EFFECT OF SYNTHETIC PYRETHROIDS ON THE PESTS OF PADDY

BY

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THESIS

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D E C L A R A T I O N

I hereby declare that this thesis entitled "Effect of synthetic pyrethroids on the pests of paddy" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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C E R T I F I C A T E

Certified that this thesis entitled "Effect of synthetic pyrethroids on the pests of paddy" is a record of research work done independently by Sri. T.S.B. Balaji, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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T.S.B. Balaji.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

Introduction

INTRODUCTION

Insect pests are one of the major constraints in rice production all over the world. From seeding to harvest a variety of insects infest the crop causing significant yield losses. The introduction of high yielding varieties and improved technology brought into existence complex pest problems in rice production. Many pests of minor importance assumed alarmingly destructive status in recent years.

Many pesticides like inorganics, botanicals, chlorinated hydrocarbons, organophosphates and carbamates came into existence in the field of pest control between 1000 BC and 1950 AD. All these groups of chemicals though had spectacular insecticidal activity also possessed certain unforeseen disadvantages like long and undue persistence in the environment, high toxicity to higher animals and other non-target organisms, pest resurgence, pest resistance to insecticides, residue hazards and environmental pollution.

With a view to minimising the above disadvantages of pesticides scientists tried to evolve new groups of chemicals which were safer to non-target organisms and are effective against the pests. Synthetic pyrethroids with high insecticidal activity and low mammalian toxicity, yet with reasonable persistence under normal conditions of field application, unlike natural pyrethroids, were thus introduced for plant protection as a highly promising group (Elliott *et al.*, 1978). During the last six years, four photostable pyrethroids permethrin, cypermethrin, NRDC 161 and fenvalerate have been developed as agricultural insecticides. The new pyrethroids were tried against a range of pests, particularly lepidoptera and have been used on different crop pests with very promising results. Efficacy of pyrethroids on bhendi fruit borer *Earias insulana* was reported by Uthamaswamy and Balasubramaniam (1978). Highwood (1979) has reported the superiority of synthetic pyrethroids over the conventional insecticides in controlling the pink boll worm (*Pectinophora gossypiella*) on cotton. Bagle and Prasad (1980) reported their efficacy on mango shoot borer *Chlumetia transversa*. *Agrotis orthogonia* a pest of wheat was effectively controlled by pyrethroid insecticides (De Pew, 1980). But the use of synthetic pyrethroids for the control of rice pests have not been investigated extensively. Hence the four synthetic pyrethroids were evaluated against the different pests of paddy in comparison with a standard insecticide, carbaryl. The present investigations included a field experiment for evaluating the efficacy of the insecticides against the major pests of paddy, a pot culture experiment to assess the persistence of the insecticides under field conditions and another pot culture study to assess the inducing effect of the different toxicants on the population build up of brown plant hopper of rice Nilaparvata lugens.

Review of literature

REVIEW OF LITERATURE

The literature available on the use of the synthetic pyrethroids for the control of pests of different crops have been summarised below. Persistent toxicity of the synthetic pyrethroids and the effect of their application on population build up of the pests have also been briefly reviewed.

1.1 <u>Use of synthetic pyrethroids for control of crop pests</u>

<u>Rice</u>

1.1.1 <u>Aleurocybotus</u> spp. Diop (1979) evaluated carbofuran, diazinon, chlorpyrifos, lindane (all at 2 kg/ha and Decis (at 25 g/ha) against <u>Aleurocybotus</u> spp. and found that all the insecticides were effective except Decis and lindane.

1.1.2 <u>Nephotettix</u> spp. Srinivasan (1980) tried the insecticides carbofuran, FMC 35001, Ripcord and chlorpyriphos with three methods of application viz. root soaking, root-zone placement and foliar spray for the control of the pest. He also assessed the incidence of tungro disease. Root soaking with Ripcord along with 1% urea followed by foliar sprays with Ripcord on the 25th and 45th day after transplanting gave low tungro incidence and good control of the pest.

Sweet corn

1.1.3 Heliothes zea. Walter and Gonger (1977) reported that Ambush at 0.2 and 0.25 lb ai/ac was as good as lannate, the standard in controlling H. zea though in lower concentrations it did not provide adequate control.

Sorghum

1.1.4 Chilo partellus. Sadakathulla (1981) working on sorghum stem borer reported that spraying of fenvalerate 0.01% or carbaryl 2.5% thrice on 20, 30 and 40th days after germination controlled the pest effectively.

1.1.5 Contarinia sorghicola. For grain midge C. sorghicola control, Sadakathulla (1981) recommended either two rounds of malathion 0.05% spray or fenvalerate 0.04% spray.

Red gram

1.1.6 Heliothes armigera. Dandale et al. (1981) tested nine insecticides for the control of pod borer H. armigera and found that methomyl 0.05%, fenvalerate 0.01% and cypermethrin 0.01% were very effective in checking the infestation in buds, flowers and pods.

Soyabean

1.1.7 Lamprosena diamenalis. Field tests in Malaysia and Indonesia revealed that permethrin at rates of 50-100 ppm was effective in controlling L. diamenalis (Voon and Chung, 1978).

Ground nut

1.1.8 Empoasca kerri. Patel and Vora (1981) reported that permethrin at 0.015% gave very good control of the pest and increased the yields. Monocrotophos and carbaryl at 0.03% and 0.15% respectively were found inferior to permethrin.

Sesamum

1.1.9 Diacrisia obliqua. Grewal et al. (1978) reported that leptophos, permethrin, endosulfan and quinalphos each at 0.05% gave more than 99% mortality of the third instar larvae of D. obliqua within three days when they were kept in treated food.

Oil palm

1.1.10 Setora nitens. Voon and Chung (1978) working on the control of lepidopterous pests on different crops reported that permethrin sprays at rates of 50-100 ppm gave good control of the pest.

Cotton

1.1.11 Heliothis virescens and H. zea. Davis et al. (1975) tested the activity of a synthetic pyrethroid NIA-33297 (LD 50 - 0.0054 and 0.0011 mg/g) and reported that it was more toxic than methyl parathion (LD 50 - 0.075 and 0.029 mg/g) against tobacco bud worm H. virescens and the boll worm H. zea. Ali et al. (1977) studied the combined toxicity of permethrin and pydrin at 0.01 kg ai/1000 m row, methyl parathion and methomyl at 0.1 kg ai/1000 m row against H. virescens and H. zea and found that there was potentiating effect. Du Rant (1979) reported that fenvalerate (0.11 kg ai/ha) and permethrin (0.22 kg ai/ha) gave good control of the pests and produced significant yield increase of cotton compared to toxaphene + methyl parathion (2.24 - 4.48 + 1.12 kg ai/ha respectively).

1.1.12 Heliothes armigera. Breese (1977) found that cypermethrin 200 g ai/ha gave better control of the pest than endosulfan 525 g ai/ha. Cypermethrin at 20-85 g/ha also was reported effective against the larvae (Damotte, 1979). Sorathia and Chari (1981) evaluated fenvalerate 150 g ai/ha against the boll worm and found that it was more effective than phosalone, quinalphos and etrimphos.

1.1.13 Heliothés spp. Pfrimmer (1979) reported that permethrin and fenvalerate at 0.11 and 0.22 kg ai/ha and a carbamate VC-51762, 75 WP 1.12 kg ai/ha gave very effective control of Heliothis spp. on cotton and good yield. Combination of permethrin and methyl parathion (0.112 : 1.12 kg ai/ha) also gave good control (Weaver et al., 1979).

1.1.14 Pectinophora gossypiella. Damotte (1979) found that cypermethrin at 20-85 g/ha sprayed on cotton was highly active against the larvae. They also tested the efficacy of a mixture of cypermethrin at 50 g ai/ha and triazophos at 400 g ai/ha against larvae in the bolls and found it effective. Experiments conducted by PAU (1981) revealed that fenvalerate (0.15 kg ai/ha) gave higher yield than permethrin (0.05, 0.10 and 0.15 kg ai/ha) and carbaryl (1 kg ai/ha). Jayaswal and Saini (1981) reported that fenvalerate and permethrin each at 75 and 100 g ai/ha, cypermethrin 40 and 80 g ai/ha and decamethrin 10 and 20 g ai/ha were as effective as carbaryl 1 kg ai/ha for the control of the pest.

1.1.15 *Earias insulana*. Thowys *et al*. (1979) conducted trials with decamethrin on cotton in the field in Senegal and found that the pyrethroid at 16 g/ha at intervals of 14 days gave excellent control of the pest and recorded the highest yield.

1.1.16 *Earias vitella* and *E. insulana*. Sorathia and Chari (1981) in their experiments to evaluate the synthetic pyrethroid fenvalerate for the control of boll worms on H-4 cotton found that the pyrethroid at 150 g ai/ha was most effective in minimising the damage to flower buds and bolls.

1.1.17 *Diparopsis watersi*. Trials conducted by Damotte ~~et al.~~ (1979) revealed that cypermethrin at 20-85 g/ha sprayed to cotton was highly active against the larvae. They also reported that a mixture of cypermethrin at 50 g/ha and triazophos at 400 g/ha gave good results.

1.1.18 Boll worms of cotton. Sellammal and Parameswaran (1979) conducted a field experiment to evolve a suitable schedule of treatments for the control of the boll worms on MCU-5 cotton with eleven treatments and found that fenvalerate 0.04% was significantly superior and it recorded low boll worm infestation of 5.6%. It was followed by monocrotophos 0.05% (21.6%). The incidence was very high (89.9%) in untreated check.

1.1.19 *Spodoptera littoralis*. Ruscoe (1979) reported that NRDC-161, cypermethrin, fenvalerate and permethrin at rates 60, 180, 360, 600 g ai/ha respectively gave good control of the pest and persistence compared to chlorpyriphos at 979 g ai/ha.

1.1.20 *Anthonomus grandis*. Weaver *et al.* (1979) working on influence of various insecticides on yield parameters (insect control, lint yield, lint %) of cotton found that a combination of permethrin and methyl parathion (0.112 : 1.12 kg ai/ha) had greatest efficacy and gave high yield of seed cotton.

1.1.21 Aphids. Sellammal *et al.* (1979) reported that monocrotophos 0.05% and fenvalerate 0.04% were equally effective in controlling the aphids on cotton.

1.1.22 Bemisia tabaci. Thewys et al. (1979) found that decamethrin at 16 g/ha at intervals of 14 days gave tremendous control of the pest and highest yield.

1.1.23 Empoasca spp. King (1978) reported that very low volume application of synthetic pyrethroids viz. permethrin and cypermethrin gave good control of the pest.

Tobacco

1.1.24 Heliothis virescens. Crowder et al. (1979) established dosage mortality line for methyl parathion and synthetic pyrethroids viz. pydrin and permethrin. They reported that pydrin and permethrin were superior to methyl parathion in controlling the pest.

1.1.25 Heliothis armigera. Voon and Chung (1978) reported that permethrin sprays at rates of 50-100 ppm gave good control of the pest on tobacco.

1.1.26 Spodoptera litura. Patel and Chari (1980) conducted tests on the control of S. litura Fb. in a tobacco nursery with eleven insecticides and found that all the compounds were effective in reducing the pest numbers, with no significant difference among the treatments, 72 hours after treatment, but fenvalerate 0.02%, chlorpyriphos 0.04% and leptophos 0.068% gave more rapid kill of the larvae than the other compounds.

Mango

1.1.27 *Chlumetia transversa*. Working on comparative efficacy of insecticides for the control of mango shoot borer *C. transversa* Walker., Bagle and Prasad (1980) reported that all the insecticides tested except nicotine sulphate were moderately effective and fenvalerate (0.01 and 0.02%) and permethrin (0.02%) gave the best control.

Tomato

1.1.28 *Peridroma saucia*. Harris *et al*. (1978b) reported that three pyrethroids viz. permethrin, Shell WL 41706 and Shell WL 43775 applied at 140 g/ha gave better control of 3rd and 4th instar larvae than carbaryl, methomyl and carbofuran.

1.1.29 *Trialeurodes vaporariorum*. Guistina and Doyran (1980) found that decamethrin at 0.75 g/hl and cypermethrin at 5 g /hl were effective concentrations against the aleurodids and they gave better control than bioresmethrin.

Brinjel

1.1.30 *Leucinodes orbonalis*. Subbaratnam (1979) conducted field trials to evaluate the relative efficacy of fenitrothion, fenvalerate, dimethoate and quinalphos in controlling the shoot and fruit borer and found fenvalerate as the best insecticide and it was found equally effective at 0.02 and

0.04% concentrations. Jaganmohan *et al.* (1980) reported that fenvalerate and permethrin each at 0.1 kg toxicant / ha effectively controlled the pest and recorded the highest yield. Nimbalkar and Ajri (1981) working on the efficacy of synthetic pyrethroids and two newer compounds against brinjal shoot and fruit borer found that cypermethrin 0.01% was the most effective insecticide when compared to decamethrin 0.003%, fenvalerate 0.015%, permethrin 0.015%, methomyl 0.05%, diflubenzuron 0.02% and carbaryl 0.2%.

1.1.31 *Amrasca biguttula biguttula*. Jaganmohan *et al.* (1980) reported that fenvalerate and permethrin at 0.1 kg toxicant per hectare gave good control of the brinjal leaf hopper.

Bhendi

1.1.32 *Earias insulana*. Melifronides *et al.* (1978) found that permethrin at 35-175 g/ha, methomyl at 570 g/ha, chlorpyriphos at 572 g/ha gave effective control of the spiny boll worm *E. insulana*. Uthamasamy and Balasubramaniam (1978) tested the efficacy of some insecticides in controlling the pests of bhendi and found that fenvalerate 0.05% effectively controlled the fruit borer *E. insulana* and gave highest yield of healthy fruits.

1.1.33 *Earias vitella*. Voon and Chung (1978) found that permethrin at 50-100 ppm gave good control of the pest.

1.1.34 Amrasca biguttula biguttula. Rai et al. (1980) studied the bioefficacy of permethrin @ 400 g/ha, cypermethrin @ 40 and 60 g/ha, fenvalerate @ 500 g/ha and malathion @ 500 g/ha against the jassid and found that all the pyrethroids were better in controlling jassid population up to nine days.

Chillies

1.1.35 Aphis gossypii and Myzus persicae. Reddy et al. (1981) reported that fenvalerate, acephate, nuvacron, rogor, HIPC, bidrin, tamaron and monitor (all insecticides at 0.05% conc.) caused 90% kill at 72 hours after the spraying.

Cabbage

1.1.36 Plutella xylostella. Kenneth (1976) reported that permethrin 0.25 lb ai/ac effectively controlled the pest. Breese (1977) observed that application of four sprays of cypermethrin (100 g ai/ha) during a period of one month, reduced the population of larvae to 16% of that of untreated control, whereas in plots treated with diazinon (1.12 kg ai/ha) the population was 24% of that of the control. Su and Rose (1977) found that the sprays of synthetic pyrethroids S-5602 and permethrin gave the best control of the pest applied at rates ranging from 50-500 g/ha and resulted in the highest yield of marketable cabbage. Fullerton (1979) evaluated fenvalerate and cypermethrin as the best insecticides for the control of *P. xylostella* when applied at 100 ml/ha at intervals of two weeks. Permethrin 50-100 ppm also controlled the pest excellently (Voon and Chung, 1978).

1.1.37 *Pieris rapae*. Breese (1977) reported that cypermethrin 100 g ai/ha was superior to diazinon 1.12 kg ai/ha. Cancelado and Radcliffe (1978) found that Ambush 0.05 and 0.1 lb ai/ac gave excellent control of the pest without any phytotoxicity.

1.1.38 *Trichoplusia ni*. Hofmaster (1977) working on the foliar treatments to the cabbage looper *T. ni* found that the synthetic pyrethroids FMC 33297, pp 557 and SD 43775, all at 0.1 lb ai/ac, controlled the pest completely. Schuster and Clark (1977) reported that permethrin applied weekly at rates ranging from 0.023 to 0.091 kg ai/ha and at 945.4 l/ha was more effective than other chemicals or *Bacillus thuringiensis*. Harris *et al*. (1978) found that permethrin, Shell WL 41706, Shell WL 43467 and Shell WL 43775 at concentrations 0.002%, 0.0005%, 0.00018% and 0.0003% respectively were more toxic than methomyl 0.0015% to 4th instar larvae of *T. ni*.

1.1.39 *Crocidolomia binotalis*. Fullerton (1979) reported that fenvalerate and cypermethrin at 100 ml/ha applied at intervals of two weeks controlled the leaf webber *C. binotalis*.

Fenvalerate and permethrin at 0.1 kg ai/ha also gave good control of the pest (Jaganmohan *et al.*, 1981).

1.1.40 *Brevicornye brassicae*. Agnihotri *et al.* (1980) observed that permethrin, cypermethrin, decamethrin and fenvalerate 0.017%, 0.015%, 0.00375% and 0.006% respectively controlled the aphid up to 25 days whereas sevin (0.05%), DDVP (0.05%) and endosulfan (0.05%) were effective for 1, 19 and 35 days respectively.

1.1.41 *Lipaphis erysimi* and *Aphis craccivora*. Singh and Sircar (1980) evaluated the synthetic pyrethroids in the field and found that the order of effectiveness was decamethrin > (7.5-25 g ai/ha) > fenvalerate (50-150 g ai/ha) > cypermethrin (50-150 g ai/ha) > permethrin (75-250 g ai/ha).

Potato

1.1.42 *Leptinotarsa decemlineata*. Hare (1980) assessed the contact toxicities of ten insecticides to fourth instar larvae of Colarado potato beetle *L. decemlineata* and found that permethrin (LD 50 : 1.015) was the most toxic compound in controlling the pest. Witkowski (1980) reported that decamethrin at 0.3-0.4 d cm^3/ha, cypermethrin at 0.05-0.1 d cm^3/ha and fenvalerate at 0.3-0.4 d cm^3/ha gave effective control against the third instar larvae of *L. decemlineata*.

Cucurbits

1.1.43 Dacus spp. Collingwood et al. (1979) in their field trials reported that decamethrin, fenvalerate and cypermethrin gave good control of the pest but decamethrin was effective only at lower concentrations.

Wheat

1.1.44 Contarinia tritici and Sitodiplosis mosellana. Olsson (1980) reported that the efficiency of permethrin 250 g/L was equal to that of fenvalerate, fenitrothion and pirimicarb in controlling the above pests.

1.1.45 Agrotis orthogonia. De Pew (1980) tested the efficacy of various insecticidal treatments in controlling infestation by A. orthogonia and found that only permethrin 0.056-0.112 kg ai/ha and acephate 0.05 kg ai/ha reduced the larval densities below those of the endrin 0.224 kg ai/ha, used as standard.

Citrus

1.1.46 Indarbela quadrinotata. Sandhu et al. (1978) evaluated the various insecticidal and other treatments for the control of bark eating larvae of I. quadrinotata and found that application of 0.05% permethrin or 0.05% monocrotophos by wash bottle to larval holes gave effective control.

Grape vine

1.1.47 Sparganothis pilleriana. Richard (1979) observed that in addition to the recommended insecticides, fenvalerate at 100, decamethrin at 17.5 and permethrin at 75 g/ha were highly effective against the pest though the older larvae were resistant to treatments.

1.2 Persistent toxicity of synthetic pyrethroids

Henzel and Lauren (1978) found that the field life for contact activity of cypermethrin and permethrin applied to pasture was similar for all of five application rates between 0.25 and 1.5 kg ai/ha. Laboratory bioassays with grass grub beetles, Costelytra zealandica showed that the insecticide lost their activity after about 4 to 9 days on pasture. He also reported that microencapsulation significantly increased the active field life of permethrin.

Leeper and Reissig (1980) studied the persistent toxicity of four insecticides to Psylla pyricola Foerster on pear trees and found that LT_{50}s of the insecticides were 20 days for fenvalerate, 13 days for permethrin and 6.86 days for amitraz. They finally concluded that the pyrethroids were the most persistent materials.

Venkataswamy and Kalode (1981) studied persistent toxicity of various materials against BPH Nilanarvata lugens (Stal) and found 55-80% mortality of BPH which occurred when caged on 10 day old spray deposits of fenvalerate (at 0.05% conc.) while carbaryl (0.05%) gave 40.6% kill only.

1.3 <u>Population build up of pests due to the application of synthetic pyrethroids</u>

Zwick and Fields (1978) reported that fenvalerate @ 0.4 kg ai/ha was destructive to the predatory phytoseiid - *Typholodromus pyri* (Schanten) and was found to cause resurgences of the European red mite, *Panonychus ulmi* (Koch) on apple and pear.

Aquino *et al.* (1979) observed an increased feeding of BPH on plants sprayed with decamethrin, methylparathion and diazinon, as assessed from the honeydew excreted. They observed that the amount of honeydew excreted was the lowest in insects fed on perthane treated plants.

In the field experiments methylparathion was sprayed once at 20 DAT in one case and 35 DAT in another or twice at 20 and 35 DAT and they observed no apparent resurgence of BPH though there was an increase in nymphal population, with one additional application at 50 DAT. Resurgence effect was not maintained in the succeeding generations. They noticed that treatments receiving foliar sprays of methyl parathion at 50 and 65 DAT caused hopper resurgence in the succeeding generations. They further observed that resurgence became apparent in the 2nd and 3rd generation eggs and nymphs when sprayed four times at 15 day intervals.

Hall (1979) found that the seasonal application of synthetic pyrethroids on apple led to general resurgence of European red mite Panonychus ulmi (Koch.) He also noticed a resurgence of European red mite with heavy rates of pyrethroid.

Herve and Delabarre (1979) could not record any population build up due to decamethrin spray two times twice a year at 6.5 to 18.75 g/ha for the control of mirid Distantiella theobroma (Dist.) on cacao. They concluded that the low degree of pest population was not due to high rate of mortality but due to a general decrease in the rate of multiplication of the pest on the treated plants. Besides the low population build up they could also record an increase in the growth parameters of cacao and pod yields during the course of four years.

Chelliah et al. (1980) working on the effect of sub lethal doses of three insecticides viz. methylparathion, decamethrin and perthane on the reproductive rate of the brown plant hopper, Nilaparvata lugens on rice noticed that topical applications of sub lethal doses of methylparathion and decamethrin on 5th instar nymphs caused increased reproduction in the resulting adults. They further observed that highest reproduction stimulation occurred at the LD_{25} dosage for methylparathion, at LD_{50} for decamethrin and perthane did not cause reproductive stimulation at any of the four dosages tested.

Chelliah and Heinrichs (1980) working on factors affecting insecticide induced resurgence of the brown plant hopper, Nilaparvata lugens (Stal) on rice, found that resurgence was induced by applications of decamethrin, methylparathion and diazinon and differential mortality of predators and hoppers did not appear to be the primary factor for resurgence. They also found that hoppers appeared to be attracted to methylparathion and decamethrin treated plants because of plant growth and plants treated with resurgence causing insecticides succumbed to feeding injury earlier than untreated plants. They could also observe population increases due to stimulation of reproduction of the hopper, either by contact action of the insecticides or through increased plant growth. Finally they found out some additional factors like reduction in the length of nymphal stage and increased adult longevity resulting in a shortened life cycle and longer oviposition period respectively contributing to resurgence.

In Philippines build up of BPH, <u>Nilaparvata lugens</u> (Stal) on rice with methylparathion 0.04%, perthane 0.04% and decamethrin 0.002% sprayed either 3 times with the same insecticide or once or twice with one, followed by another insecticide and the total number of nymphs hatching from eggs laid by two gravid females released fifteen days after the last spray on each seedling were counted and it was found that the last insecticide applied has a decisive role in inducing or preventing resurgence. Populations were largest on plants sprayed three times with decamethrin or three times with methylparathion and in all cases in which the last compound was decamethrin or methylparathion, populations were higher than when the last treatment had been perthane. Populations were lowest on seedlings treated once with decamethrin and then twice with perthane (Chelliah, 1980).

Penman and Chapman (1980) reported that substitution of the synthetic pyrethroid, fenvalerate, for azkinphosmethyl in an apple orchard spray programme in Newzealand led to an outbreak of <u>Eriosoma lanigerum</u> (Hsm). This was found to be due to the low toxicity of fenvalerate compared with azhinphosmethyl. A midge, Dasineura mali (Kieff.) was also found to be much more prevalent under the fenvalerate treatment with 75% of water sprouts infested compared with 14% in the azhinphosmethyl treated block.

Hilda et al. (1981) investigated the biochemical changes in the rice plant after insecticide applications and found that when plants of the BPH susceptible Taichung Native 1 (TN 1) were sprayed with decamethrin, levels of free amino nitrogen in the leaf sheath were significantly higher than in TN 1 plants sprayed with perthane. They also found that the carbohydrate - nitrogen ratio in decamethrin treated plants and this was attributed to the enhanced feeding of BPH on decamethrin treated plants.

Materials and methods

MATERIALS AND METHODS

A field experiment was conducted to evaluate synthetic pyrethroids against pests of paddy in comparison with carbaryl, and pot culture studies were carried out to assess the persistent toxicity of the insecticides to rice swarming caterpillar and brown plant hopper. Population build-up (resurgence) of brown plant hopper was also assessed in a pot culture experiment.

2.1 Relative efficacy of synthetic pyrethroids against pests of paddy

2.1.1 Raising nursery:

Paddy seedlings of a medium duration variety 'Jaya' were raised as wet nursery in the Farm attached to the Model Agronomic Research Station, Karamana, Trivandrum.

2.1.2 Planting and other crop husbandry operations:

Urea, superphosphate and muriate of potash were applied to each plot so as to supply nutrients at the rate of 90 kg N, 45 kg P and 45 kg K per hectare respectively. Half dose of N, full dose of P and half dose of K were applied as basal dressing at the time of transplanting followed by 1/4 dose of N and half dose of K at the maximum tillering phase and the remaining 1/4 dose of N at the panicle initiation stage.

Twenty five day old seedlings were transplanted in lines giving a spacing of 15 x 10 cm. After transplantation, controlled irrigation and drainage were given as required.

2.1.3 <u>Lay out</u>:

A randomised block design with three replications for each treatment including control was adopted. The blocks were laid out each with 19 treatment plots each of size 5 m x 5 m; the plots and the blocks were provided with border 1 m wide (Fig. 1). The plots were marked by putting wooden pegs on all the four sides, in a continuously planted field.

2.1.4 <u>Application of insecticides and collection of data</u>:

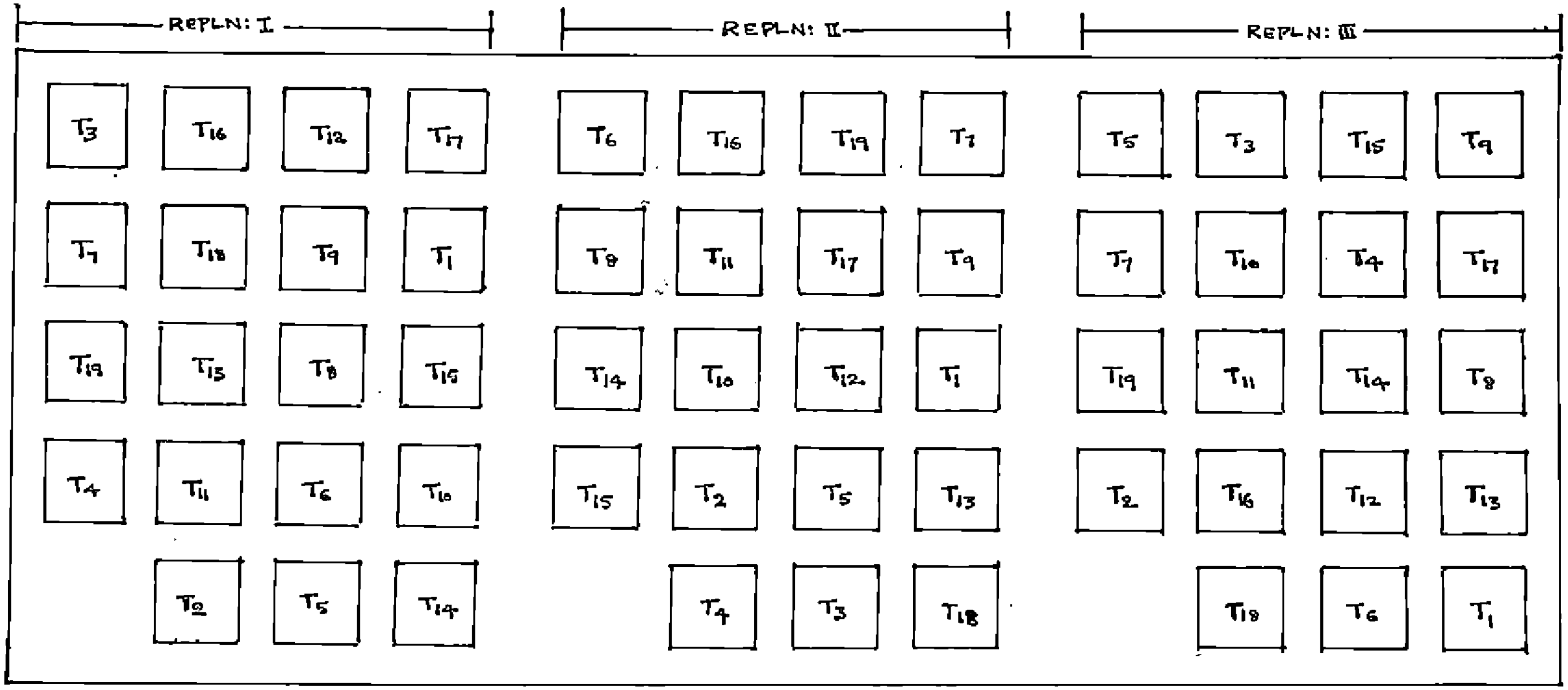
Application of insecticides was done on need basis. Counts of insect pests in the field were recorded at weekly intervals commencing from the second week after transplanting.

The details of the insecticides used and their dosages are given in Table 1. The first spraying was given on the 34 DAP and second spraying was given on 63 DAP. Second spraying was given to half the number of plots only. After the first spraying, pest counts from the two plots receiving the same doses of each pesticides in one block were added up and its averages were recorded as the incidence in the respective treatments. After the second spraying the data from the individual plots were recorded separately.

Fig. 1. Lay out of the experiment for evaluating the synthetic pyrethroids against pests of paddy

1. Fenvalerate 50 g ai/ha	2. +Fenvalerate 50 g ai/ha
3. ,, 100 ,,	4. + ,, 100 ,,
5. Permethrin 25 g ai/ha	6. +Permethrin 25 g ai/ha
7. ,, 50 ,,	8. + ,, 50 ,,
9. Cypermethrin 25 g ai/ha	10. +Cypermethrin 25 g ai/ha
11. ,, 50 ,,	12. + ,, 50 ,,
13. Decamethrin 6.25 g ai/ha	14. +Decamethrin 6.25 g ai/ha
15. ,, 12.5 ,,	16. + ,, 12.5 ,,
17. Carbaryl 1 kg ai/ha	18. +Carbaryl 1 kg ai/ha
19. Control	

+ Plots which received two sprayings



GROSS PLOT SIZE – 5M x 5M.

NET PLOT SIZE – 4.4M x 4.6M.

FIG: 1. LAY OUT OF THE FIELD EXPERIMENT FOR EVALUATING THE SYNTHETIC PYRETHROIDS AGAINST PESTS OF PADDY.

Table 1. Details of insecticides used for the control of paddy pests.

Common name	Trade name	Chemical composition	Formulation	Dose	Source
Fenvalerate	Sumicidin (R)	-cyano-m-phenoxy benzyl isopropyl-p-chlorophenyl acetate	20 EC	50g ai/ha 100g ai/ha	M/s.Rallis India Ltd., Bangalore.
Permethrin	Ambush (R)	3 phenoxy benzyl (±) cistrans 3-(2,2-dichloro-vinyl)-2,2-dimethyl cyclo propane-1-carboxylate	50 EC	25g ai/ha 50g ai/ha	M/s. Alkali and Chemical Corporation of India Ltd., Madras.
Cypermethrin	Ripcord (R)	cyano-phenoxy benzyl 2,2-di-methyl-3-(2,2-dichlorovinyl) cyclo propane carboxylate	10 EC	25g ai/ha 50g ai/ha	M/s. National Organic Chemical Industries Ltd., Madras.
Decamethrin	Decis (R)	(S)-cyano(3-phenoxy phenyl) methyl (IR-cis)-3-(2,2-dibromo-ethenyl)-2,2-dimethyl cyclopropane carboxylate	2.5 EC	6.25 g ai/ha 12.5 g ai/ha	M/s. Hoechst Pharmaceuticals Ltd., Bombay.
Carbaryl	Sevin (R)	7, Naphthyl N methyl carbamate	50 WP	1 kg ai/ha	M/s. Union Carbide India Ltd., Bombay.

The spraying was done using a pneumatic knapsack sprayer of 10 l capacity. The volume of liquid used was at the rate of 500 l per hectare. A gunny screen 1.5 m high was put up around the plots while spraying to minimise the drift of insecticide sprays. Control plots were sprayed with water. The incidence of various pests was assessed as detailed below:

2.1.4.1 Stem borer and gall fly: The number of damaged tillers and the total number of tillers in each observational unit of 1 x 0.5 m selected at random were recorded and the percentage incidence was evaluated as number of damaged tillers in the sample area x 100 / total number of tillers in the sample area.

2.1.4.2 Whorl maggot: Ten hills were randomly selected from each plot served as a unit for taking observations at each occasion. The number of damaged leaves per 10 hills were counted and the percentage incidence was evaluated as number of damaged leaves per 10 hills x 100 / total number of leaves in the 10 hills.

2.1.4.3 Other insect pests: Counts of green jassid, grass hopper, leaf roller and hispa were recorded at weekly intervals by standard net sweeps. The net consisted of a wire frame of 30 cm diameter with a wooden handle and a folding bag made of net cloth. Five 180° sweeps were made diagonally crossing the plot to have a sample catch from each plot.

Yield: The grain yields from the net plots were recorded.

2.2 Assessment of persistent toxicity of synthetic pyrethroids and carbaryl to the 3rd instar caterpillar of rice army worm *Spodoptera mauritia* and third instar nymphs of BPH, *Nilaparvata lugens*.

A pot culture experiment was carried out to study the persistent toxicity of the insecticides when applied at different doses.

2.2.1 Rearing of army worm: Adult moths of *Spodoptera mauritia* were collected from field and released on the paddy seedlings taken in rectangular glass troughs and kept closed with a piece of muslin cloth held in position with a rubber band. Honey was used to feed the moths. The egg masses laid by the gravid female moths were collected and sterilised by soaking in 5% formalin for one hour. Then the eggs were dried and transferred to cleaned and sun dried round glass troughs. A grass *Brachiara mutica*, alternate host of the pest was used to feed the emerging caterpillars. Caterpillars were transferred from one trough to another with soft camel hair brush. Eggs laid on different dates were kept in separate troughs to know the age of the caterpillar to be used in the experiments.

2.2.2 Raising potted plants: Fifteen day old 'Jaya' paddy seedlings were raised in 15 cm diameter pots, which were filled to three-fourth with soil, at the rate of 5 - 6 seedlings per pot. All the plants were given the same doses of manures, fertilizers and irrigation. The potted plants were kept insect free by keeping them in cages.

2.2.3 Application of insecticides: Fenvalerate 0.02 and 0.04%, cypermethrin 0.01 and 0.015% and permethrin 0.01 and 0.02%, decamethrin 0.0025 and 0.0035% and carbaryl 0.1 and 0.2% were sprayed using an atomizer when the plants were at the tillering stage. Each dose of the insecticides was sprayed on 24 potted plants. The control plants (24 Nos.) were sprayed with water alone. The treated plants were subjected to weathering.

2.2.4 Exposure of insects: Three potted plants from each treatment were taken and ten, third instar caterpillars of *S. mauritia* were released on each confined in glass chimneys as shown in Plate 1. The top portion of the chimney was covered with muslin cloth. This exposure was repeated at intervals of 2, 7, 12, 17 and 22 days after spraying, on different sets of plants.

Plate 1. Exposing S. *mauritia* on the residues of insecticides sprayed on rice crop

Plate 1.

2.2.5 Observations: Twenty four hours after the exposure of insects to the treated plants, mortality counts were taken and the toxicity of insecticide residues was determined in terms of the percentages of the larvae dead out of the total number released. The data were statistically analysed to observe the significance of variations. Observed mortality was corrected against control mortality using Abbott's formula and the persistent toxicity was assessed in terms of PT indices following the methods of Pradhan (1967).

2.3 Persistent toxicity of synthetic pyrethroids and carbaryl to Brown Plant Hopper of rice

2.3.1 Rearing of the test insect: Gravid females of BPH were collected from infested paddy fields with the aid of an aspirator and were released on 30 day old plants raised in flower pots of 30 cm diameter. All the potted plants were confined in 60 x 45 x 45 cm cages made out of iron frames and covered with polythene sheet. The insects were allowed to multiply and the seedlings were periodically replaced by fresh ones of same age. The pots were irrigated daily.

2.3.2 Raising potted plants and application of insecticides were done as described under 2.2. But in this experiment each treatment including control was applied on 30 potted plants.

2.3.3 <u>Exposure of insects:</u> From the each set of treated potted plants three plants were taken. The top portion of the tillers were cut off and the rest was confined within glass tubes, 5" long and 1/2" in diameter, open at both ends. The bottom portion of the glass tube was plugged with cotton (Plate 2). Twenty, third instar BPH nymphs were released on the plants with the aid of an aspirator and the top openings of the glass tube was closed with muslin cloth. This was done immediately after spraying and then at intervals of 2, 4, 6, 8, 10, 12 and 14 days of exposure to weathering.

2.3.4 <u>Observations:</u> Twenty four hours after the release of insects on the plants mortality counts were taken and the persistence was determined as explained under item 2.2.

2.4 <u>Resurgence of BPH on rice treated with synthetic pyrethroids</u>

Rearing of test insect was done as explained before.

2.4.1 <u>Raising potted plants for insecticidal treatment:</u>

Paddy seedlings were raised in flower pots as done in previous experiments.

2.4.2 <u>Application of insecticides:</u>

Twenty days after planting, the insecticides prepared from the commercial formulations were sprayed at the concentrations as used in experiment 2.2 and 2.3. The quantity

Plate 2. Exposing *N. lugens* on the residue of insecticides sprayed on rice crop

of spray fluid used was fixed by trial to give optimum coverage without run off. Each treatment including control was applied on 45 potted plants and kept in the field.

2.4.3 <u>Exposure of insects</u>: Three potted plants from each treatment were taken and two gravid females were released at the base of the plants in each pot 12 days after the spraying. The insects were confined on the plants using cages for seven days. Sufficient population of test insects of the same age were maintained on a similar set of treated plants for replacing the insects dying in the treatments within the seven day period, if any.

2.4.4 <u>Observations</u>: After seven days the adult insects were removed and the emerging population was maintained and counted at weekly intervals. Drying plants in treatments, if any, were substituted with plants taken from the corresponding lots maintained in field (2.3.2). Population build up of the ~~first~~ second generation was assessed for five weeks from the date of release (up to the emergence of all the adults).

From the ~~first~~ second generation adults, two gravid females from each treatment were released on one potted plant treated and exposed to weathering, (2.3.2) previously.

Three such replications were made for each treatment. The gravid females exposed for egg laying were removed at the end of seven days and the third generation produced during a period of five weeks was recorded as described earlier. The data thus obtained were subjected to statistical analysis.

Results

RESULTS

3.1 Relative efficacy of synthetic pyrethroids in comparison with carbaryl against gall fly — *Orseolia oryzae* (Woodmason) on rice

Data relating to the experiment are presented in Table 2. Pre treatment counts of silver shoots showed that the incidence of the pest was not significantly varying among the treatment plots. Spraying was done on 34 DAP. The observations recorded at 41 DAP and 48 DAP were also not varying significantly. The incidence at 55 DAP varied significantly in various treatments. In the control plot, the percentage incidence was 8.10 and it was significantly higher than the incidence in the treated plots. The lowest incidence of galls was observed in plots treated with permethrin at 50 g ai/ha, the percentage of galls being 5.02. The incidence in plots treated with other pyrethroids were on par with that of permethrin 50 g ai/ha. There was 6.62 per cent incidence of galls in plots treated with carbaryl at 1 kg ai/ha and the treatment was significantly superior to control but was inferior to permethrin 50 g ai/ha, fenvalerate 100 g ai/ha and cypermethrin 50 g ai/ha, the percentage incidence of galls in these treatments being 5.02, 5.17 and 5.25 respectively.

Table 2. Relative efficacy of synthetic pyrethroids in comparison with carbaryl against *Orseolia oryzae* (Woodmason) on rice

Treatments	Mean percentage incidence of silver shoots observed at					Mean
	33 DAP	41 DAP	48 DAP	55 DAP	62 DAP	
Fenvalerate 50 g ai/ha	6.47 (14.63)	2.75 (9.54)	2.10 (8.30)	6.06 (14.24)	9.25 (17.71)	5.04 (12.96)
Fenvalerate 100 g ai/ha	7.20 (15.56)	2.70 (9.42)	2.40 (8.85)	5.17 (13.14)	8.26 (16.70)	4.63 (12.42)
Permethrin 25 g ai/ha	6.54 (14.80)	2.11 (8.31)	2.00 (8.10)	6.04 (14.12)	8.18 (16.62)	4.58 (12.35)
Permethrin 50 g ai/ha	6.67 (14.88)	2.67 (9.36)	2.35 (8.80)	5.02 (12.94)	6.77 (15.07)	4.20 (11.81)
Cypermethrin 25 g ai/ha	5.68 (13.75)	2.23 (8.50)	2.16 (8.39)	5.51 (13.58)	7.23 (15.59)	4.28 (11.93)
Cypermethrin 50 g ai/ha	7.26 (15.48)	1.95 (8.06)	1.98 (8.04)	5.25 (13.23)	6.55 (14.82)	3.93 (11.42)
Decamethrin 6.25 g ai/ha	6.56 (14.79)	2.73 (9.52)	2.37 (8.81)	6.06 (14.24)	9.02 (17.48)	5.04 (12.97)
Decamethrin 12.5 g ai/ha	7.99 (16.37)	2.87 (9.76)	2.72 (9.48)	6.07 (14.24)	8.10 (16.54)	4.94 (12.83)
Carbaryl 1 kg ai/ha	6.59 (14.69)	3.02 (9.99)	2.88 (9.65)	6.62 (14.91)	9.09 (17.55)	5.40 (13.43)
Control (untreated)	7.22 (15.53)	3.53 (10.81)	3.05 (10.03)	8.10 (16.51)	10.46 (18.87)	6.28 (14.51)
C.D. for comparison between treatments	NS	NS	NS	1.45	1.26	0.86

Figures in parentheses are angular values.
The spraying was done on 34 DAP.
NS = Not significant.
DAP = Days after planting.

At 62 DAP, the plots treated with cypermethrin 50 g ai/ha showed the minimum level of incidence, the percentage of galls being 6.55 only. Permethrin 50 g ai/ha and cypermethrin 25 g ai/ha also were on par with the above treatment, the extent of gall incidence in the plots being 6.77 and 7.23 respectively. Decamethrin 12.5 g ai/ha, permethrin 25 g ai/ha and fenvalerate 100 g ai/ha were on par with cypermethrin 25 g ai/ha, there being no significant difference among these treatments. The treatments decamethrin 6.25 g ai/ha and fenvalerate 50 g ai/ha and carbaryl 1 kg ai/ha were found inferior to cypermethrin 25 g ai/ha and they were also on par with decamethrin 12.5 g ai/ha, permethrin 25 g ai/ha and fenvalerate 100 g ai/ha. Untreated control (10.46%) was on par with fenvalerate 50 g ai/ha and inferior to the rest of the treatments.

The mean of four post treatment counts showed that cypermethrin 50 g ai/ha, permethrin 50 g ai/ha and cypermethrin 25 g ai/ha gave the minimum level of gall incidence, the difference among the treatments being insignificant, the mean incidence in the treatments being 3.93, 4.20 and 4.28 per cent respectively.

3.2 Relative efficacy of synthetic pyrethroids in comparison with carbaryl against the stem borer *Scirpophaga incertulas* (Wlk.) on rice

The data relating to incidence of stem borer are presented in Table 3. Pre treatment counts of dead hearts showed that the incidence of the pest was not significantly varying among the treatment plots. Spraying was done on 34 DAP. The observations recorded at 41 DAP revealed that the treatments reduced the level of incidence of dead hearts significantly, the percentage being in the range of 3.20 to 4.92 as against 7.18 in control. Lowest incidence was recorded in the plots treated with cypermethrin 50 g ai/ha, the percentage incidence being 3.20. The treatments carbaryl 1 kg ai/ha, cypermethrin 25 g ai/ha, fenvalerate 100 g ai/ha and decamethrin 12.5 g ai/ha were on par with cypermethrin 50 g ai/ha. Decamethrin 12.5 g ai/ha was on par with the remaining treatments. The incidence of dead hearts in these treatments ranged from 4.04 to 4.92 per cent only.

The mean of the four post treatment counts showed that all treatments were superior to control. Cypermethrin 50 g ai/ha showed the least incidence of the pest. All treatments except decamethrin 6.25 g ai/ha were on par with cypermethrin 50 g ai/ha.

in comparison with carbaryl against stem borer

dead hearts observed at		Mean	Mean percentage of white earheads observed at harvest
55 DAP	62 DAP		
6.51(14.78)	7.09(15.53)	5.12(13.07)	0.100 (1.79)
—	—	—	0.086 (1.63)
5.84(13.99)	6.62(14.91)	4.72(12.54)	0.090 (1.70)
—	—	—	0.076 (1.54)
6.07(14.26)	6.32(14.56)	4.81(12.66)	0.066 (1.44)
—	—	—	0.056 (1.35)
5.90(14.06)	5.73(13.85)	4.57(12.35)	0.070 (1.49)
—	—	—	0.083 (1.63)
6.05(14.24)	5.93(14.10)	4.56(12.32)	0.113 (1.91)
—	—	—	0.056 (1.35)
5.81(13.95)	5.95(14.11)	4.46(12.19)	0.076 (1.56)
—	—	—	0.050 (1.27)
6.99(15.32)	6.38(14.62)	5.31(13.32)	0.086 (1.64)
—	—	—	0.073 (1.54)
6.09(14.28)	7.03(15.37)	4.94(12.84)	0.096 (1.73)
—	—	—	0.050 (1.27)
6.49(14.75)	6.75(15.05)	4.87(12.74)	0.073 (1.54)
—	—	—	0.066 (1.45)
7.33(15.71)	7.77(16.18)	6.47(14.72)	0.123 (2.00)
NS	NS	0.91	NS

NS = Not significant.
DAP = Days after planting.

Table 3. Relative efficacy of synthetic pyrethroids *Scirpophaga incertulas* (Wlk.) on rice

Treatments	Mean percentage incidence of		
	33 DAP	41 DAP	48 DAP
Fenvalerate 50 g ai/ha	7.18(15.45)	4.22(11.83)	2.68(9.41)
,, +50 ,,	—	—	—
,, 100 ,,	10.04(18.32)	3.85(11.29)	2.60(9.29)
,, +100 ,,	—	—	—
Permethrin 25 g ai/ha	7.72(16.11)	4.52(12.24)	2.36(8.84)
,, +25 ,,	—	—	—
,, 50 ,,	7.97(16.37)	4.16(11.77)	2.51(9.12)
,, +50 ,,	—	—	—
Cypermethrin 25 g ai/ha	7.79(16.15)	3.46(10.71)	2.82(9.63)
,, +25 ,,	—	—	—
,, 50 ,,	7.80(16.18)	3.20(10.27)	2.88(9.76)
,, +50 ,,	—	—	—
Decamethrin 6.25 g ai/ha	8.00(16.40)	4.92(12.82)	2.95(9.89)
,, +6.25 ,,	—	—	—
,, 12.5 ,,	10.32(18.72)	4.04(11.62)	2.63(9.30)
,, +12.5 ,,	—	—	—
Carbaryl 1 kg ai/ha	7.59(16.17)	3.43(10.66)	2.83(9.68)
,, +1 ,,	—	—	—
Control (untreated)	7.88(16.28)	7.18(15.52)	3.63(10.91)
C.D. for comparison between treatments	NS	1.44	NS

Figures in parentheses are angular values.
Treatments were applied on 34 and 63 DAP.
+ Plots which received two sprayings.

The incidence of white ear head observed at harvest was of a low level in the various treatments as well as in control. It ranged from 0.05 to 0.123% only. The data did not show any statistically significant variation.

3.3 Relative efficacy of synthetic pyrethroids in comparison with carbaryl against whorl maggot, *Hydrellia philippina* (Ferino) on rice

The data relating to the experiment are presented in Table 4. The pre treatment counts showed that the incidence of whorl maggot in different plots was not varying significantly though it ranged from 31.09 to 40.52 per cent. First spraying was done on 34 DAP. At 41 DAP the infestation was reduced to the range of 6.24 to 14.36 in various treated plots while in the control plot the percentage incidence declined to the level of 28.33 only. Among various treatments, the lowest incidence was seen in plots treated with cypermethrin 50 g ai/ha, the percentage of damaged leaves being 6.24. Fenvalerate 100 g ai/ha and cypermethrin 25 g ai/ha also were on par with the above treatment, the extent of damaged leaves in the plots treated with these insecticides being 7.74 and 8.42 respectively. All the treatments were significantly superior to untreated control.

Table 4. Relative efficacy of synthetic pyrethroids in on rice

Treatments	Mean percentage incidence of			
	33 DAP	41 DAP	48 DAP	55 DAP
Fenvalerate				
50 g ai/ha	37.52(37.76)	11.95(20.24)	17.68(24.84)	23.88(29.17)
+50 ,,	—	—	—	—
100 ,,	35.66(36.67)	7.74(16.13)	14.77(22.56)	20.18(26.60)
+100 ,,	—	—	—	—
Permethrin				
25 g ai/ha	34.55(35.97)	14.36(22.19)	19.99(26.51)	28.93(32.48)
+25 ,,	—	—	—	—
50 ,,	40.18(39.35)	9.71(18.11)	16.11(23.66)	23.94(29.28)
+50 ,,	—	—	—	—
Cypermethrin				
25 g ai/ha	31.09(33.88)	8.42(16.75)	11.61(19.91)	22.47(28.25)
+25 ,,	—	—	—	—
50 ,,	34.46(35.91)	6.24(14.45)	13.68(21.70)	17.12(24.43)
+50 ,,	—	—	—	—
Decamethrin				
6.25 g ai/ha	39.73(39.07)	13.88(21.79)	19.13(25.92)	25.32(30.20)
+6.25 ,,	—	—	—	—
12.5 ,,	40.52(39.50)	10.28(18.69)	16.40(23.85)	21.15(27.36)
+12.5 ,,	—	—	—	—
Carbaryl				
1 kg ai/ha	34.54(37.76)	11.75(19.96)	17.50(24.67)	27.85(31.79)
+1 ,,	—	—	—	—
Control (untreated)	37.36(37.68)	28.33(32.13)	36.03(37.06)	48.76(44.28)
C.D. for comparison between treatments	NS	3.20	3.42	4.64

Figures in parentheses are angular values.
Treatments were applied on 34 and 63 DAP.
+ Plots which received two sprayings.

comparison with carbaryl against Hydrellia philippina (Ferino)

damaged leaves observed at				Mean
62 DAP	70 DAP	77 DAP	84 DAP	
32.70(34.84)	7.41(15.50)	15.31(22.80)	8.14(16.42)	13.86(21.85)
35.60(36.63)	5.68(13.76)	12.79(20.96)	7.12(15.39)	13.39(21.45)
32.76(34.91)	6.11(14.16)	12.87(21.01)	10.21(18.42)	12.21(20.44)
29.03(32.58)	4.16(11.72)	12.57(20.22)	6.03(14.11)	10.72(19.05)
40.02(39.14)	12.76(20.74)	26.11(30.61)	11.45(19.71)	18.41(25.37)
42.29(40.55)	8.62(16.98)	17.36(24.44)	8.79(17.09)	16.88(24.24)
30.45(33.49)	8.00(16.31)	20.64(26.79)	8.30(16.61)	14.40(22.30)
35.55(36.56)	4.84(12.24)	12.60(20.77)	5.65(13.60)	12.13(20.36)
32.50(34.74)	6.27(14.48)	14.56(22.35)	9.58(17.87)	12.76(20.93)
26.77(30.95)	4.48(12.09)	13.82(21.75)	5.95(14.07)	11.63(19.93)
28.33(32.13)	6.07(14.09)	13.83(21.82)	6.58(14.71)	10.89(19.26)
23.51(29.00)	2.22(8.40)	11.06(19.42)	5.95(14.07)	9.06(17.52)
39.00(38.55)	12.29(20.52)	17.47(24.53)	12.94(20.98)	16.94(24.24)
36.16(36.96)	6.20(14.43)	16.29(23.59)	9.39(17.74)	14.95(22.74)
24.35(29.56)	11.26(19.55)	23.66(28.62)	12.12(20.71)	15.49(23.13)
28.84(32.39)	4.23(11.84)	10.64(18.95)	6.71(14.91)	11.91(20.18)
40.66(39.61)	9.87(18.13)	19.82(26.09)	10.71(18.98)	16.58(24.02)
36.77(37.24)	5.93(13.97)	14.68(22.51)	7.26(15.55)	13.82(21.81)
58.72(50.05)	15.63(23.27)	36.67(37.01)	17.30(24.48)	30.50(35.51)
5.44	3.74	7.93	4.56	2.04

NS = Not significant.
DAP = Days after planting.

At 48 DAP, the incidence increased and it ranged from 11.61 to 36.03 per cent in various plots including control. The minimum incidence was recorded in plots treated with cypermethrin 25 g ai/ha and it was followed by cypermethrin 50 g ai/ha and fenvalerate 100 g ai/ha there being no significant difference among these treatments. But cypermethrin 50 g ai/ha was on par with fenvalerate 100 g ai/ha, permethrin 50 g ai/ha and decamethrin 12.5 g ai/ha. All the treatments were significantly superior to control, the plot in which the highest incidence was noted.

The pest incidence slightly increased at 55 DAP and it ranged from 17.12 to 48.76% in the plots. Plots treated with cypermethrin 50 g ai/ha recorded the lowest incidence, the percentage of damaged leaves being 17.12. Fenvalerate 100 g ai/ha, decamethrin 12.5 g ai/ha and cypermethrin 25 g ai/ha were on par with the above treatment, the percentage of damaged leaves being 20.18, 21.15 and 22.47 respectively.

At 62 DAP the level of incidence of the pest became high and the percentage of damaged leaves ranged from 23.51 to 58.72. The second spraying was done on 63rd DAP. Data collected on 70th DAP showed that there was a very drastic decline of the pest population in all the plots including control. In control the percentage of leaves damaged decreased from 58.72 to 15.63. The data showed significant variations in all the treatments. But the plots which received the second spraying and those which were not sprayed showed the same level of incidence. At 77 DAP there was again a build up of the population in all the plots. In the control plot the percentage incidence rose from 15.63 to 36.67, while in treated plots the level of incidence increased from a range of 2.22 - 12.76% to 10.64 - 26.11%. Again at 84 DAP the population came on a declining stage in treated plots as well as in control plots. The level of incidence in the various plots were showing statistically significant variations. But between the plots which received and which did not receive a second spraying there was no statistically significant variation in pest incidence.

The mean of six post treatment counts showed that cypermethrin 50 g ai/ha (two sprayings), fenvalerate 100 g ai/ha (two sprayings) and cypermethrin 50 g ai/ha (one spraying)gave the minimum level of incidence, the difference among the treatments being insignificant. The incidence in these treatments were 9.06, 10.72 and 10.89 per cent respectively. Cypermethrin 25 g ai/ha, decamethrin 12.5 g ai/ha, permethrin 50 g ai/ha, fenvalerate 100 g ai/ha and cypermethrin 25 g ai/ha were also found on par with cypermethrin 50 g ai/ha, the mean percentage incidence in the plots being 11.63, 11.91, 12.13, 12.21 and 12.76 respectively. The remaining treatments were also superior to control, the mean percentage incidence being 13.39 to 18.41 as against 30.50 of the control.

3.4 Persistent toxicity of synthetic pyrethroids and carbaryl to *Spodoptera mauritia*

The mortality of *S. mauritia* exposed to paddy plants at different intervals after spraying are presented in Table 5a. Decamethrin 0.0035% gave the highest mortality of 97.5% and it was closely followed by decamethrin 0.0025%, fenvalerate 0.04%, cypermethrin 0.015% and fenvalerate 0.02%, the percentages of mortality in these treatments being 95.0, 92.5, 92.5 and 89.16 there being no statistically significant differences.

When exposed at 7 days after treatment, the two doses of decamethrin and fenvalerate and the higher dose of cypermethrin were found to be equitoxic and effective against the pest. The extent of kill ranged from 80.0 to 89.16 per cent. Cypermethrin 0.01% was on par with all the above treatments except decamethrin 0.0035%. Carbaryl and permethrin were equitoxic and less effective. Twelve days

Table 5a. Percentage mortality of army worm <u>Spodoptera mauritia</u> (Boisd.) observed in 24 hours when released to rice plants at different intervals after spraying with synthetic pyrethroids and carbaryl

Treatments		Period after spraying (days)		
		2	7	12
Fenvalerate	0.02%	89.16(71.96)	80.00(63.92)	43.33(41.15)
,,	0.04%	92.50(74.67)	83.33(66.14)	60.00(51.14)
Permethrin	0.01%	80.00(63.92)	53.33(46.92)	26.66(30.99)
,,	0.02%	85.83(67.90)	60.00(51.14)	33.33(35.21)
Cypermethrin	0.01%	86.66(68.59)	73.33(59.21)	53.33(46.92)
,,	0.015%	92.50(74.67)	80.00(63.92)	63.33(53.06)
Decamethrin	0.0025%	95.00(77.79)	83.33(66.14)	53.33(46.92)
,,	0.0035%	97.50(80.90)	89.16(71.96)	73.33(59.21)
Carbaryl	0.1%	76.66(61.21)	50.00(45.08)	23.33(28.78)
,,	0.2%	83.33(66.14)	60.00(51.14)	33.33(35.21)
Control		5.00(12.20)	7.50(15.32)	7.50(15.32)
C.D. for comparison between treatments		10.76	9.75	10.15

Figures in parentheses are angular values after treatment the higher doses decamethrin, cypermethrin and fenvalerate were found to be superior and the mortality observed on these treatments were 73.33, 63.33 and 60.00 respectively. The lower doses of these insecticides were found to be the next best in the series while carbaryl and permethrin were on par and least effective.

The persistent toxicity of the pesticides based on corrected percentage mortalities and PT indices are presented in Table 5b and Figs. 2 and 3. The rate of dissipation was least in decamethrin 0.0035% and it was closely followed by cypermethrin 0.015%. Both persisted up to 17 days after spraying while the test insects exposed on other treatments did not show any mortality during that period. The other treatments were in the following descending order of efficacy:- Felvalerate 0.04%, decamethrin 0.0025%, cypermethrin 0.01%, fenvalerate 0.02%, permethrin 0.02%, carbaryl 0.2%, permethrin 0.01% and carbaryl 0.1%, their PT indices being 929.52, 914.71, 830.47, 829.92, 687.63, 673.83, 602.91, 544.51, respectively.

3.5 Persistent toxicity of synthetic pyrethroids and carbaryl to *Nilaparvata lugens*

The mortality of *N. lugens* exposed to paddy plants sprayed with synthetic pyrethroids and carbaryl, at various

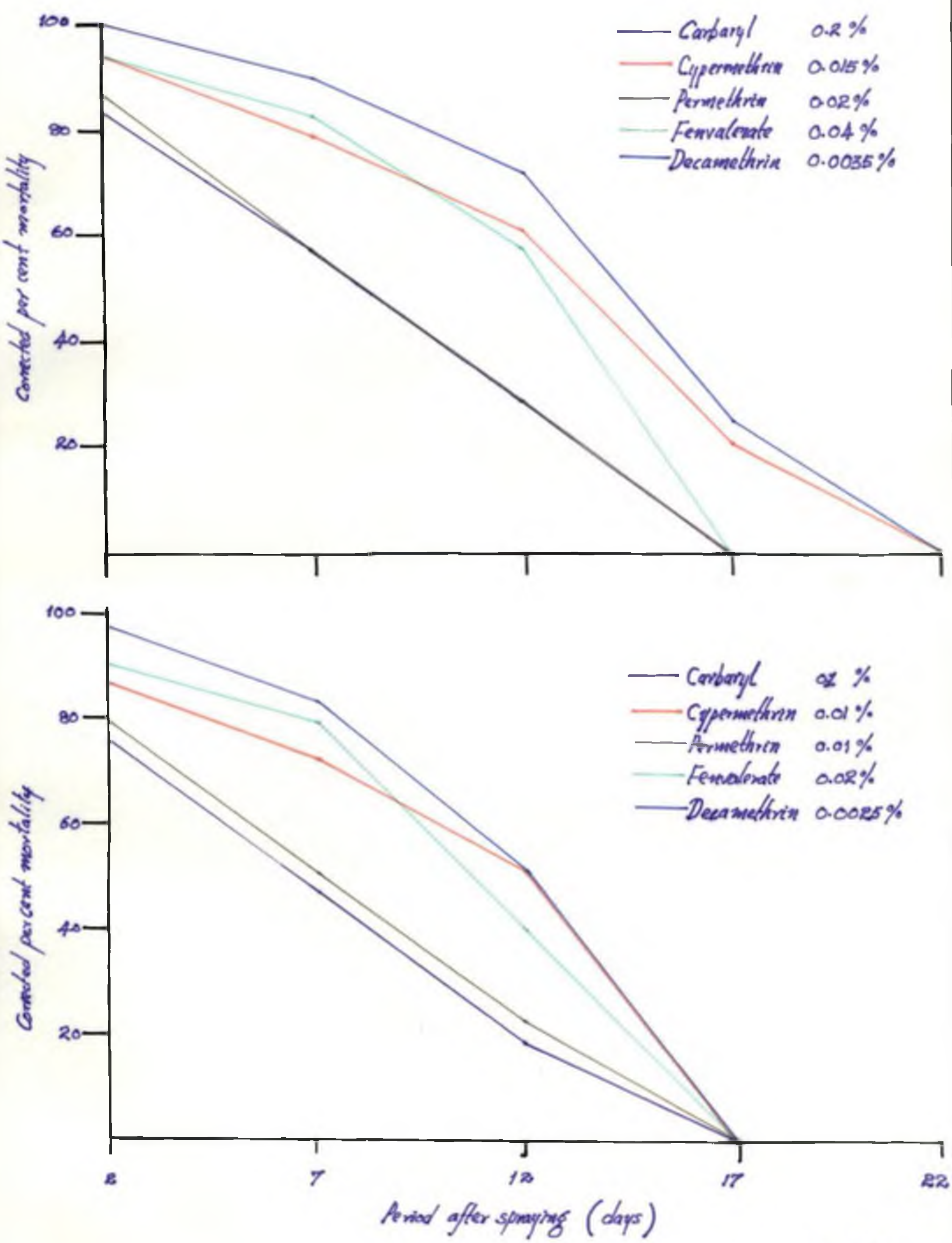
Table 5b. Persistent toxicity of synthetic pyrethroids and carbaryl to the rice swarming caterpillar *Spodoptera mauritia* (Boisd.)

Treatments		Per cent mortality of caterpillars exposed for 24 hours at different intervals after treatment (days)					P	T	PT
		2	7	12	17	22			
Fenvalerate	0.02%	89.65	78.57	39.28	—	—	12	69.16	829.92
,,	0.04%	93.10	82.14	57.14	—	—	12	77.46	929.52
Permethrin	0.01%	79.31	50.00	21.42	—	—	12	50.24	602.91
,,	0.02%	86.20	57.14	28.57	—	—	12	57.30	687.63
Cypermethrin	0.01%	86.20	71.42	50.00	—	—	12	69.20	830.47
,,	0.015%	93.10	78.57	60.71	20.68	—	17	63.26	1075.50
Decamethrin	0.0025%	96.54	82.14	50.00	—	—	12	76.22	914.71
,,	0.0035%	100.00	89.28	71.42	24.13	—	17	71.20	1210.52
Carbaryl	0.1%	75.85	46.43	17.85	—	—	12	45.37	544.51
,,	0.2%	82.75	57.14	28.57	—	—	12	56.15	673.83

P = Period after treatment in days. T = Average residual toxicity.

PT = Index of persistent toxicity.

Fig. 2. Persistent toxicity of synthetic pyrethroids and carbaryl to third instar caterpillars of *Spodoptera mauritia* (Boisd.) on rice

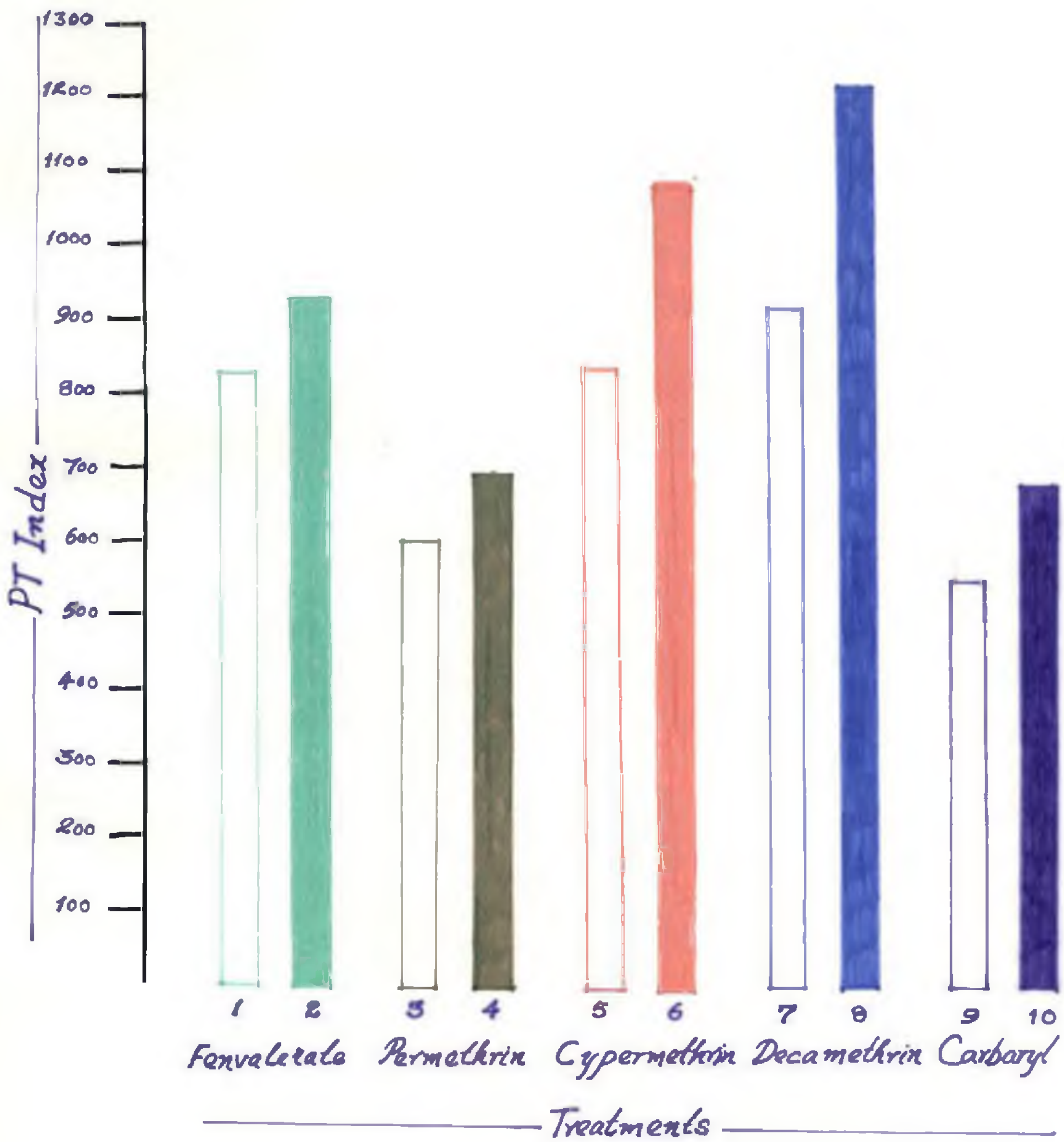


100
80
60
40
20
Corrected per cent mortality
Carbaryl 0.2 %
Cypermethrin 0.015 %
Permethrin 0.02 %
Fenvalerate 0.04 %
Decamethrin 0.0035 %
100
80
60
40
20
Corrected per cent mortality
Carbaryl
Cypermethrin 0.01 %
Permethrin 0.01 %
Fenvalerate 0.02 %
Decamethrin 0.0025 %
2
7
12
17
22
Period after spraying (days)

FIG: 2

Fig. 3. Persistent toxicity of synthetic pyrethroids and carbaryl to third instar caterpillars of *Spodoptera mauritia* (Boisd) on rice

1. Fenvalerate 0.02%
2. ,, 0.04%
3. Permethrin 0.01%
4. ,, 0.02%
5. Cypermethrin 0.01%
6. ,, 0.015%
7. Decamethrin 0.0025%
8. ,, 0.0035%
9. Carbaryl 0.1%
10. ,, 0.2%



1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
PT Index
1
2
3
4
5
6
7
8
9
10
Fenvalerate
Permethrin
Cypermethrin
Decamethrin
Carbaryl
Treatments

FIG: 3 .

intervals after spraying are presented in Table 6a. Immediately after spraying the two doses of carbaryl were found to be superior to all other treatments the mortality being 88.88 and 77.77% respectively. Cypermethrin 0.015% and 0.01%, permethrin 0.02% and fenvalerate 0.04% gave mortalities of 33.33, 28.88, 26.66 and 24.44% and they were on par. Remaining treatments gave mortalities ranging from 19.99 to 15.55 per cent only and there were no significant variations among the treatments.

The performance of carbaryl 0.2 and 0.1% on the second day after spraying was also good, the mortality obtained in the treatment being 82.22 and 64.44 per cent respectively. The efficacy of cypermethrin 0.015% and 0.01%, permethrin 0.02% and fenvalerate 0.04% was of an intermediate level, the mortality in treatments being 28.88, 24.44, 20.0 and 20.0 per cent respectively. The differences among the treatments were not statistically significant. The remaining treatments did not give appreciable mortality on the second day, the percentages being 15.55 to 8.88 only and the variations among the treatments were statistically insignificant.

Four days after spraying also the residues of carbaryl caused appreciable mortality of the test insect _N. lugens_,

Table 6a. Percentage mortality of brown plant hopper Nilaparvata lugens (Stal) observed in 24 hours when released to rice plants at different intervals after spraying with synthetic pyrethroids and carbaryl

Treatments		Period after spraying (days)		
		1/24	2	4
Fenvalerate	0.02%	17.77(24.84)	15.55(23.13)	7.19(14.54)
,,	0.04%	24.44(29.58)	20.00(26.35)	8.88(17.10)
Permethrin	0.01%	19.99(26.35)	15.55(23.13)	8.88(17.10)
,,	0.02%	26.66(30.78)	20.00(26.35)	13.33(20.97)
Cypermethrin	0.01%	28.88(32.48)	24.44(29.46)	17.77(24.84)
,,	0.015%	33.33(35.00)	28.88(32.47)	22.22(28.07)
Decamethrin	0.0025%	15.55(23.13)	11.11(19.26)	4.97(12.39)
,,	0.0035%	17.77(24.84)	8.88(17.10)	7.19(14.54)
Carbaryl	0.1%	77.77(62.13)	64.44(53.75)	62.22(52.24)
,,	0.2%	88.88(70.72)	82.22(65.35)	77.77(62.24)
Control		3.28(9.82)	4.97(12.39)	3.28(9.82)
C.D. for comparison between treatments		6.5	9.14	9.69

Figures in parentheses are angular values.

the percentages in the two doses being 77.77 and 62.22 respectively. Cypermethrin 0.015% and 0.01% and permethrin 0.02% caused 22.22, 17.77 and 13.33 per cent mortalities of the insect respectively and the efficacy of the above treatments did not show significant variations. The remaining treatments were ineffective and they gave mortalities ranging from 8.88 to 4.97 per cent and the variations among the treatments were not statistically significant.

The persistent toxicity of various pesticides to N. lugens in terms of corrected percentage mortality and PT indices are presented in Table 6b and Figs. 4 and 5. The highest toxicity was found for carbaryl 0.2% and it was closely followed by carbaryl 0.1% the PT indices in the treatments being 696.0 and 417.01 respectively. The persistent toxicity of the other treatments to N. lugens was not appreciable. However, they came in the following descending order of efficacy, cypermethrin 0.015%, cypermethrin 0.01%, permethrin 0.02%, fenvalerate 0.04%, permethrin 0.01%, fenvalerate 0.02%, decamethrin 0.0035% and decamethrin 0.0025%, the PT indices in the treatments being 146.48, 117.12, 82.32, 72.12, 48.80, 42.72, 40.98, 30.48 respectively.

Table 6b. Persistent toxicity of synthetic pyrethroids and carbaryl to the rice brown plant hopper Nilaparvata lugens (Stal)

Treatments		Per cent mortality of nymphs exposed for 24 hours at different intervals after treatment (days)							P	T	PT
		1/24	2	4	6	8	10	12			
Fenvalerate	0.02%	15.90	11.62	4.54	-	-	-	-	4	10.68	42.72
,,	0.04%	22.72	16.28	6.81	2.27	-	-	-	6	12.02	72.12
Permethrin	0.01%	18.18	11.62	6.81	-	-	-	-	4	12.20	48.80
,,	0.02%	24.99	16.28	11.36	2.27	-	-	-	6	13.72	82.32
Cypermethrin	0.01%	27.26	20.92	15.90	6.81	2.32	-	-	8	14.64	117.12
,,	0.015%	31.81	25.57	20.45	9.09	4.64	-	-	8	18.31	146.48
Decamethrin	0.0025%	13.63	6.97	2.27	-	-	-	-	4	7.62	30.48
,,	0.0035%	15.90	4.64	4.54	2.27	-	-	-	6	6.83	40.98
Carbaryl	0.1%	77.26	62.78	61.35	30.23	13.94	4.64	-	10	41.70	417.01
,,	0.2%	88.62	81.39	77.26	64.44	43.17	33.33	17.77	12	58.00	696.00

P = Period after treatment in days. T = Average residual toxicity.
PT = Index of persistent toxicity.

Fig. 4. Persistent toxicity of synthetic pyrethroids and carbaryl to third instar nymphs of *Nilaparvata lugens* (Stal.) on rice

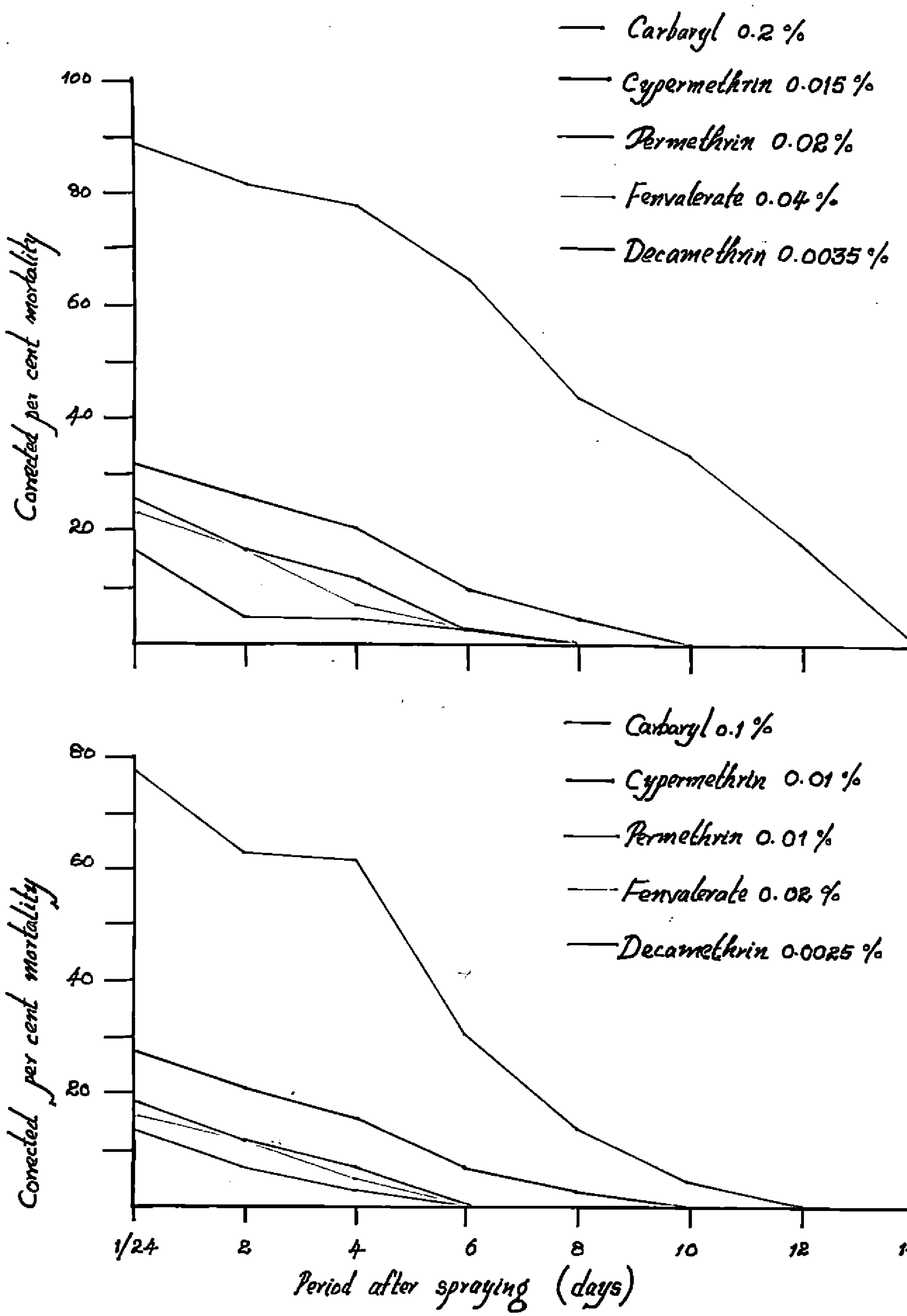
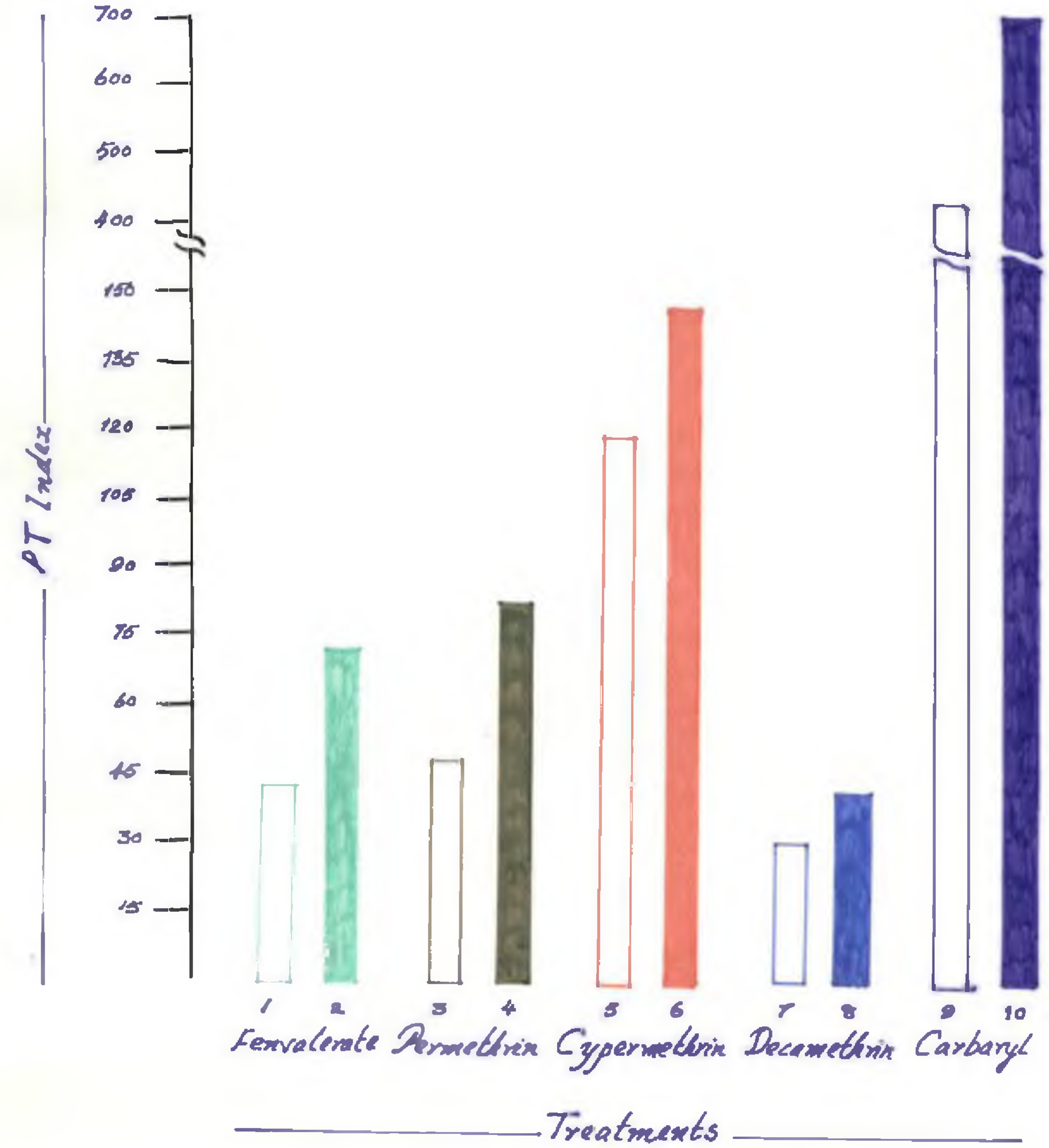

Carbaryl 0.2 %
Cypermethrin 0.015 %
Permethrin 0.02 %
Fenvalerate 0.04 %
Decamethrin 0.0035 %
100
80
60
40
20
Corrected per cent mortality
Carbaryl 0.1 %
Cypermethrin 0.01 %
Permethrin 0.01 %
Fenvalerate 0.02 %
Decamethrin 0.0025 %
80
60
40
20
Corrected per cent mortality
1/24
2
4
6
8
10
12
14
Period after spraying (days)

FIG:4

Fig. 5. Persistent toxicity of synthetic pyrethroids and carbaryl to third instar nymphs of _N. lugens_ (Stal) on rice

1. Fenvalerate 0.02%
2. ,, 0.04%
3. Permethrin 0.01%
4. ,, 0.02%
5. Cypermethrin 0.01%
6. ,, 0.015%
7. Decamethrin 0.0025%
8. ,, 0.0035%
9. Carbaryl 0.1%
10. ,, 0.2%



700
600
500
400
150
135
120
105
90
75
60
45
30
15
PT Index
1
2
3
4
5
6
7
8
9
10
Fenvalerate
Permethrin
Cypermethrin
Decamethrin
Carbaryl
Treatments

FIG: 5

3.6 Population build up of BPH on rice plants sprayed with different insecticides observed at different intervals after release of the insect

Data relating to the experiment are presented in Table 7 and Figs. 6 and 7. Two weeks after liberation of insect, the population on plants treated with decamethrin 0.0025% was the highest and it was significantly higher than all other treatments. Decamethrin 0.0035% and cypermethrin 0.01% having 70 and 72 insects respectively ranked as the second lot having no significant difference between them. The insect count in other treatments ranging from 48.0 to 28 were on par with those of untreated plants.

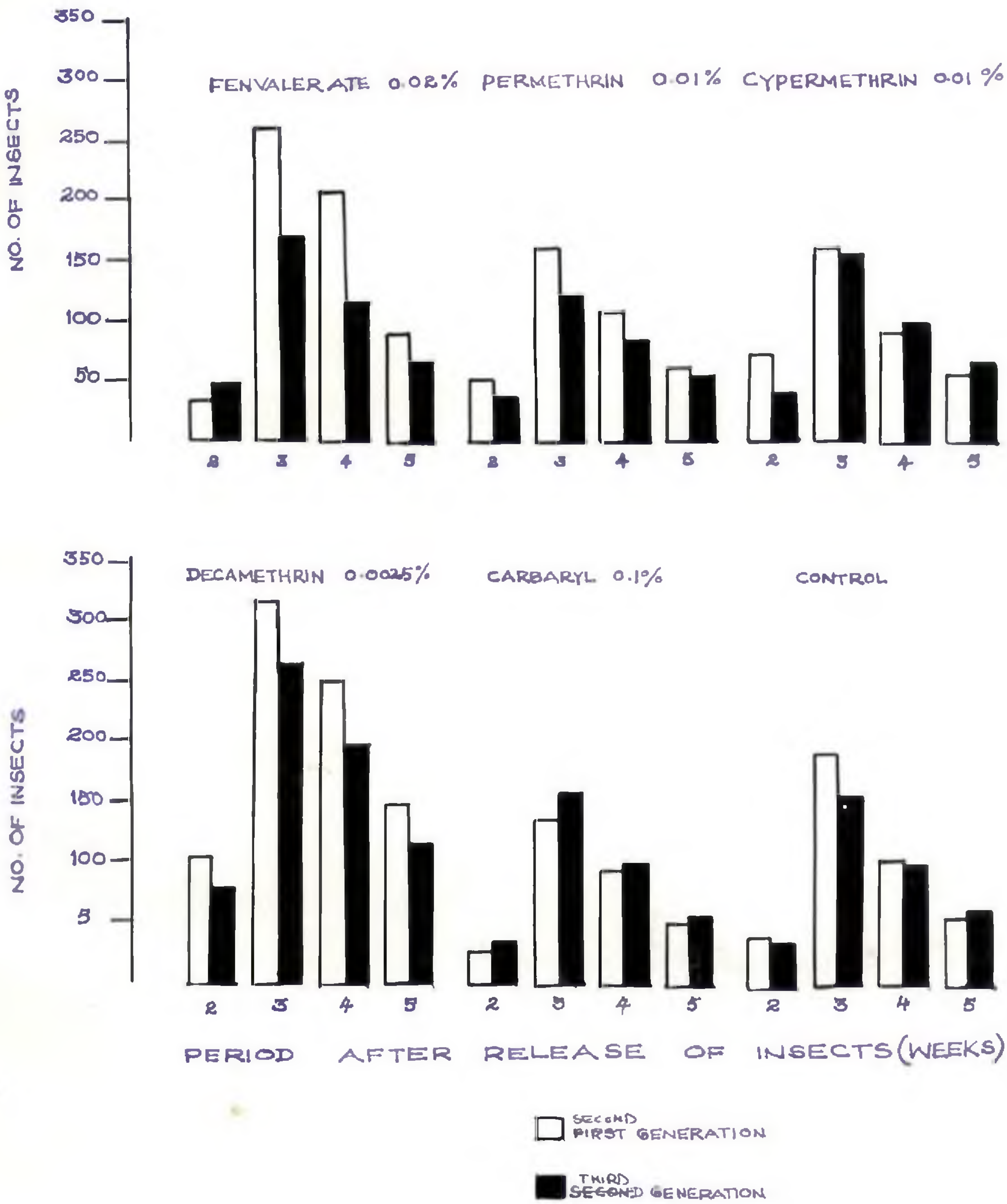
During the third week also decamethrin 0.0025 per cent treated plants maintained the highest level of population viz. 318 per pot. Fenvalerate 0.02% showed a rapid increase in population and the number in pots treated with the insecticide reached a level of 258 per pot. The population levels in the remaining treatments were on par with that of control, the range being 212 to 135 per pot. The number in pots treated with cypermethrin 0.015% and carbaryl 0.2% were 106 and 97 insects respectively and these were significantly lower than the population in control plants.

Table 7. Population build-up of brown plant hopper N. lugens released on rice plants sprayed with synthetic pyrethroids and carbaryl as observed at different intervals after the release

Treatments		Period after release			
		2 weeks	3 weeks	4 weeks	5 weeks
SECOND GENERATION					
Fenvalerate	0.02%	34(5.82)	258(16.02)	205(14.30)	89(9.42)
,,	0.04%	40(6.26)	156(12.41)	123(11.07)	52(7.20)
Permethrin	0.01%	48(6.84)	159(12.60)	107(10.27)	60(7.71)
,,	0.02%	37(5.97)	160(12.62)	88(9.35)	57(7.54)
Cypermethrin	0.01%	72(8.45)	159(12.57)	91(9.51)	55(7.40)
,,	0.015%	44(6.60)	106(10.23)	65(8.06)	48(6.90)
Decamethrin	0.0025%	105(10.25)	318(17.82)	251(15.83)	147(12.10)
,,	0.0035%	70(8.35)	212(14.54)	192(13.81)	106(10.25)
Carbaryl	0.1%	28(5.31)	135(11.61)	94(9.68)	52(7.20)
,,	0.2%	22(4.71)	97(9.83)	80(8.94)	44(6.62)
Control		39(6.21)	193(13.90)	104(10.17)	58(7.60)
C.D. for comparison between treatments		1.43	1.62	1.43	0.96
THIRD GENERATION					
Fenvalerate	0.02%	43(6.54)	170(13.02)	114(10.67)	65(8.05)
,,	0.04%	33(5.71)	140(11.80)	95(9.73)	61(7.80)
Permethrin	0.01%	35(5.90)	120(10.92)	83(9.09)	55(7.41)
,,	0.02%	32(5.64)	115(10.72)	78(8.80)	52(7.20)
Cypermethrin	0.01%	37(6.03)	154(12.36)	93(9.63)	63(7.93)
,,	0.015%	33(5.71)	142(11.90)	91(9.51)	57(7.54)
Decamethrin	0.0025%	76(8.70)	265(16.26)	195(14.00)	115(10.72)
,,	0.0035%	48(6.92)	210(14.48)	140(11.82)	92(9.60)
Carbaryl	0.1%	30(5.45)	158(12.54)	98(9.85)	53(7.27)
,,	0.2%	24(4.88)	145(12.00)	95(9.65)	48(6.92)
Control		35(5.86)	155(12.40)	102(10.07)	62(7.86)
C.D. for comparison between treatments		0.95	1.46	1.25	0.44

Figures in parentheses are square root values.

Fig. 6. Population build up of *N. lugens* released on rice plants treated with the lower doses of synthetic pyrethroids and carbaryl at 12 days after spraying



NO. OF INSECTS
350
300
250
200
150
100
50
FENVALERATE 0.02%
PERMETHRIN 0.01%
CYPERMETHRIN 0.01 %
2 3 4 5 2 3 4 5 2 3 4 5
DECAMETHRIN 0.0025%
CARBARYL 0.1%
CONTROL
NO. OF INSECTS
350
300
250
200
150
100
5
2 3 4 5 2 3 4 5 2 3 4 5
PERIOD AFTER RELEASE OF INSECTS (WEEKS)
SECOND FIRST GENERATION
THIRD SECOND GENERATION

FIG:6

Fig. 7. Population build up of *N. lugens* released on rice plants treated with the higher doses of synthetic pyrethroids and carbaryl at 12 days after spraying

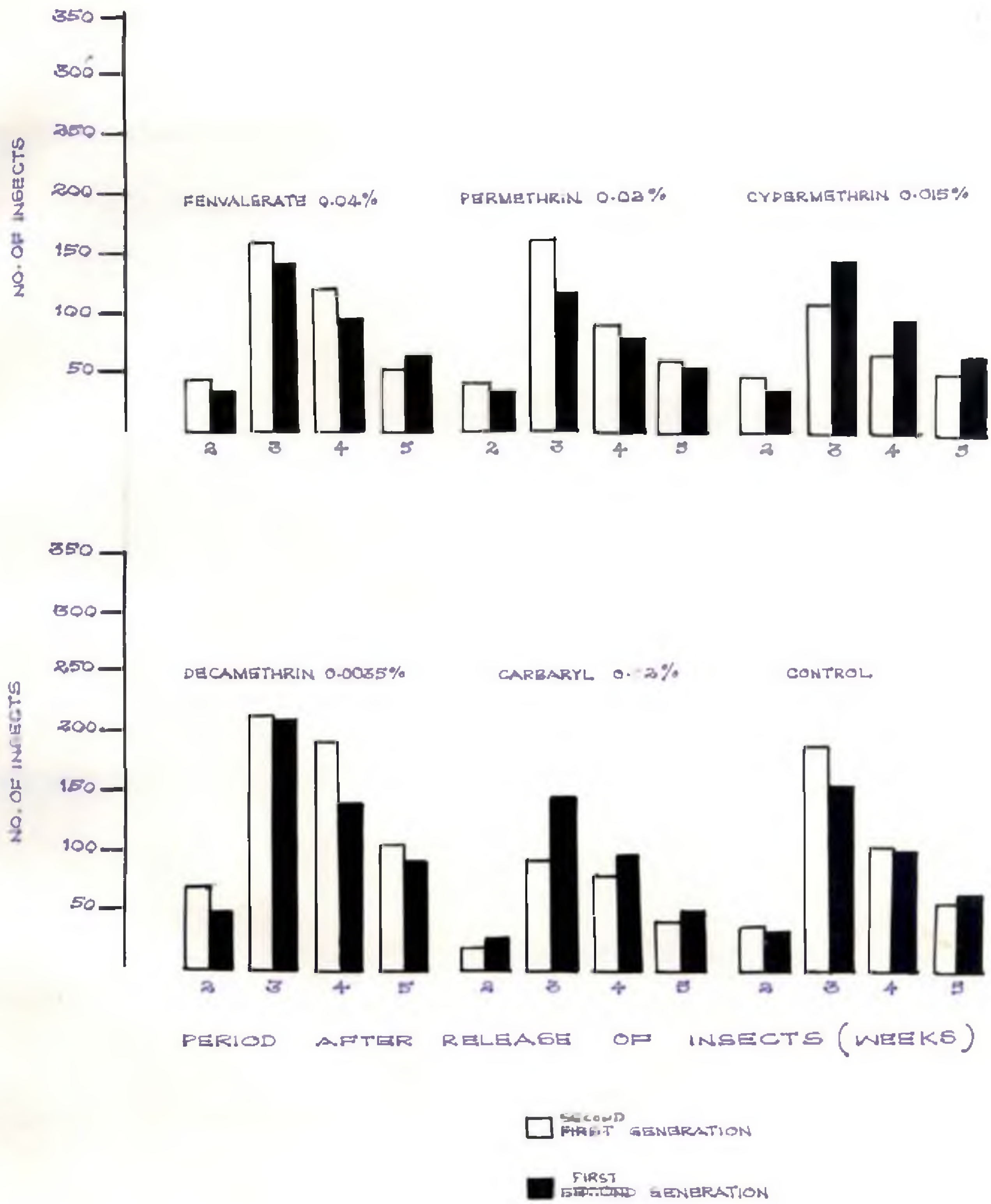

NO. OF INSECTS
350
300
250
200
150
100
50
FENVALERATE 0.04%
PERMETHRIN 0.02%
CYPERMETHRIN 0.015%
2
3
4
5
DECAMETHRIN 0.0035%
CARBARYL
CONTROL
PERIOD AFTER RELEASE OF INSECTS (WEEKS)
SECOND GENERATION
FIRST GENERATION

FIG: 7

During the fourth week decamethrin at the higher dose maintained the highest number of 251 insects per plant. It was followed by fenvalerate 0.02% and decamethrin 0.0035% the difference between them being significantly insignificant. The remaining treatments showed population levels on par with that of control or even lower than that. The apparent superiority of carbaryl seen in the third week is not manifested at the end of fourth week.

During fifth week though the population declined in all the treatments due to natural factors decamethrin treated plants (both doses) and those treated with fenvalerate at 0.02 per cent showed significantly higher levels than control, the number in these treatments being 147, 106 and 89 respectively.

In the third generation, the population in decamethrin (0.0025%) treated plants reached the level of 76 per pot during the second week after release and it was significantly higher than all the other treatments and decamethrin 0.0035 per cent with a population of 48 per plant ranked next to it. The remaining treatments with insect counts ranging from 24 to 43 were found to be on par with control.

During the third week also the two doses of decamethrin with 265 and 210 insects per pot remained significantly different from the control. The populations in the remaining treatments ranged from 170 to 115 but they were on par with the population in control except in the case of permethrin the two doses of which showed significantly lower levels of population than control.

During the fourth week plants treated with decamethrin 0.0025 per cent and 0.0035 per cent had populations of 196 and 140 insects per pot respectively the count in the lower dose being significantly higher than the other. Remaining treatments were on par with control except permethrin 0.02 per cent which showed a count significantly lower than that of control.

At the end of fifth week also the lower dose of decamethrin had the highest number of insects (115 Nos.) and it was closely followed by the higher dose of decamethrin (92 Nos.) the difference between the two being statistically significant. The other treatments were found on par with control and the levels of population ranged from 65 to 48 per pot.

Discussion

DISCUSSION

The relative efficacy of four synthetic pyrethroids viz. fenvalerate, permethrin, cypermethrin and decamethrin, each at two doses, were evaluated in a field experiment taking carbaryl as standard. The pest incidence during the crop season was in general low. The incidence of gall fly, stem borer and whorl maggot assumed significant severity by the fifth week after transplantation and the first spraying was given on the 34th day after transplanting.

Regarding the control of rice gall fly the effect of treatments was significantly seen during the third and fourth weeks after spraying. The third week data showed that all the synthetic pyrethroids were equally effective in controlling the pest and during the fourth week permethrin (50 g ai/ha) and cypermethrin (50 and 25 g ai/ha) were seen significantly superior. Fenvalerate 100 g ai/ha was on par with cypermethrin 25 g ai/ha but was significantly inferior to its higher dose (50 g ai/ha). The means of four post treatment counts also showed the significant superiority of the two doses of cypermethrin and higher dose of permethrin. Though these pyrethroids gave a significantly higher level of control when compared to carbaryl the variation in the extent of gall incidence in plots treated with the two categories of pesticides was not sufficiently high to justify the use of the high cost for the control of the pest (Table 2). There is no earlier report on the relative efficacy of synthetic pyrethroids against D. oryzae.

The pre treatment observation showed the incidence of dead hearts in the different plots caused by the rice stem borer Scirpophaga incertulas, was homogeneous and above the economic threshold (5% dead hearts). The first observation made on the seventh day after spraying showed the efficacy of the treatments which brought down the dead heart incidence to a range of 3.20 to 4.92 per cent. Cypermethrin 50 and 25 g ai/ha, carbaryl 1 kg ai/ha, fenvalerate 100 g ai/ha and decamethrin 12.5 g ai/ha ranked as the effective group of pesticides against the pest the difference among the treatments being statistically insignificant. Here also even the higher doses of pyrethroids were only on par with carbaryl in controlling the pest. The data collected in subsequent weeks did not show significant variations in the incidence of dead hearts in plots treated with the various insecticides. During the second week alfter spraying the percentage incidence of dead hearts in treated plots came low. But the level of incidence in the control plot also declined during the period. In subsequent weeks the incidence was again on the increase and hence the effect of treatments seemed to have been lost by the second week after spraying. The sprayings did not control the incidence of white ear heads also significantly. The level of incidence of white ears was very low in the various treatments as well as control. The effect of synthetic pyrethroids against rice stem borer has not been studied earlier. But they are reported effective against tissue borers in other crops. The level of incidence of the pest could have been very low for a proper evaluation of the treatments and hence on the basis of the available data it cannot be concluded that synthetic pyrethroids are totally ineffective against rice stem borer.

The relative efficacy of the pyrethroids against Hydrellia philippina compared to carbaryl is shown in Table 4. The reduction in the percentage of infested leaves in the treated plots at the end of one week after spraying showed that cypermethrin 50 and 25 g ai/ha and fenvalerate 100 g ai/ha were superior and on par for the control of H. philippina. But cypermethrin 25 g ai/ha was also on par with carbaryl 1 kg ai/ha and permethrin and decamethrin at the higher doses of 50 and 12.5 g ai/ha respectively. The percentages of infested leaves were lower in plots treated with the two doses of cypermethrin, the higher dose of fenvalerate (100 g ai/ha) and the higher dose of decamethrin during the second, third and fourth week after spraying when compared to carbaryl showing the relatively higher persistence of pyrethroids under field conditions. The incidence in the various plots given the second spraying got reduced to 50% of the pre treatment level but a similar reduction was seen in the plots which did not receive any spraying also. The percentages of damaged leaves between the plots which were sprayed and unsprayed with the second round also did not show significant variations in most of the cases. These findings indicated that the reduction in incidence observed after the second spraying was more due to the natural adversities than due to the effect of spraying. However, the incidence in plots treated with cypermethrin in both the doses and fenvalerate at the higher dose remained relatively lower. In general cypermethrin may be ranked as the most effective insecticide against <u>H. philippina</u>. The higher dose of fenvalerate may also be treated as effective against the pest as cypermethrin. Carbaryl though found to give satisfactory initial control (on par with cypermethrin) had a low persistent toxicity when compared to synthetic pyrethroids.

The mortality of <u>Spodoptera mauritia</u> exposed to the insecticide residues on rice plants, two days after spraying

(Table 5a) revealed that decamethrin (0.0035%) was most toxic to the pest and it was closely followed by fenvalerate (0.04%) and cypermethrin (0.015%). All the other treatments were on par with carbaryl.

The mortality of insects exposed seven days after spraying showed that the decamethrin was most toxic and it was followed by fenvalerate and cypermethrin. Permethrin was on par with carbaryl and significantly inferior to the other synthetic pyrethroids.

On the twelfth day after spraying the higher doses of decamethrin, cypermethrin and fenvalerate remained highly toxic to S. mauritia while the lower doses of the insecticides ranked next. Carbaryl and permethrin were on par and inferior to the other pyrethroids.

The persistent toxicity of different insecticides to S. mauritia as shown in Table 5b and Fig. 2 revealed that decamethrin (0.0035%) and cypermethrin (0.015%) ranked high and they were followed by fenvalerate 0.04%, decamethrin 0.0025%, cypermethrin 0.01% and fenvalerate 0.02%. Decamethrin 0.0035% and cypermethrin 0.015% persisted up to 17 days after spraying causing 24.13 and 20.68 per cent mortality respectively while the mortality reached zero level in other treatments during that period. The relative persistent toxicity of various insecticides as shown by the PT indices (Fig. 3) was in the following descending order decamethrin, cypermethrin, fenvalerate, permethrin, carbaryl.

The relative efficacy of the insecticides against the brown plant hopper of rice N. lugens as revealed from the mortality of the insect when exposed to the residues at different intervals after spraying (Table 6a) showed that the synthetic pyrethroids are far less effective against the pest than carbaryl. While residues of carbaryl 0.2 and 0.1% one hour after spraying caused 88.62 and 77.26 per cent mortality respectively the mortality on plants treated with the pyrethroids ranged from 15.90 to 31.81 per cent only. The mortality of insects exposed on residues at 2 and 4 days after spraying showed that cypermethrin had comparatively higher level of persistent toxicity among the pyrethroids but even that was far lower than that of carbaryl. On the sixth day the mortality on the pyrethroid treated plants reached below ten per cent while the mortality on the carbaryl treated plants ranged from 30-64 per cent. The higher dose of carbaryl caused mortality of the test insects up to 12 days after treatment while in the lower dose the toxicity persisted up to the 10th day after spraying. The PT indices (Fig. 5) also showed that the pyrethroids were far less effective than carbaryl for the control of N. lugens. Among the pyrethroids cypermethrin was the most persistent and it was followed by permethrin, fenvalerate and decamethrin. Pyrethroids were reported ineffective against sucking pests earlier also. Cauquil and Guillaumont (1979) reported that synthetic pyrethroids had only intermediate action against aphids. Diop (1979) found that the synthetic pyrethroid decamethrin was not at all effective against Aleurocybotus indicus, a sucking pest of rice. Spraying with decamethrin caused the most severe hopper burn of N. lugens (Chelliah, 1980). But Jaganmohan et al. (1980) reported that fenvalerate and permethrin at 0.1 kg toxicant per hectare gave good control of the brinjal leaf hopper Amrasca biguttula biguttula. Singh and Sircar (1980) found that synthetic pyrethroids were effective against cabbage aphids. Venkataswamy and Kalode (1981) recorded 55-80% mortality of BPH when caged on 10 day old spray deposits of fenvalerate (0.05%) while carbaryl (0.05%) gave 40.6% kill only.

The tendency for the resurgence of N. lugens following the treatment with pyrethroids were reported earlier (Aquino et al., 1979; Chelliah, 1980; Chelliah and Heinrichs, 1980 and Chelliah et al., 1980) and hence the effect of the sub lethal doses of these insecticides on *N. lugens* was studied in a pot trial. In the second generation the highest population of the insect was noted on plants treated with the lower dose (0.0025%) of decamethrin. The higher dose of decamethrin and lower dose of fenvalerate also showed a population level higher than those of the remaining treatments. The population in higher dose of fenvalerate and both doses of cypermethrin and permethrin were on par with that of control. The ultimate population as seen in the fifth week after release also showed the favourable influence of both tho doses of decamethrin and the lower dose of fenvalerate on the population build up of *N. lugens*. In the third generation of the insect the two doses of decamethrin were found to retain the stimulatory effect on population as observed at two weeks after release and at five weeks after release. The populatien on plants treated with fenvalerate was on par with that of control. Thus of the four pyrethroids included in the present studies decamethrin alone appeared to have any adverse effect in inducing a rapid population build up of *N. lugens* and a consequent resurgence of the pest. Aquino et al. (1979) observed an increased feeding of brown plant hopper on rice plants sprayed with decamethrin. Chelliah *et al.* (1980)

noticed that topical applications of sub lethal doses of methylparathion and decamethrin on fifth instar nymphs caused increased reproduction in the resulting adults. It was also observed that resurgence was induced by applications of decamethrin, methylparathion and diazinon because of plant growth, stimulation of reproduction of the hopper either by contact action of the insecticides or through increased plant growth, reduction in the length of the nymphal stage and increased adult longevity resulting in a shortened life cycle and longer oviposition period (Chelliah and Heinrichs, 1980). Hilda et al. (1981) investigated the biochemical changes in the rice plant after insecticide applications and found that decamethrin sprays on BPH susceptible Taichung Native 1 (TN 1) plants lowered the carbohydrate-nitrogen ratio which were attributed to the enhanced feeding of BPH on decamethrin treated plants.

Herve and Delabarre (1979) could not record any population build up due to decamethrin spray two times twice a year at 6.5 to 18.75 g/ha for the control of mirid Distantiella theobroma (Dist.) on cacao.

Another interesting point observed in this experiment was that the population was higher on plants treated with lower doses of pesticides than in their respective higher doses (Figs. 6 & 7). This indicates the possibility of overcoming the resurgence problem by increasing the dosages of pyrethroids applied in the field.

Summary

SUMMARY

A field experiment was carried out in the paddy fields attached to Model Agronomic Research Station, Karamana, during the first crop season of 1981 with a view to evaluating four synthetic pyrethroids against pests of paddy in comparison with carbaryl. The pyrethroids were applied at two doses each and carbaryl was applied at single dose. The first spraying of the insecticides was done on 34th day after transplantation and second spraying on 63rd day after transplantation.

The pest incidence during the crop season was in general low. The incidence of silver shoot observed at weekly intervals showed that the treatments had given significant control of the pest. The plots sprayed with both the doses of cypermethrin (25 and 50 g ai/ha) and high dose of permethrin (50 g ai/ha) showed the lowest incidence of the pest. Though these pyrethroids recorded lower incidence than carbaryl the variation in the extent of gall incidence in the plots treated with the two categories of insecticides was not sufficiently high to justify the use of synthetic pyrethroids.

The data relating to the incidence of dead heart caused by S. *incertulas* showed significant variations one week after spraying. The two doses of cypermethrin,

the higher dose of fenvalerate and decamethrin as well as carbaryl gave the same level of control of the pest. During the second week after spraying the incidence of dead hearts in the treated as well as control plots declined. In subsequent observations the incidence again increased but did not show significant variations indicating that the effect of spraying persisted only for a short time. The incidence of white ear heads also was low during the crop period and was not significantly varying. Thus the pyrethroids were not found promising against S. incertulas. But the incidence of the pest being rather low the inference could not be considered conclusive.

With reference to the control of whorl maggot H. philippina as shown from the percentage of infested leaves in various plots, it was seen that two doses of cypermethrin (25 and 50 g ai/ha) and the higher dose of fenvalerate (100 g ai/ha) were effective against the pest. Though the incidence in carbaryl treated plots was on par with fenvalerate treated plots one week after spraying its rank was seen low in subsequent observations thus showing that the persistent toxicity of the chemical against H. philippina was not satisfactory. The incidence of damaged leaves between the plots which were sprayed and unsprayed in the second round also did not show significant variations in most of the cases. Hence the decline observed in the extent of damage subsequent to the second treatment might be more due to the natural adversities than due to the effect of spraying.

The mortality of Spodoptera mauritia exposed to plants treated with various insecticides (pot culture) at different intervals after spraying showed that decamethrin was most toxic to the pest and it was closely followed by cypermethrin and fenvalerate at their higher doses. All the other treatments were on par with carbaryl.

Regarding the persistent toxicity of these pyrethroids and carbaryl, decamethrin and cypermethrin at the higher doses persisted up to 17 days after spraying whereas the remaining treatments persisted up to 12 days only. Decamethrin had the highest PT index and it was followed by fenvalerate, cypermethrin and permethrin. Carbaryl was least persistent.

A similar pot culture experiment showed that on N. lugens the synthetic pyrethroids caused far lower mortality than carbaryl, when exposed on the crop at different intervals after spraying. Among the pyrethroids cypermethrin showed higher level of persistent toxicity but even that was far lower than that of carbaryl. Carbaryl, higher and lower doses persisted up to 14 and 10 days respectively and they showed the highest PT indices also. Among the pyrethroids cypermethrin showed the highest PT index. The results indicated that synthetic pyrethroids could not be used effectively against brown plant hopper of rice *N. lugens*.

The effect of spraying rice crop with the pyrethroids on the population build up of brown plant hopper *N. lugens* was studied and it was found that the lower dose of decamethrin enhanced the population significantly. The higher dose of decamethrin and lower dose of fenvalerate also had a favourable influence. Populations on plants treated with other pyrethroids and carbaryl were on par with that of control plants. In the third generation of the pest the stimulatory effect was seen only in the two doses of decamethrin. In both the generations, it was seen that lower doses of pesticides caused higher population levels than their respective higher doses. Hence the use of higher dose of pyrethroids may help in overcoming the resurgence problem in the field.

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* Original not seen

EFFECT OF SYNTHETIC PYRETHROIDS ON THE PESTS OF PADDY

BY

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ABSTRACT OF THE THESIS
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ABSTRACT

The relative efficacy of four synthetic pyrethroids against the important rice pests was assessed through a field experiment laid out at the Model Agronomic Research Station, Karamana, during 1981, taking carbaryl as standard.

Against the rice gall midge *Pachydiplosis oryzae* cypermethrin (50 and 25 g ai/ha) and permethrin (50 g ai/ha) were found superior. The low variation in the percentage incidence of silver shoots in plots treated with pyrethroids and carbaryl showed that the use of the former category of pesticides is not justified due to the high cost involved.

One week after spraying the incidence of dead heart got reduced. The two doses of cypermethrin and higher doses of fenvalerate, decamethrin and carbaryl were found superior and on par for the control of the pest, *S. incertulas*. The lack of variation in the percentage incidence of dead hearts in subsequent weeks showed that the effect of treatment was not lasting sufficiently. The incidence of white ear head also did not vary significantly. However, due to the low level of infestation it was not possible to conclude that pyrethroids were totally ineffective against the pest.

Against the whorl maggot _H. philippina_ two doses of cypermethrin and higher dose of fenvalerate were found effective. Carbaryl was also as effective as fenvalerate in the first week after spraying but in subsequent observations the former ranked low indicating its poor persistent toxicity against the pest.

The mortality of 3rd instar caterpillars of _Spodoptera mauritia_ exposed to potted rice plants sprayed with different insecticides, at different intervals after spraying, showed that decamethrin was most toxic to the pest and it was closely followed by cypermethrin and fenvalerate at their high doses. Decamethrin had the highest persistence in the field and it was followed by fenvalerate, cypermethrin, permethrin and carbaryl.

In a similar pot culture experiment the persistent toxicity of different pyrethroids and carbaryl to the brown plant hopper of rice _N. lugens_ was studied. The pyrethroids were found far less toxic and persistent than carbaryl. Among the pyrethroids cypermethrin showed the highest toxicity and persistence. The results showed that synthetic pyrethroids could not be used effectively against _N. lugens_.

The influence of synthetic pyrethroids on the population build up of *N. lugens* on rice and the consequent resurgence of the pest was studied in a pot culture experiment. The two doses of decamethrin and lower dose of fenvalerate resulted in population levels significantly higher than those on untreated plants. In the third generation of the pest, decamethrin alone had this effect. The increase in population was caused more by the lower doses of pesticides than by the corresponding higher doses indicating a possibility of reducing the disadvantage of resurgence effect through the use of higher dose of pyrethroids when applied in field.