	0.66	0.50	0.66	0.33
	300+400	0.66	0.33	0.00	0.00
	0	1.00	0.16	0.66	0.33
Larvin	300	1.00	1.00	1.00	0.33
	350	0.66	0.66	0.00	0.00
	400	2.00	1.00	1.16	1.16
	475	0.66	0.33	0.16	1.16
	0	0.66	0.66	0.66	0.50
LSD			0.73 NS	0.81 NS	0.71 NS

HBS = Hour before spray, HPS = Hour after spray, NS = Not significant at P = 0.05.

Table 36: **Effect different rates of Four insecticides on the Population of lady Bird Beetle on cotton at 14 weeks after sowing (WAS) in 1992.**

Mean Population of lady Bird Beetles per three stands of cotton

Treatment	Rate (g/ha)	24 HBS	24 hps	48 hps	72 hps
Polo	250	0.66	0.33	0.17	0.67
	300	0.00	0.00	0.17	0.00
	400	0.00	0.00	0.00	0.00
	500	0.66	0.50	0.17	0.00
	0	0.33	0.17	0.33	0.33
Match	100	0.33	0.17	0.17	0.17
	150	0.00	0.00	0.00	0.00
	200	0.00	0.00	0.00	0.00
	300	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
Vertimec	5	0.33	0.33	0.17	0.17
	10	0.00	1.33	1.33	1.33
	18	0.00	0.00	0.00	0.00
	20	0.00	0.67	0.50	0.50
	0	0.00	0.00	0.00	0.00
Larvin	300	0.00	0.33	0.17	0.00
	350	0.00	0.17	0.00	0.17
	400	0.67	0.17	0.33	0.33
	475	0.33	0.00	0.00	0.50
	0	1.00	0.17	0.50	0.50
Match+ Polo	100+200	0.67	0.33	0.33	0.17
	150+400	0.33	0.17	0.00	0.00
	200+500	0.33	0.17	0.50	0.50
	300+400	0.00	0.00	0.00	0.00
	0	0.33	0.17	0.50	0.50
LSD			0.91 NS	0.91 NS	0.87 NS

HBS = Hour before spray; HPS = Hour after spray; NS = Not significant at P = 0.05.

Table 37: **Effect different rates of Four insecticides on the Population of Lady Bird Beetle on cotton at 9 weeks after sowing (WAS) in 1993.**

Mean Population of Lady bird beetles per three stands of cotton

Treatment	Rate (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
Polo	250	0.00	0.00	0.00	0.00
	300	0.00	0.00	0.00	0.00
	400	0.00	0.00	0.00	0.00
	500	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
Match	100	1.33	0.66	0.66	0.66
	150	1.33	1.16	1.00	0.66
	200	2.33	1.16	1.33	1.83
	300	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.50	0.33
Vertimec	5	0.00	0.00	0.00	0.00
	10	0.00	0.00	0.00	0.00
	18	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
Larvin	300	0.00	0.00	0.00	0.00
	350	0.00	0.00	0.00	0.00
	400	0.00	0.00	0.00	0.00
	475	0.67	0.33	0.33	0.00
	0	0.00	0.00	0.33	0.66
Match+ Polo	100+200	0.00	0.00	0.00	0.00
	150+400	0.00	0.00	0.00	0.00
	200+500	0.00	0.00	0.00	0.00
	300+400	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.60	0.66
LSD			0.65 NS	0.47 NS	0.45 NS

HBS Hour before spray; HPS Hour after spray; NS Not significant at P = 0.05

Table 38: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF SPIDER ON COTTON IN 1992 AND 1993.

Mean Number of Spider per three stands of cotton

		1992			1993		
Chemicals	Rates(g/ha)	24HPS	48HPS	72HPS	24HPS	48 HPS	72 HPS
			At Ten (10) WAS			At Ten (10) WAS	
Polo	250-500	4.87	3.97	3.77	1.4	0.97	0.87
Match	100-300	4.7	4.53	3.8	0.63	0.37	0.4
Vertimec	5.20	4.77	4.63	4.5	0.73	0.9	0.8
Larvin	300-475	3.77	3.87	3.93	1.67	1.23	1.03
Match + Polo	100-300 + 200-500	4.93	3.5	3.23	1.67	0.57	1.47
LSD(0.05)		1.80 NS	1.56 NS	1.48 NS	1.03 NS	0.87 NS	0.85 NS

* = Significant at P=0.05 NS=Not significant at the same level of probability.

Values followed by the same letter (s) is / are not signifcantly different at P = 0.05 HPS = Hour after 8 spray.

Table 39: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF SPIDER ON COTTON AT 10 (WAS) IN 1992

Mean Population of Spiders per three stands of cotton

Treatment	Rate (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
Polo	250	4.33	5.17	4.0	2.17
	300	2.00	3.83	2.33	2.00
	400	4.00	5.67	3.67	2.67
	500	7.00	4.50	5.33	3.83
	0	16.67	13.33	10.00	10.50
Match	100	3.67	4.67	2.50	1.83
	150	6.33	4.33	3.50	3.50
	200	6.00	3.67	3.67	3.83
	300	10.33	7.50	8.17	6.00
	0	5.00	5.17	8.17	4.17
Vertimec	5	5.00	4.00	3.83	3.50
	10	3.67	1.83	1.50	1.83
	18	8.00	5.67	4.00	5.67
	20	5.00	3.83	2.83	3.33
	0	6.67	7.17	7.67	5.17
Larvin	300	5.00	3.33	4.17	3.67
	350	9.33	6.00	5.17	4.67
	400	3.33	2.67	2.33	1.67
	475	9.33	5.67	6.00	6.33
	0	5.00	4.00	5.67	3.83
Match+ Polo	100+200	7.33	5.67	4.50	3.67
	150+400	8.00	5.67	7.67	4.50
	200+500	2.67	2.33	3.50	2.67
	300+400	4.67	3.50	3.83	2.83
	0	5.33	5.33	5.17	3.33
LSD			4.04 NS	3.36 NS	3.32 NS

HBS Hour before spray, HPS Hour after spray, NS Not significant at P 0.05

Table 40: EFFECT DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF SPIDER ON COTTON AT 14 WEEKS AFTER SOWING (WAS) IN 1992

Mean Population of Spiders per three stands of cotton

Treatment	Rate (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
Polo	250	7.33	4.00	4.03	7.03
	300	1.67	0.67	5.03	4.03
	400	3.67	1.03	4.17	2.50
	500	2.00	1.00	1.00	1.67
	0	7.00	6.33	7.17	7.33
Match	100	10.00	5.50	6.00	5.50
	150	6.00	4.50	3.67	3.00
	200	2.33	1.33	4.01	1.03
	300	7.00	5.17	4.67	4.67
	0	3.33	3.17	6.00	6.03
Vertimec	5	7.33	4.33	7.67	5.17
	10	6.67	4.33	4.33	4.50
	18	6.33	3.17	5.03	3.33
	20	5.67	2.03	3.17	2.03
	0	7.00	5.03	7.03	6.17
Larvin	300	4.67	3.67	5.03	4.33
	350	3.00	1.03	2.03	1.03
	400	4.00	2.00	1.50	2.00
	475	5.33	2.67	2.67	2.56
	0	4.33	2.17	0.50	6.33
Match+ Polo	100+200	7.67	5.17	6.03	4.50
	150+400	7.00	4.17	1.67	2.67
	200+500	1.33	5.17	5.50	5.03
	300+400	1.67	4.03	4.33	4.67
	0	7.33	7.17	10.33	0.33
LSD			4.25 NS	5.48 NS	0.33

HBS Hour before spray; HPS = Hour after spray. NS = Not significant at P = 0.05.

Table 41: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON THE POPULATION OF SPIDER ON COTTON AT 9 WEEKS AFTER SOWING (WAS) IN 1993

Mean Population of Spiders per three stands of cotton

Treatment	Rate (g/ha)	24 HBS	24 HPS	48 HPS	72 HPS
Polo	250	1.00	1.17	0.83	0.50
	300	0.00	0.33	0.67	0.00
	400	2.33	2.17	1.17	1.50
	500	3.33	2.17	1.83	1.83
	0	2.33	1.17	0.33	0.50
Match	100	0.67	0.33	0.50	0.67
	150	0.67	0.17	0.17	0.33
	200	0.67	0.17	0.00	09.33
	300	0.00	0.17	0.67	0.00
	0	1.67	1.33	0.50	0.00
					0.67
Vertimec	5	2.00	1.00	1.00	1.00
	10	2.00	0.00	0.00	0.00
	18	0.33	0.33	0.30	0.17
	20	1.00	0.50	0.50	0.50
	0	2.60	1.83	2.20	2.33
Larvin	300	1.33	0.83	0.67	1.17
	350	2.33	1.83	1.17	1.17
	400	2.00	2.00	1.83	1.00
	475	1.67	1.17	1.00	1.00
	0	1.67	1.67	1.50	0.83
Match + Polo	100+200	1.33	1.50	1.17	0.67
	150+400	3.00	2.67	1.50	1.67
	200+500	1.00	1.67	1.00	0.83
	300+400	2.33	1.83	2.00	2.33
	0	1.33	0.67	2.17	1.83
LSD			2.19 NS	2.45 NS	2.95 NS

HBS Hour before spray, HPS Hour after spray, NS Not significant at P 0.05.

Table 42: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON DIPAROPSIS EGGS (WAS) IN 1992

Mean number of Diparopsis eggs per three stands of cotton

		10WAS		12WAS		14WAS	
Treatment	**Rate (g/ha)**	**24 HBS**	**24 HPS**	**24 HBS**	**24 HPS**	**24HBS**	**24 HPS**
Polo	250	6.30	2.00	6.33	6.00	7.00	7.00
	300	6.33	1.67	6.33	5.33	5.33	4.00
	400	9.33	4.00	6.33	0.33	2.33	0.67
	500	11.67	7.67	7.67	2.67	2.67	0.00
	0 (Control)	10.33	10.0	14.00	14.33	7.67	7.67
Match	100	4.00	3.00	3.00	2.33	2.33	2.33
	150	7.33	3.00	4.00	2.00	4.00	2.00
	200	9.00	5.00	5.00	3.00	3.00	0.67
	300	9.33	6.33	6.33	5.67	6.33	5.33
	0 (Control)	9.67	9.00	5.00	5.00	5.67	5.67
Vertimec	5	5.33	2.33	2.33	1.67	2.67	0.67
	10	5.33	1.33	1.33	0.67	0.67	0.33
	18	11.67	7.67	7.67	4.00	4.33	3.33
	20	6.33	2.33	3.33	2.67	3.67	2.67
	0	7.33	7.67	7.67	7.67	5.33	5.33
Larvin	300	4.33	4.00	3.33	2.33	3.33	2.67
	350	7.33	4.33	6.33	4.33	4.33	4.00
	400	7.33	2.33	5.33	2.33	5.33	0.33
	475	10.33	4.33	6.33	4.33	5.33	0.67
	0	5.67	4.33	6.67	6.67	9.67	9.33
Match + Polo	100 + 200	3.33	1.33	2.33	1.67	3.33	1.67
	150 + 400	4.00	1.67	3.33	2.33	5.67	4.67
	200 + 500	7.67	0.67	5.33	2.33	7.67	5.67
	300 + 400	7.67	1.67	5.33	1.67	7.67	5.67
	0	6.33	6.33	5.67	5.67	8.33	8.00
LSD (P=0.05)			6.23 NS		7.05 NS		6.65 NS

HBS = Hour before spray; HPS = Hour after spray; NS = Not significant at P = 0.05

Table 43: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON DIPAROPSIS EGGS ON COTTON IN 1993

Mean number of Diparopsis eggs per three stands of cotton

		9 WAS		11 WAS		13 WAS	
Treatment	**Rate (g/ha)**	**24 HBS**	**24 HPS**	**24 HBS**	**24 HPS**	**24HBS**	**24 HPS**
Polo	250	0.0	0.00	10.33	10.33	5.33	4.44
	300	0.0	0.00	4.33	2.33	5.67	1.67
	400	0.0	0.00	10.33	3.33	10.67	5.00
	500	1.67	0.67	10.33	5.55	10.67	7.33
	0 (Control)	1.00	0.60	10.00	0.67	10.67	10.67
Match	100	0.00	0.00	8.67	5.67	9.00	8.33
	150	2.67	1.67	1.67	0.67	11.33	9.33
	200	2.33	0.33	2.00	1.00	11.33	7.00
	300	2.67	0.67	7.33	5.33	5.33	2.67
	0 (Control)	3.33	3.00	6.33	6.33	11.33	11.33
Vertimec	5	0.00	0.00	8.00	8.00	9.00	5.00
	10	2.00	1.00	12.00	10.00	9.33	5.33
	18	0.00	0.00	11.33	8.00	10.00	6.33
	20	0.00	0.00	11.33	10.33	9.33	5.3
	0	0.00	0.00	11.67	11.67	9.33	9.67
Larvin	300	0.00	0.00	1.67	1.67	1.67	1.67
	350	0.00	0.00	7.00	3.00	3.00	0.00
	400	2.33	0.33	10.67	7.67	7.33	1.33
	475	2.67	0.67	10.67	7.00	7.33	3.33
	0	3.00	3.00	10.67	10.67	13.33	3.67
Match + Polo	100 + 200	0.00	0.00	8.00	8.00	9.00	5.00
	150 + 400	2.00	1.00	12.00	10.00	9.33	5.33
	200 + 500	0.00	0.00	11.33	8.00	10.00	6.33
	300 + 400	0.00	0.00	11.33	10.33	9.33	5.3
	0	0.00	0.00	11.67	11.67	9.33	9.67
LSD			1.33 NS		6.00 NS		6.31 NS

HBS = Hour before spray, HPS = Hour aftere spray, NS = Not significant at P = 0.05

Table 44: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON INSECT DAMAGE TO COTTON BOLLS IN 1992

Treatment	(g/ha)	TNB	DGB	TNBU	DBU	TNF	DF*
Polo	250	124.0	3.3	147.0	1..67	133.3	1.33
	300	128.3	3.33	149.7	1.67	137.3	1.33
	400	154.3	4.67	171.7	1.67	164.0	1.33
	500	155.7	1.33	170.7	1 67	159.0	0.00
	0	141.3	3.67	168.3	1.33	149.0	1.00
Match	100	169.3	2.00	189.0	0.67	175.7	0.62
	150	140.0	1.33	162.0	3.33	147.3	1.10
	200	131.7	2.67	156.0	1.00	140.7	1.00
	300	159.0	2.67	170.7	1.67	167.3	0.67
	0	156.0	3.33	174.3	0.00	163.3	2.00
Vertimec	5	150.0	1.00	168.3	0.67	154.0	2.00
	10	149.7	1.67	171.0	1.33	162.0	0.67
	18	136.0	0.33	153.3	0.67	141.7	0.67
	20	147.0	2.67	162.3	2.33	150.7	0.00
	0	129.3	1.67	151.7	1.67	138.3	0.33
Larvin	300	130.0	1.33	151.7	0.33	137.7	0.00
	350	148.0	0.33	164.3	1.00	150.3	1.00
	400	146.0	3.00	163.7	3.00	154.3	0.00
	475	134.0	1.33	151.7	1.67	141.3	0.33
	0	111.7	3.33	133.7	0.00	120.3	2.00
Match + Polo	100 + 200	172.0	2.33	189.0	1.00	178.3	0.00
	150 + 400	139.3	1.00	162.0	0.00	146.00	1.00
	200 + 500	123.3	3,.000	145.3	0.67	132.0	0.00
	300 + 400	120.0	1.56	145.0	2.67	128.7	0.33
	0	118.7	4.00	140.3	1.00	128.3	2.00
LSD(P 0.05)		38.83 NS	3.64NS	34.57 NS	2.14 NS	37.8 NS	1.94 NS

DGB Damaged green bolls TNBU Total No of Buds DBU Damaged Buds
TNFT Total No of flowers DF Damaged flower TNB Total No of Bolls

Table 45: EFFECT OF DIFFERENT INSECTICIDE RATES ON INSECT DAMAGE TO COTTON BOLLS IN 1993

Treatment rates(g/ha)		No of boll	Damaged boll	No of buds	Damaged Buds	No of Flowers	Damaged flower
Polo	250	40..3	27.3 (67)	95.3	12.7(13)	65.3	16.7(25)
	300	26..3	17.3 (65)	61.	9.3(15)	48.7	19.7(40)
	400	31.3	11.7(37)	41.7	28.3(67)	47	10.0(21)
	500	27	25.7(95)	75	18.3(24)	55	26.7(48)
	'0'	30.7	10.0(32)	59	14.7(25)	44.3	20.7(46)
Match	100	34	21.7(63)	74.	14.0(18)	61	21.7(35)
	150	36.7	12.3(63)	369	16.3(23)	51	10.0(19)
	200	38.3	19.7(51)	76.2	18(22)	62.3	13.3(21
	300	59.6	12.7(21)	104.3	17.0(16)	76.3	21.3(27
	'0'	33.3	26.3(79)	97	20.7(21)	63.7	18.3(28)
Vertimec	5	38	17.6(44)	74.3	12.3(16)	58.3	5.0(8)
	10	36.7	11.0(30)	62.3	7.7(12)	56.3	2.3(3)
	18	52.3	11.3(21)	79.7	15.7(19)	65.7	11.0(16)
	20	42.3	16.7(38)	73	12.0(16)	61.7	9.7(150
	'0'	26.7	20.3(96)	69	16.3(23)	48.7	19.0(30
Larvin	300	71..3	12.0(16)	104.3	13.3(12)	85	3.0(3)
	350	63.7	9.3(14)	85.7	14.0(16)	94.7	3.3(4)
	400	55.3	28.0(50)	136.7	12.0(11)	85	6.0(7)
	475	48.3	15.0(31)	74.3	6.0(11)	65.3	2.3(3)
	'0'	35	12.7(36)	70.3	14.7(21)	49.3	18.0(36)
Match + Polo	100 + 200	29.7	27..3(92)	74.3	1.00(14)	597	26.7(44)
	150 + 400	25.3	18..3(27)	62.3	10.7(17)	45.7	34.7(76)
	200 + 500	26	13.0(50)	62.7	16.3(26)	40.7	14.7(36)
	300 + 400	34	16.3(48)	76.7	20.3(26)	52.7	14.3(27)
	'0'	26..3	25.7(97)	81	18.3(22)	54.7	24.7(45)
LSD		17.78 NS	13.3 NS	126.00 NS	10.49 NS	19.58 NS	13.18 Ns

Table 46: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDE ON DAMAGE TO COTTON FRUITING POINTS IN 1992.

		Number of Fruiting Bodies per three Stands			Insect responsible for Damages to fruiting bodies					
TREATMENTS	RATES(g/ha)	Flower	Green Bolls	Split Bolls	Mum Boll	Total	Bollworm	sap suckers	insects	undamaged
Polo	250	1.33	30	34	13	78.33	13.3	5	23	--
	300	1.33	50.3	29	17.67	98.3	16.7	4	21	79
	400	1.33	33.3	27	13	74.63	16.3	10	32	68
	500	0	45.3	29.7	26	101	27	7.67	34	66
CONTROL	0	1	39.3	31.7	23.33	95.33	23	9	35	65
MACTCH	100	0.62	49	25	12	86.62	14.32	33.3	20	80
	150	1.1	57	24.7	13.33	96.13	15	9/33	25	75
	200	1	33.3	26.3	8	68.6	9	7.33	23	--
	300	0.67	29	45.7	11	87.74	11	8.67	20	80
CONTROL	0	2	46.3	28.3	17.67	94.27	22.7	12.67	37	63
VETUMEC	5	2	38	41	11	92	22.7	7.33	38	62
	10	0.67	44	34	21	99.67	16.7	14.33	31	69
	18	0.67	57	29.7	15.33	102.7	17	15	31	69
	20	0	45	40	14.33	99.33	17	9	26	74
CONTROL	0	0.33	37.3	46	19.33	92.96	142	8.33	51	49
LARVIN	300	0.33	42.7	29.3	8	80.33	14	11.67	32	68
	350	0	51.3	29.7	10	91	13.3	6.33	21	79
	400	0	34	51.3	14.67	99.97	12.7	6.33	19	81
	475	0	42.3	40.3	12	84.6	13	3.67	19	81
CONTROL	0	4	46.7	35.7	20	106.4	22.7	10	30	70
MACH + POLO	100 + 2000	0	43.7	37.7	18	99.4	16	4.67	20	80
	150 + 400	1	36.3	28.7	10	76	12	5.67	23	77
	200 + 500	0	48.3	36.7	14.67	99.67	17.3	8.33	25	75
	300 + 4000	0.33	38.7	35.3	11.33	85.99	14.4	4.67	22	78
CONTROL	0	2	48.3	24.7	14	89	16.3	3.67	22	78
LSD		1.94 NS	18.31 NS	15.14 NS	26.84 Ns		30.72 NS	4.50 NS		

Table 47: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDE S ON DAMAGE TO COTTON FRUITING POINTS IN 1993

		Number of Fruiting Bodies per three Stands			Insect responsible for Damages to fruiting bodies					
TREATMENTS	RATES(g/ha)	Flower	Green Bolls	Split Bolls	Mum Boll	Total	Bollwom	sap suckers	insects	undamaged
POLO	250	16.7	5	2.33	4	28.03	7.33	0.33	27.3	73
	300	19.7	6	2.67	4.67	33.04	10.67	0	32	68
	400	10	5.33	2.67	3.33	21.33	10.67	0	50	50
	500	26.7	3.67	1.33	4.67	36.37	8.67	0	23	77
CONTROL	0	20.7	13.33	6	3	43.03	19.67	0	45	55
MATCH	100	21.7	6.67	2.33	5.33	36.03	13.67	1.00	40	60
	150	10	5.67	3.33	5.67	24.67	12.57	0.00	51	49
	200	13.3	7.67	3.67	7.00	30.64	16	0.67	54	46
	300	21.3	5.67	1.33	3.67	31.97	8.67	1.67	32	68
CONTROL	0	18.3	8.33	2.00	4.33	32.96	9.33	0.00	28	72
VERTIMEC	5	5.00	10.67	4.67	9.33	29.67	23.67	0.00	78	21
	10	2.3.00	10.00	5.33	4.67	22.3	20.67	0.00	92	8
	18	11.00	14.67	4.00	5.67	35.34	23.67	0.00	67	33
	20	9.70	12.67	4.00	5.00	31.37	17.67	0.00	56	44
CONTROL:	0	19.00	3.67	1.33	5.67	29.67	18.33	0.00	29	72
LARVIN	300	3.00	19.67	1.33	4.67	28.67	19.33	0.00	67	33
	350	3.3.00	18.00	1.67	2.33	25..3	20.00	0.00	79	21
	400	6.00	12.33	2.00	2.33	40..99	12.00	0.00	29	71
	475	2.3.00	14.0	4.33	1.33	21.96	15.33	0.00	69	31
CONTROL	0	18.00	14.67	0.33	14.00	47.00	25..33	0.00	47	59
MATCH + POLO	100 + 2000	26.7	2..33	0.67	3.00	32.7	5.57	2.33	24	76
	150 + 400	34.7	7.67	1.00	4.33	47.7	10.0	2.33	25	75
	200 + 500	14.7	3.33	5.00	6.00	29.03	13.67	5.00	64	36
	300 + 4000	14.3	3.33	4.33	5.33	27.29	9.00	2.00	40	60
CONTROL	0	24.7	6.00	3.00	5.33	39.03	15.6	2.00	43	57
LSD (p =0.05)		13.18 NS	6.95 NS	3.77 NS	4.29 NS		9.69 NS	1.60 NS		

4.9 Yield Data

4.9.1 Seed Cotton yield

Data in respect to seed cotton yield in 1992 and 1993 are presented in Tables 48 and 49. In 1992. The highest seed cotton yield was obtained from plots treated with Match at the rate of 100g/ha and 300g/ha and this was closely followed by Match + Polo at the rate of 100 +200g/ha. The yield of seed cotton recorded with Match were 1730kg per hectare and 1679 kg per hectare respectively. Polo applied at the rate of 400g/ha and 500g/ha resulted in yield of 1431kg/ha and 1448kg/ha respectively. While Vertimec at the rate of 10 g/ha gave similar yield of 1415kg/ha. Match at the rate of 150g/ha and 200g/ha, Larvin at the rate of 350g/ha and 475g/ha and mixture of Match + Polo at the rate of 150+400g/ha gave similar yield to the yield obtained from plots treated with Vertimec at the rate 18 and 20g/ha The yields recorded were 1336kg/ha, 1373kg/ha, 1313kg/h 1362kg/ha and 1305kg/ha as against 1308kg/ha respectively. Differences between the means of yield were not statistically significant at P = 0.05 (Table 48).

In 1993. The highest seed cotton yield was recorded from plots treated with Larvin at the rate of 300g/ha. The seed cotton yield in 1993 was too low (453kg/ha). However, the performance of the insecticides rate were deduced from the data. Larvin at all the rates gave better yield compared with yield obtained with other insecticides treatments. The yield obtained with

application of Match at the rate of 300g/ha, Vertimec at the rate of 18g/ha and Match + Polo at the rate of 300+400g/ha are higher compared with the yields obtained from the lower rates of applications (Table 49).

4.9.2 **Seed Cotton Quality**

In 1992 the highest clean seed cotton was obtained from plots treated with Match at the rate of 100g/ha & 300g/ha. But in 1993, the highest clean seed cotton was obtained in plots treated with Larvin at the rate of 300g/ha and this was closely followed by Match and Vertimec at the rate of 300g/ha, 18g/ha respectively (Table 48 &49).

4.10 **Laboratory Evaluation of Four Insecticides Applied at Two Rates on Mortality of Dysdercus volkeri**

The efficacy of the insecticides spray treatments on Dysdercus is presented in Tables 50 and 51. From the spray data, it was shown that there was a significant difference in the percentage mortality of Dysdercus at 5 hours and 24 hours after spraying the four insecticides (Table 50). All the insecticides sprayed caused mortality of Dysdercus volkeri with time but the effect of Polo relative to mortality of D. volkkeri was remarkable and this was closely followed by Match at 72 hours after spray.

Treatment with Polo resulted in 26% mortility at five hours after spray. Differences between the mean percentage mortality was statistically significant (P =0.05) at 5 hours and 24 hours after spray (Table 50). The efficacy of the insecticides on Dysdercus at three rates is presented in Table 50. Polo applied at 1.0g/ha resulted in a mortality rate of 14% at five hours but at 72 hours

there was 100% mortality. Whereas Polo at 2.0g gave 38% mortality at five hours and 100% mortality at 24, 48 and 72 hours.

Polytrin at 1g/ha gave no mortality at five hours and mortality rose gradually to 95% at 72 hours after spray. However polytrin at 2.0g resulted in only 10% mortality at five hours and 95% at 72 hours. Larvin applied at 1g resulted to 5% mortality at five hours but the mortality rate increased at 48 hours and 72 hours to 85% and 90% respectively. At the rate of 2.0g 10% and 100% mortality resulted at 72 hours. Match at 1.0g/ha effected 10% mortality at five hours and 95% at 72 hours while at 2.0g the mortality rose from 14% at five hours to 100% at 72 hours. Differences between the treatment means were not statistically significant (P = 0.05)

Based on the data in Table 51. Polo at 1.0g and 2.0 gave similar levels of control of Dysdercus with time. Likewise polytrin at 1.0g and 2.0g, gave good control of Dysdercus. Larvin and Match at 2.0g resulted in high mortality of Dysdercus at 72 hours respectively. Polo effected high mortality of Dysdercus at 24 hours compared with the other insecticides sprayed. Polytrin, Larvin and Match resulted in the same level of mortality (90%) at 48 hours while Larvin and Match gave 78% mortality at 24 hours. Polytrin and Larvin effected the same level of mortality (95%) at 72 hours. There was no mortality recorded for the insects that were not sprayed in the control throughout the period of the experiment.

Table 48: EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON LEVEL OF COTTON YIELD IN 1992

		Kg/ha	Kg/ha	Kg/ha	Kg/ha	Kg/ha
Treatment	Rates g/ha	Clean seed Cotton	Stained seed Cotton	Total yield	Seed yield	Lint yield
Polo	250	809	256(24)	1065	93.1	79.4
	300	947	213(18)	1160	66.3	61.4
	400	1179	252(17)	1431	126.7	77.6
	500	1102	346(23)	1448	127.4	77.1
	control	983	267(21)	1250	111.8	650
Match	100	1415	315(18)	1730	153.2	93.5
	150	1052	274(29)	1326	117.5	68.5
	200	1092	216(16)	1308	117.7	60.3
	300	1407	272(22)	1679	159.7	87.9
	Control	1090	308(220	1398	124.3	74.7
Vertimec	5	1074	299(21)	141.5	141.5	72.0
	10	1099	316(22)	126.2	126.2	74.6
	18	1045	327(23)	122.2	122.2	74.4
	20	1156	210(15)	122.8	122.8	70.7
	Control	929	207(18)	192.9	102.9	57.7
Larvin	300	951	223(19)	1174	104.7	61/1
	350	1078	234(19)	1313	112.5	65.4
	400	1037	245(19)	1282	112.7	68.8
	475	1109	253(18)	1362	721.0	73.3
	Control	906	199(18)	1105	98.0	57.7
Match + Polo	100+200	1218	288(19)	1506	150.9	71.8
	150+400	1057	248(19)	1302	117.1	69.9
	200+500	816	216(21)	1032	92.4	53.1
	300+400	1029	267(20)	1296	107.7	60.6
	Control	867	185(17)	1052	94.0	54.3
SE+ / -		182.9	58.64	241.54	20.64	13.4
LSD (P = 0.05)		382.8	127.5	510.3	43.2	28.1

No in parenthesis are % Figures

Table 49: **EFFECT OF DIFFERENT RATES OF FOUR INSECTICIDES ON LEVEL OF COTTON YIELD IN 1993**

		Kg/ha	Kg/ha	Kg/ha	Kg/ha	Kg/ha
Treatment	Rates g/ha	Clean seed Cotton	Stained seed Cotton	Total yield	Seed yield	Lint yield
Polo	250	198	30.8(13)	228.8	158.1	101.8
	300	76	32.3(29)	108.3	79.4	37.0
	400	98	31.9(24)	129.9	69.5	46.0
	500	88	36.3(29)	124.3	69.4	41.6
	control	106	30.7(22)	136.3	83.3	46.2
Match	100	119	38.8(24)	157.8	46.2	50.9
	150	184	57.5(23)	115.7	115.7	87.9
	200	153	51.29(25)	115.7	115.7	74.0
	300	239	53.69(18)	180.5	180.5	111.1
	Control	451	34.0(7)	78.7	78.7	50.9
Vertimec	5	170	57.8(25)	227.8	134.2	87.9
	10	08	54.6(42)	222.6	134.2	79.7
	18	240	91.3(3)	331.3	208.3	111.1
	20	197	54.0(23)	233	157.4	50.9
	Control	90	26.2(22)	116.2	69.4	
Larvin	300	362	91.6(20)	453.6	293.9	157.3
	350	298	65.3(18)	363.3	226.8	138.8
	400	313	71.4(18)	384	245.2	143.5
	475	256	48.1(15)	304	189.8	115.7
	Control	173	27.3(13)	200	101.8	89.4
Match + Polo	100+200	106	39.8(27)	453.6	87.9	50.9
	150+400	94	34.8(27)	363.3	75.0	46.2
	200+500	90	35.7(28)	384	69.4	42.6
	300+400	142	59.3(29)	304	74.0	69.4
	Control	116	25.4(18)	200	78.7	55.5
LSD (P = 0.05)		173.5 NS	207.58 Ns	381.08 Ns	79.9 NS	49.75 NS

( ) no. in parenthesis are % figures.

Table 50: **EFFICACY OF FOUR INSECTICIDES APPLIED AT TWO RATES ON THE MORTALITY OF DYSDERCUS VOLKERI IN THE LABORATORY**

		Percentage Mortality			
Chemical	**Rates (g)**	**5 hrs**	**24 hrs**	**48 hrs**	**72 hrs**
Polo	1 –2	26	95	97	100
Polytrin	1 –2	5	62	90	95
Larvin	1 –2	7	78	90	95
Match	1 -2	12	78	90	97
LSD (P = 0.05)		0.43*	0.64*	0.46 Ns	0.75 NS

- = significant at P =0.05 ; NS = not significant at the same level of probability

Table 51: **EFFICACY OF FOUR INSECTICIDES APPLIED AT TWO RATES ON THE MORTALITY OF DYSDERCUS VOLKERI IN THE LABORATORY**

		Percentage Mortality			
Chemical	**Rates (g)**	**5 hrs**	**24 hrs**	**48 hrs**	**72 hrs**
Polo 500 SE	1	14	90	90	100
	2	38	100	100	100
Control	③	0	0	0	0
Polytrin 400 EC	1	0	48	90	95
	2	10	76	90	95
Control	③	0	0	0	0
Larvin 375	1	5	71	85	90
	2	10	86	95	100
Control	③	0	0	0	0
Match 50%	1	10	81	85	95
	2	14	76	95	100
Control	③	0	0	0	0
LSD (P = 0.05)		0.60 NS	1.59 NS	0.65 NS	0.35 NS

- = Significant at P =0.05 , NS = not significant at 5% level of probability.

CHAPTER 5

DISCUSSION

5.1 Field Trial:

The insect pests population generally decreased with insecticides application from 24 hours, 48 hours to 72 hours after spraying respectively, although individuals insect data showed some variations with the spray treatments. The high population of sap-suckers and leaf rollers in 1992 could be due to the luxuriant growth of the cotton plant. This similar observation was made by Jackson et al., 1973.

In both years, Polo, Match, Larvin and mixture of Match + Polo were effective on sap-suckers and bollworms. Thus, the effectiveness of Polo on sap-suckers and bollworms in this study is similar to the report of All et al., (1977) that pyrethroid/organo-phosphate mixtures were effective in the control of both bollworms and sap-sucking insect pests, as well as the control of aphids and cotton stainer (Gaines et al., 1950: Hayward, 1973). The use of cypermethrin synergised with monocrotophos to control whiteflies on cotton was also reported by Ishaya and Ascher, 1984. Match (insect growth egulator) at 200g/ha effectively controlled the population of whiteflies at three spray regimes but the mixture of Match + Polo at the rate of 200 + 500g/ha controlled the population of whitefly at two spray regimes. The effectiveness of Match on whitefly in both year was apparently due to the fact that insect growth regulator interfered with the moulting process by inhibiting the biosynthesis of chitin as reported by Bull et al., (1983)

According to Gerling (1986), whitefly has shorter life cycle of about 2.3 days. The application of Match on whitefly at the developmental stage could hinder the nymph from emerging into adult whitefly. The observed better performance of Polo, Match, Larvin and Match + Polo on sap-suckers and leaf roller in both seasons might be due to proper coverage of spray deposits on the treated plants. The effectiveness of Larvin (thiodicarb) on bollworms in this study is also similar to the report by Matthews (1989) that thiodicarb controls Heliothis and Dipropsis. In earlier work at Samaru, it was found that Larvin gave good control of sap-suckers and bollworms (Onu, 1991). The observed good performance of Larvin (Thiodicarb) in this study may be probably due to its larvicidal property and its quick action as stomach toxicant with complementary contact action. Larvin and Vertimec showed remarkable effectiveness on Diparopsis egg, in the study.

The use of Vertimec (Avermectin) was most effective on aphids and Leaf rollers in this study. Vertimec at the rate of 5g/ha was effective on Aphids and Sylepta larvae. This observation is contrary to the report of Wright et al., (1985), that Vertimec have been evaluated as cotton insecticide at 11 - 33g/ha. From the results on Tables 38 - 41, it was shown that application of mixture of Match + Polo at all the rates favoured the population of spiders in this study. The spiders encountered in this study were not destructive and according to Leigh (1985), such spiders are predators of other insect pests on cotton. The low population of spiders before spraying commenced in the second cropping season might be due to rainfall intensity on cotton leaves.

This observation agrees with the report of Leigh (1985) that infestation by spiders are checked by heavy rain.

It was also observed that moderate application of Match on cotton insect pests favoured ants and ladybird beetle population in this study (Tables34 - 37). Thus this observation agrees with the report by Bull et al (1983) that insect growth regulators have little impact on natural enemies. Generally, insecticides that will give moderate elimination of natural enemies and at the same time reduce the devastating insect pests of cotton is best for control. In the absence of insecticides application, the feeding activities of cotton stainers may considerably reduce seed cotton yield and quality (Faulkner, 1974; Kumar et al., 1982). Thus making insecticide application imperative for good cotton yield. In the current study, insecticide application was effective against D. volkeri. Generally, it was observed that spraying gave good control of sucking pests in both years.

Sucking pests and bollworm accounted for 20% and 25% total fruiting bodies damaged in 1992 and 1993 respectively. From the result in Table 45, it is obvious that the low boll formation in 1993 was attributed to the high fruiting bodies shed during the dry-spell. This is because, the effect of sucking pests and bollworms on total fruiting bodies damaged in 1992 and 1993 were comparable (20% and 25%) respectively. Thus the 25% insect damage to the fruiting bodies in 1993 cannot cause a drastic low yield. The results in Table 45 indicate that insect pests attacking the buds and bolls were effectively controlled with Larvin while those attacking the flowers were better controlled with Vertimec, Larvin and Match + Polo.

The protection of fruiting bodies against damage by sap-suckers and bollworms was achieved by spraying at 10 – 14 WAS and 9 – 13 WAS in 1992 and 1993 respectively. Fruiting bodies produced by the cotton plants were fed on by the insects and consequently damaged in the process. The bollworms tunnelled into the boll feeding on the contents and thereby introducing rot pathogens (Libby, 1968; Raheja, 1981). The sucking pests on the other hand suck the contents of the bolls and predispose the lint to Nematospora fungus.

From the results obtained on insecticide application, it was observed that the no-spray plots (control) had a higher proportion of fruiting bodies damaged than in the sprayed plots. Among the insecticides sprayed, there was no significant difference in the level of protection given by all the rates of application, thus indicating that all the rates of application were effective in protecting the fruiting bodies from damage. However, Larvin (thiodicarb) was most effective on insects damaging squares, flowers, and the bolls, while Match (insect growth regulator) and Larvin were most effective on bollworms and sap-suckers in both years. This perhaps may be that Larvin and Match had better contact with the fruiting bodies. Larvin, Polo, and mixture of Match + Polo gave good control of all categories of insect pests attacking the fruiting bodies.

Yield: The seed cotton yield was higher for the sprayed plots and this may have resulted from a number of factors including plant populations, variety vigour, proper coverage of insecticides sprayed on plants and effect of pests on fruiting bodies.

In this study, the observed marked difference between the seed cotton yield of the un-sprayed and sprayed plots indicate that pest populations and their effect on yield was controlled by the insecticide application. This agrees with the report by Caswell and Raheja (1977); and Kumar and Ogunlela (1982) that insecticide spraying resulted in increased cotton yield. The very low yield of seed cotton in 1993 was due to the dry-spell during the fruiting stage of the cotton plant which resulted in shedding of squares and young bolls.

The higher yield from the sprayed plots compared to the control plots reflected the efficacy of the spray treatments. From results on Tables 48 – 49 Match (insect growth regulator), Larvin and mixture of Match + Polo treatments recorded higher cotton yield than Vertimec (Avermectin) and Polo. Seed cotton yield from the plants treated with Match compared well with those from plants treated with Larvin. However, the difference between means of insecticides rates were not statistically significant (P = 0.05).

Based on seed cotton quality data, the sprayed plots had significantly more clean seed cotton and less stained seed cotton than the control (P = 0.05). Among the insecticides applied, Match and Larvin had more clean seed cotton. This was consistent with their observed performance in controlling sucking pests and level of fruiting body damage.

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5.2 Laboratory Trial: From the results in Table 57, Polo at the rates of 1g and 2g applied, induced mortality in Dysdercus at the same level at 72 hours after spraying. Thus Polo at the rate of 1g induced 100% mortality at 72 hours after spraying. This trend was same with Polytrin 440ec. The mortality

rate induce by Larvin 375 and Match 50% at the first rate of application were also comparable. There was no significant difference in the level of mortality induced by all the rates of the insecticides in Dysdercus (P 0.05). However, Polo at the rates of 1g and 2g showed remarkable high mortality rate when compared with other insecticides used in this laboratory study. From the mortality data, it was observed that Polo 500 S.E. and Polytrin 400 e.c. , Larvin 375 and Match 50% at the rate of 2g will result to insecticide wastage since the application of 1g induced a comparable mortality rate with the 2g rate of application.

5.3 General Discussion:

The Laboratory and field tests of insecticides are important tools for insecticide screening. According to Matthews (1989), laboratory tests provide direct comparisons between insecticides and the controlled conditions bear little relationship to actual conditions in the field. From the result of field trials, it was observed that Polo, Match and Larvin were effective on sap-suckers and bollworms, whereas the laboratory screening indicated that Polo, Match and Larvin induced high mortality rate in the test insects (Dysdercus volkeri). Thus it can be deduced from the laboratory and field tests of the insecticide rates that, these chemicals can perform well on insect pests of cotton at these various rates tested.

From both laboratory and field tests, it is obvious that effectiveness of these insecticides applied at their various rates commenced at 24 hours after spraying and progressively reduced the insect pest population at 48 hours and

72 hours after spraying. The results from laboratory screening indicate good relationship with the effect on the field.

From the research work, three salient points emerge. First, all the insecticides effectively controlled the insect pests of cotton as reflected in the seed cotton yield.

Secondly, the number of spraying regime reflected on the insecticide rates.

Thirdly, Match and Larvin were most effective on Sap-suckers and Bollworms. While Larvin and Vertimec showed remarkable effectiveness on Diparopsis eggs and Sylepta larvae.

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CHAPTER 6

SUMMARY AND CONCLUSION

Insect pest particularly the sucking pests and bollworms adversely affect the quality and quantity of seed cotton yield. Thus, emphasis is placed on rates of insecticides that could effectively prevent their activities on the cotton plant. From this study, the rates of insecticides applied showed effectiveness on the insect pests from 24 hours after spraying to 48 hours and 72 hours after spraying in the field trials. All the insecticides reduced the population of the insect pests but the effect of Larvin, Match and Match + Polo were remarkable. The efficacy of Match and Larvin on sap-sucker and bollworms was reflected in the yield data in 1992 and 1993 respectively. The high yield and increased seed cotton quality obtained with Match, Larvin, Match + Polo treatments correlated with their effective control and preservation of bio-control insects on cotton. The yield of seed cotton obtained from plots treated with Match, Larvin, Match + Polo and Vertimec at their various rates were comparable.

The efficacy of Polo, Match and Larvin applied at their various rates which induced high mortality rate on Dysdercus in the laboratory screening is an obvious fact that these insecticides will be effective on sap-sucking pests in the field. From the results of this study, the application of Polo at the rate of 500g/ha Match at 300g/ha, Vertimec at 5 – 18g/ha and Larvin at the rate of 475g/ha mixed in 400 litres of water is effective in the control of insect pests of cotton.

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APPENDIX 1

SAMARU METEOROLOGICAL OBSERVATIONS IN 1993

Month	Rainfall	Rainfall Humidity (%)		Air Temperature (0 °C)		Sunshine hours
		AM	PM	MIN	MAX	
January	0	23.6	19.2	11.6	26.3	4
February	0	19.5	23.3	14.6	31.8	NA
March	0	31.5	29.7	18.2	34.4	NA
April	8.3	42.7	33.8	23.5	36.5	NA
May	113.6	62.9	46.8	22	37.8	8.2
June	155.8	72.7	51.8	20.9	31.7	7.6
July	269	78.4	56.7	20.2	29.5	6
August	300	81.8	62.1	19.5	28.4	5
September	181.8	76.7	58.2	19.3	30.2	7
October	32.4	63.1	54	18.7	34.1	8.4
November	0	NA	NS	14.1	3.36	8.6
December	0	31.3	25.5	14.1	29.1	6
TOTAL	1060.9	461.1	216.7	284.96		60.8
MEAN		48.6	38.9	18.1	32	6.1

NA. Not Available

Sources: Meteroglogical station at Institute for Agricultural Research, Samaru, Zaria.

Appendix 2: Analysis of variance for the effect of different rates of four Insecticides on cotton insect pests at 10 WAS in 1992

24 Hours Data:					
Source of Variation	DF	SS	MS	F	LSD (P = 0.05)
Whiteflies :					
Replicate	2	34.253	17.127	6.68	
Chemicals	4	48.293	12.073	417	0.81*
Treatement Time Chemicals	16	20.573	1.286	0.5	
Error	98	251.08	2.562		
Total		349.199	32.978		
Jassids:					
Replicate	2	2.163	1.307	0.28	
Chemicals	4	82.093	20.523	4.47	
Treatement Time Chemicals	16	48.893	3.056	0.66	1.09*
Error	98	449.387	4.586		NS
Total		582.986	29.472		
Aphids					
Replicate	2	10.893	5.447	2.62	
Chemicals	4	30.617	7.654	3.3.68	0.73*
Treatement Time Chemicals	16	11.310	0.707	0.34	NS
Error	98	203.440	2.076		
Total		75.260	15.884		
Dysdercus :					
Replicate	2	0.093	0.046	0.11	
Chemicals	4	1.760	0.440	1.04	NS
Treatement Time Chemicals	16	6.560	0.410	0.97	NS
Error	98	41.240	0.420		
Total		49.653	1.316		
Sylepta Larvae					
Replicate	2	11.253	5.647	227	
Chemicals	4	88.427	22.107	3.72	1.24*
Treatement Time Chemicals	16	19.040	1.190	0.48	NS
Error	98	242.747	2.479		
Total		361.464	31.401		

Appendix 3: Analysis of variance for the effect of different rates of four Insecticides on cotton insect pests at 10 WAS in 1992

Source of Variation	DF	SS	MS	F	LSD (P = 0.05)
		48 Hours Data:			
Whiteflies					
Replicate	2	21.973	10.987	5.43	
Chemicals	4	22..30	5.577	2.76	0.72*
Treatement Time Chemicals	16	39.293	2.456	1.21	NS
Error	98	198.027	2.021		
Total		281.323	21.041		
Jassids:					
Replicate	2	10.973	5.487	1.02	
Chemicals	4	150.707	37.677	7.05	1.18*
Treatement Time Chemicals	16	47.107	2.944	0.55	NS
Error	98	523.693	5.344		
Total		732.280	51.484		
Aphids					
Replicate	2	0.583	0292	0.16	
Chemicals	4	16.343	4.086	2.35	NS
Treatement Time Chemicals	16	10.123	0.633	0.36	NS
Error	98	169.917	1.734		
Total		196.966	6.745		
Dysdercus :					
Replicate	2	0.0133	0.0067	0.02	
Chemicals	4	0.7067	0.1767	063	NS
Treatement Time Chemicals	16	3.5733	0.2233	0.8	NS
Error	98	27..320	0.2788		
Total		31.853	0.6855		
Sylepta Larvae					
Replicate	2	4.173	2.087	1.00	
Chemicals	4	25..907	6.477	1.53	1.24*
Treatement Time Chemicals	16	18..560	1.160	0.55	NS
Error	98	204.490	2.087		
Total		253.130	11.811		

Appendix 4: Analysis of variance for the effect of different rates of four Insecticides on cotton insect pests at 14 WAS in 1992

Source of Variation	DF	SS	MS	F	LSD (P = 0.05)
	24 Hours Data:				
Whiteflies :					
Replicate	2	15073	7547	2.03	
Chemicals	4	23560	5070	1.5	NS
Treatement Time Chemicals	16	346278	2164	0.5	NS
Error	98	364240	3717		
Total		430500	18490		
Jassids:					
Replicate	2	17040	7720	1	
Chemicals	4	16075	4023	0.73	NS
Treatement Time Chemicals	16	62100	30005	0.7	NS
Error	98				
Total					
Aphids					
Replicate	2	6603	3302	212	
Chemicals	4	2913	730	47	NS
Treatement Time Chemicals	16	22003	1300	66	NS
Error	98	152210	1555		
Total		183769	6887		
Dysdercus :					
Replicate	2	4015	2407	1.32	
Chemicals	4	7275	2323	1.27	NS
Treatement Time Chemicals	16	24040	1503	0.02	NS
Error	98	170530	1022		
Total		205860	7455		
Sylepta Larvae					
Replicate	2	7613	4007	2.37	
Chemicals	4	7307	1027	0.7	1.24*
Treatement Time Chemicals	16	17640	1103	0.54	NS
Error	98	1555060	1571		
Total		287620	7.708		

Appendix 5: Analysis of Variance for the effect of different rates of four Insecticides on cotton insect pests at 9 WAS in 1993

Sources of Variation	DF	24 Hrs data, SS	MS	F	LSD (P = 0.05)
Whiteflies					
Rep	2	27.160	13.580	3.63	
Chemicals	4	10.267	2.562	0.68	NS
Treatment Time Chem	16	23.560	1.472	0.39	NS
Error	98	366.173	3.736		
Total		427.160	21.340		
Jassids					
Rep	2	4.813	2.407	0.40	
Chemicals	4	28.893	7.223	0.21	NS
Treatment Time Chem	16	18.840	1.177	0.19	NS
Error	98	593.187	5.951		
Total		645.733	13.758		
Aphids					
Rep	2	1.630	0.815	1.56	
Chemicals	4	3.783	0.945	1.81	0.38*
Treatment Time Chem	16	6.960	0.435	0.83	NS
Error	98	51.036	0.520		
Total		63.409	2.715		
Dysdercus					
Rep	2	0.333	0.166	1.96	
Chemicals	4	0.266	0.066	0.78	NS
Treatment Time Chem	16	1.466	0.091	1.07	NS
Error	98	8.333	0.085		
Total		10.398	0.408		
Sylepta Larvae					
Rep	2	10.613	5.306	6.09	
Chemicals	4	5.600	1.400	1.60	NS
Treatment Time Chem	16	24.00	1.500	1.72	NS
Error	98	85.386	0.871		
Total		125.599	9.077		

Appendix 6: Analysis of Variance for the effect of different rates of four Insecticides on cotton insect pests at 9 WAS in 1993

Sources of Variation	48 Hrs data, DF	SS	MS	F	LSD (P = 0.05)
Whiteflies					
Rep	2	38.560	19.280	5.14	
Chemicals	4	7.107	1.777	0.47	NS
Treatment Time Chem	16	20.017	1.257	0.33	NS
Error	98	367.440	3.749		
Total		444.214	26.563		
Jassids					
Rep	2	2.613	1.307	0.25	
Chemicals	4	22.173	5.543	1.10	NS
Treatment Time Chem	16	24.760	1.548	0.30	NS
Error	98	494.053	5.041		
Total		543.099	13.479		
Aphids					
Rep	2	0.9300	0.4650	0.83	
Chemicals	4	6.967	1.7267	3.09*	NS
Treatment Time Chem	16	4.6567	0.2910	0.52	
Error	98	54.7367	0.5585		
Total		67.2201	3.0412		
Dysdercus					
Rep	2	2.25333	1.1267	3.33	
Chemicals	4	3.0400	0.7600	2.25	NS
Treatment Time Chem	16	6.1600	0.3850	1.14	NS
Error	98	33.0800	8.3376		
Total		44.533	2.6153		
Sylepta Larvae					
Rep	2	12.000	6.000	3.39	
Chemicals	4	12.640	3.160	1.78	NS
Treatment Time Chem	16	0.000	0.000	0.00	NS
Error	98	173.333	1.769		
Total		197.973	10.929		

Appendix 7: **Analysis of Variance for the effect of different rates of four Insecticides on cotton insect pests at 13 WAS in 1992.**

Sources of Variation	24 Hrs data DF	SS	MS	F	LSD (P = 0.05)
Whiteflies					
Rep	2	24.333	12.167	1.66	0.95*
Chemicals	4	223.240	55.810	7.62	9.58
Treatment Time Chem	16	134.227	8.389	1.14	
Error	98	717.000	7.316		
Total	120	2308.800	83.718		
Jassids					
Rep	2	5.080	5.40	0.53	1.40*
Chemicals	4	29.693	2.423	1.57	3.50
Treatment Time Chem	16	29.973	1.873	0.39	
Error	98	462.253	4.717		
Total	120	525.99	16.483		
Aphids					
Rep	2	2.343	1.172	0.65	
Chemicals	4	19.307	4.827	2.70	0.63 NS
Treatment Time Chem	16	16.577	1.036	0.58	2.15 NS
Error	98	174.990	1.640		
Total	120	213.326	8.675		
Dysdercus					
Rep	2	0.286	0.140	1.51	0.12 NS
Chemicals	4	0.626	0.156	1.69	0.47 NS
Treatment Time Chem	16	1.800	0.112	1.21	
Error	98	174.990	1.821		
Total	120	176.702	2.229		
Sylepta Larvae					
Rep	2	4.213	2.107	1.50	
Chemicals	4	4.693	1.173	1.00	0.36 NS
Treatment Time Chem	16	4.027	0.252	0.21	1.74 NS
Error	98	114.45	1.168		
Total	120	126.978	4.700		

Appendix 8: **Analysis of Variance for the effect of different rates of four Insecticides on cotton insect pests at 13 WAS in 1993**

Sources of Variation	48 Hrs data. DF	SS	MS	F	LSD (P = 0.05)
Whiteflies					
Rep	2	18.893	9.447	3.71	
Chemicals	4	56.573	14.143	5.56	0.95*
Treatment Time Chem	16	17.360	1.085	0.42	2.57 NS
Error	98	249.107	2.542		
Total	120	341.933	27.137		
Jassids					
Rep	2	5.453	2.727	0.37	1.02*
Chemicals	4	151.640	37.910	5.22	4.35
Treatment Time Chem	16	56.907	3.557	0.49	
Error	98	711.213	7.257		
Total	120	945.213	51.551		
Aphids					
Rep	2	7.963	3.982	1.65	0.79*
Chemicals	4	31.877	7.969	3.38	1.94 NS
Treatment Time Chem	16	35.517	2.220	0.92	
Error	98	236.537	2.414		
Total	120	311.794	16.585		
Dysdercus					
Rep	2	0.373	0.185	0.64	0.27*
Chemicals	4	2.9067	0.716	2.52	0.85 NS
Treatment Time Chem	16	6.360	0.397	1.37	
Error	98	28.290	0.288		
Total	120	38.090	1.599		
Sylepta Larvae					
Rep	2	2.773	1.387	0.80	0.66 NS
Chemicals	4	11.773	2.943	1.71	2.09 NS
Treatment Time Chem	16	5.827	0.64	0.21	
Error	98	167.893	1.713		
Total	120	88.266	6.407		

Appendix 9: Analysis of Variance for the effect of different rates of four Insecticides on Damage to cotton fruiting points in 1992

Sources of Variation	DF	SS	MS	F	LSD (P = 0.05)
Bollworm:					
Replicate	2	2085.6	1024.8	1.61	
Treatment Time Chemical	16	9871.3	617.0	0.95	3072
Error	48	3036.4	646.6		
Total	60	13907.0	1263.6		
Sapsuckers					
Replicate	2	4.16	2.08	0.15	
Treatment Time Chemical	16	434.19	27.14	1.95	4.50
Error	48	665.84	13.87		
Total	60	1004.19	43.09		

Appendix 10: Analysis of Variance for the effect of different rates of four Insecticides on Damage to cotton fruiting points in 1993

Sources of Variation	DF	SS	MS	F	LSD (P = 0.05)
Bollworm.					
Replicate	2	84.35	24.37	0.37	
Treatment Time Chemical	16	1052.13	65.76	1.02	9.69
Error	48	3088.32	64.34		
Total	60	41888.80	154.47		
Sapsuckers					
Replicate	2	4.347	2.175	1.22	
Treatment Time Chemical	16	53.387	3.337	1.88	1.60
Error	48	84.987	1.771		
Total	60	181.721	7.283		

Appendix 11: Analysis of Variance for the effect of different rates of four Insecticides on level of cotton yield in 1992

Sources of Variation	DF	SS	MS	F	LSD (P = 0.05
Clean Seed Cotton					
Replication	2	140675.3	703.377	7.00	
Treatment Time Chemical	16	783679	48980	0.48	382.8
Error	48	4819825	100413		
Total	66	1406179.3	590916		
Stained seed cotton					
Replication	2	22804	11402	1.12	
Treatment Time Chemical	16	96527	6033	0.59	121.50
Error	48	48472	10098		
Total	66	167803	17533		
Seed Yield					
Replication	2	16537	8268	6.46	
Treatment Time Chem	16	15872	992	0,77	43.20
Error	48	61355	1278		
Total	66	93774	10538		
Light yield					
Replication	2	4861.4	2430.7	4.46	
Treatment Time Chem	16	3074.4	192.1	0.35	28.18
Error	48	2610.2	543.9		
Total	66	10545.9	8056.7		

Appendix 12: Analysis of Variance for the effect of different rates of four Insecticides on level of cotton yield in 1993

Sources of Variation	DF	SS	MS	F	LSD (P = 0.05)
Clean Seed Cotton					
Replication	2	80068	40034	1.93	
Treatment Time Chemical	16	329238	20577	0.99	173.5 NS
Error	48	993817	20705		
Total	66	1400123	81316		
Stained seed cotton					
Replication	2	1235.3	617.7	1.18	
Treatment Time Chemical	16	9821.8	613.9	1.17	12.34 NS
Error	48	250200	521.2		
Total	66	13558.1	1752.8		
Seed Yield					
Replication	2	12792	6396	1.46	
Treatment Time Chem	16	91715	5732	1.31	79.92 NS
Error	48	209937	4374		
Total	66	324444	16502		
Light Yield					
Replication	2	7240	3620	2.135	
Treatment Time Chem	16	27402	1713	1.010	49.75 NS
Error	48	81399	1696		
Total	66	116041	7029		

Appendix 13: Analysis of Variance for the effect of different rates of four Insecticides Applied at two rates on the mortality of Dysdercus volkeri in the Laboratory

Sources of Variation	DF	SS	MS	F	LSD (P = 0.05)
5 Hours data					
Replication	2	3.250	1.625	3.74	
Treatment Time Chemical	3	1.791	0.597	1.37	0.60 NS
Error	14	6.0833	0.434		
Total	19	6.5874	2.656		
24 hours data					
Replication	2	1750	0.875	0.90	
Treatment Time Chemical	3	4.166	1.388	1.43	1.59 NS
Error	14	13.58	0.970		
Total	19	19.74	3.233		
48 hours data					
Replication	2	0.333	0.166	0.33	
Treatment Time Chem	3	0.458	0.152	0.33	0.65 NS
Error	14	7.000	0.500		
Total	19	7.791			
72 hours data					
Replication	2	0.5833	0.291	1.96	
Treatment Time Chem	3	0.4583	0.1528	1.02	0.35 NS
Error	14	2.0833	0.1488		
Total	19	3.1249	02.307		

Appendix 14: **Cotton stand count per plot in 1992 & 193.**

Chemical	Rates g/ha	1992 Total stand /3 plots	1993 Total stand /3plots
Polo	250	39	30
	300	31	36
	400	38	42
	500	38	33
	'0'	35	31
Match	100	38	39
	150	42	40
	200	36	37
	300	41	38
	'0'	34	27
Vertimec	5	35	34
	10	37	32
	18	32	34
	20	35	34
	'0'	35	34
Larvin	300	31	33
	350	29	34
	400	24	34
	475	35	31
	'0'	29	31
Match + Polo	100 +200	29	33
	150 + 400	34	38
	200 + 500	31	34
	300 + 400	30	40
	'0'	33	37