STUDIES ON THE RELATIVE TOXICITY OF SOME MODERN INSECTICIDES AGAINST RED COTTON BUG, *Dysdercus cingulatus* (Fabricius) AND ITS BIOLOGY ON DIFFERENT HOST PLANTS

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CERTIFICATE-I

This is to certify that the thesis entitled, "STUDIES ON THE RELATIVE TOXICITY OF SOME MODERN INSECTICIDES AGAINST RED COTTON BUG, Dysdercus cingulatus (Fabricius) AND ITS BIOLOGY ON DIFFERENT HOST PLANTS", submitted in partial fulfilment of the requirements for the degree of "DOCTOR OF PHILOSOPHY" of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, is a record of the bonafide research work carried out by Shri ARUN KUMAR CHOUDHARY under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate awarded etc.) or has been published. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

(V.P. Gargav)
Chairman of the Advisory Committee

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE.

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CERTIFICATE-II

This is to certify that the thesis entitled, "STUDIES ON THE RELATIVE TOXICITY OF SOME MODERN INSECTICIDES AGAINST RED COTTON BUG, Dysdercus cingulatus (Fabricius) AND ITS BIOLOGY ON DIFFERENT HOST PLANTS", submitted by Shri ARUN KUMAR CHOUDHARY to the J.N. Krishi Vishwa Vidyalaya, Jabalpur, in partial fulfilment of the requirements for the degree of Ph.D., in the Department of ENTOMOLOGY, has been approved by the Student's Advisory Committee and External Examiner after an oral examination on the same.

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Director of Instructions (Dr. B.P. Tiwari) 20.9.85

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27/2/85

Jabalpur,
Feb. 27, 1985

(A.K. Choudhary)

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Chapter - I

INTRODUCTION

1. INTRODUCTION

Red cotton bug, Dysdercus cingulatus (Fabricius) (Hemiptera : Pyrrhocoridae) is one of the major constraints in the successful cultivation of cotton and okra in Madhya Pradesh. The bug is known to attack wide range of crops and plants such as cotton, okra (Trehan et al., 1961; Singh and Purohit, 1973 and Butani and Verma, 1976), bajra, maize, wheat, jute, pearl millets, gooseberry (Physulus peruviana), malberry (Bombax malbaricum), sambhal (Solmalia malabericum), silk cotton (Eridendron anffractuasum), jahn bull tree (Tespesia populanea), daccum hemp (Hibiscus cannabinus), China rose (H. rosa sinensis), musk mellow (H. abelmischus), Indian mellow (Abutilon spp), hollyhock (Althea rosa), kapok (Ceiba pentandra) and many other malvaceous plants (Lall, 1964; Sohi, 1964 and Singh, 1970). Prem Kishore and Srivastava (1975) also recorded this pest on various varieties of sorghum.

The genera covers a wide range of species. Other species reported in India and other parts of the world were D. andreae, D. bimaculatus, D. cardinalis, D. disolor (delauneyi), D. doenigii, D. fasciatus, D. fernaldi, D. flavidus, D. fulvoniger, D. honestus, D. insularis, D. intermidius, D. koenigii, D. longirostris, D. manurus,

D. megalopygus, D. melanoderes, D. mendesi, D. nigrofasciatus, D. obscuratus, D. pallidus, D. peruvianus, D. ruficollis, D. sanguinarius, D. sidae, D. similis, D. superstitiosus, D. voelkeri etc.*

In India, red cotton bug is common in M.P., U.P., Bihar, Maharashtra and Tamilnadu. In those parts of the country where, winter is mild, pests have a wide active period, i.e., mid-January to mid-November. But in the parts where the winter is severe, its activity is restricted and found only in warm parts of the year.

Both, nymphs and the adults suck the sap from the leaves, bolls, seeds and other succulant parts of the plant. As a result of this, plants are deprived of amino acids, carbohydrates and their vitality. The damage to young seeds starts with the opening of the bolls. Besides, bugs also make the lint of cotton dirty with their yellow excreta (Hem Singh, 1924). The attacked bolls of cotton opens badly and produce lint of poor quality (Sohi, 1964).

Lewin (1933) reported that 34.4 to 62.4 per cent cotton crop was affected due to red cotton bug. Wille et al. (1955) reported 50 per cent loss in cotton crop. Owing

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* R.A.E./A 1960 to 1984, subject index utilised as source for collecting names of various species belonging to genera Dysdercus.

to severe damage to cotton in Nigeria, the bug is considered to be the most injurious (Pomeroy and Colding, 1923). While Jameson (1946) stated that Dysdercus did great damage to early planted cotton crop and seriously impaired the viability of seeds. It is also found to cause considerable reduction in yield of Hibiscus esculentus (Manickavasagar, 1955).

Besides direct losses to the crops, red cotton bug is known as a vector of baterium Nematospora gossypii, which stains cotton fibre (Pearson, 1934).

Prevention of crop losses from pest attacks is necessary to realise the high yield potential of the okra and cotton varieties. Despite the role of synthetic pesticides in green revolution, their wide spread and indiscriminate use gives rise to the deleterious side-effects on non-target organisms and to the problems of environmental pollution, pest resurgence and pest resistance, disrupting the ecosystem. The pesticidal toxicity is of special significance in vegetable cultivation due to its hazards to the farmers, consumers, parasites and predators. Hence, to avoid the disastrous side-effects of the chemicals, judicious and timely need-based use of selective chemicals under the integrated pest management and control strategy is now the need of the hour.

Very little work has been done so far in respect of chemical control and host preference of the pest. Keeping in view the importance of the pest, the present investigations were conducted with the following objectives :-

(1) To determine the median lethal concentrations of modern insecticides including synthetic pyrethroids, compare them and find out the most effective compound against the pest in the laboratory conditions.

(2) To determine the efficacy of selected insecticides against the bug on okra in field conditions.

(3) To study the residual toxicity of these insecticides.

(4) To study the food preference of the pest by studying their biology on different host plants.

There is no doubt that the determination of such a correlation will prove highly beneficial to the poor farming community. Dysdercus has already risen to the status of major pest of okra and cotton and it is popularly known as'cotton stainer' in many countries but unfortunately, attention of Indian scientific community has remained unfocussed on its stature.

Chapter - II

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The scientific literature on red cotton bug was scanned with a view to collect information on the following aspects :-

1. Biology of red cotton bug on different hosts and their host preferences
2. Chemical control of red cotton bug
3. Residual toxicity of insecticides in the field conditions.

Very little information was available on the bug, D. cingulatus, hence, the information available on other related bugs was also collected and incorporated in the following review. The information so collected was used for fixing the precise objectives of experiment, and for comparing our results with the experiences of others. The summary of the information so collected is presented below:-

2.1 Biological Studies

2.1.1 Red cotton bug, D. cingulatus

Shrivastava and Bahadur (1958) studied the life history of D. cingulatus in the laboratory and found that

the eggs were laid in soft moist soil in a single batch of 100-130 or occasionally, in two unequal batches. The eggs stage and five nymphal instars lasted 4-5, 2.5-3, 2.5-4, 3.5-4, 4-6 and 13-14 days, respectively. Thomas (1966) in the similar studies in Malaya, found that there were five nymphal instars. The time required to develop from egg to adult was 29-43 days. All the nymphs were susceptible to dry conditions, but were resistant to hunger except fifth instars. The eggs were laid in cluster but did not adhere to one another. A few female laid upto 5-7 clusters, but the average was 2-3. The number of eggs per cluster varied from 25 to 112 with an average of about 68, out of which, about 81 per cent were viable. The total nymphal period was 6-7 weeks (Pruthi, 1969).

According to Encarnacion (1970), the incubation period was 6-9 days. There were five nymphal instars and total nymphal period lasted for 32-42 days. About 49 per cent eggs were viable and number of eggs laid per female was 465.

Vishwanath and Agrawal (1982) also observed 100-130 eggs per female, laid in loose irregular mass. The incubation period and nymphal period was 4-7 and 26-89 days, respectively. Nayar et al. (1983) confirmed that the eggs were laid in irregular mass in the soil. The incubation period and total nymphal period was about 7 and 49 to 89

days, respectively.

Ahmad (1979) reared the D. cingulatus on four different plants, i.e., cotton, sorghum, Pennisetum americanum and okra. The per cent nymphs developed successfully to adult was 62, 48, 61 and 50 per cent, respectively, while the average number of eggs laid per female were 100.2, 29.0, 76.09 and 105.4, respectively. The per cent hatch was higher in cotton and okra than other two host plants.

2.1.2 Other species of Dysdercus

Pomeroy and Colding (1923) observed that the female of D. superstitiosus laid 237 eggs during her life time. The incubation, nymphal period and longevity of male and females were 5-6, 24-29, 57 and 47 days, respectively.

As per Pope (1930), the females of D. ruficollis laid 60-80 eggs. The egg and nymphal period lasted 8 and 45 days, respectively, while the adult longevity was 30 days. The fecundity varied according to food quality, i.e., part of plant part (and their age) fed to a female.

MacGill (1935) conducted an experiment on the biology of D. howardi on cotton, in Manchester. The life span at 27°C was found to be 32 days, the average number of eggs laid per female was 141.9 and with average of two batches.

The per cent of adults obtained from first instar nymphs was about 16 per cent (7.6 to 65.7%); the mortality appeared to be highest in fifth instar nymphs. The female longevity was about 11 days.

Vrydagh (1944) studied the biology of three species of bug viz., D. fasciatus, D. superstitiosus and D. nigrofasciatus at Belgian Congo. The developmental period was 46.3, 52 and 36 days, while the eggs per female were 100, 84 and 111, respectively.

Freiberg (1945) studied a specified bug of Dysdercus species and recorded that in the laboratory, the egg and total developmental period was 5 and 24-42 days, respectively, at a mean temperature of 30.5°C, while 14 and 60-100 days at 17.6-26.6°C. The mean number of eggs laid by a single female was 675.

In case of D. nigrofasciatus, Barbosa (1950) found that egg and five nymphal stages lasted 4-9, 3-4, 3-11, 4-14, 6-11 and 9-17 days, respectively. The males and females survived for 48.8 and 33.7 days, respectively; the maximum eggs laid by single female were 829.

Roy and Mondal (1973) studied the biology of D. koenigii (Fab.) in the laboratory. The female laid 70 to 80 eggs in masses. The egg and the five nymphal stages lasts for 4-6, 4-5, 4-9, 5.8, 18 and 19 days, respectively.

Geering and Coaker (1960) reared D. superstitiosus on the immature seeds of sorghum, Pennisetum typhoides, maize and cowpea and compared with cotton matured seeds. All the immature seeds were less suitable for breeding. Females from sorghum seeds were smaller in size than that of cotton. It was observed that oil removed from cotton seeds before feeding, caused reduction in fecundity but not the developmental period of nymphs, although the mortality percentage was increased. The duration requirement for completion of second, third, fourth and fifth instar nymphs and from second instar to adult was 8.7, 8.2, 10.4, 16.8 and 44.3 days, respectively, while the adults obtained from 2nd instar were 42.0 per cent.

2.2 Chemical Control

2.3 Chemical control of D. cingulatus and relevant species

Malathion 50 EC @ 20 ml per 10 litre of water was recommended for the efficient control of D. cingulatus (Anonymous, N.A.).

Manickavasagar (1955) treated okra (Hibiscus esculentus) when the plant had about eight adults or nymphs of D. cingulatus with DDT (0.1 and 0.2%), dieldrin (1.5

NA : Year not mentioned in original.

and 3%), chlordane (0.4 and 0.9%) and BHC (0.06 and 0.1%). Except in the lower concentrations of BHC in all other treatments, complete mortality of the pest was observed the next day. Reinfestation occurred within 16 days. In South Africa, monocrotophos (360 g a.i./ha), azinphos (360 g a.i./ha) and carbaryl (1800 g a.i./ha) were used for the control of D. suturellus. After three days of treatment, the mortality percentage was found to be 100-95, 79-50 and 94-80, respectively. It was suggested that monocrotophos could readily control the pest @ 200-300 g a.i./ha and recommended concentration for high volume sprays was 0.02 per cent (Anonymous, 1959).

Mathur et al. (1961) reported that 80 and 100 per cent adults and nymphs were killed after 48 hrs, when treated with pyrethrum extract containing 0.02% pyrethrins.

Trehan et al. (1961) used BHC, endrin, parathion, aldrin, dieldrin, lethane (a thiocynate), toxaphene, and rothan with DDT in a bioassay test against last instar of D. cingulatus, in which, nymphs were sprayed with insecticides under a spraying tower and then transferred to jars containing fresh food. The observations about the mortality were taken 24 hrs after. On the basis of LD-50 values, insecticides were found 3.9, 1.9, 1.6 (LD-50 - 0.154), 1.008, 0.9, 0.23, 0.22 and 0.07 times as toxic as DDT.

Pierrad and Cadou (1969) evaluated endrin and other insecticides for seven years against D. voelkeri Schmidt and Pectinophora gossypiella (Sound) and concluded that the mixture of DDT with endosulfan, phosalone, fenitrothion, or carbaryl were as effective as endrin, while phosalone alone was inadequate for the effective control of the pest.

Gupta and Singh (1970) bio-assayed 12 insecticides against D. cingulatus in the laboratory. They found that parathion, malathion, methyl-demeton and Metacid combi were 3.811, 1.002, 0.984 and 0.113 times as toxic as dimethoate, while the LC-50 values were 0.008193, 0.002587, 0.002632 and 0.02284, respectively.

According to Peyrelonque et al. (1974), monocrotophos was superior to the insecticides previously applied against the cotton pests. The residual toxicity of monocrotophos in the field, lasted 8-10 days. The mixture of DDT @ 550-600 g toxicant/ha was recommended for the control of D. flavidus.

Cloria (1977) carried out a test in Peru for the control of D. peruvianus (Guer.) on Tanjuis cotton. Monocrotophos 40% (@ 1.3 lit./ha), carbaryl 85% (@ 3.3 kg/ha) and omethoate 100% (@ 0.6 lit./ha) were used as controlling agents. It was found that all the treatments retained their effectiveness upto 21 days.

Rani and Osmani (1982) studied the effectiveness of synthetic pyrethroids, i.e., allethrin, cyphenothrin, and

fenvalerate against the adults D. cingulatus in the laboratory. Fenvalerate had the highest mortality, while allethrin proved a remarkable knock-down agent.

2.2.2 Chemical control of other bugs

Kalode et al. (1959) laid out an experiment on the persistence and residual toxicity of nine different insecticides against Leptocorisa acuta (Thnb.) on rice. The insecticides used were fenthion, phosphamidon, endosulfan, malathion, parathion, endrin, EPN, diazinon and BHC. In the order of decreasing persistency, fenthion proved the best. Endosulfan and malathion lost their effectiveness to a great extent within 24 hrs of treatment.

Lim (1970) tested 15 insecticides against Nezara viridula on rice and found dicrotophos most effective. Endosulfan and chlorfenvinphos were effective only at 0.1%.

Sarup et al. (1972) compared the contact toxicity of 33 insecticides against Bagrada hilaris (Burm.) in the laboratory. The mortality observations were taken after 48 hrs and on the basis of LC-50 values, fenitrothion provided the best results. Methyl parathion, ethyl parathion, fenthion, endosulfan, and malathion were found to be 48.76, 24.75, 9.52, 3.25 and 3.00 times as toxic as DDT.

Calcagnolo and Massariol (1974) evaluated different insecticides for the control of some pentatomid bugs,

associated with sorghum in Brazil. The species observed were Euschistus heros (F.), Nezara viridula (L.) and Piezodorus guildinii (Westw.). Out of the insecticides tested, monocrotophos (0.24 lit./ha), endosulfan (0.42 lit./ha) and parathion (0.192 lit./ha) proved most effective.

Morosini and Fonseca (1976) worked on the effectiveness of various insecticides for the control of Nezara viridula (L.) in soybean in Brazil. The chemicals used were monocrotophos (160 g/ha), dimethoate (200 g/ha), methyl-parathion (288 g/ha) and endosulfan (240 g/ha). On the basis of three counts (1st, 4th and 14th day of treatment), monocrotophos and methyl-parathion were found superior to endosulfan and dimethoate.

Calcagnolo et al. (1977) studied the role of various insecticides in controlling pentatomid bugs associated with soybean in Brazil. The crop was sprayed four times at weekly intervals. The best results were obtained by monocrotophos 60% @ 400 ml/ha, endosulfan 35% @ 1200 ml/ha, and parathion 60% @ 320 ml/ha, while phosphamidon was fair and carbaryl and DDT were not satisfactory for the control.

As per Santos et al. (1977), 60% methyl-parathion applied @ 0.19 lit./ha, controlled Egyptian cotton stainer bug, Oxycarenus hyalinipennis (Costa) and increased the seed yields by 11.87 kg/ha over control (61.31 kg/ha).

Corsevil and Meyer (1979) evaluated systemic action of dimethoate, phosphamidon, monocrotophos and varmidothion against N. viridula (L.) on soybean. Monocrotophos was found most effective as compared to all other insecticides.

In the experiments, where efficacy of different insecticides was compared against red cotton bug, the cotton was treated with monocrotophos @ 100-200 g/ha and endosulfan @ 350 g/ha at seed ripening stage. On the basis of mortality counts after 48 hrs, monocrotophos proved the best, while endosulfan gave inadequate control (Foerster, 1979). In the trials of Morosini and Bertoldo (1981), the synthetic pyrethroids gave significantly higher mortality of the pest (33.8-68.8%) as compared with organophosphorus compounds (0-13%).

Dina (1979) concluded that in cowpea, synthetic pyrethroids viz., decamethrin and permethrin offered better protection of flowers and pods from Maruca testulalis (Geyer), Cydia ptychora (Meyer) and Clavigralla horrida (Germ.) than did monocrotophos, but were not superior to it in grain production.

Wilde and Morgan (1979) carried out field and laboratory experiments and concluded that foliar application of parathion-ethyl, parathion-methyl, and permethrin successfully controlled the Chinch bug, Blissus leucopterus (Say.) on sorghum. The granular application of various

insecticides which proved effective in the laboratory conditions, were ineffective at field levels.

2.3 Residual Toxicity of Insecticides

Dixit et al. (1977) studied the residual toxicity of malathion and endosulfan on okra fruits with reference to Amrasca devastans. Both the chemicals remained effective against jassids for seven days.

Nair et al. (1977) reported that quinalphos and fenthion at 0.05% concentration, were found to effectively control the nymphs and adult population of Amrasca biguttula biguttula upto seven days.

Svestka (1978) found that permethrin (0.25 and 0.125%) treated foliage gave cent per cent mortality of Lymantria dispar (L.) for 20 days, while reducing the concentration to 0.062 gave 93 per cent mortality. Permethrin had remarkable persistency in comparison to pirimiphos.

Siddiqui (1979) concluded that permethrin was highly effective as contact poison to Schistocerca gregaria (Forsk) and remained toxic for 21 days at 5, 15 and 30°C.

According to Agnihotri et al. (1980), cypermethrin, fenvalerate, and decamethrin were effective upto 28 days on cauliflower, whereas conventional insecticides like endosulfan remained effective only upto 7 days.

Dutta and Lal (1980) determined the residual toxicity of monocrotophos (0.03 and 0.05%) @ 1100 lit./ha with reference to A. biguttula biguttula on cowpea. Cent per cent mortality was observed in both concentrations upto 5 days. The mortality reduced to 56.66 and 83.33 per cent, respectively within 10 days, while 15 days after the treatment, the mortalities were non-significant.

Leeper and Reissig (1980) evaluated the persistency of various insecticides against Psylla pyricolla Forst. on pear trees. Only permethrin gave 50 per cent mortality 13 days after treatment.

Nimbalkar and Ajri (1980) determined the residual toxicity of cypermethrin 0.01%, decamethrin 0.003%, fenvalerate 0.015% and permethrin 0.015% on 50 day old okra against spotted bollworms. The LT-50 values were found to be 20.58, 20.05, 17.18 and 13.75 days, respectively.

Rai et al. (1980) studied the residual toxicity of cypermethrin, fenvalerate and permethrin against the A. biguttula biguttula on okra. The crop was sprayed twice with an interval of 15 days. All the chemicals were found to be very effective in controlling the pest upto 9 days. The waiting period was suggested to be 3 days for permethrin and cypermethrin and 7 days for fenvalerate.

Dhamdhere et al. (1981) reported that synthetic pyrethroids were as effective as parathion-methyl against A. biguttula biguttula on okra. Among all the insecticides used viz., permethrin, fenvalerate, cypermethrin and deltamethrin; deltamethrin (decamethrin) proved to be the best in controlling the jassids on the crop.

Koshy et al. (1981) tested lindane, endosulfan, DDT, carbaryl and fenitrothion for their persistency on glass surface in sunlight. Lindane and endosulfan were the least persistent compounds.

Gunnarson (1982) compared various synthetic pyrethroids for their efficacy and residual toxicity on different crops and their pests. Deltamethrin proved to be the best as pest controlling agent with persistency of 5 to 20 days depending upon weather, crop stage and the doses used.

Sharma (1982) studied the persistency of synthetic pyrethroids on cotton against bollworms and found that the chemicals were effective upto 21 days. The ideal spraying interval was found to be 15 days.

Chapter - III

MATERIALS AND METHODS

3. MATERIALS AND METHODS

Toxicological studies on red cotton bug, Dysdercus cingulatus (Fabricius) (cotton stainer) were initiated with the object to determine the most effective insecticides which can also be economical to the farmers. According to the objectives, the work was divided into 4 sets of experiments. The procedure followed in each case is described under the concerned section.

The test insect, D. cingulatus was identified with the help of prepared specimen, kept in the Department of Entomology, J.N. Krishi Vishwa Vidyalaya, Jabalpur (M.P.). The adults were collected from the field, which were bred in the laboratory. Okra leaves and fruits were fed to them as food. The fifth instar nymphs were used as test insect for bioassays, while for the residual toxicity tests, the adults were used. The certified seeds of Pusa Sawni (variety) of okra were obtained from the Department of Horticulture, JNKVV, Jabalpur.

The insecticides used in the trials were obtained directly from the manufacturers as samples (Table 3.1). Throughout the experiments, the insecticidal formulations were diluted to desired concentration with tap water. The concentrations were always expressed in terms of active ingredients.

Table 3.1 : List of insecticides tested along with their chemical, commercial name and source of supply

S. No.	Chemical name and formula	Commercial name	Source
1.	2.	3.	4.
1.	Formothion 0,0-dimethyl-S-(N-methyl-N-fomoyl cabamoyl-methyl) dithiophosphate	Anthio 25 EC	M/S Sandoz India Ltd., Sandoz House, Dr. A. Basant Road, Bombay-18
2.	Thiometon 0,0-dimethyl-S-2 (ethyl thio) ethyl dithiophosphate	Ekatin 25 EC	-do-
3.	Quinalphos 0,0-dimethyl-0-(2,quinoxalyl) thiophosphate	Ekalux 25 EC	-do-
4.	Methyl-Parathion 0,0-dimethyl-0-P-nitrophenyl phosphorothionate	Metacid 50 EC	M/S Bayer India Ltd., Express Tower, Nariman Point, Bombay-21
5.	Oxydemeton-methyl S-[2-(ethyl-salphinyl) ethyl]o-o-dimethyl phosphorothionate	[illegible]	-do-
6.	Fenthion 0,0-dimethyl-o-(4-methyl-mercapto-3-methyl phenyl) phosphorothionate	[illegible]	-do-
7.	Monocrotophos Dimethyl (E)-1-methyl-3-(methyl amino)-3-oxo-1-propenyl-phosphate	[illegible]	M/S National Organic Chemical Industries Ltd., Mafatlal Centre, Nariman Point, Bombay-21

contd...

Table 3.1 contd...

1.	2.	3.	4.
8.	Chlorfenviphos Cis-8-trans isomer of 2 chloro-1(2,4-dichloro phenyl) vinyl diethyl-phosphate	Fenocil 24 EC	M/S National Organic Chemical Indu. Ltd., Mafatlal Centre, Nariman Point, Bombay-21
9.	Permethrin (3-phenoxyphenyl)-methyl-3-(2,2-dichloroethyl)-2,2-dimethyl cyclo-propane-carboxylate	Permasect 25 EC	M/S Bharat Pulverising mills Ltd., Hexamar House, Sayani Road, Bombay-25
10.	Cypermethrin Cyano (3-phenoxyphenyl)-methyl-3-(2,2-dichloroethyl)-2,2-dimethyl cyclopropanecarboxylate	Cyperkil 25 EC	M/S Bharat Pulverising -do-
11.	-do-	Ripcord 10 EC	M/S National Organic Chemical Indu. Ltd., Mafatlal Centre, Nariman Point, Bombay-21
12.	-do-	Fenom 200 20 EC	M/S Ciba Geigy India Ltd., Agro-chemical Division, 14, J. Tata Road, Bombay-20
13.	Monocrotophos 0,0-dimethyl-o-(2 methyl carbamoyl-1-methyl vinyl) phosphate	Nuvacron 36 EC	-do-
14.	Decamethrin Cyclopropanecarboxylic acid, 3-(2,2-dibromoethenyl) 2,2-dimethyl-cyano (3-phenoxyphenyl) methyl easter	Decis 2.8 EC	M/S Hoechst Pharmaceuticals Ltd., Hoechst House, Nariman Point, Bombay-21

contd...

Table 3.1 contd...

1.	2.	3.	4.
15.	Endosulfan 6,7,8,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide	n	M/S Hoechst Pharmaceuticals Ltd., Hoechst House, Nariman Point, Bombay-21
16.	-do-		M/S Excel Industries Ltd., Swami Vivekanand oad, Jogeshwari, Bomba -102
17.	Fenvalerate a-cynano-M-phenoxy benzyl-a-iso-prophyl-P-chlorophenylacetate	Sumicidin 20 EC	M/S Rallis India Ltd., 21, Ravelin Street, Bombay-1
18.	Malathion 0,0-dimethyl-S-(1,2-dicabethoxyethyl) phosphorodithioate	Cythion 50 EC	M/S Cynamid India Ltd., Agricultural Division, Bombay-27
19.	BPMC 2-secondary-butylphenyl-N-methyl carbamate	BPMC 50 EC	M/S Union Carbide India Ltd., Agril. Division, Shamla Hills, Bhopal-462 013

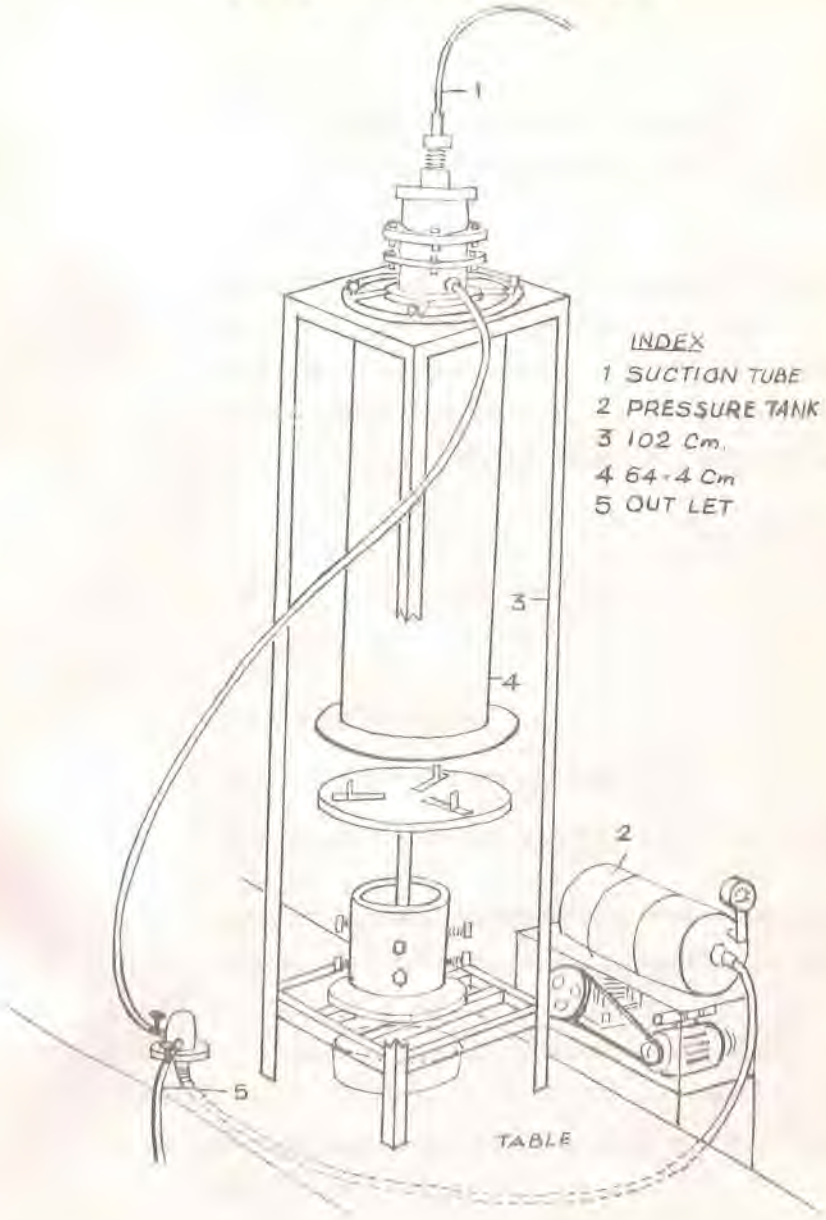
3.1 Determination of Median Lethal Concentration of Different Insecticides Against Red Cotton Bug (D. cingulatus)

For the determination of median lethal concentrations and relative efficacy, 19 different insecticides were tested under "Potter's Tower". At least, seven concentrations of every insecticide and control were tested to determine the median lethal concentration.

The insecticidal film of the desired concentrations for every insecticide was obtained by atomizing 4 ml solution at 1.5 ± 0.5 kg/cm^2 on the petridishes of 4" diameter. After 15 minutes drying, five fifth instar nymphs were released and allowed to crowl for one hour. After this exposure, the nymphs were transferred to clean petridishes in which, fresh okra leaves were supplied and the lids were closed.

Every concentration was repeated three times and the average was used for the estimation of median lethal concentration. The observations for the condition of the insect were recorded after 48 hrs after the treatment. At the time of observations, the insects were classified as living, slightly affected, moribund and dead. Insects which could walk normally were considered living, the trembling ones were recorded as slightly affected. The insects showing no other movement except slight movement

FIG 3.1 POTTER'S TOWER



of antennae when touched with brush were recorded as moribund, while those showing no sign of movement were classified as dead.

Throughout the experiment, the living and slightly affected insects were also considered living and the moribund insects were included as dead, and the mortality percentage was calculated accordingly. All the mortality percentages were corrected by using Abbott's (1925) formula given below :-

$$P = \frac{F - C}{100 - C} \times 100$$

where,

P = corrected mortality

F = per cent kill in the treatment

C = per cent kill in the control

The corrected mortality percentages were transformed to Probits and were plotted against the Logarithms of concentrations (mg/lit.) on a graph. A provisional line to fit these points was drawn on the graph. The median lethal concentration (LC-50) of the insecticides and their fiducial limits were then estimated from this line as per the method given by Finney (1964).

The relative toxicity of the insecticides was expressed in terms of "Toxicity Index" which is a comparison of each insecticide with malathion and was calculated as below :-

$$\text{Toxicity index} = \frac{\text{LC-50 of malathion}}{\text{LC-50 of given insecticide}} \times 100$$

The results, after the analysis are given in Appendix-2 and Probit Regression lines for the estimation of median lethal concentrations of different insecticides are depicted in Fig. 4.1 to 4.5.

3.2 Relative Efficacy of Field Withered Insecticides to Red Cotton Bug (*D. cingulatus*)

The experiment was conducted in the experimental area of the Department of Entomology, JNKVV, Jabalpur. Okra (Pusa Sawni) was sown in seven lines, 50 cm apart in a randomized block design. The plot size was 3.5 x 2.5 m. Eight different treatments (7 insecticides + 1 control) (Table 3.2) were replicated three times. The fertilizers and other agronomical operations were carried out as recommended in the package of practices (1984) of JNKVV, Jabalpur.

The crop was sprayed @ 800 lit./ha with different treatments when the bugs (adult + nymphs) population reached 4-5 bugs/plant.

Table 3.2 : Details of the insecticides used in field test

24 hrs before the treatment and 24, 48, 72, 96 hrs; 8, 12, 15 days and 3, 4, 5 and 6 weeks after the treatment. All the bugs (adult + nymphs) on five random plants/plot were counted to determine the population. The mean per plant was taken as a representative for the respective plot. The seed yield of different treatments was also recorded.

The data for insect population were then transformed to $\sqrt{X + 0.5}$ and used for statistical analysis, and the C.D. at 5% level was calculated (Appendix-3).

3.3 Residual Toxicity of Field Whithered Insecticides to Red Cotton Bug (*D. cingulatus*)

The residual toxicity of the insecticides to red cotton bug was determined in the laboratory. The leaves, treated with the required insecticides were obtained from the experimental field, described earlier (3.2) and fed to the adult bugs in the petridishes in the laboratory. Each treatment including the control was replicated thrice. The treated leaves from the field were obtained on 1st (one hr), 2nd, 4th, 6th, 9th, 12th, 15th and 18th day of the treatment for bioassay. The observations for mortality were taken 48 hrs after the exposure in the manner already described. The data obtained were statistically analysed and compared on the basis of C.D. at 5% level (Appendix-4).

3.4 Biological Studies of Red Cotton Bug (*D. cingulatus*) On Different Host Plants

These studies were carried out in the laboratory on four host plants viz., ambari, okra, cotton and hollyhock with a view to determine the most suitable host for red cotton bug.

The nymphs emerged from the eggs on the same day were used as test insect in these experiments. The test nymphs were transferred to a glass chimney and the tender leaves and fruits of the desired host were fed to them in sufficient quantity for all their life.

The bugs were observed every day. The observations were recorded in respect of the duration of every stage. The morphological and all physical changes like length, height, weight and width, life span of male and female, the fecundity, incubation period and the survival in each life stage, were recorded. Each observation was supported by the data at least from 10 individuals. The data so obtained were consolidated, statistically analysed and are presented in Appendix-5.

The preference of red cotton bug to four different hosts viz., okra, cotton, ambari and hollyhock was tested with the help of preference chamber in the laboratory. There were eight different treatments viz., okra leaves and fruits, cotton leaves and fruits, ambari leaves and fruits and hollyhock leaves and fruits. Each test material (treatment) was placed in separate chambers and 80 nymphs were released in the central release chamber and the lid was closed. The observations about the number of nymphs attracted towards particular host were recorded 24 hrs after the release. The experiment was replicated 12 times and the per cent bugs attracted towards each host was calculated. The data were statistically analysed and presented in Table 4.9.

Chapter - IV

EXPERIMENTAL FINDINGS

4. EXPERIMENTAL FINDINGS

As per our objectives, the work was divided into four sections and the results obtained in each of them are described separately below :-

4.1 Determination of Median Lethal Concentration of Different Insecticides Against Red Cotton Bug, *D. cingulatus*

Nineteen different insecticides viz., fenthion, thiometon, quinalphos, methyl parathion, oxydemeton methyl, monocrotophos (Monocil), cypermethrin (Ripcord), cypermethrin (Fenom), cypermethrin (Cyperkil), monocrotophos (Nuvacron), permethrin, endosulfan (Thiodan), endosulfan (Endocel), fenvalerate, decamethrin, malathion, formothion, BPMC, fenthion and chlorfenviphos, were tested against 5th instar nymphs of red cotton bug in the laboratory. The spraying was accomplished with the help of 'Potter's Tower' from December 15, 1983 to February 25, 1984.

The mortalities observed 48 hrs after the treatment were transferred and analysed as per Finney (1964). The analysed data are given in Appendix-2. The regression lines showing log. concentrations and probit mortalities for each insecticide are given in Fig.4.1 to 4.5.

Table 4.1 : Relative toxicity of some insecticides against red cotton bug, D. cingulatus (fifth instar nymphs)

S. No.	Insecticides	Formulations used	Heterogeneity	Regression equation	mg of a.i./lit. LC-50	Fidu. limits M+	Fidu. limits M-	Toxicity index*
5.	Cypermethrin	Fenom	X^2_6 : 0.65	y = 3.4680X + 0.23	0.23	0.28	0.19	165217.39
6.	Cypermethrin	Ripcord	X^2_6 : 0.58	y = 7.6513X - 10.02	0.90	1.00	0.80	42222.22
6a.	Cypermethrin	Cyperkil	X^2_5 : 2.50	y = 2.5860X + 2.50	0.93	1.17	0.74	40860.21
6b.	Decamethrin	Decis	X^2_7 : 7.10	y = 2.7509X - 0.64	1.10	1.40	0.89	34545.45
6c.	Fenvalerate	Sumicidin	X^2_7 : 0.17	y = 4.6015X - 3.80	8.10	8.90	7.40	4691.36
6d.	Permethrin	Permasect	X^2_6 : 0.45	y = 10.1045X - 14.40	8.30	8.70	7.90	4578.31
7.	Monocrotophos	Monocil	X^2_6 : 0.54	y = 2.3245X + 1.36	36.0	47.0	27.0	1055.55
8.	Thiometon	Ekatin	X^2_6 : 1.20	y = 1.8074X + 2.14	38.0	52.0	27.0	1000.00
9.	Monocrotophos	Nuvacron	X^2_6 : 7.50	y = 1.5779X + 2.37	46.0	64.0	33.0	826.09
10.	Fenthion	Lebacid	X^2_6 : 1.15	y = 2.3892X + 0.89	52.0	66.0	42.0	730.77
11.	Oxydemeton methyl	Metasystox	X^2_6 : 0.60	y = 2.7213X + 0.38	50.0	60.0	41.0	760.00
12.	Methyl parathion	Metacid	X^2_6 : 0.12	y = 2.7839X + 0.03	64.0	81.0	51.0	593.75
13.	Quinalphos	Ekalux	X^2_6 : 0.37	y = 7.1532X + 8.58	80.0	90.0	70.0	475.00
14.	Formothion	Anthio	X^2_5 : 0.15	y = 3.1844X - 1.12	80.0	160.0	40.0	475.00
15.	BPMC	BPMC	X^2_5 : 1.24	y = 4.6519X - 3.93	80.0	110.0	60.0	475.00
16.	Chlorfenvi-phos	Fenocil	X^2_6 : 1.65	y = 1.1750X + 3.17	350.0	560.0	220.0	108.57
17.	Endosulfan	Endocel	X^2_6 : 3.65	y = 2.6615X + 0.88	350.0	440.0	280.0	108.57
18.	Malathion	Cythion	X^2_6 : 0.13	y = 2.8467X + 0.49	380.0	570.0	250.0	100.00
19.	Endosulfan	Thiodon	X^2_5 : 0.97	y = 3.0981X - 0.23	490.0	590.0	410.0	77.55

* Malathion was regarded as standard, i.e., 100.

FIG:- 4.1. TOXICITY OF DIFFERENT INSECTICIDES TO FIFTH INSTAR NYMPH OF *D. cingulatus*.

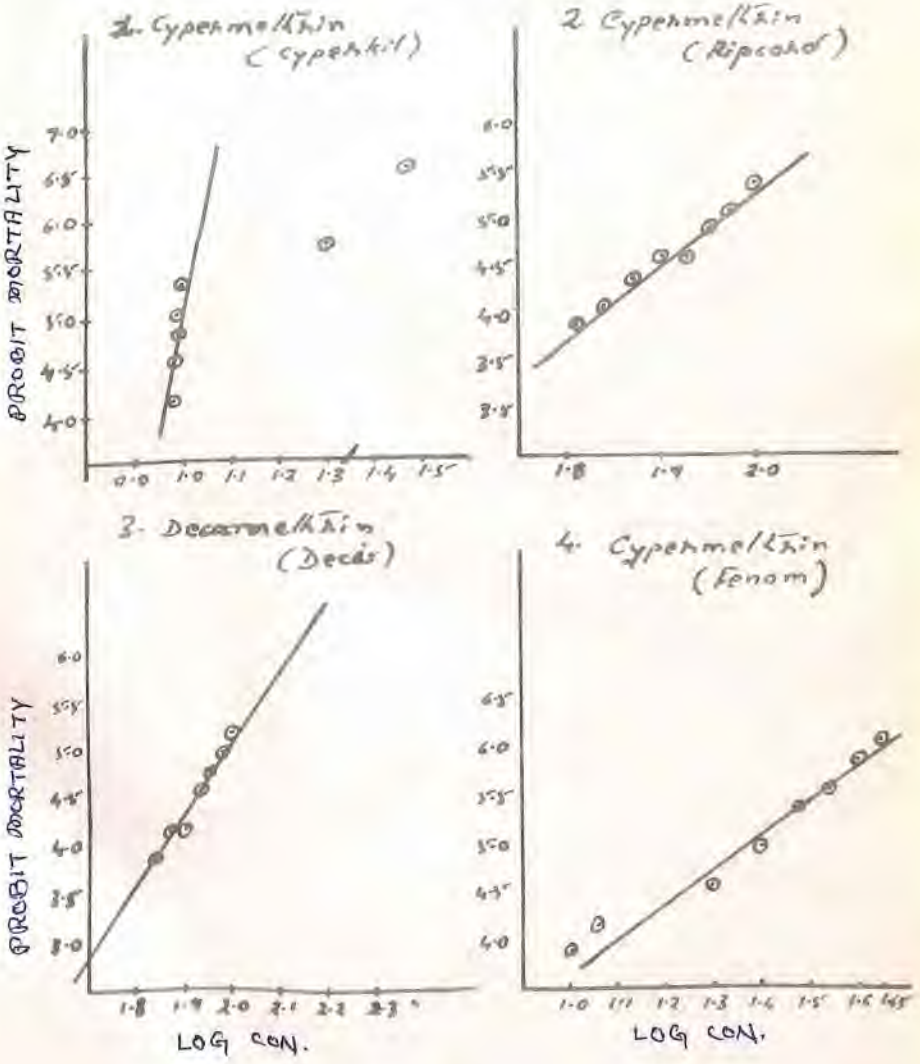
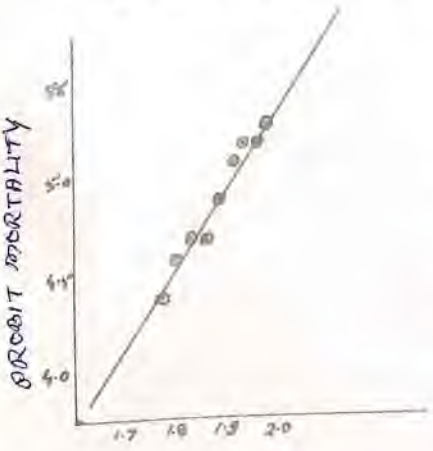
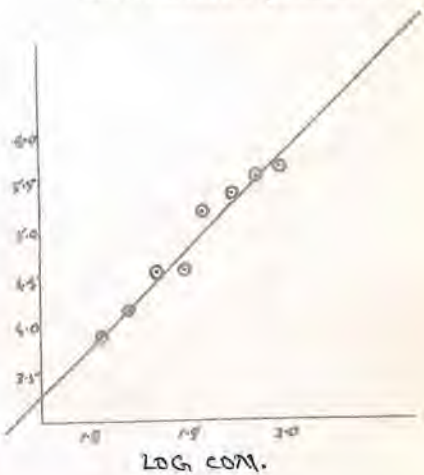


Fig. 4.2 TOXICITY OF DIFFERENT INSECTICIDES TO FIFTH INSTAR NYMPH OF *D. cingulatus*.

1. Fevalanate (Sumicidin)



2. Permethrin (Permasect)



3. Thiometon (Ekalin)

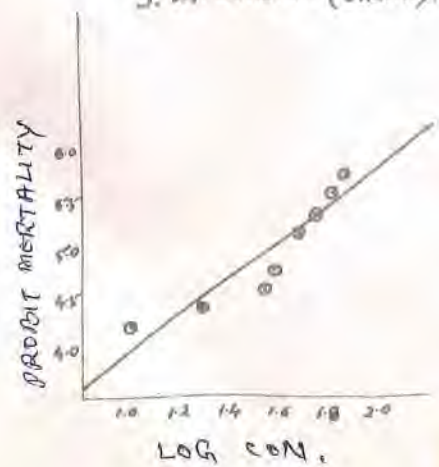


FIG:-4.3 TOXICITY OF DIFFERENT INSECTICIDES TO FIFTH INSTAR NIMPH OF *D. cingulata*.

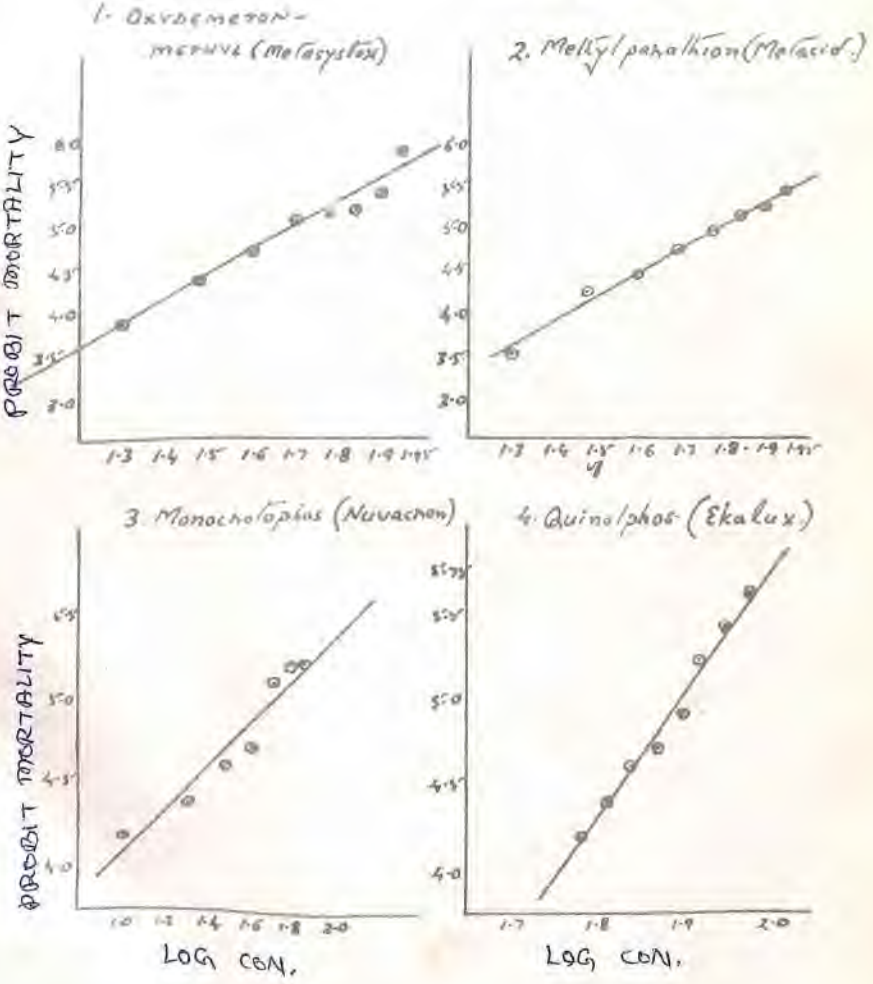


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FIG. 4.4 TOXICITY OF DIFFERENT INSECTICIDES TO FIFTH INSTAR NYMPH OF D. cingulatus

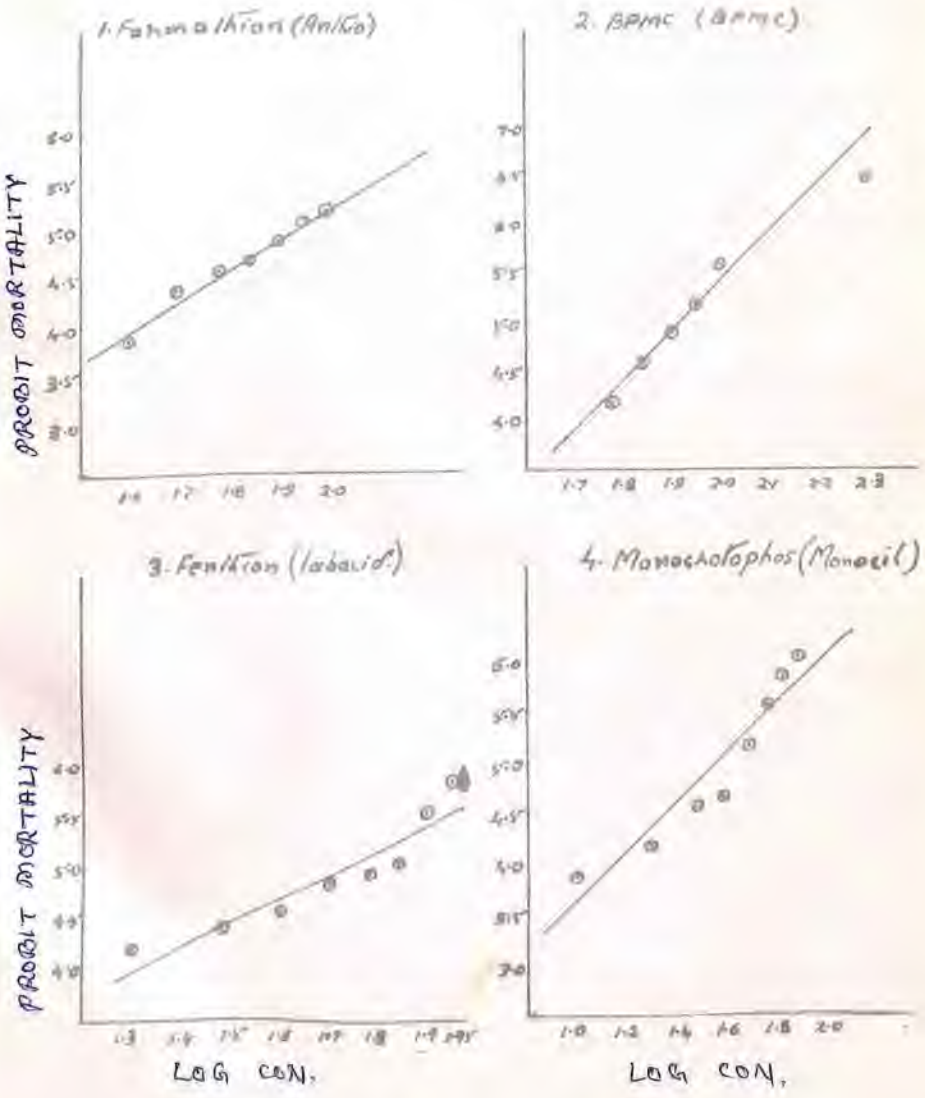


Fig :- TOXICITY OF DIFFERENT INSECTICIDES TO FIFTH INSTAR NYMPH OF D. singulatus.

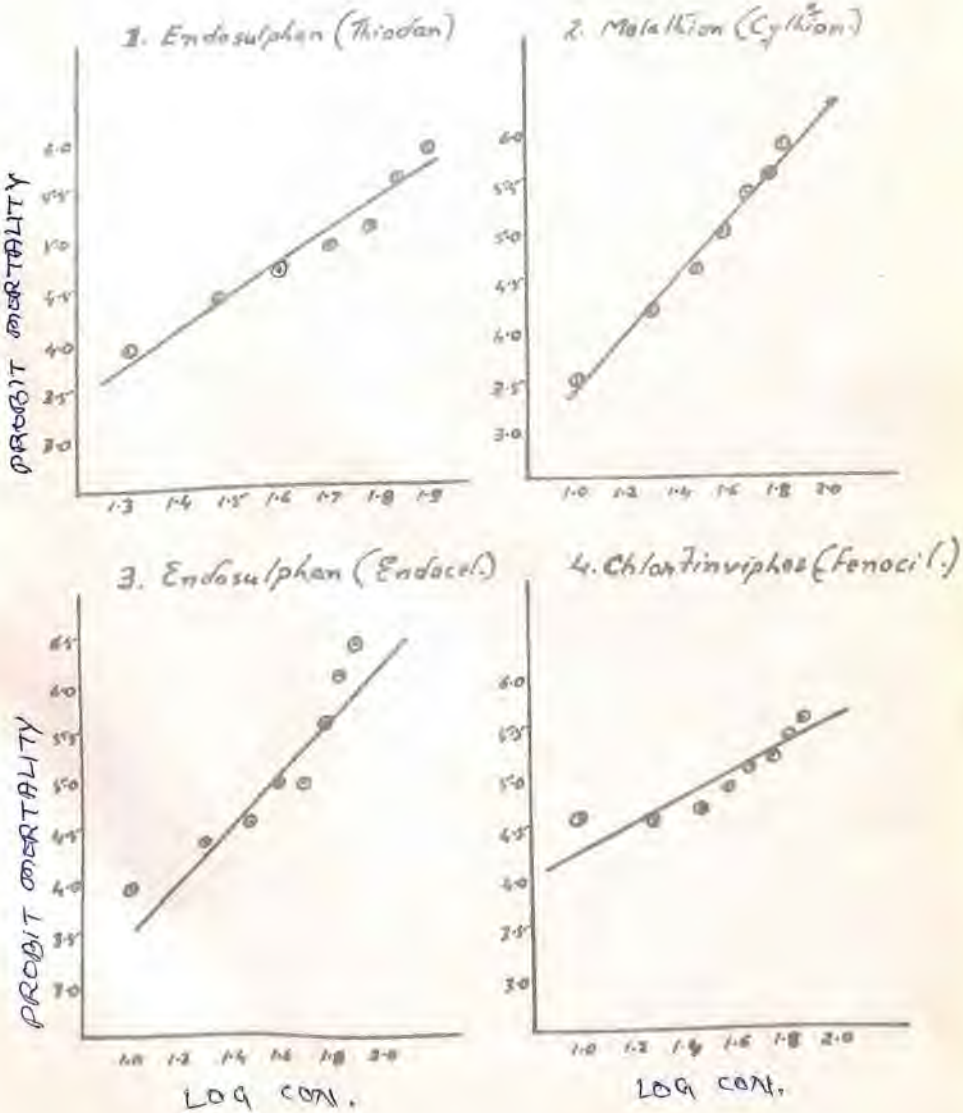


FIG: 9.6 TOXICITY INDEX OF DIFFERENT INSECTICIDES AGAINST RED COTTON BUG *D. cingulatus* (Fab.)

All the insecticides, except endosulfan (Thiodan), were found to be more toxic than commonly used malathion (the standard). From all the 19 insecticides tested, cypermethrin (particularly, Fenom) was found to be the most toxic insecticide to red cotton bug. Synthetic pyrethroids occupied the first six positions, followed by organophosphates. The only carbamate used - BPMC, was intermediate. Amongst the two formulations of endosulfan; Endocel proved better than malathion (T.I./108), while Thiodan proved less effective (T.I./77) (Table 4.1, Fig.4.6).

The insecticides tested can be arranged in the order of decreasing toxicity to red cotton bug as follows :-

Cypermethrin (Fenom) > cypermethrin (Ripcord) > cypermethrin (Cyperkil) > decamethrin > fenvalerate > permethrin > monocrotophos (Monocil) > thiometon > monocrotophos (Nuvacron) > fenthion > oxydemeton methyl > methyl parathion > quinalphos > formothion > BPMC > chlorfinviphos > endosulfan (Endocel) > malathion > endosulfan (Thiodan)

4.2 Relative Efficacy of Different Insecticides to Red Cotton Bug in the Field (Table 4.2)

The efficacy of seven different insecticides viz., phosalone, endosulfan, decamethrin, monocrotophos, permethrin, quinalphos and cypermethrin with control was determined

Table 4.2 : Effect of different insecticides on the population of red cotton bug, *D. cingulatus* (Fab.) on okra (Insect population per plant during November & December, 1983)

Insecticide	Pre-treatment pd.	Post-treatment Period											Av. population	Seed yield (kg/ha	Unfit seeds (kg/ha)
		1 day	2 days	3 days	4 days	8 days	12 days	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks			
Phosalone	2.20 (4.33)	0.82 (0.20)	0.82 (0.20)	1.02 (0.60)	1.19 (0.93)	1.58 (2.00)	1.67 (2.40)	1.84 (2.93)	2.11 (4.00)	2.27 (4.66)	2.35 (5.07)	2.31 (4.87)	1.97 (3.39)	892.67	101.17
Endosulfan	2.09 (3.87)	0.93 (0.40)	1.05 (0.60)	1.19 (0.93)	1.40 (1.47)	1.58 (2.00)	1.73 (2.53)	1.91 (3.20)	2.19 (4.33)	2.31 (4.87)	2.39 (5.27)	2.34 (5.00)	2.02 (3.56)	853.66	112.94
Decamethrin	2.15 (4.13)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.88 (0.33)	1.02 (0.53)	1.23 (1.07)	1.64 (2.33)	1.86 (3.00)	2.15 (4.13)	2.35 (5.07)	1.67 (2.27)	937.10	89.41
Monocrotophos	2.14 (4.20)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.80 (0.13)	0.97 (0.47)	1.08 (0.67)	1.53 (1.87)	1.76 (2.67)	2.03 (3.67)	2.20 (4.33)	1.55 (1.90)	1011.66	47.06
Pyrethrin	2.05 (3.73)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.87 (0.27)	1.20 (1.00)	1.30 (1.20)	1.70 (2.40)	1.83 (2.87)	2.10 (4.07)	2.25 (4.60)	1.64 (2.20)	955.02	72.94
Quinalphos	2.00 (3.53)	0.71 (0.00)	0.83 (0.20)	1.04 (0.60)	1.18 (0.93)	1.50 (1.80)	1.47 (2.33)	1.74 (2.47)	2.02 (3.60)	2.12 (4.07)	2.31 (4.87)	2.40 (5.27)	1.91 (3.17)	930.34	89.41
Cypermethrin	2.09 (3.87)	0.71 (0.00)	0.75 (0.07)	0.71 (0.00)	0.85 (0.27)	0.82 (0.20)	1.19 (0.93)	1.35 (1.33)	1.60 (2.07)	1.87 (3.13)	2.06 (3.80)	2.35 (5.07)	1.65 (2.25)	953.71	75.29
Control	2.13 (4.07)	2.16 (4.20)	2.27 (4.67)	2.23 (4.53)	2.33 (4.93)	2.37 (5.13)	2.42 (5.67)	2.55 (6.00)	2.41 (5.33)	2.45 (5.53)	2.41 (5.33)	2.44 (5.47)	2.40 (5.29)	780.14	131.76
S.Em.±	0.05	0.07	0.06	0.08	0.09	0.11	0.18	0.13	0.16	0.15	0.16	0.09	0.06	38.49	5.08
CD 5%	NS	0.20	0.18	0.25	0.27	0.32	0.54	0.38	0.48	0.46	NS	NS	0.17	116.76	15.40

Note : Figures without parenthesis are $\sqrt{X + 0.5}$ transformed values.

against red cotton bug in the experimental field. The recommended concentration of insecticides was sprayed on November 1, 1983 when the bug population reached to 4-5 bugs/plant.

4.2.1 Effect of insecticides on bug population

The observations for reduction of population were taken at the intervals as indicated in Table 4.2.

4.2.1.1 Pre-treatment population

The pre-treatment population of the bugs was fairly uniform.

4.2.1.2 Effect after a day

All the insecticidal treatments were significantly superior over control. The pyrethroids, monocrotophos and quinalphos were superior over endosulfan and phosalone. The last two were at par with each other.

4.2.1.3 Effect after two days

The untreated (control) had significantly higher bug population as compared with the insecticidal treatments. Amongst the treatments, endosulfan had the highest population.

4.2.1.4 Effect after three, four and eight days

The control was significantly inferior to all the

insecticidal treatments. Monocrotophos was the superior most, followed by decamethrin, permethrin and cypermethrin, although statistically, they were at par with decamethrin. All the earlier treatments were significantly superior to phosalone, quinalphos and endosulfan.

The position remained identical even after four days and after eight days, the sequence changed, i.e., decamethrin, monocrotophos, permethrin, cypermethrin, quinalphos, phosalone, endosulfan for four days after; and monocrotophos, cypermethrin, permethrin, decamethrin, quinalphos, phosalone and endosulfan after eight days of treatment.

4.2.1.5 Effect after 12 days

The insecticidal treatments still retained their superiority over control. Monocrotophos had the least insect population, although it was at par with decamethrin, cypermethrin, permethrin and quinalphos. Phosalone and endosulfan were significantly inferior than the first two, while at par with rest of the insecticides.

4.2.1.6 Effect after two weeks

The results continued to be similar to the observations made on fourth day except that monocrotophos and decamethrin interchanged their positions, i.e., monocrotophos had the lesser bug population than decamethrin.

4.2.1.7 Effect after three weeks

The treatments were still effective and the insect population was significantly lesser than control. Monocrotophos was significantly superior over others except cypermethrin, decamethrin and permethrin. The latter three were at par with quinalphos. Quinalphos, phosalone, endosulfan were at par with untreated control.

4.2.1.8 Effect after four weeks

Monocrotophos was significantly superior over all other treatments, except permethrin, decamethrin, cypermethrin and quinalphos, which were also at par with phosalone, while the latter three were at par with endosulfan. Phosalone and endosulfan were at par with control.

4.2.1.9 Effect after five and six weeks

The insecticidal treatments appear to have lost their effect on the fifth week as the insect population rose and was at par with untreated control in all the treatments. The same picture can be seen on the sixth week.

4.2.1.10 Effect on overall bug population

The pre-treatment bug population was uniform in the entire experimental plot as can be seen by the non-significant difference in all the plots. The average control population was significantly high as compared to

the treated plots. Monocrotophos had the lowest population, followed by permethrin, cypermethrin, decamethrin, quinalphos, phosalone and endosulfan. However, permethrin, cypermethrin and decamethrin were at par with monocrotophos, while the rest of the three had significantly higher population than the first four.

4.2.2 Effect on seed yield (Fig.4.7)

All the insecticidal treatments except phosalone and endosulfan, gave significantly higher yield over the control (780.14 kg/ha). Monocrotophos (1011 kg/ha) gave the highest yield, followed by permethrin (955.02 kg/ha), cypermethrin (953.71 kg/ha), decamethrin (937.10 kg/ha) and quinalphos (930.34 kg/ha). Statistically, the last four were at par with monocrotophos (Table 4.2).

4.2.3 Effect on seed quality

All the insecticidal treatments had significantly less unfit seeds as compared with control (131.76 kg/ha). Monocrotophos (47.06 kg/ha) was significantly superior over all other treatments, followed by permethrin (72.94 kg/ha) and cypermethrin (75.29 kg/ha), which were at par with each other. Decamethrin (89.41 kg/ha), quinalphos (89.41 kg/ha) and phosalone (101.17 kg/ha) were superior to endosulfan, which in turn was significantly better than control.

4.3 Residual Toxicity of Field-whithered Insecticides to Red Cotton Bug, D. cingulatus (Table 4.3)

The residual toxicity of the seven insecticides was determined against D. cingulatus at various intervals as detailed in chapter 3.3.

4.3.1 Residual toxicity an hour after the treatment

All the insecticides were significantly effective against bugs as compared to untreated control. Quinalphos, permethrin, monocrotophos and decamethrin gave cent per cent mortalities. Cypermethrin, phosalone and endosulfan were at par with each other and were slightly inferior to the earlier treatments.

4.3.2 After two days

All the insecticidal treatments were found to gave significantly more mortality than control. Permethrin and monocrotophos continued to give cent per cent mortality. Phosalone and quinalphos were significantly less effective than permethrin, monocrotophos, cypermethrin and decamethrin. Others were intermediate.

4.3.3 After four days

All the insecticidal treatments were still significantly effective as compared to control. Permethrin, monocrotophos and cypermethrin were the most effective and were

Table 4.3 : Residual toxicity of different insecticides against red cotton bug *D. cingulatus* (Fab.) on okra (Mean of three replications)

S. No.	Treatment	Post-treatment period							
		1 hr	2 days	4 days	6 days	9 days	12 days	15 days	18 days
1.	Phosalone	56.33 (53.33)	51.15 (60.00)	60.00 (66.67)	51.15 (60.00)	25.01 (33.33)	17.71 (13.33)	8.85 (6.67)	8.85 (6.67)
2.	Endosulfan	47.30 (53.33)	60.00 (66.67)	51.15 (60.00)	38.85 (40.00)	30.78 (26.67)	21.93 (20.00)	8.85 (6.67)	0.00 (0.00)
3.	Decamethrin	90.00 (100.0)	81.15 (93.33)	81.15 (93.33)	90.00 (100.0)	90.00 (100.0)	60.00 (66.67)	30.00 (33.33)	17.71 (13.33)
4.	Monocrotophos	90.0 (100.0)	90.00 (100.0)	90.00 (100.0)	90.00 (100.0)	90.00 (100.0)	60.00 (66.67)	25.78 (26.67)	13.08 (13.33)
5.	Premethrin	90.00 (100.0)	90.00 (100.0)	90.00 (100.0)	81.15 (93.33)	81.15 (93.33)	43.08 (46.67)	17.71 (13.33)	8.85 (6.67)
6.	Quinalphos	90.00 (100.0)	50.77 (60.00)	55.37 (66.67)	30.00 (33.33)	43.08 (46.67)	30.78 (13.33)	8.85 (6.67)	8.85 (6.67)
7.	Cypermethrin	72.29 (86.67)	81.15 (93.33)	90.00 (100.0)	72.29 (93.33)	81.15 (93.33)	46.92 (53.33)	13.08 (13.33)	8.85 (6.67)
8.	Control	8.85 (6.67)	0.00 (0.00)	0.00 (0.00)	8.85 (6.67)	17.71 (13.33)	0.00 (0.00)	8.85 (6.67)	8.85 (6.67)
	S.Em.±	8.45	8.60	7.18	8.30	6.29	10.57	11.09	9.55
	CD 5%	25.64	26.01	21.78	25.18	19.08	32.07	NS	NS

Note : Figures without parenthesis are arsin, i.e., transformed values.

significantly superior to endosulfan, quinalphos and phosalone. Decamethrin was intermediate. Phosalone, quinalphos and endosulfan were at par with each other.

4.3.4 After six days

The control was found to be significantly inferior than all others, except quinalphos. Monocrotophos, decamethrin, permethrin and cypermethrin were significantly superior over all other insecticides except phosalone which was at par with cypermethrin.

4.3.5 After nine days

Monocrotophos, decamethrin (cent per cent mortality), cypermethrin and permethrin proved highly significant over all other insecticidal treatments. Except endosulfan and phosalone, other treatments were significantly effective against the bugs as compared to control.

4.3.6 After 12 days

Except phosalone, endosulfan and quinalphos, all other treatments were still significantly more effective than control. Monocrotophos and decamethrin were the best compounds.

4.3.7 After 15 and 18 days

All the insecticidal treatments lost their toxicity and were at par with untreated control.

4.4 Biological Studies of D. cingulatus on Different Hosts

The life cycle of red cotton bug, D. cingulatus was studied on four hosts with a view to determine their effect on the biology of the pest.

4.4.1 Effect of different host plants on the developmental period of D. cingulatus (Table 4.4)

The duration required for completion of different life stages on different hosts was observed and compared to know the significancy of tested host plants in the life of D. cingulatus.

4.4.1.1 Effect on incubation period

The host had no effect on the egg period of the pest.

4.4.1.2 First instar

The duration of the first instar was also not influenced by the hosts.

Table 4.4 : Effect of different host plants on the developmental period of red cotton bug, *D. cingulatus*

S. No.	Host	Mean of 10 individuals (in days)							ADULT			
		Egg stage	Nymphal stages					Total nymphal period	Male	Female	Av.	Total life cycle
			Ist instar	IInd instar	IIIrd instar	IVth instar	Vth instar					
1.	Ambari	11.9	4.5	5.3	5.8	9.2	12.8	37.6	12.2	12.2	12.2	61.7
2.	Okra	12.8	4.6	5.3	5.5	9.3	13.0	37.7	12.1	12.9	12.5	63.0
3.	Cotton	12.0	5.0	6.3	6.6	12.2	14.2	44.3	13.3	13.9	13.6	69.9
4.	Holly-hock	12.0	4.8	6.5	7.5	13.1	16.9	48.8	13.8	13.7	13.7	73.5
	S.Em.±	0.83	0.36	0.31	0.36	0.54	0.49	-	0.81	0.49	-	-
	CD 5%	NS	NS	0.89	0.72	1.54	1.42	-	NS	NS	-	-

4.4.1.3 Second instar

The duration required for second instar was significantly lower for ambari and okra (both 5.3 days) than on cotton (6.3 days) and hollyhock (6.5 days).

4.4.1.4 Third instar

The nymphs reared on okra (5.5 days) and ambari (5.8 days) developed significantly faster than on the other hosts. The duration was significantly more on hollyhock than on cotton.

4.4.1.5 Fourth instar

The nymphs grew significantly faster on ambari and okra than on cotton and hollyhock.

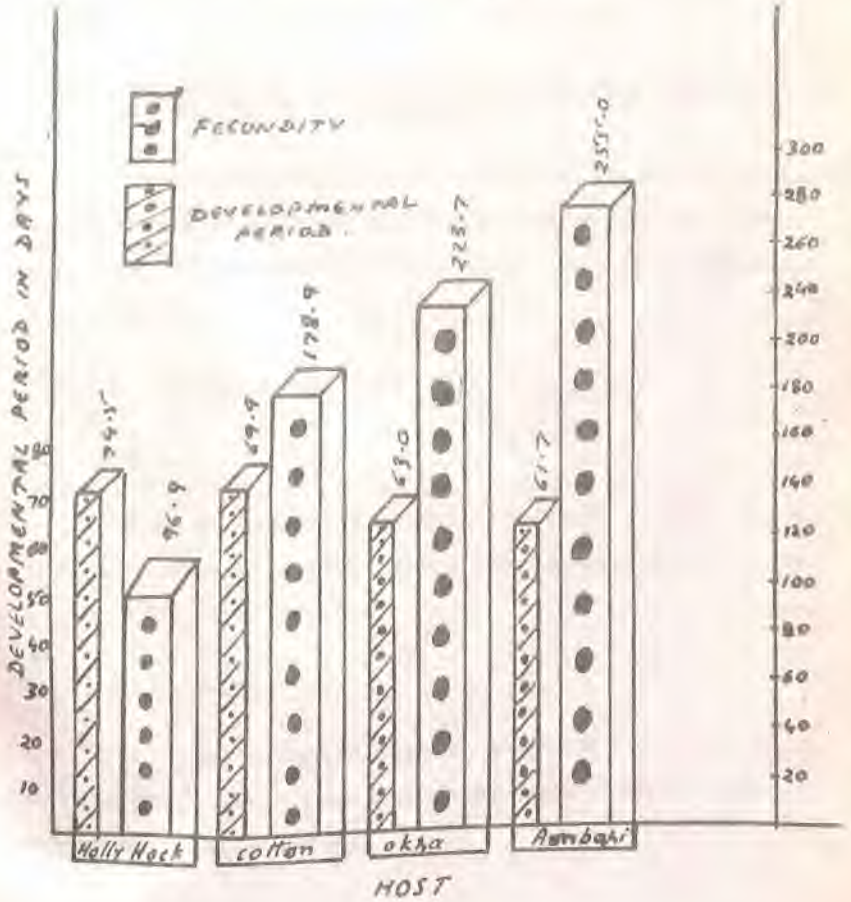
4.4.1.6 Fifth instar

Ambari (12.8 days), okra (13.0 days) and cotton (14.2 days) were found to be significantly more suitable hosts for the fifth instar nymphs as the nymphs grew faster on these hosts as compared to hollyhock.

4.4.1.7 Total nymphal stage

When the entire nymphal stage was considered, ambari proved the best, followed by okra, cotton and hollyhock. The period required was 37.6, 37.7, 44.3 and 48.8 days respectively.

FIG:-4.7 EFFECT OF DIFFERENT HOST PLANT ON FECUNDITY AND DEVELOPMENTAL PERIOD OF *D. cingulatus*.



4.4.1.8 Adult stage (male and female)

Feeding on different hosts did not influence the duration of adult stage in red cotton bugs.

4.4.2 Effect of different hosts on the survival and fecundity of D. cingulatus

While studying the life cycle of the bug on different hosts, the mortality at different life stages was also recorded and is presented here under separate subheadings (Table 4.5).

4.4.2.1 Effect on survival

(a) Egg

The egg mortality ranged from 23 to 41 per cent on different hosts. However, there was no significant difference due to hosts on eggs.

(b) First instar

The significantly highest survival was observed on ambari, while the lowest was found on hollyhock. Okra and cotton were intermediate.

(c) Second instar

Okra was found to be significantly superior over others, except ambari, while the hollyhock was significantly the most inferior one.

Table 4.5 : Effect of different host plants on the survival and fecundity of red cotton bug, *D. cingulatus*

S. No.	Host	Egg Stage	(per cent survival) I instar	II instar	III instar	IV instar	V instar	Total nymphal period	Fecundity (No. of eggs laid)
1.	Ambari	76.56	80.44	74.26	86.93	68.82	64.42	23.02	255.0
2.	Okra	80.51	84.39	74.87	84.16	66.87	63.75	22.69	223.7
3.	Cotton	78.45	81.72	65.31	75.91	64.73	62.09	16.28	178.9
4.	Holly-hock	58.77	71.93	59.63	71.09	60.13	60.30	11.01	96.9
	S.Em.±	7.34	0.89	0.73	0.90	1.17	2.19	0.72	21.01
	CD 5%	NS	2.65	2.19	2.71	3.52	NS	2.16	60.30

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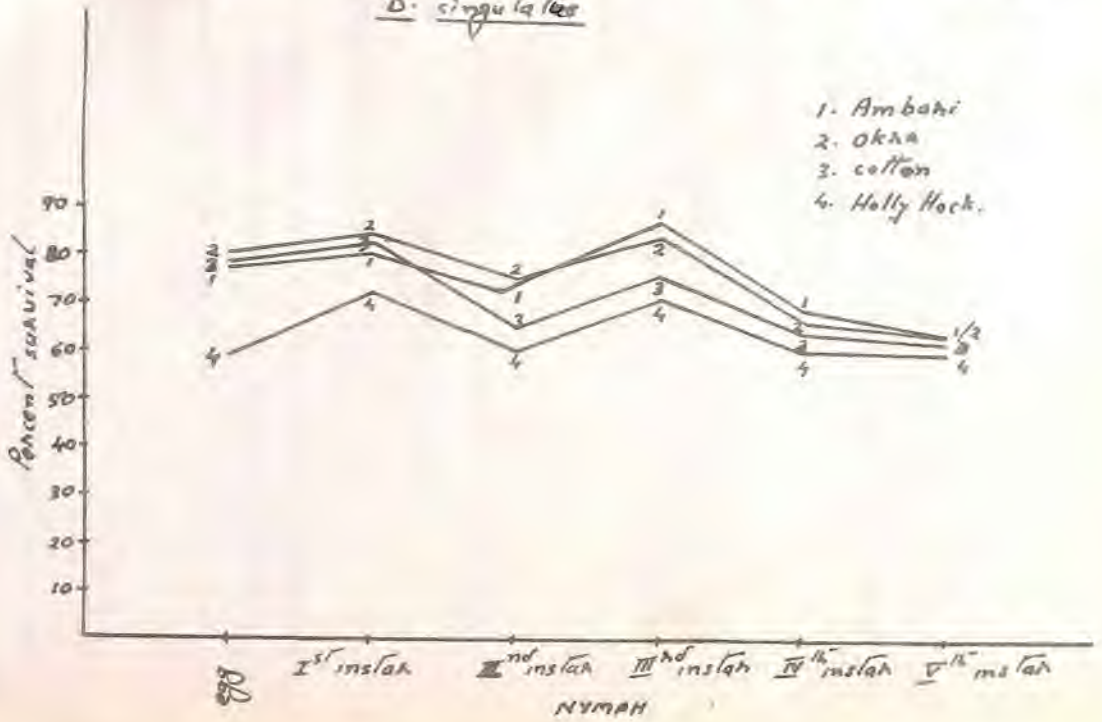
FIG:- 4.8. EFFECT OF DIFFERENT HOST ON THE SURVIVAL OF D. singulatus



(d) Third instar

All the treatments differed significantly with each other. Feeding on ambari gave least mortality, followed by okra, cotton and hollyhock.

(e) Fourth instar

Ambari was again found the best host except okra. Cotton was at par with okra but was significantly superior to hollyhock.

(f) Fifth instar

Feeding on different hosts did not significantly influence the survival in 5th instar nymphs.

(g) Overall nymphal stage

Ambari was the most suitable host as compared with others as the nymphs developed on ambari with least mortality. Hollyhock was the least suitable. Okra and cotton were intermediate.

4.4.2.2 Fecundity

The bugs reared on ambari laid significantly more eggs (225.0 eggs/female) than on cotton (178.9 eggs/female) and hollyhock (96.9 eggs/female). Okra (223.7 eggs/female) was at par with ambari. Hollyhock was least suitable as

the bugs reared on them laid significantly lesser eggs than ambari and okra.

The morphological characters like length, breadth and weight of the bugs feeding on different hosts were also recorded to determine the differences. The results were as below :-

4.4.3 Effect on length (Table 4.6)

4.4.3.1 First instar

The nymphs feeding on ambari were significantly longer than any other host except okra. The nymphs feeding on cotton were significantly shorter than the earlier, but were significantly longer than the nymphs on hollyhock.

4.4.3.2 Second instar

Again, the longest nymphs were observed on ambari. Okra was at par with ambari. Hollyhock and cotton produced significantly shorter nymphs.

4.4.3.3 Third instar

The influence of hosts on the length of nymphs was clearly visible in this case as there was significant difference in the length of nymphs fed on all four hosts. Ambari produced the longest nymphs, followed by okra, cotton and hollyhock.

Table 4.6 : Effect of different host plants on the body length of red cotton bug, *D. cingulatus*

S. No.	Host	(Length in mm - mean of 10 individuals)						
		Nymphs					Adults	
		I instar	II instar	III instar	IV instar	V instar	Female	male
1.	Ambari	1.66	3.18	4.48	5.80	7.82	14.45	10.76
2.	Okra	1.64	2.91	4.29	5.79	7.71	12.47	10.34
3.	Cotton	1.55	2.52	4.00	5.51	7.34	10.09	9.24
4.	Holly-hock	1.49	2.39	3.78	5.11	7.11	8.75	7.14
	S.Em.±	0.017	0.094	0.026	0.18	0.13	0.24	0.25
	CD 5%	0.05	0.27	0.070	0.51	0.37	0.70	0.71

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4.4.3.4 Fourth instar

Bugs fed on ambari were longer than on okra and cotton. All were on par with each other but significantly superior over hollyhock.

4.4.3.5 Fifth instar

Again, the bugs from hollyhock were shorter as compared with bugs from ambari and okra. Cotton was at par with hollyhock.

4.4.3.6 Adult (male and female)

The adult female bugs emerged after feeding on different hosts, varied significantly in their length due to feeding. The longest female bugs were observed on ambari, while the shortest were on hollyhock. Okra and cotton were intermediate. The same trend was seen in male adults.

4.4.4 Effect on body width (Table 4.7)

4.4.4.1 Body width of first instar nymphs

The bugs fed on ambari were broader than on hollyhock. Ambari, okra and cotton were at par with each other.

4.4.4.2 Second instar

The width of bugs fed on ambari and okra were significantly more than on hollyhock and cotton. The last two were at par with each other.

Table 4.7 : Effect of different host plants on the body width of red cotton bug, *D. cingulatus*

S. No.	Host	(Width in mm - mean of 10 individuals)						
		Nymphs					Adults	
		I instar	II instar	III instar	IV instar	V instar	Female	Male
1.	Ambari	1.21	1.49	1.72	2.25	2.82	4.59	3.97
2.	Okra	1.14	1.38	1.61	2.20	2.82	4.26	3.62
3.	tton			1			3 3	3 1
4.	ly-ck			1 1			2 6	2 1
	Em				7	0	1	2
	C 5		0			NS		

4.4.4.3 Third instar

All the treatments had significant influence on the body width of the bugs. Nymphs from ambari had the maximum width, followed by okra, cotton and hollyhock.

4.4.4.4 Fourth instar

Again, the bugs from ambari and okra were broader than from hollyhock. Okra and cotton were at par but were significantly better than hollyhock.

4.4.4.5 Fifth instar

The body width of the bugs was not influenced by feeding on the hosts tested.

4.4.4.6 Adult (male and female)

The body width of adult female bugs was significantly influenced by all the four hosts tested. The highest width was recorded in the bugs fed on ambari, followed by okra, cotton and hollyhock. The same trend was seen in male adults.

4.4.5 Effect of different host plant on the weight of red cotton bug, D. cingulatus (Table 4.8)

4.4.5.1 Third instar

The nymphs fed on ambari were significantly heavier than those reared on hollyhock. Okra and cotton were intermediate.

Table 4.8 : Effect of different host plants on the weight of red cotton bug, *D. cingulatus*

S. No.	Host	(Wt. in mg - mean of 10 individuals)				
		Nymphal instars			Adults	
		IIIrd	IVth	Vth	Female	Male
1.	Ambari	10.0	16.3	30.0	60.2	43.1
2.	Okra	9.9	14.4	29.3	48.8	36.4
3.	Cotton	8.1	13.0	23.4	32.6	30.5
4.	Hollyhock	7.2	11.4	22.7	25.9	22.3
	S.Em.±	0.80	1.22	1.39	0.93	0.89
	CD 5%	2.29	3.50	4.00	3.08	2.55

4.4.5.2 Fourth instar

Ambari again produced the heaviest nymphs, followed by okra, cotton and hollyhock. Cotton and hollyhock were statistically at par with each other.

4.4.5.3 Fifth instar

The bugs fed on ambari proved significantly heavier to that of hollyhock; okra and cotton were intermediate.

4.4.5.4 Adult (male and female)

The weight of adult bugs (male as well as female) was significantly influenced by feeding on four different hosts. The bugs fed on ambari were the heaviest, followed by those fed on okra, cotton and hollyhock.

4.4.6 Host preference of red cotton bug (Table 4.9)

The host preference of the 3rd instar bugs was studied with the help of "preference chamber" in the laboratory. Each of the four hosts tested were represented by leaves and fruits.

Ambari leaves were the most preferred material, followed by okra and cotton leaves. The fruits and leaves of hollyhock were the least preferred material. Other materials were intermediate.

Table 4.9 : The preference of red cotton bug, *D. cingulatus* to different host plants and their parts (in %)

Treatments	1	2	3	4	5	6	7	8	9	10	11	12	Total	Mean
Ambari leaf	30.16	21.74	26.67	37.50	23.8	2	8	27.40	31.34	25.67	30.00	31.58	27.03	341.28	28.44
Okra leaf	19.05	28.98	26.67	26.56	6	2	3	26.03	25.37	17.57	25.00	17.54	24.32	295.63	24.64
Cotton leaf	20.63	17.39	16.67	12.50	1	1		10.96	17.91	18.92	13.33	17.54	18.92	192.10	16.01
Ambari fruit	15.87	11.59	10.00	12.50	11.11	8.11		9.59	5.97	13.51	10.00	8.77	10.82	127.84	10.65
Okra fruit	4	1	1		7	1	6		95	1	1	0	14	03	6	6
Cotton fruit					3	1	1	11			13		3		7	4
H-hock leaf	6					3		6.						8		2
H-hock fruit		5						4				5		3		
Total	99.99	99.99	100.01	99.99	100.00	100.00	100.01	99.99	100.00	99.99	99.98	100.01	1199.96	100.0

ANOVA TABLE

S. No.	Source	D.F.	S.S.	M.S.S.	Cal. F	Table F
1.	Treatment	7	8107.95	1158.28	118.07	2.15
2.	Error	88	863.29	9.81		
	Total	95	8971.24			

S.Em.± : 0.90
CD 5% : 2.54

Chapter - V

D I S C U S S I O N

5. DISCUSSION

Nineteen different insecticides were bio-assayed against 5th instar nymphs of red cotton bug, D. cingulatus under precise laboratory conditions. On the basis of the median lethal concentrations, except endosulfan, all other insecticides proved more toxic to bug than malathion. Cypermethrin was the most toxic compound which was almost 165217to 408,60 times as toxic as malathion. All the six synthetic pyrethroids tested, occupied the first six positions in the effectivity against the bug. As a group, organophosphorus compounds stood second, while the carbamate - BPMC, was third and the endosulfan was the least effective. Amongst organophosphorus insecticides, monocrotophos was the most efficacious. It was 1055 times more toxic to bugs than malathion. In order of decreasing toxicity to the bugs, the insecticides can be arranged as under :-

> Cypermethrin (Fenom) > cypermethrin (Ripcord) > cypermethrin (Cyperkil) > decamethrin > fenvalerate > permethrin > monocrotophos (Monocil) > thiometon > monocrotophos (Nuvacron) > fenthion > oxydemeton methyl > methyl parathion > quinalphos > formothion > BPMC > chlorfenviphos > endosulfan (Endocel) > malathion > endosulfan (Thiodan).

Rani and Osmani (1982) reported synthetic pyrethroids to be superior over conventional insecticides in the control of red cotton bug, D. cingulatus.

While working on the pest complex of cotton, Harris and Turnbull (1978) found synthetic pyrethroids superior over chlorpyriphos. Choudhary (1983) on the other hand, claimed that the synthetic pyrethroids were superior to monocrotophos and endosulfan against cotton bollworms (H. armigera). Dina (1979) similarly found decamethrin and permethrin superior to monocrotophos against sucking pests like Clavigralla horrida, Cydia ptychoro etc. Similar experience was recorded by Morosini and Bertoldo (1981) against stink bug (Nezara viridula).

Our results thus confirmed the experiences of the above scientists and further clarified the quantitative aspect of the synthetic pyrethroids. Cypermethrin was 400 times more potential than malathion. Even with monocrotophos, it was 40 times more effective. If we can use the entire potential of this chemical, the field dose could be reduced to 1/4th of presently recommended quantity which is already 1/10th of monocrotophos (i.e., 50 g/ha). Further search, however, is needed to determine the factors which interfere in achieving this potential in the field.

Even among the different formulations of cypermethrin, Fenom proved 4.5 times more toxic than the rest.

Fenom is supposed to contain higher proportion of trans-isomer. This may be the cause of its higher effectivity.

Relative efficacy and residual toxicity of the insecticides in the field

The relative efficacy and the residual toxicity of seven insecticides were determined on red cotton bug, on okra in the field. The bug population, 24 hrs after the treatments, was significantly lower in all the insecticidal treatments than in control. The pyrethroids, monocrotophos and quinalphos were significantly superior to endosulfan and phosalone. The pest population remained suppressed till 3 weeks, when it rose to the level of control in quinalphos, phosalone and endosulfan. The rest of the insecticides - monocrotophos, cypermethrin, decamethrin and permethrin also lost their toxicity 5 weeks after the treatment. Throughout this period, monocrotophos, followed by the pyrethroids, sustained lowest bug population. The continuous effective suppression of the pest was also reflected in the quality and the quantity of okra seeds produced. All the treated plots had significantly lesser proportion of unfit seeds than in control. Except endosulfan and phosalone, the insecticidal treatments gave significantly higher seed yields than the control. Monocrotophos produced the highest yields, followed by cypermethrin, decamethrin, permethrin and quinalphos.

The laboratory bio-assays of the field-whithered insecticides at various intervals after the treatment gave similar picture. Except endosulfan and phosalone, all other insecticides gave 90 to 100 per cent mortality of bugs 24 hrs after the treatment. Initially, quinalphos killed cent per cent bugs but within a week, it had lost 1/3rd of its effectivity. Phosalone and endosulfan gave only around 30 per cent kill 10 days later. Monocrotophos, decamethrin, cypermethrin and permethrin remained highly toxic till 10th day when they started losing their effect and lost completely by 19th day after the treatment. In the field, monocrotophos and synthetic pyrethroids used, appeared to remain effective till 5 weeks because, here effectivity was judged on the basis of bug population/plant in the plots. The difference of 2 weeks was probably required for the built-up of the pest population to the level of control.

Our results are in agreement with those of Calcagnolo and Massariol (1974), Morosini and Fonseca (1976), Corsevil and Meyer (1979) and Foerster (1979) who found monocrotophos as the best insecticide for the control of bugs. Calcagnolo *et al.* (1977) found monocrotophos more effective than endosulfan. Kalode *et al.* (1959) also reported that endosulfan lost its toxicity to Gandhi bug in 24 hrs. Gupta and Dhari (1980) could get the highest

Fig : 51

ECONOMICS OF DIFFERENT INSECTICIDES FOR *D. cingulatus*

(Based on Total Yield)

yields of okra with monocrotophos when used against Ealias spp and Amrasca devastans on okra. Dina (1979), similarly got higher yields of cowpea, in monocrotophos treatment although, decamethrin and permethrin gave better kill of the pest. Synthetic pyrethroids were reported superior to the conventional insecticides by many workers (Dina, 1979; Siddiqui, 1979; Nimbalkar and Ajri, 1980 and Dhamdhere et al., 1981).

Monocrotophos in our experiments not only gave better kill, higher yields of quality seeds than the synthetic pyrethroids but was also economical. The cost-benefit ratio in case of monocrotophos was 1:31, while with cypermethrin, decamethrin and permethrin it was 1:7, 1:15 and 1:25, respectively (Table 5.1, Fig. 5.1).

The present high cost of pyrethroids appears to be the major factor. In future, however, discovery of more potent compounds, use of synergist and reduction of cost of chemical due to large scale production, may tip the balance in favour of pyrethroids. Till then, monocrotophos can be considered as the most effective and economical chemical for the control of red cotton bug, D. cingulatus on okra.

Food preference of red cotton bug

The red cotton bugs (D. cingulatus) were reared on the leaves of four different hosts : ambari, okra, cotton

Table 5.1 : Economics of different field sprayed insecticides against D. cingulatus (Fab.) (based on seed yield kg/ha)

S. No.	Treatment	Yield (kg/ha)	Increase in yield over control (kg/ha)	Profit (Rs./ha)	Cost of treatment (Rs./ha)	Net profit (Rs./ha)	Benefit-cost ratio
1.	Phosalone	892.67	112.53	1350.36	133.80	1216.56	9.09
2.	Thiodan	853.66	73.52	882.24	86.04	796.20	9.25
3.	Decis	937.10	156.96	1883.52	129.64	1883.52	14.52
4.	Monocil	1011.66	231.52	2778.24	86.80	2691.44	31.01
5.	Permasect	955.02	174.88	2098.56	79.80	2020.37	25.32
6.	Ekalux	930.34	150.20	1802.40	78.19	1544.70	19.76
7.	Ripcord	953.71	173.57	2082.84	257.70	2003.04	7.77
8.	Control	780.14					

and hollyhock for their entire life time. The suitability of the host was assessed on the basis of the relative time taken by them for the development, in size, the weight and survival of the pest at every stage, fecundity of female etc. The bugs fed on the suitable host are likely to develop faster, grow larger and heavier, the adults will live longer and the female will lay more viable eggs. The experimental results, in fact, showed that the bugs fed on ambari developed faster, the individual of each stage were larger and heavier, the adults survived longer and the female laid more number of viable eggs. Okra and cotton were intermediate and hollyhock was the least suitable host. The laboratory studies conducted with the help of Preference Chamber also confirmed that ambari leaves were the most preferred material, followed by okra and cotton. Hollyhock leaves were the least preferred one.

Our results have reaffirmed the contention of the earlier workers that the host exert profound influence on the life cycle of the pest (Menon, 1978 and Reddy, 1980 for bean aphis; Choudhary, 1983 and Nawab, 1983 for gram pod borer and Rathi, 1984 for tobacco caterpillar).

Ahmad (1979), studied the biology of red cotton bug on different hosts and found that the highest number of bugs survived on cotton, followed by Pennisetum sp., okra and sorghum. Geeting and Coaker (1960) earlier reported cotton more suitable host for D. superstitiousus than sorghum, maize, cowpea and bajra. The hosts tested by the earlier workers were different from the ones we have used, however, the preference of cotton by the bug is indicated by the majority.

From amongst the four host plants tested, cotton and okra were economically important, while hollyhock and ambari of lesser value. Our findings that Ambari is most attractive crop for red cotton bug which is a severe pest of cotton and okra, can be of practical importance for the farmers who are customarily growing these crops. Growing okra or ambari during summer, can provide suitable food for the faster development of red cotton bug, resulting in the heavier damage of the pest to cotton in the next season. Hence, ambari or okra in summer may be discouraged in the cotton belt. Ambari, which is highly attractive for red cotton bug can be grown with advantage for green manuring and can be burried into the soil when heavily infested with bugs. The technique can reduce pest in cotton. The details of the technique, however, needs detail study for few years.

Chapter - VI

SUMMARY, CONCLUSIONS AND SUGGESTIONS

6. SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

SUMMARY AND CONCLUSIONS :

The median lethal concentrations of 19 insecticides were determined against red cotton bug, Dysdercus cingulatus (Fabricius) in the laboratory. The relative toxicity of these insecticides was then calculated on the basis of the "Toxicity Index", where the toxicity of malathion was taken as 100.

Except endosulfan, all the insecticides tested were more effective against red cotton bug D.cingulatus than malathion. All the four synthetic pyrethroids tested were more effective than the rest, i.e., 165217 (Cypermethrin, Fenom) to 4578 (Permethrin) times as toxic as malathion. Cypermethrin (Fenom) was the most effective compound. Amongst organophosphorus insecticides, monocrotophos (1055 and 826 times) and thiometon (10,00 times) were more toxic than the rests. The carbamate BPMC was 475 times as toxic as malathion. In order of decreasing toxicity to red cotton bug, the insecticides can be arranged as below:-

Cypermethrin (Fenom) > cypermethrin (Ripcord) > cypermethrin (Cyperkil) > decamethrin > fenvalerate >

permethrin > monocrotophos (Monocil) > thiometon > monocrotophos (Nuvacron) > fenthion > oxydemeton methyl > methyl parathion > quinalphos > formothion > BPMC > chlorfenvinphos > endosulfan (Endocel) > malathion > endosulfan (Thiodan)

Seven insecticides were evaluated in the field for the control of red cotton bug. All the insecticides proved significantly superior over control in reducing pest population and gave proportionately higher grain yields and cost-benefit ratio (Table 5.1). Monocrotophos was the best, followed by permethrin, cypermethrin and decamethrin. Quinalphos, phosalone and endosulfan were intermediate.

Monocrotophos exhibited maximum residual toxicity which was for 15 days, followed by synthetic pyrethroids. Endosulfan and phosalone detoriated after 9 days and were inadequate for longer protection.

On the basis of median lethal concentration, field effectivity, residual toxicity and cost-benefit ratio, monocrotophos emerged as the best compound, while permethrin, decamethrin and cypermethrin were intermediate.

The study of the biology of the bug on four different hosts indicated ambari as the most suitable host. The pest reared on ambari developed faster, were bigger in size and weight, the adults lived longer and the female laid more

eggs than on any other host. Okra was very close to ambari, while cotton was intermediate. Hollyhock was least suitable. The host preference studies with the help of Preference Chamber corroborated these findings.

SUGGESTIONS FOR FURTHER WORK :

1. Further experiments on a larger area may be carried out for the confirmation of our findings.

2. While studying the relative toxicity, the observations were taken only on contact toxicity, it is desirable to note their systemic action.

3. In the field trials, it may be necessary to test more concentrations to evaluate the efficacy and the cost-benefit ratio of insecticides.

4. As okra is a vegetable which is consumed fresh, it will be useful if the residual toxicity of the insecticides is determined from the point of view of the waiting period required before harvest.

5. Ambari and okra proved most attractive and suitable hosts. This information can be used in planning further trials, where ambari or okra can be used as a trap crop against red cotton bugs.

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APPENDICES

Appendix-1 : Toxicity of different insecticides for D. cingulatus

S.			4.				

2. Cypermethrin (Cyperkil 25 EC)

1.	0.00	14	1	0	0	15	0	0.00
2.	0.60	12	0	0	3	15	3	20.00
3.	0.70	7	3	1	4	15	5	33.33
4.	0.80	7	1	2	5	15	7	46.67
5.	0.90	5	2	1	7	15	8	53.33
6.	1.00	1	4	2	8	15	10	66.67
7.	2.00	0	3	4	8	15	12	80.00
8.	3.00	0	2	2	11	15	13	86.67

3. Endosulfan (Thiodan 35 EC)

1.	0.00	11	4	0	0	15	0	0.00
2.	200.0	13	0	2	0	15	2	13.33
3.	300.0	7	4	3	1	15	4	26.67
4.	400.0	6	3	4	2	15	6	40.00
5.	500.0	6	2	5	2	15	7	46.67
6.	600.0	5	2	4	4	15	8	53.33
7.	700.0	4	0	4	7	15	11	73.33
8.	800.0	1	2	3	9	15	12	80.00

4. Monocrotophos (Monocil 36 EC)

1.	0.00	13	2	0	0	15	0	0.00
2.	10.00	13	0	0	2	15	2	13.33
3.	20.0	11	1	1	2	15	3	20.00
4.	30.0	10	0	0	5	15	5	33.33
5.	40.0	6	3	0	6	15	6	40.00
6.	50.0	6	0	1	8	15	9	60.00
7.	60.0	4	0	2	9	15	11	73.33
8.	70.0	3	0	2	10	15	12	80.00
9.	80.0	1	1	0	13	15	13	86.67

Appendix-1 contd...

1.	2.	3.	4.	[redacted]	8.	9.
5. Malathion (Cythion 50 EC)						
1.	0.00	11	3	1	0	15	1	6.67
2.	100.00	8	5	1	1	15	2	13.33
3.	200.00	7	4	1	3	15	4	26.67
4.	300.00	6	3	1	5	15	6	40.00
5.	400.00	6	1	2	6	15	8	53.33
6.	500.00	4	1	1	9	15	10	66.67
7.	600.00	3	1	2	9	15	11	73.33
8.	700.00	2	1	4	8	15	12	80.00
6. Fenthion (Labacid 80 EC)						
1.	0.00	13	1	1	0	15	1	6.67
2.	20.0	11	0	0	4	15	4	26.67
3.	30.0	7	3	0	5	15	5	33.33
4.	40.0	7	2	2	4	15	6	40.00
5.	50.0	8	0	3	4	15	7	46.67
6.	60.0	4	3	3	5	15	8	53.33
7.	70.0	4	2	1	8	15	9	60.00
8.	80.0	4	0	3	8	15	17	73.33
7. BPMC 50 EC						
1.	0.00	13	2	0	0	15	0	0.00
2.	60.0	10	2	2	1	15	3	20.00
3.	70.0	7	3	1	4	15	5	33.33
4.	80.0	3	5	2	5	15	7	46.67
5.	90.0	2	4	1	8	15	9	60.00
6.	100.0	1	3	3	8	15	11	73.33
7.	200.0	1	1	4	10	15	14	93.33
8. Endosulfan (Endocel 35 EC)						
1.	0.00	10	4	1	0	15	0	0.00
2.	100.0	9	3	1	2	15	3	20.00
3.	200.0	7	3	1	4	15	5	33.33
4.	300.0	5	4	3	3	15	6	40.00
5.	400.0	4	3	5	3	15	8	53.33
6.	500.0	4	3	3	5	15	8	53.33
7.	600.0	1	3	5	6	15	11	73.33
8.	700.0	1	1	4	9	15	13	86.67
9.	800.0	0	1	3	11	15	14	93.33

Appendix-1 contd...

9.	
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
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9.	
11.	
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4.	
5.	
6.	
7.	
8.	
9.	
12.	
1.	0.00
2.	20.0
3.	26.67
4.	33.33
5.	40.00
6.	53.33
7.	60.00
8.	60.00
9.	66.67

Appendix-1 contd...

1					6.	7.	8.	9.
				20 EC)				
			1	0	0	15	0	0.00
		9	2	1	3	15	4	26.67
			1	3	2	15	5	33.33
		4	5	2	4	15	6	40.00
		3	6	0	6	15	6	40.00
		2	6	2	5	15	7	46.67
		0	7	1	7	15	8	53.33
		0	6	2	7	15	9	60.00
		4	2	1	8	15	9	60.00
		4	1	4	6	15	10	66.67
14.	Methyl parathion (Metacid 50 EC)							
1.	0.00	14	1	0	0	15	0	0.00
2.	20.0	7	7	1	0	15	1	6.67
3.	30.0	8	4	3	0	15	3	20.00
4.	40.0	7	4	1	3	15	4	26.67
5.	50.0	5	4	1	5	15	6	40.00
6.	60.0	8	0	0	7	15	7	46.67
7.	70.0	5	2	1	7	15	8	53.33
8.	80.0	5	1	5	4	15	9	60.00
9.	90.0	0	5	0	10	15	10	66.67
15.	Oxydemeton methyl (Metasystox 25 EC)							
1.	0.00	14	1	0	0	15	0	0.00
2.	20.0	11	2	0	2	15	2	13.33
3.	30.0	11	0	0	4	15	4	26.67
4.	40.0	8	1	0	6	15	6	40.00
5.	50.0	7	0	1	7	15	8	53.33
6.	60.0	3	3	0	9	15	9	60.00
7.	70.0	3	3	1	8	15	9	60.00
8.	80.0	2	3	2	8	15	10	66.67
9.	90.0	3	0	1	11	15	12	80.00
16.	Chlorfenviphos (Fenocil 25 EC)							
1.	0.00	13	2	0	0	15	0	0.00
2.	100	6	4	1	4	15	5	33.33
3.	200	6	1	0	5	15	5	33.33
4.	300	4	5	1	5	15	6	40.00
5.	400	7	1	1	6	15	7	46.67
6.	500	3	4	3	5	15	8	53.33
7.	600	2	4	2	7	15	9	60.00
8.	700	3	2	2	8	15	10	66.67
9.	800	0	4	3	8	15	11	73.33

Appendix-1 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.
								0

Appendix-2 : Computation for probit regression equation and median lethal concentration of different insecticides

Sr. No.	λ	log.Con. (X)	No. of insects per batch (n)	Mortality	P % of mortality	P probit value corrected mortality	Emperical probit	Expected probit (Y)	Weighing coefficient (W)	Working probit (y)
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1.	Cypermethrin (Fenom) 0.00001									
1.	10.	1.0000	15	3	20.00	14.2826	3.9331	3.500	0.12657	4.168
2.	15	1.1761	"	4	26.67	21.4293	4.2074	4.20	0.37085	4.194
3.	20	1.3010	"	6	40.00	35.7120	4.6335	4.70	0.51470	4.642
4.	25	1.3979	"	8	53.33	49.9946	5.0000	5.00	0.55332	5.000
5.	30	1.4771	"	10	66.67	64.2880	5.3665	5.30	0.54919	5.358
6.	35	1.5441	"	11	73.33	71.4240	5.5592	5.60	0.50545	5.553
7.	40	1.6021	"	12	80.00	78.5707	5.7926	5.80	0.45879	5.806
8.	45	1.6531	"	13	86.67	85.7173	6.0669	6.00	0.40261	6.036
9.	00		"	1	6.67					

$\bar{X}$ = 1.43 Sxx = 1.4662 b = 3.4680 M+ = 0.28

$\bar{y}$ = 5.19 Sxy = 5.0848 g = 0.22 M = 0.23

x^2 = 0.6498 Syy = 18.2840 $M_{(\ell)}$ = 0.08 M- = 0.19

Appendix-2 contd.

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
2.	Cypermethrin(Cyperkil)									
	0.00006									
1.	6	0.7781	15	3	20.00	20.00	4.1584	4.60	0.60052	4.207
2.	7	0.8451	"	5	33.33	33.33	4.5684	4.75	0.54150	5.563
3.	8	0.9031	"	7	46.67	46.67	4.9172	4.90	0.63431	4.925
4.	9	0.9542	"	8	53.33	53.33	5.0828	5.00	0.63662	5.075
5.	10	1.0000	"	10	66.67	66.67	5.4316	5.10	0.63431	5.428
6.	20	1.3010	"	12	80.00	80.00	5.8416	5.70	0.53159	5.834
7.	30	1.4771	"	13	86.67	86.67	6.1123	6.10	0.40474	6.126
8.	0	0.0000	"	0	0.00	0.00	0.00	0.00	0.00	0.00

$\bar{x}$ = 1.01 Sxx = 2.8446 b = 2.5860 M+ = 1.17

$\bar{y}$ = 5.11 Sxy = 7.3562 g = 0.20 M = 0.93

x^2 = 2.4971 Syy = 21.5204 $M_{(f)}$ = 0.10 M- = 0.74

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
3. Thiodan (Endosulfan)										
	0.02									
1.	20	1.3010	15	2	13.33	13.33	3.8877	3.72	0.33589	3.894
2.	30	1.4771	"	4	26.67	26.67	4.3781	4.38	0.55788	4.387
3.	40	1.6021	"	6	40.00	40.00	4.7467	4.80	0.62742	4.747
4.	50	1.6990	"	7	46.67	46.67	4.9172	5.12	0.63431	4.929
5.	60	1.7781	"	8	53.33	53.33	5.0828	5.40	0.60052	5.059
6.	70	1.8451	"	11	73.33	73.33	5.6219	5.62	0.55788	5.613
7.	80	1.9031	"	12	80.00	80.00	5.8416	5.84	0.50260	5.841
8.	0.0	0.00	"	0.0	0.00	0.00				

$\bar{X}$ = 1.68 Sxx = 1.8176 b = 3.0981 M+ = 590

$\bar{y}$ = 4.97 Sxy = 5.6311 g = 0.22 M = 490

x^2 = 0.9706 Syy = 18.4163 M(£)= 0.08 M- = 410

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
4.	Monocrotophos (Monocil)									
	0.001									
1.	10	1.00	15	2	13.33	13.33	3.8877	3.25	0.17994	3.882
2.	20	1.3010		3	20.00	20.00	4.1584	4.16	0.50260	4.159
3.	30	1.4771		5	33.33	33.33	4.5684	4.57	0.60052	4.560
4.	40	1.6		6	40.00	40.00	4.7467	4.95	0.63431	4.748
5.	50	1		9	60.00	60.00	5.2533	5.20	0.62742	5.253
6.	60	1		11	73.33	73.33	5.6219	5.37	0.60052	5.603
7.	70	1		12	80.00	80.00	5.8416	5.60	0.55788	5.823
8.	80	1		13	86.67	86.67	6.1123	5.76	0.50260	6.083
9.	0.0		"	0.00	0.00					

$\bar{x}$ = 1.63 Sxx = 3.2970 b = 2.3245 M+ = 47

$\bar{y}$ = 5.15 Sxy = 7.6640 g = 0.21 M = 36

x^2 = 0.5442 Syy = 18.3598 $M_{(f)}$ = 0.12 M- = 27

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
5.	Malathion (Cythion)									
	0.01									
1.	10	1.0000	15	2	13.33	7.14	3.5316	3.44	0.1008	3.537
2.	20	1.3010	"	4	26.67	21.43	4.2074	4.21	0.37085	4.194
3.	30	1.4771	"	6	40.00	39.71	4.6335	4.79	0.53221	4.645
4.	40	1.6021	"	8	53.33	49.99	5.000	5.06	0.55669	5.000
5.	50	1.6990	"	10	66.67	64.29	5.3665	5.40	0.53866	5.358
6.	60	1.7781	"	11	73.33	71.42	5.5651	5.64	0.50545	5.553
7.	70	1.8451	"	12	80.00	78.57	5.7926	5.79	0.45879	5.806
8.	0.00	0.00	"	1	6.67					

$\bar{x}$ = 1.61 Sxx = 1.8895 b = 2.8467 M+ = 570

$\bar{y}$ = 5.07 Sxy = 5.3788 g = 0.24 M = 380

x^2 = 0.13 Syy = 15.4463 $M_{(\pm)}$ = 0.18 M- = 250

Appendix-2 contd..

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
6.	Fenthion (Labacid)									
	0.002									
1.	20	1.3010	15	4	26.67	21.43	4.2074	4.10	0.33461	4.198
2.	30	1.4771	"	5	33.33	28.56	4.4349	4.48	0.46705	4.447
3.	40	1.6021	"	6	40.00	35.71	4.6335	4.76	0.53221	4.645
4.	50	1.6990	"	7	46.67	42.86	4.8211	4.98	0.55332	4.824
5.	60	1.7781	"	8	53.33	49.99	5.0000	5.14	0.55669	5.000
6.	70	1.8451	"	9	60.00	57.14	5.1789	5.30	0.54919	5.174
7.	80	1.9031	"	11	73.33	71.42	5.5651	5.42	0.53866	5.548
8.	90	1.9542	"	12	80.00	78.57	5.7926	5.52	0.52396	5.780
9.	0.00	-	"	1	6.67	-				

$\bar{x}$ = 1.72 Sxx = 2.2682 b [illegible].38 2 M+ = 66

$\bar{y}$ = 5.00 Sxy = 5.4192 g [illegible]30 M = 52

x^2 = 1.1469 Syy = 14.0945 $M_{(f)}$ = [illegible]10 M- = 42

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
7.	BPMC									
	0.006									
1.	60	1.7781	15	3	20.00	20.00	4.1584	4.16	0.50260	4.159
2.	70	1.8451	"	5	33.33	33.33	4.5684	4.54	0.58099	4.560
3.	80	1.9031	"	7	46.67	46.67	4.9172	4.92	0.63431	4.900
4.	90	1.9542	"	9	60.00	60.00	5.2533	5.25	0.62742	5.253
5.	100	2.0000	"	11	73.33	73.33	5.6219	5.58	0.55788	5.613
6.	200	2.3010	"	14	93.33	93.33	6.4985	6.50	0.26907	6.475
7.	0.0	0.0	"	0	0.00	-				

$\bar{x}$ = 1.93 Sxx = 0.8450 b = 4.6519 M+ = 110

$\bar{y}$ = 5.05 Sxy = 3.9309 g = 0.21 M = 80

x^2 = 1.2410 Syy = 19.5274 $M_{(\pounds)}$ = 0.14 M- = 60

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
8.	Endosulfan (Endocel)									
	0.01									
1.	10	1.000	15	3	20.00	14.2826	3.9331	3.72	0.18896	3.952
2.	20	1.3010	"	5	33.33	28.5653	4.4349	4.43	0.43774	4.447
3.	30	1.4771	"	6	40.00	35.7120	4.6335	4.86	0.54514	4.642
4.	40	1.6021	"	8	53.33	49.9946	5.0000	5.14	0.55669	5.000
5.	50	1.6990	"	8	53.33	49.9946	5.0000	5.38	0.53866	4.978
6.	60	1.7781	"	11	73.33	71.4240	5.5651	5.56	0.50545	5.553
7.	70	1.8451	"	13	86.67	85.7173	6.0669	5.72	0.48357	[illegible]
8.	80	1.9031	"	14	93.33	92.8533	6.4611	5.84	0.45879	[illegible]
9.	0.0	0.0000	"	10	6.67					

$\bar{x}$ = 1.62 Sxx = 3.0832 b = 2.6615 M+ = 440

$\bar{y}$ = 5.19 Sxy = 8.2060 g = 0.17 M = 350

x^2 = 3.6571 Syy = 25.4975 $M_{(\pm)}$ = 0.10 M- = 280

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
9.	**Formothion** (Anthio)									
	0.004									
1.	40	1.6021	15	2	13.33	13.33	3.8877	4.04	0.43863	3.882
2.	50	1.6990	"	4	26.67	26.67	4.3781	4.34	0.53159	4.390
3.	60	1.7781	"	5	33.33	33.33	4.5684	4.57	0.60052	4.560
4.	70	1.8451	"	6	40.00	40.00	4.7467	4.75	0.61609	4.747
5.	80	1.9031	"	7	46.67	46.67	4.9172	4.93	0.63431	4.925
6.	90	1.9542	"	8	53.33	53.33	5.0828	5.08	0.63431	5.075
7.	100	2.0000	"	9	60.00	60.00	5.2533	5.23	0.62742	5.253
8.	0.0	0.0000	"	0.0	0.00	0.00				

$\bar{x}$ = 1.84 Sxx = 0.9689 b = 3.1844 M+ = 160

$\bar{y}$ = 4.74 Sxy = 3.0854 g = 0.39 M = 80

x^2 = 0.1576 Syy = 9.9829 $M_{(E)}$ = 0.29 M- = 40

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
10.	Cypermethrin (Ripcord)									
	0.000065									
1.	65	1.8129	15	2	13.33	13.33	3.8877	3.95	0.40474	3.874
2.	70	1.8451	"	3	20.00	20.00	4.1485	4.17	0.50260	4.160
3.	75	1.8751	"	4	26.67	26.67	4.3781	4.38	0.55788	4.387
4.	80	1.9031	"	5	33.33	33.33	4.5684	4.57	0.60052	4.560
5.	85	1.9294	"	5	33.33	33.33	4.5684	4.79	0.62742	4.568
6.	90	1.9542	"	7	46.67	46.67	4.9172	4.92	0.63431	4.925
7.	95	1.9777	"	8	53.33	53.33	5.0828	5.12	0.63431	5.075
8.	100	2.0000	"	10	66.67	66.67	5.4316	5.27	0.61609	5.437
9.	0.00	0.00	"	0.0	0.00					

$\bar{x}$ = 1.92 Sxx = 0.2343 b = 7.6513 M+ = 1.0

$\bar{y}$ = 4.67 Sxy = 1.7927 g = 0.30 M = 0.9

x^2 = 0.58 Syy = 14.2996 $M_{(\pounds)}$ = 0.04 M- = 0.8

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
11.	Quinalphos (Ekalux)									
	0.006									
1.	60	1.7781	15	3	20.00	20.00	4.1584	3.7		
2.	65	1.8129	"	4	26.67	26.67	4.3781	4.		
3.	70	1.8451	"	5	33.33	33.33	4.5684	4.		
4.	75	1.8751	"	6	40.00	40.00	4.7467	4.		
5.	80	1.9031	"	7	46.67	46.67	4.9172	5.		
6.	85	1.9294	"	9	60.00	60.00	5.2533	5.		
7.	90	1.9542	"	10	66.67	60.67	5.4316	5.		
8.	95	1.9777	"	11	73.33	73.33	5.6219	5.		
9.	000	0.0000	"	0	0.00	0.00				

$\bar{x}$ = 1.89 Sxx = 0.2509 b = 7.1532 M+ = 90

$\bar{y}$ = 4.94 Sxy = 1.7951 g = 0.30 M = 80

x^2 = 0.38 Syy = 13.2177 $M_{(f)}$ = 0.04 M- = 70

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
12.	Monocrotophos (Nuvacron)									
	0.001									
1.	10	1.0000	15	3	20.00	20.00	4.1584	4.03	0.43863	4.171
2.	20	1.3010	"	4	26.67	26.67	4.3781	4.38	0.55788	4.387
3.	30	1.4771	"	5	33.33	33.33	4.5684	4.69	0.61609	4.563
4.	40	1.6021	"	6	40.00	40.00	4.7467	4.91	0.63431	4.748
5.	50	1.6990	"	8	53.33	53.33	5.0828	5.08	0.63431	5.075
6.	60	1.7781	"	9	60.00	60.00	5.2533	5.22	0.62742	5.253
7.	70	1.8451	"	9	60.00	60.00	5.2533	5.33	0.61609	5.253
8.	80	1.9031	"	10	66.67	66.67	5.4316	5.43	0.60052	5.440
9.	0.0	0.0000	"	0.0	0.00	0.00				

$\bar{x}$ = 1.61 Sxx = 5.4374 b = 1.5779 M+ = 64

$\bar{y}$ = 4.91 Sxy = 8.5795 g = 0.28 M = 46

x^2 = 7.54 Syy = 21.1777 $M_{(f)}$ = 0.14 M- = 33

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
13.	Fenvalerate (Sumicidin)									
	0.0006									
1.	60	1.7781	15	4	26.67	26.67	4.3781	4.38	0.55788	4.387
2.	65	1.8129	"	5	33.33	33.33	4.5684	4.53	0.58099	4.561
3.	70	1.8451	"	6	40.00	40.00	4.7467	4.66	0.61609	4.747
4.	75	1.8751	"	6	40.00	40.00	4.7467	4.81	0.62742	4.747
5.	80	1.9031	"	7	46.67	46.67	4.9172	4.95	0.63431	4.925
6.	85	1.9294	"	8	53.33	53.33	5.0828	5.09	0.63431	5.075
7.	90	1.9542	"	9	60.00	60.00	5.2533	5.19	0.62742	5.253
8.	95	1.9777	"	9	60.00	60.00	5.2533	5.33	0.61609	5.253
9.	100	2.0000	"	10	66.67	66.67	5.4316	5.43	0.60052	5.440
10.	0.0			0	0.00	0.00				

$\bar{x}$ = 1.90 Sxx = 0.4058 b = 4.6015 M+ = 89

$\bar{y}$ = 4.94 Sxy = 1.8673 g = 0.45 M = 81

x^2 = 0.1702 Syy = 8.7626 $M_{(f)}$ = 0.04 M- = 74

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
14.	Methyl parathion(Metacid)									
	0.002									
1.	20	1.3010	15	1	6.67	6.67	3.5015	3.50	0.26907	3.525
2.	30	1.4771	"	3	20.00	20.00	4.1584	4.03	0.43863	4.171
3.	40	1.6021	"	4	26.67	26.67	4.3781	4.38	0.55788	4.387
4.	50	1.6990	"	6	40.00	40.00	4.7467	4.67	0.61609	4.747
5.	60	1.7781	"	7	46.67	46.67	4.9172	4.91	0.63431	4.925
6.	70	1.8451	"	8	53.33	53.33	5.0828	5.08	0.63431	5.075
7.	80	1.9031	"	9	60.00	60.00	5.2533	5.25	0.62742	5.253
8.	90	1.9542	"	10	66.67	66.67	5.4316	5.40	0.60052	5.440
9.	00	0.000	"	0.0	0.00	0.00				

$\bar{x}$ = 1.74 Sxx = 2.2842 b = 2.7839 M+ = 81

$\bar{y}$ = 4.81 Sxy = 6.3590 g = 0.22 M = 64

x^2 = 0.12 Syy = 17.8269 $M_{(f)}$ = 0.10 M- = 51

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
15.	Oxydemeton methyl (Metasystox)									
1					33		3 8	5 9		
				4	2 6		1	3		
				6						
			"		5					
			"		6		53			
			"		6		53			
	8		"		66 7		4	6		
			"	2			16	4		
			"	00		0				

	1	Sxx	2	b = 2 7213	
		Sxy	6 7	g =	
x^2 = 0.60		Syy = 19.3249		$M_{(£)}$ = 0.80	M- = 41

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
16.	Chlorfenviphos (Fenocil) 0.01									
1.	10	1.0000	15	5	33.33	33.33	4.5684	4.15	0.47144	4.649
2.	20	1.3010	"	5	33.33	33.33	4.5684	4.57	0.60052	4.560
3.	30	1.4771	"	6	40.00	40.00	4.7467	4.82	0.62742	4.747
4.	40	1.6021	"	7	46.67	46.67	4.9172	5.00	0.63663	4.925
5.	50	1.6990	"	8	53.33	53.33	5.0828	5.14	0.63431	5.075
6.	60	1.7781	"	9	60.00	60.00	5.2533	5.25	0.62742	5.253
7.	70	1.8451	"	10	66.67	66.67	5.4316	5.35	0.61609	5.437
8.	80	1.9031	"	11	73.33	73.33	5.6219	5.42	0.60052	5.603
9.	00	0.0000	"	0	0.00					

$\bar{x}$ = 1.59 Sxx = 5.2053 b = 1.1750 M+ = 560

$\bar{y}$ = 5.04 Sxy = 6.1162 g = 0.53 M = 350

x^2 = 1.65 Syy = 8.8386 $M_{(\pm)}$ = 0.20 M- = 220

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
17.	Permethrin (Permasect)									
	0.00065									
1.	65	1.8129	15	3	20.00	14.2826	3.9331	3.93	0.26031	3.920
2.	70	1.8451	"	4	26.67	21.4293	4.2074	4.27	0.40546	4.198
3.	75	1.8751	"	6	40.00	35.7180	4.6335	4.48	0.46705	4.646
4.	80	1.9031	"	6	40.00	35.7120	4.6335	4.76	0.53221	4.645
5.	85	1.9294	"	9	60.00	57.1433	5.1789	5.05	0.55332	5.175
6.	90	1.9542	"	10	66.67	64.2880	5.3665	5.23	0.55527	5.355
7.	95	1.9777	"	11	73.33	71.4240	5.5651	5.52	0.52396	5.553
8.	100	2.000	"	12	80.00	78.5707	5.6935	5.69	0.48357	5.802
9.	00	-	"	1	6.67					

$\bar{x}$ = 1.92 Sxx = 0.1789 b = 10.1045 M+ = 8.7

$\bar{y}$ = 5.00 Sxy = 1.8077 g = 0.21 M = 8.3

x^2 = 0.46 Syy = 18.7228 $M_{(\pm)}$ = 0.02 M- = 7.9

Appendix-2 contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
18.	Decamethrin (Decis)									
	0.00007									
1.	70	1.8451	15	3	20.00	14.2826	3.9331	3.93	0.26031	4.195
2.	75	1.8751	"	4	26.67	21.4293	4.2074	4.17	0.37085	4.194
3.	80	1.9031	"	4	26.67	21.4293	4.2074	4.40	0.43774	4.207
4.	85	1.9294	"	6	40.00	35.7170	4.6335	4.58	0.49286	4.642
5.	90	1.9542	"	7	46.67	42.8587	4.8211	4.80	0.53221	4.824
6.	95	1.9777	"	8	53.33	49.9946	5.0000	5.00	0.55332	5.000
7.	100	2.0000	"	9	60.00	57.1433	5.1789	5.16	0.55527	5.176
8.	00	0.0000	"	1	6.67					

$\bar{x}$ = 1.93 Sxx = 0.1111 b = 7.5274 M+ = 1.38

$\bar{y}$ = 4.60 Sxy = 0.8363 g = 0.61 M = 0.95

x^2 = 0.48 Syy = 6.7751 $M_{(P)}$ = 0.15 M- = 0.68

1				6.					
1		E							
1			4	6 6		4 2 7	4.		
				33 3		4	2		
			6	4	.	3	.		
		60				4			
5		9		9	6		1		
6.		7			66	366	5 3		
		4				65	5		
8		0		2		.	.		
		0		1					

	6		4. 571		74	+	=
	0	Sxy					
	2		1 .		= 1	-	=

S.Em.±

Appendix-3 contd...

1.	
	S.Em.± :
	4.9099
	-
Error	
	-
Treat. Error	
	-
	-
	S.Em.±

	3.	4.
S.Em.±		
S.Em.±		

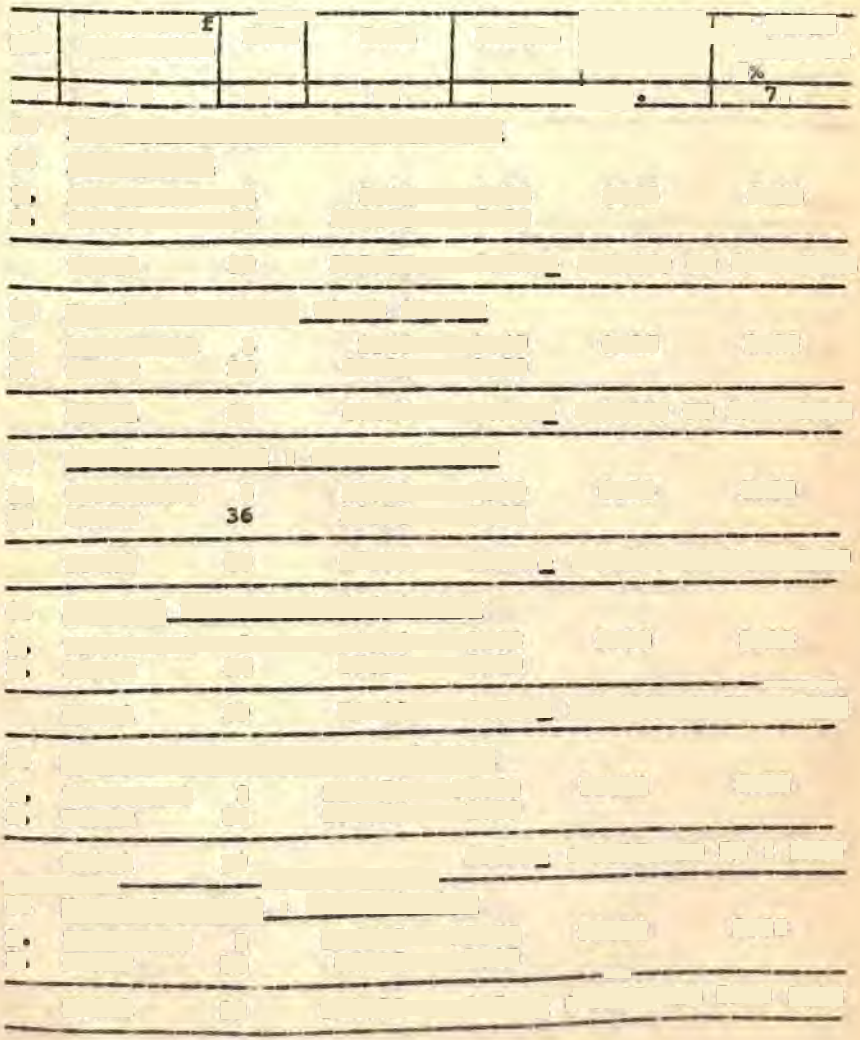
S.			S.S.	M.S.S.		

S.Em.±

S.Em.±

S.Em.±

Appendix-5 : Analysis of variance for the effects of different host plants on the biology of Dysdercus cingulatus (Fab.)



Appendix-5 contd...

1.	2.	3.	4.	5.	6.	7.
7.	Female longevity					
1.	Treatment	3	18.28	6.09	2.51	2.88
2.	Error	36	87.50	2.43		
	Total	39	105.78	S.Em.± : 0.49; CD 5% : NS		
8.	Male longevity					
1.	Treatment	3	20.90	6.97	0.86	2.88
2.	Error	36	290.20	8.06		
	Total	39	311.10	S.Em.± : 0.81; CD 5% : NS		
8.	Effect on percent survival					
1.	Percent survival of eggs					
1.	Treatment	3	1499.93	499.98	1.85	3.24
2.	Error	16	4314.11	269.63		
	Total	19	5814.04	S.Em.± : 7.34; CD 5% : NS		
2.	Percent surival : First instar					
1.	Treatment	3	434.39	144.80	36.75	3.24
2.	Error	16	63.10	3.94		
	Total	19	497.49	S.Em.± : 0.89; CD 5% : 2.65		
3.	Percent survival : Second instar					
1.	Treatment	3	813.46	271.15	101.17	3.24
2.	Error	16	42.87	2.68		
	Total	19	S.Em.± : 0.73; CD 5% : 2.19			
4.	Percent survival : Third instar					
1.	Treatment	3	802.43	267.48	65.56	3.24
2.	Error	16	65.35	4.08		
	Total	19		S.Em.± : 0.90; CD 5% : 2.71		
5.	Percent survival : Fourth instar					
1.	Treatment	3	208.89	69.63	10.10	3.24
2.	Error	16	110.23	6.89		
	Total	19	319.12	S.Em.± : 1.17; CD 5% : 3.52		

Appendix-5 contd...

1.	2.	3.	4.	5.	6.	7.
6.	Percent survival : Fifth instar					
1.	Treatment	3	50.97	16.99	0.70	3.24
2.	Error	16	385.69	24.10		
	Total	19	436.66	S.Em.± : 2.19; CD 5% : NS		
7.	Percent survival (whole nymphal stage)					
1.	Treatment	3	463.91	164.64	63.57	3.24
2.	Error	16	41.47	2.59		
	Total	19	535.38	S.Em.± : 0.72; CD 5% : 2.16		
8.	Egg fecundity per female					
1.	Treatment	3	141439.50	47146.50	10.68	2.88
2.	Error	36	158965.90	4415.77		
	Total	39	300407.40	S.Em.± : 21.04; CD 5% : 60.30		
C.	On Length					
1.	Length of first instar					
1.	Treatment	3	0.36	0.1200	42.86	2.88
2.	Error	36	0.10	0.0028		
	Total	39	0.46	S.Em.± : 0.017 CD 5% : 0.05		
2.	Length of second instar					
1.	Treatment	3	3.93	1.310	14.89	2.88
2.	Error	36	3.16	0.088		
	Total	39	7.09	S.Em.± : 0.094; CD 5% : 0.27		
3.	Length of Third instar					
1.	Treatment	3	2.90	0.9667	140.10	2.88
2.	Error	36	0.25	0.0069		
	Total	39	3.15	S.Em.± : 0.26; CD 5% : 0.07		
4.	Length of fourth instar					
1.	Treatment	3	3.20	1.07	3.34	2.88
2.	Error	36	11.39	0.32		
	Total	39	14.59	S.Em.± : 0.18; CD 5% : 0.51		

Appendix-5 contd...

1.	2.	3.	4.	5.	6.	7.
5.	Length of fifth instar					
1.	Treatment	3	3.24	1.08	6.35	2.88
2.	Error	36	6.05	0.17		
	Total	39	9.29	S.Em.± : 0.13; CD 5% : 0.37		
6.	Length of female					
1.	Treatment	3	179.87	39.96	99.93	2.88
2.	Error	36	21.77	0.60		
	Total	39	201.64	S.Em.± : 0.24; CD 5% : 0.70		
7.	Length of male					
1.	Treatment	3	80.69	26.89	44.08	2.88
2.	Error	36	21.93	0.61		
	Total	39	102.62	S.Em.± : 0.25; CD 5% : 0.71		
D.	On width					
1.	Effect on width of first instar					
1.	Treatment	3	0.49	0.163	4.939	2.88
2.	Error	36	1.18	0.033		
	Total	39	1.67	S.Em.± : 0.057; CD 5% : 0.16		
2.	Width of second instar					
1.	Treatment	3	0.85	0.283	20.21	2.88
2.	Error	36	0.50	0.014		
	Total	39	1.35	S.Em.± : 0.037; CD 5% : 0.11		
3.	Width of third instar					
1.	Treatment	3	0.54	0.180	22.5	2.88
2.	Error	36	0.29	0.008		
	Total	39	0.83	S.Em.± : 0.28; CD 5% : 0.08		
4.	Width of fourth instar					
1.	Treatment	3	0.57	0.19	13.57	2.88
2.	Error	36	0.49	0.014		
	Total	39	1.06	S.Em.± : 0.037; CD 5% : 0.11		
5.	Width of fifth instar					
1.	Treatment	3	0.39	0.13	1.62	2.88
2.	Error	36	2.94	0.08		
	Total	39	3.33	S.Em.± : 0.89; CD 5% : NS		

Appendix-5 contd...

1.	2.	3.				

V I T A

The author saw the light on 10th September, 1959 at Nepa Nagar (M.P.).

He passed his Higher Secondary School Certificate Examination in the year 1976 from Higher Secondary School, Nepa Nagar, with 56.5 per cents of marks.

He joined the College of Agriculture, Indore (J.N.K.V.V.) and accomplished his graduation with OCGA 3.11 in the year 1980.

For his Post-graduation programme, he sought admission in the Department of Entomology, College of Agriculture, Jabalpur (JNKVV) and completed the same in the year 1982 by earning an OCGA 3.29 out of 4.00 scale.