BIO-EFFICACY AND DISSIPATION OF CERTAIN INSECTICIDES IN BRINJAL (*Solanum melongena* Linn.)

BY

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B.Sc.(Ag.)

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CERTIFICATE

Mr. SACHIN S. SUROSHE, has satisfactorily prosecuted the course of research and that the thesis entitled **"BIO-EFFICACY AND DISSIPATION OF CERTAIN INSECTICIDES IN BRINJAL (*Solanum melongena* Linn.)"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for the degree of any university.

Date: 02/08/2K
Place: Hyderabad

(Dr. K. DHARMA REDDY)
MAJOR ADVISOR

CERTIFICATE

This is to certify that the thesis entitled **"BIO-EFFICACY AND DISSIPATION OF CERTAIN INSECTICIDES IN BRINJAL (*Solanum melongena* Linn.)"** is submitted in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURE** of the Acharya N.G. Ranga Agricultural University, Hyderabad is a record of the bonafide research work carried out by **Mr. SACHIN S. SUROSHE** under our guidance and supervision. The subject of the thesis has been approved by the student's advisory committee.

No part of the thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All assistance and help received during the course of investigations have been duly acknowledged by the author of the thesis.

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DECLARATION

I, Mr. SACHIN S. SUROSHE, hereby declare that the thesis entitled **"BIO-EFFICACY AND DISSIPATION OF CERTAIN INSECTICIDES IN BRINJAL (*Solanum melongena* Linn.)"** submitted to Acharya N.G. Ranga Agricultural University for the degree of **MASTER OF SCIENCE IN AGRICULTURE** is a result of original research work done by me. I also declare that the thesis or part thereof has not been published earlier elsewhere in any manner.

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ABSTRACT

A field experiment was conducted to study the bioefficacy of endosulfan @ 350 g a.i/ha, carbaryl @ 750 g a.i/ha, fenvalerate @ 100 g a.i/ha, profenofos @ 250 g a.i/ha, polytrin @ 220 g a.i/ha and spark @ 180 g a.i/ha against the major pests of brinjal (*Solanum melongena* Linn.).

The results indicated that endosulfan was most effective in controlling jassids followed by profenofos and polytrin. Endosulfan was also effective against whiteflies followed by spark and profenofos. The shoot and fruit borer was effectively controlled by spark followed by carbaryl. In all the above cases fenvalerate was found to be least effective among all the insecticides tested. Regarding fruit yield, spark recorded maximum of 6150 kg/ha followed by endosulfan at 4020 kg/ha.

Dissipation studies conducted with endosulfan, carbaryl and fenvalerate indicated that their initial deposits on brinjal fruits were 5.35, 4.01 and 0.43 mg/kg respectively. Endosulfan and carbaryl dissipated to below detectable level by fifteenth day of third spraying, however fenvalerate recorded 0.03 mg/kg of residues on fruits. Waiting periods were also suggested for these insecticides. Fruit dipping in two per cent salt solution followed by washing with water was found as an effective method of removing the insecticide residues from brinjal fruits.

INTRODUCTION

CHAPTER I

INTRODUCTION

Vegetables are the rich sources of nutrients, providing a balanced diet to our population. A meal without vegetables is considered to be incomplete. In India, total vegetable production stood at 72.83 mt from a cropped area of 5.6 mha. Among the Solanaceous vegetables which are widely cultivated in India, brinjal (*Solanum melongena* Linnaeus) is the most preferred one not only by human beings for consumption but also by the phytophagous insects. Brinjal was reported to have been attacked by more than 26 insect and non insect pests, of which the shoot and fruit borer (*Leucinodes orbonalis* Guenee), jassid (*Amrasca biguttula biguttula* Ishida) and whitefly (*Bemisia tabaci* Gennadius) are the most destructive ones (Joshi and Sharma, 1973). On an average, these nefarious enemies not only reduces the yield by 25 to 30 per cent but also the nutritional qualities of the produce.

During the last five decades, several studies have been made to identify the key pests, their distribution, behaviour, biology and bionomics and attempts were also made to control the same effectively by use of insecticides. As a result, more and more insecticides belonging to different groups have been developed and marketed in quick succession against these pests. The cultivators being highly impressed by the apparent advantages of the insecticides, started using the same indiscriminately without caring for the side/ill effects of these poisonous chemicals.

Now the crop protection strategies, however experienced a paradigm shift from pest "control" to pest "management". As exclusion of chemical insecticides is impracticable, many IPM tactics have been developed for different crops by retaining the most selective and effective insecticides. However it must be pointed out that the vegetables will retain residues of a varietable cocktail of dangerous poisons (applied at different stages of crop growth). The vegetables being perishable in nature, the health hazards to consumers are inevitable and enormous.

At this juncture, the efficacy of insecticide, its toxic residues on harvested produce and techniques to decontaminate them have gained importance to achieve cent per cent crop protection as well as to ensure safer produce for consumption.

In this background, it has been proposed to study the bioefficacy, dissipation and decontamination of certain insecticides in brinjal with the following objectives:

1) To study the bioefficacy of endosulfan, carbaryl, fenvalerate, profenofos, polytrin and spark against the pests of brinjal,

2) To establish dissipation pattern of endosulfan, carbaryl and fenvalerate in brinjal,

3) To study the effectiveness of decontamination procedure for the removal of endosulfan, carbaryl and fenvalerate residues in brinjal,

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

2.1 BIO-EFFICACY

2.1.1 Jassids and whiteflies

Verma (1984) reported that carbaryl formulation (wettable powder) was effective against *A. biguttula biguttula* and *Leucinodes orbonalis*.

Subbaratnam and Butani (1984) reported the highest initial and persistent toxicities with 0.04% fenvalerate on 2nd instar nymphs of *Amrasca biguttula biguttula*, followed by 0.02% fenvalerate, 0.1% phenthoate, 0.1% quinalphos, 0.05% phenthoate and 0.1% fenitrothion.

Quinalphos at 0.05% and 0.025%, carbaryl at 0.15% and 0.1%, sevisulf at 0.15% and 0.1% were effective against *Amrasca biguttula biguttula* (Kumar et al., 1988).

Singh and Kavadia (1989) reported that foliar sprays of 0.1% lindane, 0.32% methyl parathion, 0.03% thiometon and 0.07% endosulfan applied twice with an interval of 10 days were effective sagainst jassids and thrips in nursery.

Shah *et al.* (1990) reported that 0.036% monocrotophos was the most effective against *A. biguttula biguttula* on cotton followed by 0.05% malathion and 0.07% endosulfan.

Among the nine insecticides evaluated against the eggs and newly hatched nymphs (crawlers) of whitefly, *Bemisia tabaci* on cotton, profenofos at 0.1% recorded highest reduction in egg hatching by 18% over untreated, profenofos at 0.1% was effective with highest mortality of crawlers (Venugopal Rao *et al.*, 1990).

Quinalphos (0.05%) and endosulfan (0.07%) were found effective in the control of hemipteran pests of brinjal (Thanki and Patel, 1991).

Dhawan *et al.* (1991a) reported that *B. tabaci* was significantly less in the plots treated with curacron at 0.75 and 1.0 kg a.i/ha.

Dhawan *et al.* (1991b) indicated that curacron (profenofos) at 0.75 and 1.0 kg a.i/ha was effective over standard quinalphos and monocrotophos against *A. biguttula biguttula*.

Dhawan *et al.* (1991) reported that deltaphos was effective in controlling bollworms *Pectinophora gossypiella*, *E. vitella* and *E. insulana* and also kept the population of sucking pests below economic threshold level.

The good control of *B. tabaci* upto 15 days after spraying was recorded with 0.05% quinalphos as compared to sevisulf (Kumar and Jain, 1992).

The endosulfan was the most effective insecticide and Triazophos, deltamethrin and acephate were regarded as moderately effective. Cypermethrin and fenvalerate were found effective upto 7th day but later they caused resurgence of jassids (Goel *et al.*, 1992).

Sridharan and Janarthanan (1992) reported that monocrotophos 300 g a.i/ha was significantly superior over fenvalerate 75 g a.i/ha in bringing down the okra leaf hopper.

One spray of the acaricide dicofol followed by one spray with endosulfan, monocrotofos, or phosphomidon controlled *Tetranychus cinnabarinus*, *A. biguttula biguttula* and *B. tabaci*. It was found that *Bemisia tabaci* and *L. orbonalis* were controlled effectively with monocrotophos and endosulfan respectively (Verma, 1992).

Monocrotophos was compatible with either mancozeb or carbendazim in controlling infestations by jassid and leaf blight (Nagia *et al.*, 1993). However, fenvalerate was ineffective when combined with any of these fungicides.

Dhawan and Simwat (1993) recorded effective reduction in population of *B. tabaci* on cotton after the application of polytrin @ 1.25 litre/ha .

Dhawan and Simwat (1994) reported that the population of jassid on cotton was significantly less in profenofos treated plots at 1.0 kg a.i/ha than quinalphos.

Dhawan and Simwat (1994) reported that the combination product 'polytrin-C" (profenofos + cypermethrin) at 1 kg a.i/ha was effective in controlling cotton bollworms and jassid than either of the insecticide alone.

Narasimha Rao *et al.* (1996) reported that profenofos 0.05% ranked first in reducing the population of whitefly, *B. tabaci* on brinjal and was on par with polytrin 0.044% besides recording higher fruit yields.

Mali *et al.* (1997) found that cypermethrin (25 kg/ha) was effective than methyl parathion (25 kg/ha) against jassids and epilachna. It was also reported that insecticidal emulsions were superior over dusts during the fruiting phase.

Ashok (1998) concluded from the field trial that the build up of *B. tabaci* population on cotton was significantly less in polytrin-C than in profenofos and triazophos.

2.1.2 Shoot and fruit borer

Mohan (1985) observed comparatively more per cent infestation of brinjal fruit borer in the plots treated with curacron 50 EC (profenofos) at 0.5 kg a.i/ha over other treatment (permethrin and fenobucarb at 0.5 kg a.i/ha).

Major pests of brinjal like shoot and fruit borer, jassids, thrips and whiteflies were most effectively controlled by the application of granular disulfoton at 1.5 kg a.i/ha as a side dressing 8 days after transplanting,followed by 2-3 sprays of 0.07% endosulfan or 0.1% carbaryl (Singh and Kavadia, 1989).

Reddy and Joshi (1990) when tested the effect of carbaryl (0.2%), dimethoate (0.05%), monocrotophos (0.04%), phosalone (0.05%) and endosulfan (0.07%) alone and in combination with planofix (100 ppm NAA) on the growth and

yield of brinjal, found that all treatments (except planofix alone) resulted in a significant reduction in infestation by *L. orbonalis* and gave the best yield.

Fenvalerate at 0.005% reduced the *L. orbonalis* infestation and improved the seed germination and subsequent seedling vigour of brinjal plants (Krishnasamy, 1990).

Endosulfan reduced the fruit infestation by *L. orbonalis* to 7.5 per cent as compared with 17.9 per cent of untreated and recorded the yield increase of 87.7 per cent by weight and 79.3 per cent by number compared with untreated plants (Islam and Quiniones, 1990).

Paul and Ghosh (1990) reported that 2.8% deltamethrin at 225 ml/ha reduced the damage by *L. orbonalis* to 21.25% and fenvalerate to 39.04% as compared with 58.67% of untreated. Deltamethrin at 0.005% was effective (Thanki and Patel, 1991).

Raghunath and Nanda Kumar (1990) showed that application of carbofuran 0.5 kg or phorate granules at 1.0 kg a.i/ha respectively followed by need based application of carbaryl 0.2, quinalphos 0.05, or malathion 0.1% controlled the pest and increased the fruit yield in brinjal.

Patil *et al.* (1991) reported that endosulfan 0.5 kg/ha was more effective against *L. orbonalis* and registered greatest yield than quinalphos (0.3 kg/ha), methyl parathion (0.4 kg/ha).

Bothara and Dethe (1991) reported that endosulfan 25 ULV formulation was more effective than 35 EC and 50 EC formulations against *L.*

orbonalis. It was also found that the treatments at lower dosage (1.75 kg/ha) reduced the fruit infestation by *L. orbonalis* to 16.44 per cent as compared with 52.68 per cent in control.

Mixing neemark (0.5% extract of *Azadirachta indica*) with cypermethrin (0.01%) or fenvalerate (0.01%) gave better control of brinjal shoot and fruit borer than neemark alone (Temurde *et al.*, 1992).

Five sprays of fenvalerate at 50 g a.i/ha at 15 days intervals proved better than endosulfan at 525 g a.i/ha and carbamate 1000 g a.i/ha for the control of *L.orbonalis* (Brar *et al.*, 1992).

Misra (1993) concluded that fenvalerate, cypermethrin and deltamethrin were the most suitable insecticides for the control of *L. orbonalis* on the basis of pest control, fruit yield and cost benefit ratio,

Srinivas and Clement Peter (1993) reported that propenofos @ 1 kg a.i/ha reduced the brinjal shoot and fruit borer, *L. orbonalis* recording 2.06 per cent damage of shoots as against 13.5 per cent in untreated. The fruit damage was also significantly reduced.

Srinivas and Clement Peter (1993) reported that application of polytrin @ 1 litre/ha reduced the infestation of *L. orbonalis* over the control.

Srinivas and Clement Peter (1993) revealed that the insecticidal mixture deltamethrin + triazophos (deltaphos) 1 litre/ha was significantly superior to the other insecticides tested for the control of shoot and fruit borer by recording

low fruit infestation 6.19 per cent. Similarly it has been found effective at 1250 ml/ha (Anonymous, 1996).

Narasimha Rao (1994) reported that polytrin-C at 0.044% was highly effective in reducing the incidence of *L. orbonalis* with higher fruit yields.

It was reported that out of 8 insecticides evaluated against the *Leucinodes* fenvalerate (280 g a.i/ha) was the most effective with highest net profit and cost benefit ratio followed by deltamethrin (280 g a.i/ha) and endosulfan (1400 g a.i/ha) Roy and Pande (1994).

Singh *et al.* (1996) showed that, endosulfan 0.5 kg a.i/ha was significantly superior in reducing the shoot infestation to 1.72 – 3.29 per cent compared with other insecticides.

The highest fruit yields and returns were obtained with the need based application of 0.1% triazophos when 20% of the fruit borer infested by Leucinodes (Radhika *et al.*, 1997).

Sudhakar *et al.* (1998) found that a higher dose of potash (100 kg/ha) along with chemicals (carbaryl 0.15% + dicofol 0.036%, malathion 0.1% and bifenthrin 0.01%) was more effective against *L. orbonalis.*

Walunj *et al.* (1998) observed that the new combination insecticide Spark 36 EC @ 1250 ml/ha was significantly superior and recorded least fruit damage by *L. orbonalis* both on number (11.04%) and weight basis (15.49%) than the conventional insecticides, highest yield of 164.20 q/ha was also obtained.

2.2 DISSIPATION

Subbaratnam *et al.* (1984) reported that brinjal fruits were sprayed with 0.02 and 0.04% fenvalerate and it was found that the half life values were 5.28 and 12.86 days respectively at 0.02 and 0.04%.

Rao *et al.* (1985) reported that carbaryl when sprayed @ 2.0 kg a.i/ha on fruits and leaves of brinjal recorded initial deposits of 10.18 ppm and 44.56 ppm respectively. Residues on fruits declined to 4.92 ppm on the first day itself, resulting in almost 52 per cent dissipation. Initial deposits of 44.56 ppm on leaves declined to 5.89 ppm after 7 days resulting in 86.78 per cent dissipation and residues could not be detected after 21 days.

Devi and Manjunath (1985) reported that when carbaryl at 0.1% and fenvalerate at 0.02% were applied on brinjal fruits, the initial deposit of carbaryl (2.6 ppm) was below the tolerance limit of 5 ppm. The waiting period for fenvalerate was 10 days.

Rao *et al.* (1986) reported that the initial endosulfan deposits 13.16 ppm on brinjal leaves and 4.34 ppm on fruits dissipated to reach below detectable levels after 1.10 and 5 days of spraying respectively. Half lifes were worked out as 1.072 days on leaves and 0.810 days on the fruits, and suggested that 0.91 days as waiting period for safe consumption.

Fenvalerate residues were found above the tolerance limit of 1 ppm, 3 days after spraying on brinjal fruits. The residues recorded were 2.66 ppm (when sprayed at 0.05%), 1.98 ppm (at 0.01%) and 2.02 ppm (at 0.015%). At the highest

concentration of 0.02% fenvalerate, residues were 2.94 ppm,10 days after application. The residues were not detectable after 15 days (Murthy and Devi, 1986). Waiting period of 3 days was recommended for safe consumption.

Dikshit (1987) reported that the residues of carbaryl on brinjal when sprayed @ 1 kg a.i/ha at fruit formation stage were found to be reduced to 1.00 ppm (from 8.06 ppm) after 7 days. The waiting period of 7 days was recommended.

The carbaryl at 3 rates (0.6, 1.2 and 2.4 kg a.i/ha) when sprayed on brinjal, the initial level of residues were 5.94, 6.49 and 9.76 ppm respectively. These levels reduced below 3 ppm in 3-5 days after spraying and went below detectable levels after 15-21 days (Gangawar and Singh, 1987).

Gupta *et al.* (1987) revealed that carbaryl deposits in brinjal fruits reached the tolerance limit of 5 ppm within 7 days after treatment at 0.1 and 0.15 per cent and within 10 days after treatment at 0.2 per cent.

Pal *et al.* (1988) reported 72.8 and 77.3 per cent dissipation on brinjal fruits after 5 days of carbaryl spraying @ 0.75 kg and 1.5 kg a.i/ha respectively.

Singh and Kavadia (1988) reported that on brinjal fruits, the initial deposits (5.47 to 5.66 ppm) of endosulfan @ 0.07 per cent lost to about 50 per cent in 3 days and completely in 21 days and reached below tolerance limit of 2 ppm in 7 days. The initial deposits of 6.45 to 6.62 ppm of carbaryl 0.1 per cent degraded by 50 per cent in about 5 days and completely in 15 days from brinjal fruits. They suggested waiting period of 7 and 3 days for endosulfan and carbaryl for safe consumption.

The endosulfan 0.05 and 0.10% dissipated to the tolerance limit of 2 ppm within 2.57 and 4.48 days after application respectively. The carbaryl 0.2 and 0.4% reached the tolerance limit of 3 ppm within 2.28 and 5.74 days after application respectively. From these results, Dethe *et al.* (1988) suggested a waiting period of 3 days for endosulfan and carbaryl.

Murthy and Devi (1988) reported that a waiting period of 12.99 days should be followed for safe consumption of brinjal fruits when sprayed with fenvalerate 0.005, 0.01, 0.015 or 0.02 per cent.

Bhattacharya *et al.* (1989) reported that endosulfan at 500 g and 1000 g a.i/ha required a safe waiting period of 6.00 – 10.54 days in brinjal fruits with half life values of 2.01 – 2.99 days.

Ashtaputre and Jadhav (1989) calculated the waiting period for endosulfan in brinjal as 5.46 days.

Islam and Quiniones (1990) reported that brinjal endosulfan residues (0.0023 mg/kg) were detected on harvested fruits upto 6 days after application.

Dethe and Bothara (1991) investigated the presence of endosulfan residues on brinjal with three different formulations (35 EC, 50 EC and 25 ULV). They found that the initial concentration was higher when the ULV formulation was used. The residues in fruits reached 2 ppm by 6 and 3.4 – 3.6 days after spraying with ULV and EC formulations respectively.

Raj *et al.* (1991) reported that endosulfan 0.07% recorded initial deposits of 9.42 and 4.44 µg g on tomato and brinjal fruits respectively. The

deposits dissipated below the tolerance limit of 2.0 μg/g for both tomato and brinjal fruits in 7 and 14 days respectively.

Sangama *et al.* (1991) reported that when brinjal plants were sprayed with endosulfan at 0.5 and 1.0 kg a.i/ha the residues persisted for 15 days and 4.08 days for the corresponding safety intervals of 15.97 and 14.89 days.

Chahal *et al.* (1991) reported that the residues of endosulfan 500 and 1000 g a.i/ha in brinjal were 2.43 and 4.37 mg/kg respectively. Endosulfan residues dissipated below the maximum residue level of 2 mg/kg within a day.

Raha *et al.* (1993) found that the residues of endosulfan and fenvalerate in the brinjal fruits were below the tolerance limit of 2 ppm immediately after application. The waiting period of 2.57 and 0.14 days were suggested for endosulfan and fenvalerate respectively, when double the recommended rate was applied.

2.3 DECONTAMINATION

Awasthi (1986) reported that dip treatments of the brinjal fruits with water, sodium chloride solution, hydrochloric acid solution, acetic acid solution or potassium permanganate solution were found to remove 30-33 per cent of the residues of synthetic pyrethroids (sprayed 1 hour before harvest). Sodium hydroxide solution and teepol solution was found to remove 40-45 and 50-60 per cent respectively. He also reported that the effect of washing in reducing the residues decreased progressively at the 2nd and 3rd harvests.

Out of three methods suggested for removing insecticide residues, tap water washing did not remove residues of endosulfan when sprayed at 700 ppm. Warm water washing and cooking removed the residues significantly and resulted in substantial reduction of waiting periods i.e., 4 and 1 days respectively (Jadhav and Ashtaputre, 1989).

Yadav and Yadav (1989) showed the loss of endosulfan (0.07%) from the okra fruits due to washing for 2 min, cooking and boiling for 20 min from 42.85 to 59.19 per cent and 61.32 to 74.49 per cent, respectively.

Raha *et al.* (1993) reported that approximately 50-70 per cent of the remaining residues of endosulfan, deltamethrin and fenvalerate when sprayed at recommended dosage on brinjal fruits was removed during washing followed by cooking.

MATERIAL & METHODS

Plate 1. View of Experimental Plot.

CHAPTER III

MATERIAL AND METHODS

Field bioefficacy studies were undertaken with six insecticides against the pests of brinjal *Solanum melongena* (Linn.) (Table 1) during *rabi* 1999-2000 at the Students Farm, College of Agriculture, Rajendranagar, Hyderabad. The dissipation and decontamination of endosulfan, carbaryl and fenvalerate in brinjal fruits was carried out at All India Coordinated Research Project on Pesticide Residues, College of Agriculture, Rajendranagar. The different materials utilised in conducting the experiment and the various methods employed during the course of investigation are given below.

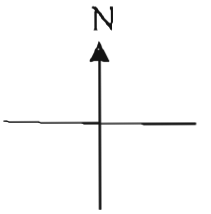
3.1 LAY OUT

The experiment was laid out in a randomised block design with seven treatments each replicated thrice. The plot size was 20 m^2 (Fig. 1).

3.2 RAISING OF CROP

3.2.1 Sowing, spacing and fertilisation

Brinjal seeds of variety 'Shyamala' was raised in nursery beds. About four weeks old seedlings were transplanted in the main field on 10-12-1999 with a spacing of 60 x 45 cm. Fertilizer doses were used in the experiment as per ICAR recommendations.



1	5	7
2	6	4
3	1	2
4	7	1
5	4	3
6	2	5
7	3	6

Plot Size : 5 x 4 m^2

Design : RBD

Replications : 3

Treatments : 7

T_1: Endosulfan - 350 g a i ha^{-1}

T_2: Carbaryl - 750 g a i ha^{-1}

T_3: Fenvalerate - 100 g a i ha^{-1}

T_4: Profenofos - 250 g a i ha^{-1}

T_5: Polytrin - 220 g a i ha^{-1}

T_6: Spark - 180 g a i ha^{-1}

T_7: Control - -----

FIG. 1: FIELD LAYOUT PLAN OF THE EXPERIMENT

3.2.2 Irrigation

The experimental crop was irrigated as and when required.

TABLE 1: DETAILS OF THE TEST INSECTICIDES

Common name and chemical group	Trade name and formulation	Chemical name	Source of supply
1. Endosulfan (organochlorine)	Endocel-35 EC	6.7.8.9.10.10-hereachloro-1.5.5a.6.9.9a.hexahydro-6. 9-methano-2.4.3-benzo dioreathiepin 3-oxide	M/s Excel Industries Ltd.. Mumbai
2. Carbaryl (Carbamate)	Sevin-50 WDP	1-Naphthyl N-methyl Carbamate	M/s Rhone-Poulenc Agrochemicals (India) Ltd.. Mumbai
3. Fenvalerate (Pyrethroid)	Tatafen-20 EC	(α-cyano-n-phenoxy benzyl-α-isopropyl-P-chloro phenyl acetate	M/s Rallis (India) Ltd.. Mumbai
4. Profenofos' (Organo-phosphate)	Curacron-50 EC	0-(4-bromo-2-chlorophenyl) 0-ethyl s-n-propyl phosphorothioate	M/s Novartis (India) Ltd.. Mumbai
5. Polytrin-C (Combination insecticide)	Polytrin 44 EC	0-(4-bromo-2-chlorophenyl) 0-ethyl s-n-propyl phosphorothioate + (R_1S)-alpha-cyanaa-3-phenoxy benzyl ($1R_1 1S$)-cis. trans-3-(2.2-dichloro vinyl)-2.2 dimethyl-cyclopropane carboxylate	M/s Hindustan Ciba-Geigy ltd.. Mumbai
6. Spark (Combination insecticide)	Spark 36 EC	(S)-cyano-m-phenoxy benzyl (IR. 3R)-3-(2.2-dibromovinyl)- 2.2-dimethyl-cyclopropane – carboxylate + 0.0-diethyl-0-(1-phenyl-1-H-1.2.34-triazol-3-yl)-thiophosphate	M/s Hoechst Schering AgrEvo Ltd.. Mumbai

3.2.2 Irrigation

The experimental crop was irrigated as and when required.

TABLE 1: DETAILS OF THE TEST INSECTICIDES

	Common name and chemical group	Trade name and formulation	Chemical name	Source of supply
1.	Endosulfan (organochlorine)	Endocel-35 EC	6.7.8.9.10.10-hereachloro-1.5.5a.6.9.9a.hexahydro-6. 9-methano-2.4.3-benzo dioreathiepin 3-oxide	M/s Excel Industries Ltd.. Mumbai
2.	Carbaryl (Carbamate)	Sevin-50 WDP	1-Naphthyl N-methyl Carbamate	M/s Rhone-Poulenc Agrochemicals (India) Ltd.. Mumbai
3.	Fenvalerate (Pyrethroid)	Tatafen-20 EC	(α-cyano-n-phenoxy benzyl-α-isopropyl-P-chloro phenyl acetate	M/s Rallis (India) Ltd.. Mumbai
4.	Profenofos' (Organo-phosphate)	Curacron-50 EC	0-(4-bromo-2-chlorophenyl) 0-ethyl s-n-propyl phosphorothioate	M/s Novartis (India) Ltd.. Mumbai
5.	Polytrin-C (Combination insecticide)	Polytrin 44 EC	0-(4-bromo-2-chlorophenyl) 0-ethyl s-n-propyl phosphorothioate + (R_1S)-alpha-cyanaa-3-phenoxy benzyl ($1R_1 1S$)-cis. trans-3-(2.2-dichloro vinyl)-2,2 dimethyl-cyclopropane carboxylate	M/s Hindustan Ciba-Geigy ltd.. Mumbai
6.	Spark (Combination insecticide)	Spark 36 EC	(S)-cyano-m-phenoxy benzyl (IR. 3R)-3-(2.2-dibromovinyl)- 2.2-dimethyl-cyclopropane – carboxylate + 0.0-diethyl-0-(1-phenyl-1-H-1.2.34-triazol-3-yl)-thiophosphate	M/s Hoechst Schering AgrEvo Ltd.. Mumbai

3.2.3 Intercultivation

The brinjal crop was kept weed free by timely hand weedings.

3.3 APPLICATION OF INSECTICIDAL TREATMENTS

The test insecticides were applied as foliar sprays. Details of test insecticides are presented in the table 1 and Fig. 1. The first spray was given at 50 per cent flowering of brinjal and thereafter repeated at fifteen days interval and a total of five sprays were given.

The measured quantities of the test insecticides were mixed with small quantity of water and the remaining quantity of water was added to it. Subsequently to make up the volume. The spray fluid was evenly mixed with a stick before spraying.

3.3.1 Insecticidal application

Insecticides were applied using a knapsack sprayer at 15 PSI. Sprayings were taken up during early hours of the day and necessary precautions were taken to prevent drift. The sprayer and container used for preparing spray fluid were thoroughly cleaned with water before changing the insecticide and rinsed with spray fluid to be applied next.

3.4 PESTS OBSERVED

The efficacy of different treatments was studied against the following pests.

S.No.	Common name	Scientific name	Family/order
1.	Brinjal jassid	*Amrasca biguttula biguttula* Ishida.	Cicadellidae/ Homoptera
2.	Brinjal whitefly	*Bemisia tabaci* Gennadius	Aleurodidae / Homoptera
3.	Brinjal shoot and fruit borer	*Leucinodes orbonalis* Guenee	Pyralidae / Lepidoptera

3.5 DETAILS OF FIELD OBSERVATIONS

3.5.1 Sucking pests

The population of sucking pests (jassids and whiteflies) were recorded on five randomly selected plants per plot leaving the border rows. The population counts were recorded from top, bottom and middle leaf in each of the five selected plants in every plot and the mean number per 5 plants was calculated. Pre-treatment counts were taken one day prior to spraying and post treatment counts were taken at 1, 3, 5 and 10 days after each spraying.

3.5.2 Borer

The borer infested brinjal fruits were counted at each harvest taken 15 days after each of 3, 4 and 5th spray and total number of fruits infested and healthy were separated and the per cent damage was worked out.

3.5.3 Yield

The brinjal fruits were harvested at 15 days after 3, 4 and 5th spray and expressed in kg/plot. From this the yield per hectare was calculated.

3.6 STATISTICALANALYSIS

3.6.1 Sucking pests

The per cent reduction of sucking pests in different treatments over control was calculated by modified Abbot's formula (Fleming and Retnakaran, 1985).

$$\text{Population Reduction (\%)} = 1 - \frac{\text{Post-treatment population in treatment}}{\text{Pre-treatment population in treatment}} \times \frac{\text{Pre-treatment population in control}}{\text{Post treatment population in control}} \times 100$$

The percentage reductions at one, three, five and ten day after each spraying were pooled and transformed into angular values which were further subjected to statistical analysis. The overall effect of the treatments by combining these four (1, 3, 5, and 10th day) observations were also assessed by analysing the data through ANOVA.

3.6.2 Borer

In the case of borer, percentage of damage was transformed into angular values and the data analysed statistically. The yield data too was subjected to statistical analysis.

3.7 DISSIPATION OF INSECTICIDES IN BRINJAL

The dissipation pattern of endosulfan, carbaryl and fenvalerate was studied by collecting fruit samples from the bio-efficacy trial. The samples of

brinjal fruits were collected randomly from top, middle and lower portion of each plant at 0, 1, 3, 5, 10 and 15 days after third spraying. However the methodology of insecticides viz., profenofos and polytrin is not standardised hence these were not included in dissipation and decontamination studies. However, triazophos was not included because it has already been studied by AICRP on Pesticide Residues, Rajendranagar on brinjal.

3.7.1 Analysis of Endosulfan Residues

3.7.1.1 Preparation of standard stock solution

In 100 ml n-hexane 100 mg of standard endosulfan I, II, endosulfan sulphate was dissolved to get 1000 ppm solution. From this standard stock solution, fortification standard containing one ppm of endosulfan I, II, and endosulfan sulphate was prepared.

3.7.1.2 Recovery

Brinjal fruits were collected from control plots and after chopping and blending transferred (100 g) to the reagent bottles. A known amount of standard solution (equal to 1 ppm) was added. The contents of reagent bottles were then shaken and the samples were subjected to extraction and clean-up procedure. The recovery obtained was 99 per cent for endosulfan I and II and 97.5 per cent for endosulfan sulphate at 1 ppm level of fortification.

3.7.1.3 Extraction and cleanup

The chopped and blended brinjal sample (50 g) was taken from the composite sample (500 g) and extracted with 150 ml mixture of n-hexane : isopropanol (2:1). The filtered extract was washed with distilled water and the aqueous phase was discarded. The hexane layer was collected through anhydrous

sodium sulphate. A drop of keeper was added and extract was concentrated (ISI 12611:1989).

The concentrated extract was dissolved in 45-50 ml of hexane : acetone (9:1) and little quantity of Darco G 60 (activated charcoal) was added with occasional shakings. This was filtered through filter paper and residues were washed with 3 x 15 ml of hexane : acetone (9:1) mixture. The contents were dried and dissolved in 10 ml of hexane : acetone (9:1) mixture and analysed on Fisons GC.

3.7.1.4 Determination

The residues of endosulfan were determined by Gas Chromatography (GC) with the following parameters.

GC : Fisons-9000

Detector : ECD (Ni^{63}) Electron Capture Detector

Column : Glass packed with 3 % OV-17 on chromosorb WHP 80/100 mesh

Injection (port) temperature (°C) : 230

Column (oven) temperature (°C) : 200

Detector temperature (°C) : 300

Carrier gas and flow (ml/min) : Nitrogen, 40

Retention time (min) :

Endosulfan I	: 9.17
Endosulfan II	: 16.9
Endosulfan sulphate	: 19.4

3.7.2 Analysis of Carbaryl Residues

3.7.2.1 Preparation of standard stock solution

In 100 ml of methanol 100 mg of standard carbaryl was dissolved to get 1000 ppm solution. From this standard stock solution fortification standard containing one ppm of carbaryl was prepared.

3.7.2.2 Recovery

Brinjal fruits were collected from control plots and transferred (100 g) to the reagent bottles after chopping and blending. A known amount of standard solution (equal to 1 ppm) was added. The contents of reagent bottles were then shaken and the samples were subjected to extraction clean-up and determination procedures.

The recovery obtained was 91 per cent at 1 ppm level of fortification.

3.7.2.3 Extraction and clean up

The samples collected at 0, 1, 3, 5, 10 and 15 days after third spraying were chopped and blended. Dichloromethane (100 ml) was added to 50 g blended sample, taken from composite (500 g). The method given by Oeji and Kanazawa (1974) was followed for extraction, clean-up and determination of residues. The extract was suction filtered and then evaporated to near dryness. Later the residues were dissolved in 50 ml hexane and transferred to a separating funnel and 100 ml of acetonitrile was added. Upper hexane layer was discarded and left

over organic phase was transferred to another separating funnel and 250 ml of 5 per cent sodium chloride was added. It was cleaned up later with 2 x 30 ml of dichloromethane (DCM). The cleaned up DCM extract thus obtained was concentrated. The concentrated extract was passed through column having 5 g florisil and eluted using 25-50 ml of dichloromethane. The eluate was again concentrated and dissolved in n-hexane and later subjected to alumina column clean-up.

The final elution with hexane : acetone (9 : 1) was done and evaporated to dryness. To this residual contents, 2 ml of 5 per cent methanolic potassium hydroxide (KOH) was added followed by 1 ml of 0.01 per cent of colour reagent (Nitrobenzene diazonium tetrafluoroborate). This was further diluted to 10 ml and allowed to stand for half an hour and absorbance was measured using Spectronic-20 at 530 nm wavelength. The calibration curve was derived.

3.7.2.4 Standard curve preparation

A quantity of 100 ml technical carbaryl was weighed and dissolved in 100 ml redistilled methanol to give stock solution of 1000 ppm and from this standard solution and subsequent dilutions were made.

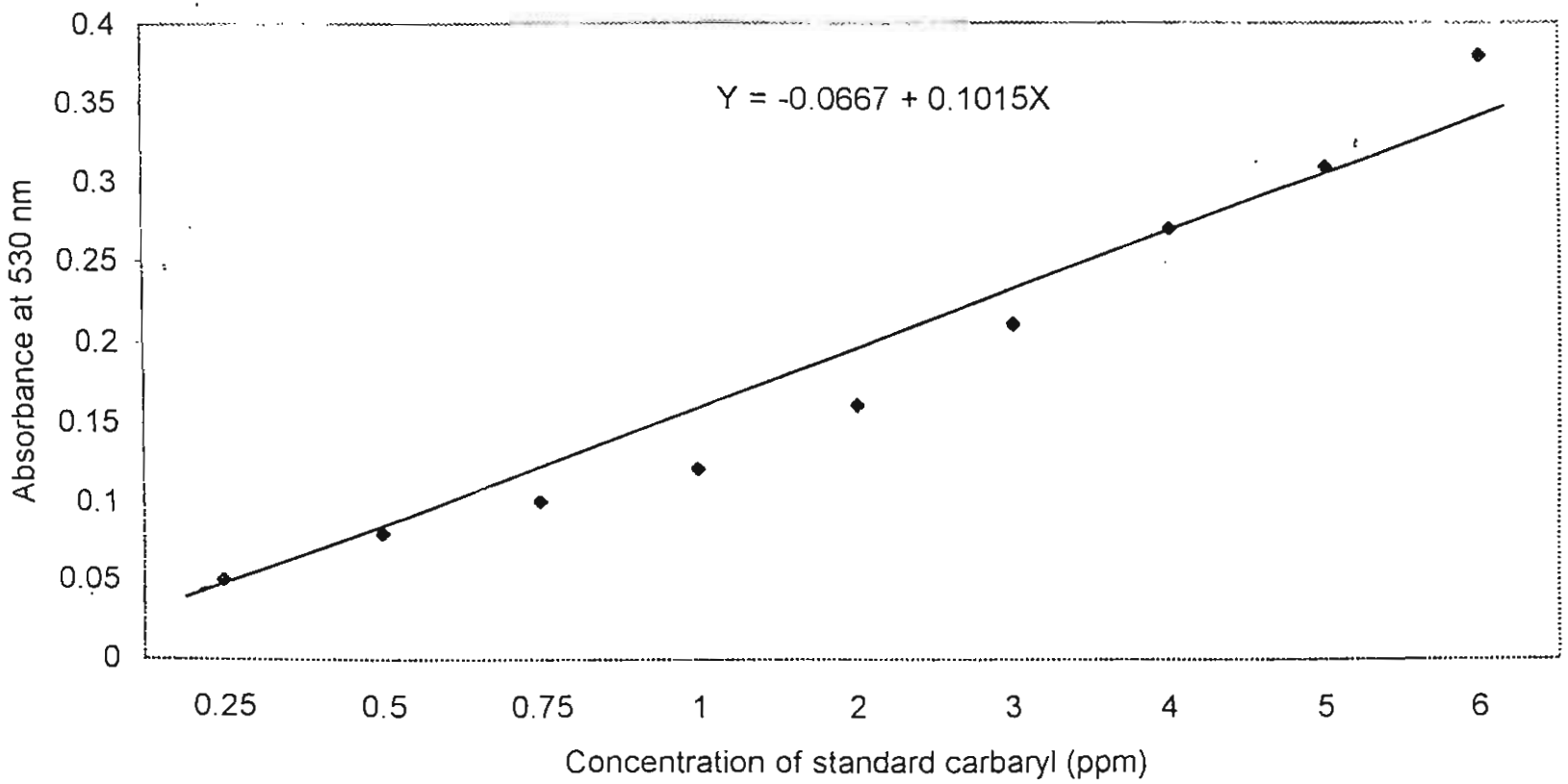
Series of solutions containing 0.25 to 6.0 ppm carbaryl were prepared. To this solution, 2 ml of 5 per cent methanolic KOH was added followed by 1 ml of 0.01 per cent of colour reagent (Nitrobenzene diazonium tetrafluoroborate). This was further diluted to 10 ml and allowed to stand for half an hour and later absorbance was measured using Spectronic-20 at 530 nm

TABLE 2: STANDARD CURVE OF CARBARYL

Concentration of standard carbaryl (ppm)	Absorbance at 530 nm
0.25	0.05
0.50	0.08
0.75	0.10
1.00	0.12
2.00	0.16
3.00	0.21
4.00	0.27
5.00	0.31
6.00	0.38

nm = nanometer
ppm = part per million

FIG. 2: STANDARD CURVE OF CARBARYL



wavelength. A standard curve of carbaryl was prepared by plotting absorbance values against the standard concentrations in ppm (Table 2 and Fig.2).

3.7.3 Analysis of Fenvalerate Residues

3.7.3.1 Preparation of standard stock solution

In 100 ml of n-hexane 100 mg of standard fenvalerate was dissolved to get 1000 ppm solution. From this standard stock solution fortification standard containing one ppm of fenvalerate was prepared.

3.7.3.2 Recovery

Brinjal fruits were collected from control plots and 100 g blended sample was mixed with 100 ml of acetone : hexane (1:1) mixture. A known amount of standard (equal to 1 ppm) of fenvalerate was added. Then the sample was subjected to clean-up and determination of residues.

Recovery obtained was 90 per cent at 1 ppm level of fortification.

3.7.3.3 Extraction and clean up

The brinjal fruit samples collected at 0, 1, 3, 5, 10 and 15 days after third spraying were chopped and blended. Fifty grams of chopped and blended sample from the composite sample (500 g) was extracted with 100 ml of acetone : hexane mixture. Extraction and cleanup was done up as per procedure of Awasthi (1985).

The extract was later sunction filtered and transferred to a one litre separating funnel and diluted with 500 ml distilled water and allowed the layer to separate. The upper hexane phase was collected through anhydrous sodium sulphate and concentrated to about 5 ml.

The concentrated extract was then passed through a glass column containing 5 g of neutral alumina and 5% of florisil overlaid with a 20 mm layer of anhydrous sodium sulphate. The columns were eluted with solvent mixture of hexane : acetone (9:1) and the eluate was collected.

3.7.3.4 Determination

The residues of fenvalerate were determined using Gas chromatograph with the following parameters

GC	:	Packard 437 A
Detector	:	ECD (Ni^{63}) Electron Capture Detector
Column	:	60 cm long, 2 mm with 5 per cent OV-101 on gas chromo 60/80 mesh.

Injection (port) temperature (°C)	: 270
Column (oven) temperature (°C)	: 240
Detector temperature (°C)	: 300
Carrier gas and flow (ml/min)	: Nitrogen, 40
Retention time (min) :	
Fenvalerate	: 3.36

3.8 DECONTAMINATION STUDIES

For decontamination studies, brinjal fruit samples were collected after six hours of third spraying and later on fifth day from endosulfan, carbaryl and fenvalerate treated plots.

The decontamination of insecticide residues was studied by subjecting the harvested brinjal samples to the following procedure viz., dipping of brinjal fruit samples in 2 per cent salt solution for 10 min. followed by washing.

After subjecting to the above decontamination, processing procedure the residue estimation was done using standard procedure as described earlier for the three different insecticides.

3.9 INTERPRETATION OF DATA

3.9.1 Residues (mg/kg)

The following formula was utilised to arrive the residues.

$$= \frac{\text{Area of sample}}{\text{Area of standard}} \times \frac{\mu\text{l of sample injected}}{\text{ng of standard injected}} \times \frac{\text{final volume}}{\text{weight of the sample in g}} \times \text{Recovery factor}$$

3.9.2 Safety Interval

Safety interval (Ttol) for the permissible consumption of crops sprayed with insecticides is defined as the minimum number of days to lapse before insecticide reaches the tolerance limit.

The safety interval were computed by using Hoskins (1961) formula.

$T_{tol} = (\log K_2 - \log tol.)/K_1$

where,

T_{tol}	=	minimum number of days to lapse before the insecticide reaches the tolerance limit.
K_2	=	Initial deposit (ppm)
tol	=	Tolerance limit of the insecticide
K1	=	Regression coefficient of the equation of RL 50.

(b) of log ppm residue (Y) on the number of lapsed days and (X) is calculated by the formula

$$b = \frac{\Sigma (X - \overline{X}) \quad (Y - \overline{Y})}{\Sigma (X - \overline{X})^2}$$

i.e sum of the products of the deviations from means divided by the sum of the squares of the deviations from the mean X.

3.9.3 Prediction Of Approximate Time Required To Dissipate The Residue Below The Tolerance Limit

The period to be allowed to expect the residues to reach below the tolerance limit after treatment for safe use of the treated material was calculated by using the formula (Gunther and Blinn, 1955).

$$y = a + bx$$

where,

y	=	log of tolerance limit
a	=	log of initial deposit
b	=	slope of the regression line

TABLE 3: METEOROLOGICAL DATA RECORDED DURING THE COURSE OF EXPERIMENTAL CROP PERIOD

Month	Temperature (°C)		Relative humidity (%)		Rainfall	No. of rainy days	Sunshine (hrs)	Wind speed (kg/hr)	Evapo-ration (mm/day)	Mean temp. (°C)
	Max	Min	At 07.16 hrs	At 14.16 hrs						
Nov. 99	30.42	15.12	80.96	35.9	0	0	9.33	2.06	3.74	22.8
Dec. 99	28.30	11.30	84	34	--	--	9.4	1.5	3.1	19.8
Jan. 2000	30.2	12.9	84	30	--	--	9.7	1.9	3.6	21.5
Feb,. 2000	31.5	18.0	84	44	--	--	8.5	3.0	4.4	24.7
Mar. 2000	35.4	18.3	70	41	--	--	10.4	2.4	6.7	26.9
Apr. 2000	39.4	23.1	61	36	12.4	2	9.9	3.1	8.2	31.2

RESULTS

CHAPTER IV

RESULTS

4.1 BIO-EFFICACY OF INSECTICIDES AGAINST PEST OF BRINJAL

Six insecticides (Table 1) were evaluated against brinjal jassid, whitefly and shoot and fruit borer. The results obtained on the efficacy of six insecticides on the above pests are presented below.

4.1.1 Jassids

The results obtained about efficacy of insecticides tested on population reduction of jassid are presented.(Table 4, Fig.3 and 4).

4.1.1.1 One day after spraying

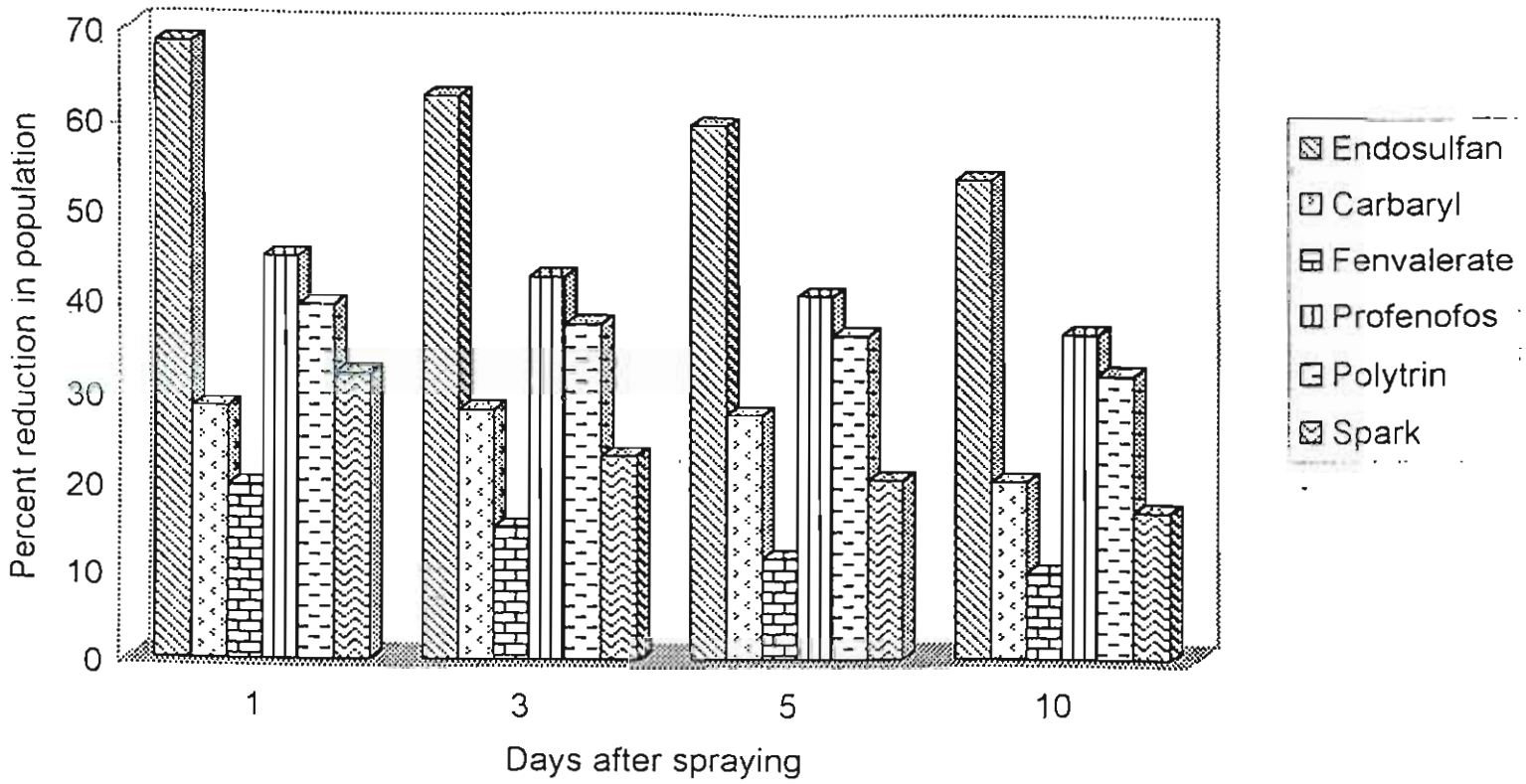
The mean per cent reduction of jassid population one day after five sprayings in all the insecticidal treatments was found to be superior to control. Endosulfan at 350 g a.i/ha showed superiority by recording 68.41 per cent mean reduction of jassid population over control. The other best effective treatments were profenofos at 250 g a.i/ha and polytrin at 220 g a.i/ha with 44.89 and 39.51 per cent mean reduction of jassid population over control, and were at par. Other two insecticides carbaryl at 750 g a.i/ha and spark at 180 g a.i/ha showed less per cent mean reduction, that is 28.48 and 32.10 respectively, and found to be at par with each other.

TABLE 4: EFFICACY OF INSECTICIDES AGAINST JASSIDS AFTER FIVE SPRAYINGS

Treatments	Concentration (g a.i/ha)	Reduction in population (%)				
		1 DAS	3 DAS	5 DAS	10 DAS	Overall efficacy
Endosulfan	350	68.41 (55.90)	62.75 (52.51)	59.35 (50.41)	53.47 (47.04)	60.92 (57.38)
Carbaryl	750	28.48 (32.01)	27.92 (31.53)	27.15 (31.21)	19.93 (26.01)	25.82 (30.32)
Fenvalerate	100	19.80 (26.30)	14.93 (22.66)	11.34 (19.15)	9.73 (17.83)	13.90 (21.70)
Profenofos	250	44.89 (42.05)	42.38 (40.57)	40.25 (39.32)	36.19 (36.87)	40.88 (39.69)
Polytrin	220	39.52 (38.92)	37.11 (37.41)	35.95 (36.80)	31.81 (34.26)	36.06 (36.85)
Spark	180	32.10 (34.32)	22.73 (28.10)	20.05 (26.06)	16.66 (23.64)	22.77 (28.09)
Control	-	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	C.D	7.1476	8.7547	7.6886	8.6671	7.4543
	S.Ed	3.2802	4.0177	3.5285	3.9776	3.4210

The figures in parentheses are angular transformed values

FIG 3 DAY WISE EFFICACY OF INSECTICIDES AGAINST JASSIDS AFTER FIVE SPRAYINGS



Fenvalerate at 100 g a.i/ha was found to be least effective by recording 19.80 per cent mean reduction of jassid population.

4.1.1.2 Three days after spraying

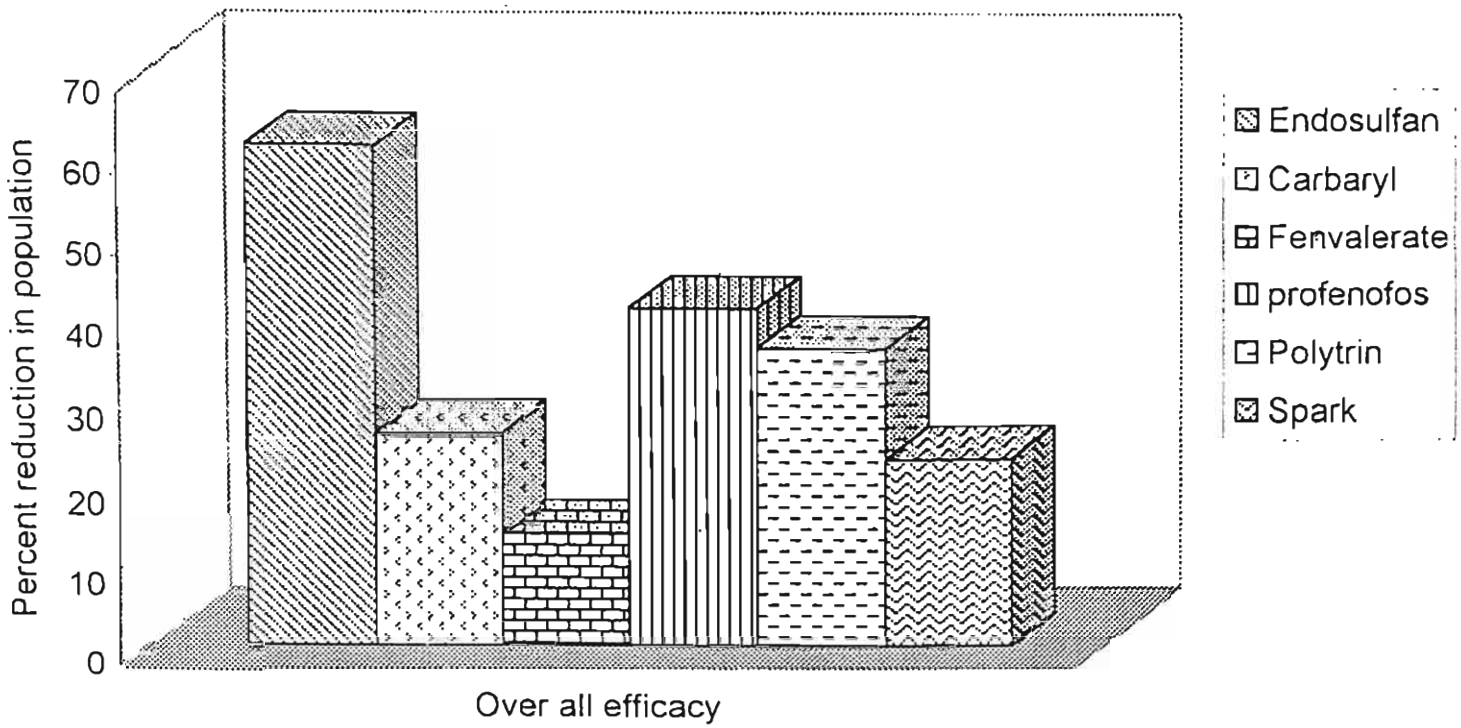
The mean per cent reduction of jassid population three days after five sprayings indicated that all the insecticidal treatments were found to be superior to control. Again endosulfan stood top by recording 62.75 per cent mean reduction of jassid population over control. Profenofos and polytrin showed 42.38 and 37.11 per cent mean reduction of jassid population respectively with no significant difference. Treatments like carbaryl and spark were found to be at par, and gave 27.92 and 22.73 per cent mean reduction of jassid population. Fenvalerate was found to be least effective and gave 14.93 per cent mean reduction of jassid population.

4.1.1.3 Five days after spraying

The superiority of all insecticidal treatments over control was maintained five days after spraying. Endosulfan was effective with high mean per cent reduction of jassid population (59.35) and showed supremacy over other treatments. Other treatments like profenofos and polytrin recorded 40.25 and 35.95 per cent mean reduction, with no significance difference. The treatments which found at par were carbaryl and spark gave 27.15 and 20.05 mean reduction respectively. The treatment fenvalerate was found to be least effective, gave 11.34 per cent mean reduction of jassid population.

Plate 2. Jassid Adults on Brinjal.

Plate 3. Jassid Damage.


Percent reduction in population
70
60
50
40
30
20
10
0
Over all efficacy
Endosulfan
Carbaryl
Fenvalerate
profenofos
Polytrin
Spark

4.1.1.4 Ten days after spraying

Same trend was found even ten days after five sprayings. Again endosulfan showed superiority over other treatments by recording 53.47 per cent reduction. Next to endosulfan, profenofos and polytrin showed 36.19 and 31.81 per cent mean reduction respectively with no significant difference. In other treatments efficacy was found to be in descending order were carbaryl, spark and fenvalerate which showed 19.93, 16.66 and 9.73 per cent mean reduction of jassid population respectively. Carbaryl was found to be on par with spark.

4.1.1.5 Overall efficacy

Overall efficacy of all the insecticidal treatments was found to be significantly superior over control in reducing the jassid population. The endosulfan was effective compared to other treatments in reducing the jassid population (60.92%). Treatments profenofos and polytrin recorded 40.88 and 36.06 per cent reduction of jassid population respectively with no significant difference. The treatments like carbaryl and spark showed 25.82 and 22.77 per cent reduction respectively and found to be at par. Fenvalerate showed less reduction (13.90%) of jassid population and found to be least effective compared to other treatments.

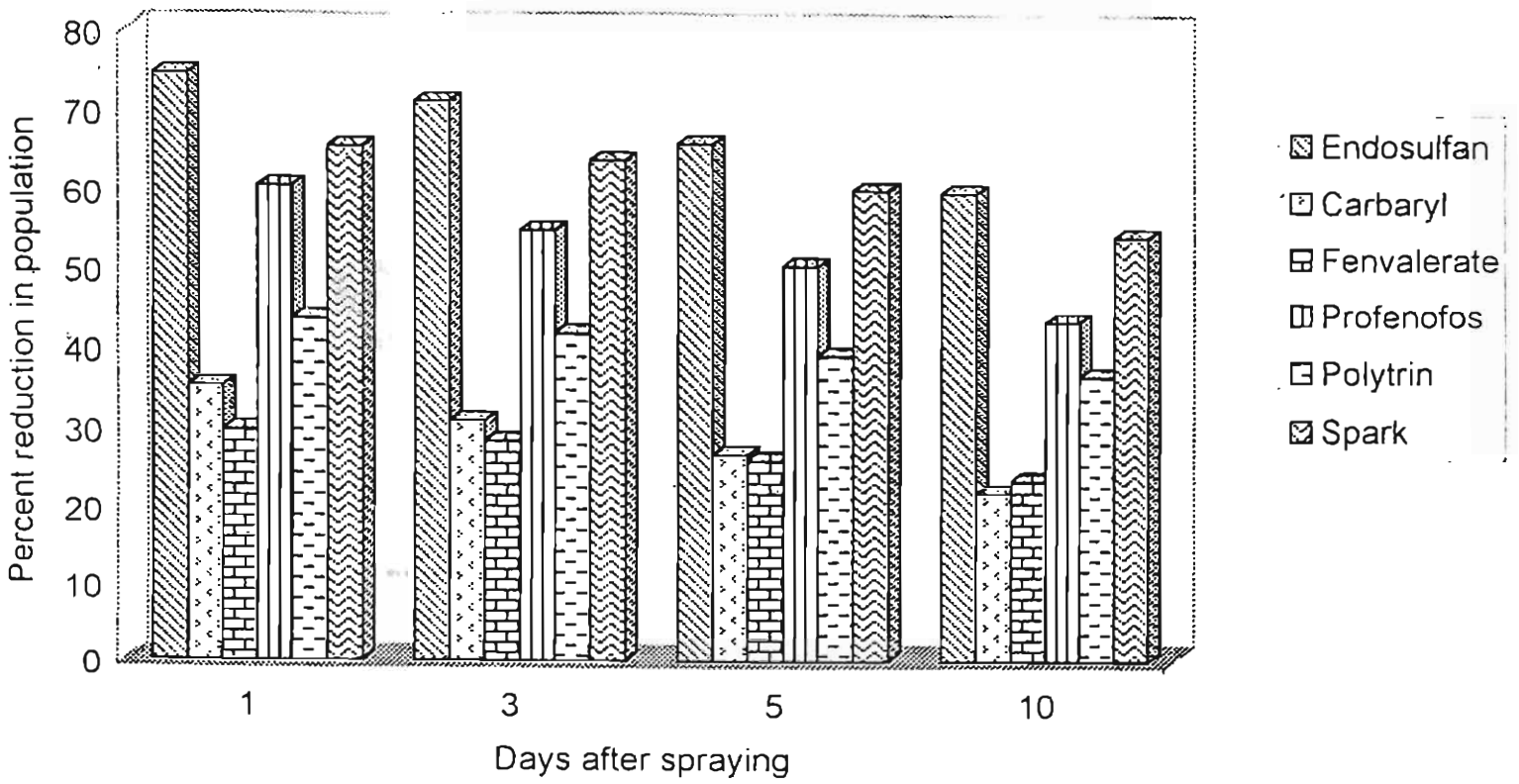
4.1.2 Whiteflies

The results obtained about the efficacy of insecticides on population reduction of whitefly are presented (Table 5, Fig.5 and 6).

TABLE 5: EFFICACY OF INSECTICIDES AGAINST WHITE FLIES AFTER FIVE SPRAYINGS

Treatments	Concentration (g a.i/ha)	Reduction in population (%)				
		1 DAS	3 DAS	5 DAS	10 DAS	Overall efficacy
Endosulfan	350	74.46 (59.67)	71.03 (57.44)	65.69 (54.16)	59.70 (50.60)	67.59 (55.31)
Carbaryl	750	35.25 (36.42)	30.84 (33.70)	26.72 (31.04)	21.63 (27.65)	28.49 (32.23)
Fenvalerate	100	29.88 (33.04)	28.37 (32.14)	26.03 (30.60)	23.32 (28.83)	26.85 (31.14)
Profenofos	250	60.50 (51.06)	54.71 (47.71)	50.31 (45.18)	43.20 (41.08)	52.03 (46.17)
Polytrin	220	43.59 (41.29)	41.71 (40.21)	39.01 (38.60)	36.29 (36.96)	40.10 (39.25)
Spark	180	65.38 (54.00)	63.52 (52.88)	59.98 (50.76)	54.01 (47.32)	60.63 (51.16)
Control	-	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	C.D	5.0871	4.5898	4.9230	5.6741	4.7070
	S.Ed	2.3346	2.1064	2.2593	2.6040	2.1602

The figures in parentheses are angular transformed values


Percent reduction in population
80
70
60
50
40
30
20
10
0
1
3
5
10
Days after spraying
Endosulfan
Carbaryl
Fenvalerate
Profenofos
Polytrin
Spark

4.1.2.1 One day after spraying

All the insecticidal treatments were found to be superior over untreated. The treatment endosulfan showed supremacy on other treatments by recording 74.46 per cent mean reduction of whitefly population. Treatments like spark and profenofos gave 65.38 and 60.50 per cent reduction respectively with no significance difference. The other three insecticides which showed their efficacy in descending order were polytrin, carbaryl and fenvalerate which recorded 43.59, 35.25 and 29.88 per cent mean reduction of whitefly population, respectively. The treatment fenvalerate was found to be least effective (29.88% reduction).

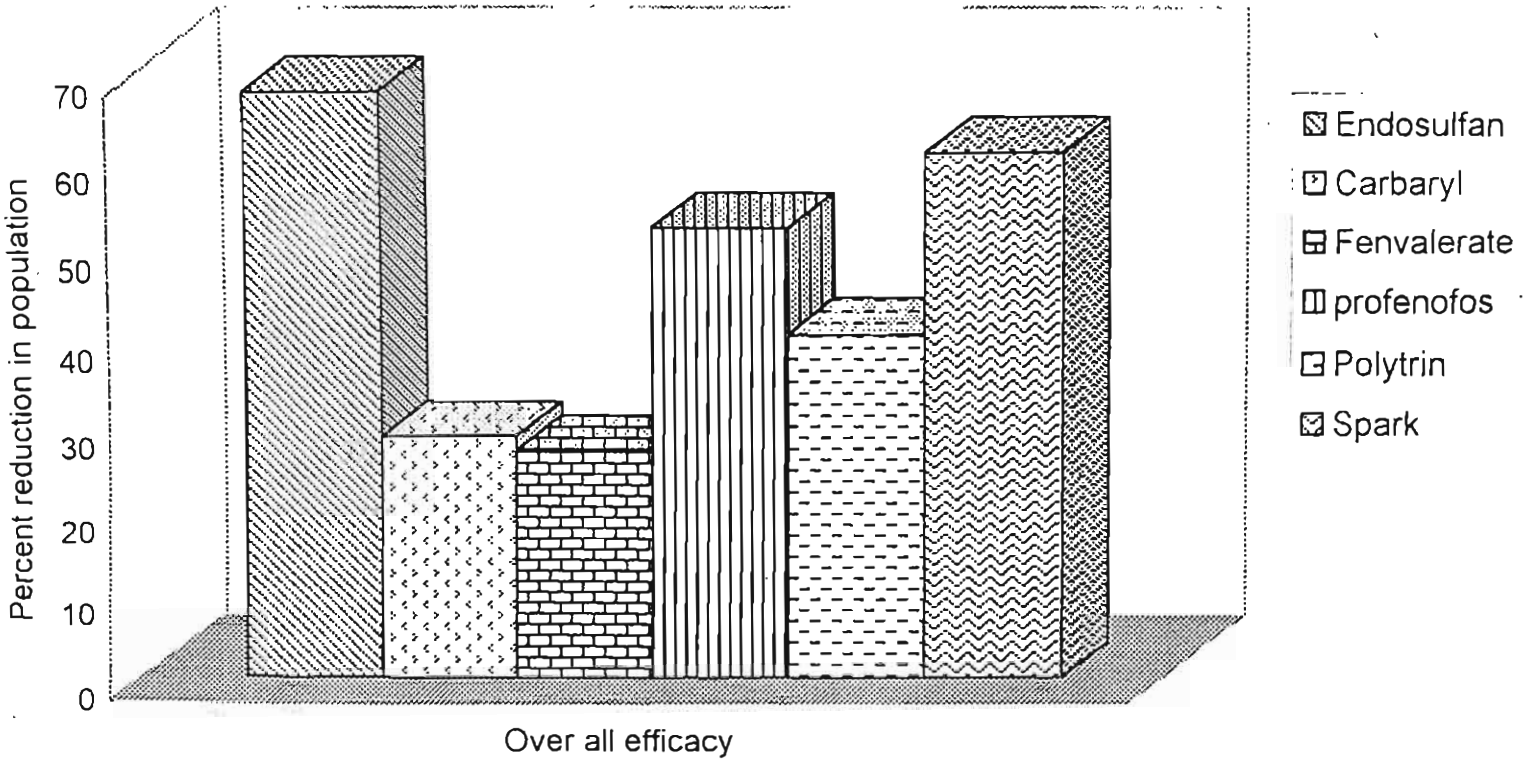
4.1.2.2 Three day after spraying

The same trend was observed three days after five sprayings. All the insecticidal treatments were found to be superior to untreated. Treatment endosulfan found to be superior over other insecticidal treatments by recording highest (71.03%) mean reduction of whitefly population. Spark found to be significant over profenofos and recorded 63.52 and 54.71 per cent mean reduction. The other treatments which showed efficacy in descending order were polytrin, carbaryl and fenvalerate showing 41.71, 30.84 and 28.37 per cent reduction over control respectively. The treatment fenvalerate was found to be on par with carbaryl.

4.1.2.3 Fifth day after spraying

The plots received endosulfan spray showed supremacy over other treatments by recording 65.69 per cent mean reduction of whitefly population over control. The treatment spark showed significance (59.98% reduction) over

Plate 4. Whitefly Adults on Brinjal.


Percent reduction in population
70
60
50
40
30
20
10
0
Over all efficacy
Endosulfan
Carbaryl
Fenvalerate
profenofos
Polytrin
Spark

profenofos (50.31% reduction). Other treatments which showed their efficacy in descending order where polytrin (39.01% reduction), carbaryl (26.72% reduction) and fenvalerate (26.03% reduction). Fenvalerate was found to be on par with carbaryl and showed least efficacy compared to other treatments.

4.1.2.4 Ten day after spraying

Similar trend was observed with endosulfan ten days after spraying continued to show its superiority over other treatments by recording 59.70 per cent mean reduction of whitefly population over control. Spark was found to be significant (54.01% reduction) over profenofos (43.20% reduction).

Other treatments which found to be effective in descending order were polytrin (36.29% reduction), fenvalerate (23.32% reduction) and carbaryl (21.63% reduction). Carbaryl was found to be on par with fenvalerate, but carbaryl was found to be least effective over other treatments.

4.1.2.5 Overall efficacy

Overall efficacy of all insecticidal treatments was found to be superior over control. The treatment endosulfan stood good against the all insecticidal treatments by recording highest (67.59%) mean reduction of whitefly population. Spark (60.63% reduction) was found to be significantly superior over profenofos (52.03% reduction). In other treatments efficacy was found to be in descending order were polytrin (40.10% reduction), carbaryl (28.49% reduction) and fenvalerate (26.85% reduction). Fenvalerate was found to be least effective insecticidal treatment, compared to others and found to be on par with carbaryl.

4.1.3 Shoot and Fruit Borer

The data obtained on the per cent infestation of fruit borer (Table 6 and Fig.7) suggested that all the insecticidal treatments were significantly superior over control in reducing the fruit borer infestation. The treatment spark was most effective and significantly superior over all other treatments by recording only 10.00 per cent infestation, that is 82.58 per cent reduction over control. The other best treatments found to be carbaryl 15.78 per cent fruit infestation (72.50% reduction), endosulfan 16.70 per cent fruit infestation (71.00% reduction). Both endosulfan and carbaryl were found to be at par with each other. Profenofos and polytrin were found to be at par, and showed 21.82 and 21.34 per cent fruit infestation, with 61.97 and 62.82 per cent reduction over control, respectively. Among insecticidal treatments per cent fruit infestation was highest (43.10) in fenvalerate. Highest fruit infestation (57.39%) was observed in untreated plots.

4.2 Efficacy of Insecticides on Yield of Brinjal

The results obtained about the efficacy of treatments, on yield of brinjal are presented in Table 7 and Fig. 8 and suggested that all the insecticidal treatments were significantly superior except fenvalerate over control. The treatment spark stood top over all other treatments, by recording highest (6150 kg ha) yield of brinjal fruits, with 275.69 per cent increase over control. The other best treatments were endosulfan (4020 kg/ha) and carbaryl (3770 kg/ha) with an increase of 145.57 and 130.29 per cent respectively, and were found to be on par. The other treatments which showed their efficacy in descending order were polytrin 3005 kg/ha (83.57% increase), profenofos 2905 kg/ha (77.46% increase) and fenvalerate

TABLE 6: EFFICACY OF INSECTICIDES AGAINST BRINJAL SHOOT AND FRUIT BORER AFTER THREE SPRAYINGS

Treatment	Concentration (g a.i/ha)	Fruit infestation (%)	Reduction over control (%)
Endosulfan	350	16.70 (24.00)	71.00
Carbaryl	750	15.78 (23.39)	72.50
Fenvalerate	100	43.10 (41.04)	24.89
Profenofos	250	21.82 (27.73)	61.97
Polytrin	220	21.34 (27.51)	62.82
Spark	180	10.00 (8.42)	82.58
Control	-	57.39 (49.26)	0
	C.D	4.2137	
	S.Ed	1.9338	

The figures in parentheses are angular transformed values

FIG. 7: EFFICACY OF INSECTICIDES AGAINST BRINJAL SHOOT AND FRUIT BORER AFTER THREE SPRAYINGS

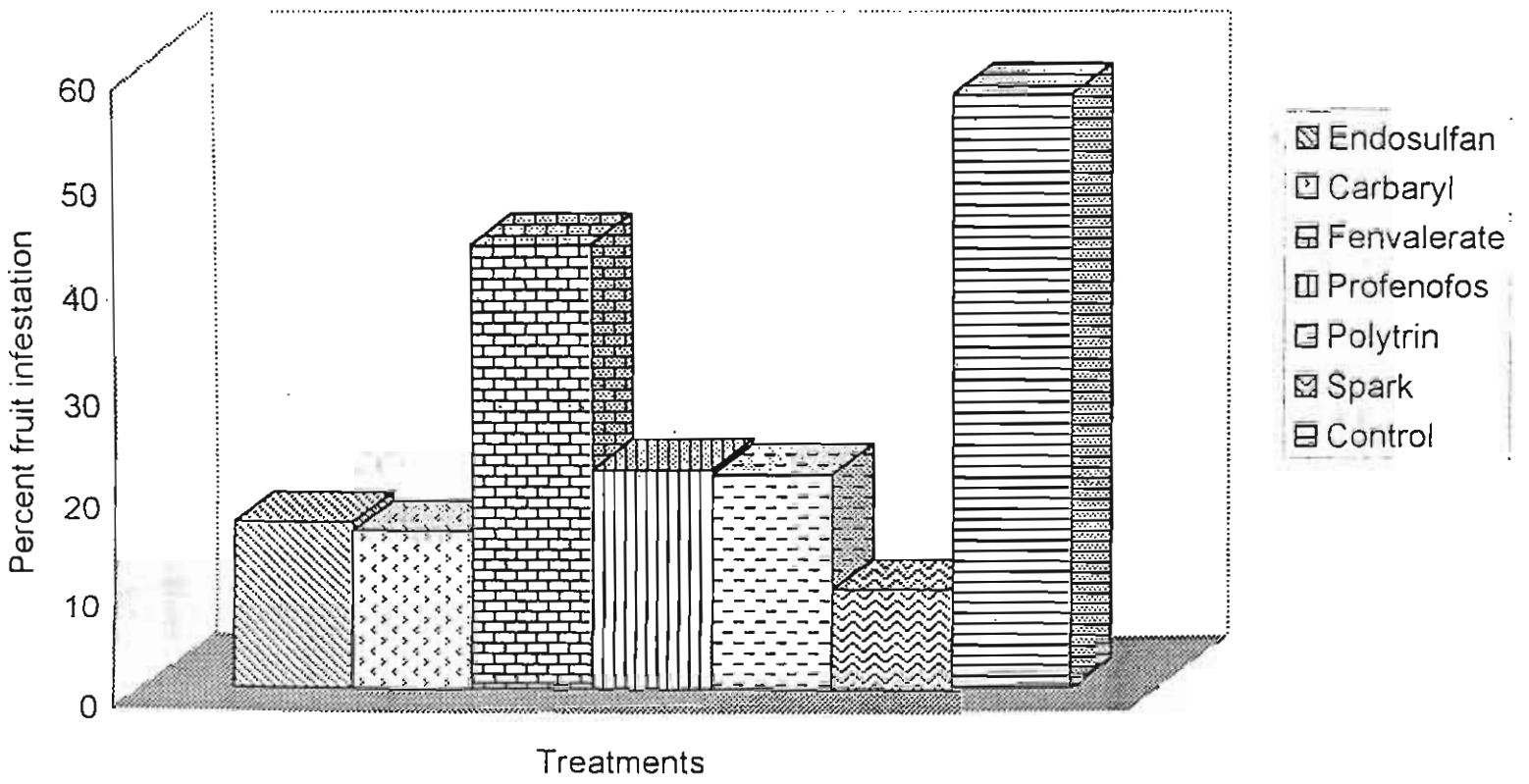
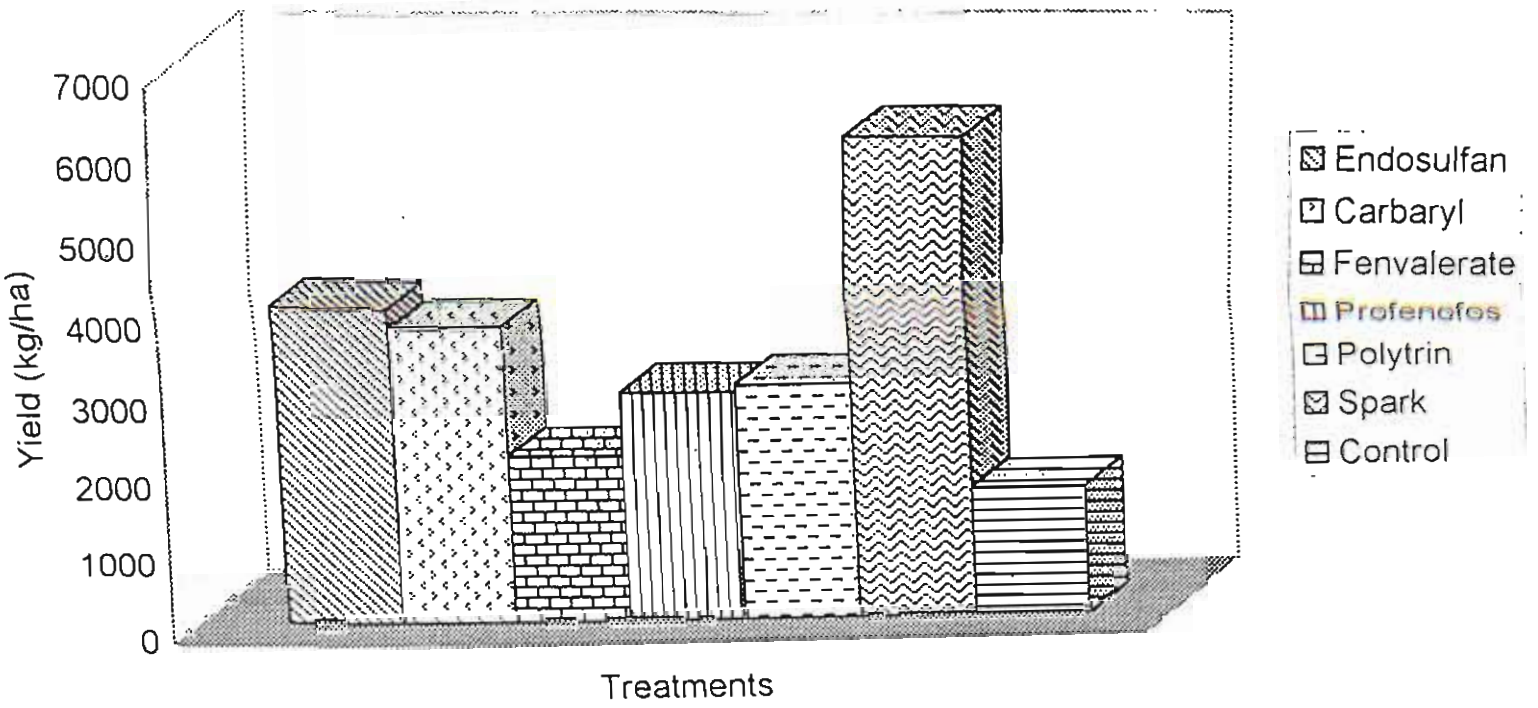


TABLE 7: EFFICACY OF INSECTICIDES ON YIELD OF BRINJAL

Treatment	Concentration (g a.i/ha)	Yield (kg/plot)	Yield (kg/ha)	Percent increase over control
Endosulfan	350	8.04 (16.46)	4020	145.57
Carbaryl	750	7.54 (15.93)	3770	130.29
Fenvalerate	100	4.23 (11.86)	2115	29.19
Profenofos	250	5.81 (13.94)	2905	77.46
Polytrin	220	6.01 (14.19)	3005	83.57
Spark	180	12.30 (20.51)	6150	275.69
Control	-	3.27 (10.41)	1637	-
	C.D	1.4228		
	S.Ed	0.6530		

The figures in parentheses are angular transformed values

-ICACY OF INSECTICIDES ON YIELD OF BRINJAL



with yield 2115 kg/ha (29.19% increase). Fenvalerate was found to be least effective among the insecticidal treatments. Lowest yield of brinjal fruits (1637 kg/ha) was obtained from untreated plots.

4.3 DISSIPATION OF INSECTICIDES IN BRINJAL

The results on dissipation pattern of three insecticides viz., endosulfan @ 350 g, carbaryl @ 750 g and fenvalerate @ 100 g a.i/ha in brinjal are presented here under.

4.3.1 Endosulfan

The residues of endosulfan @ 350 g a.i/ha in brinjal fruits detected at periodical intervals of 0, 1, 3, 5 , 10 and 15 days after third spray are presented in Table 8 and depicted in Fig. 9.

It is evident from the data that initial deposit of endosulfan (5.35 mg/kg) dissipated to 3.06, 2.33, 2.00, 0.51 mg/kg and BDL in 1, 3, 5, 10 and 15 days after third spraying with percentage dissipation of 42.81, 56.45, 59.63, 90.47, and 100 respectively.

The waiting period (T_{tol}) for endosulfan was worked out to be 3.25 days.

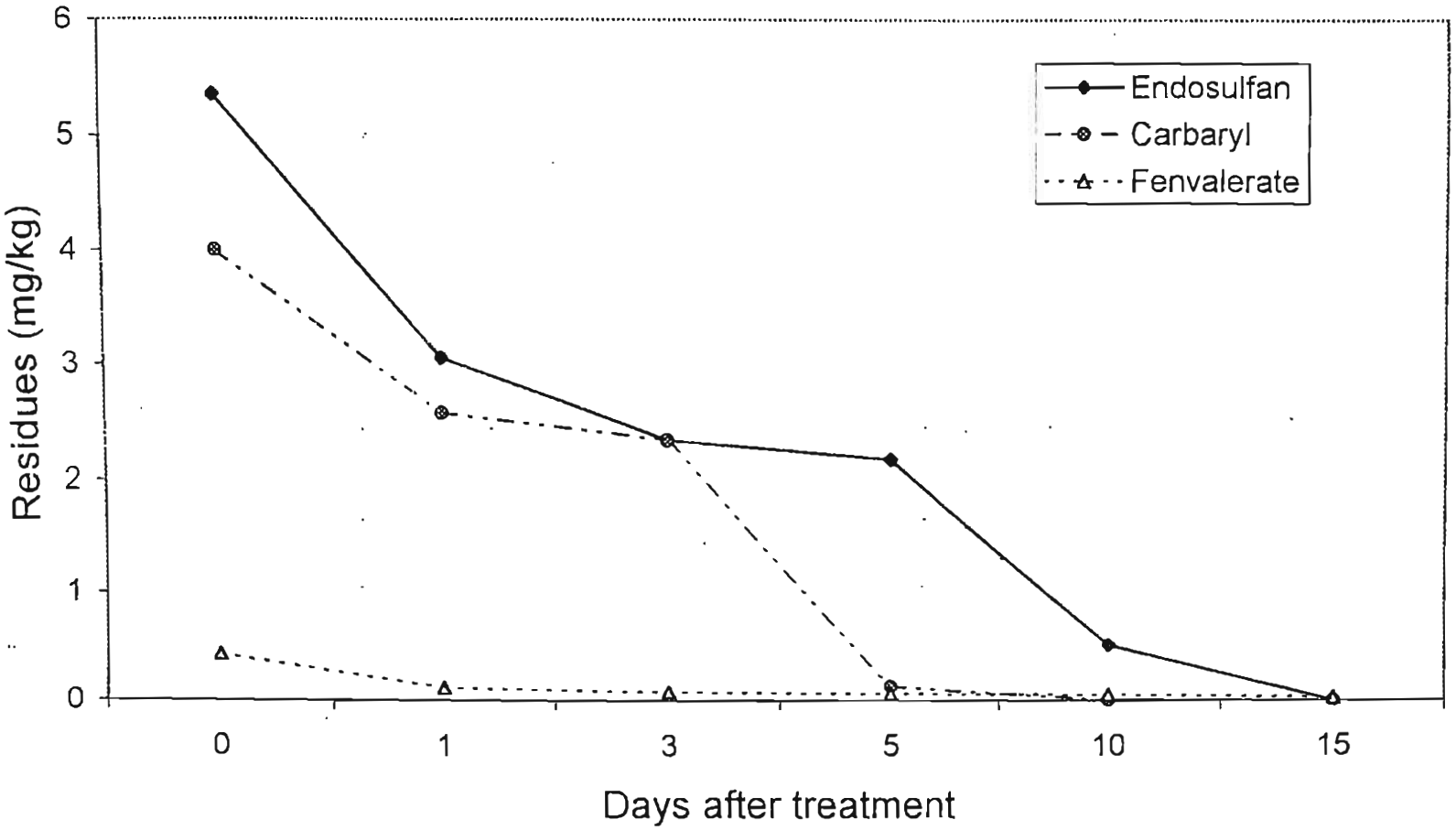
4.3.2 Carbaryl

Carbaryl @ 750 g a.i/ha recorded an initial deposit of 4.01 mg/kg which dissipated to 2.57, 2.33 and 0.13 mg/kg on 1, 3 and 5 days after third spraying, respectively. The residues were below detectable level from 10 days

TABLE 8: DISSIPATION OF ENDOSULFAN, CARBARYL AND FENVALERATE RESIDUES IN BRINJAL

DAT	Endosulfan @ 350 g a i/ha		Carbaryl @ 750 g a i/ha		Fenvalerate @ 100 g a i/ha	
	Residues (mg/kg)*	Dissipation (%)	Residues (mg/kg)*	Dissipation (%)	Residues (mg/kg)*	Dissipation (%)
0.	5.35	-	4.01	-	0.43	-
1	3.06	42.81	2.57	35.92	0.12	72.10
3	2.33	56.45	2.33	41.90	0.08	81.40
5	2.00	59.63	0.13	96.76	0.06	86.05
10	0.51	90.47	BDL	100	0.05	88.38
15	BDL	100	BDL	100	0.03	93.03
Regression equation:	Y = 4.0168 + 0.2202 X		Y = 3.6617 + 0.2791 X		Y = 1.6021 + 0.05818 X	
T_{tol} (days) :	3.25		1.00		1.00	
MRL (mg/kg):	2.00		5.00		0.20	

* Average of three replications BDL = Below Detective Level DAT = Days After Treatment


Endosulfan
Carbaryl
Fenvalerate
Residues (mg/kg)
0
1
2
3
4
5
6
0
1
3
5
10
15
Days after treatment

onwards (Table 8 and Fig. 9). Dissipation percentage was found to be 35.92, 41.90, 96.76, 100 and 100 on 1, 3, 5, 10 and 15 days respectively after third spraying .

The initial deposit itself recorded below MRL 5 ppm (Codex Alimentarius, 1998). The waiting period (T_{tol}) for carbaryl was worked out to be one day.

4.3.3 Fenvalerate

It is evident from the data that initial deposit (0.43 mg/kg) of fenvalerate @ 100 g a.i/ha was dissipated to 0.12, 0.08, 0.06, 0.05 and 0.03 mg/kg in 1, 3, 5, 10 and 15 days after third spraying, with percentage dissipation of 72.10, 81.40, 86.05, 88.38 and 93.03 respectively (Table 8 and Fig. 9).

The waiting period (Ttol) for fenvalerate was worked out to be one day.

4.4 DECONTAMINATION OF INSECTICIDE RESIDUES FROM BRINJAL

The insecticide removal from the brinjal was carried out by using procedure viz., dipping of brinjal fruits in 2 per cent salt solution for 10 minutes followed by washing. The results are presented in Table 9.

4.4.1 Endosulfan

The initial deposit of endosulfan @ 350 g a.i/ha at zero and five days of spraying were found to be 5.35 and 2.00 mg/kg.

TABLE 9: DECONTAMINATION OF ENDOSULFAN, CARBARYL AND FENVALERATE RESIDUES IN BRINJAL

Processing procedures	Endosulfan @ 350 g a i/ha		Carbaryl @ 750 g a i/ha		Fenvalerate @ 100 g a i/ha	
	Residues (mg/kg)*	Removal (%)	Residues (mg/kg)*	Removal (%)	Residues (mg/kg)*	Removal (%)
Six hrs after third spray	5.35	-	4.01	-	0.43	-
2% salt solution dipping (10 min) followed by washing	3.97	25.79	1.59	60.35	0.12	72.10
5 day	2.00	-	0.13	-	0.06	-
2% salt solution dipping (10 min) followed by washing	0.93	56.95	0.098	24.62	0.04	33.34

* Average of three replications

The dipping of brinjal fruits in 2 per cent salt solution followed by washing with water reduced the deposits to 3.97 mg/kg (25.79 %) and 0.93 mg/kg (56.95 %) at zero and fifth day respectively after third spraying.

4.4.2 Carbaryl

The initial deposit of carbaryl @ 750 g a.i/ha at zero and five days of spraying were found to be 4.01 and 0.13 mg/kg. The dipping of brinjal fruits in 2 per cent salt solution followed by washing with water reduced the deposits to 1.59 mg/kg (60.35 %) and 0.098 mg/kg (24.62 %) at zero and fifth day respectively after third spraying.

4.4.3 Fenvalerate

The experimental findings in respect of removal of fenvalerate clearly revealed that the initial deposits of fenvalerate @ 100 g a.i/ha at zero and five days of spraying were found to be 0.43 and 0.06 mg/kg. And dipping of brinjal fruits in 2 per cent salt solution followed by washing with water reduced the deposits to 0.12 mg/kg (72.1 %) and 0.04 mg/kg (33.34 %) at zero and fifth day respectively after third spraying.

Hence the decontamination studies with above processing procedure revealed to be good in removal of insecticide residues to a maximum extent from brinjal fruits.

DISCUSSION

CHAPTER V

DISCUSSION

The results obtained with following objectives in the present investigations were discussed with available literature in this chapter.

i) To study the bioefficacy of endosulfan, carbaryl, fenvalerate, profenofos, polytrin and spark against the pests of brinjal.

ii) To establish dissipation pattern of endosulfan, carbaryl and fenvalerate in brinjal.

iii) To study the effectiveness of decontamination procedure for the removal of endosulfan, carbaryl and fenvalerate residues in brinjal.

5.1 BIOEFFICACY OF INSECTICIDES AGAINST THE PESTS OF BRINJAL

The results obtained about the efficacy of six (Table 1) insecticides against the pests of brinjal are discussed here under.

5.1.1 Jassids

The pooled overall efficacy of five round of insecticidal application showed that all the insecticidal treatments were significantly superior in minimising jassid population over untreated (Table 4).

Endosulfan was found to be most effective against jassid over the others (60.92% reduction). It might be due to its greater persistent with strong contact and stomach activity The efficacy of endosulfan was reported by Singh and Kavadia (1989), Thanki and Patel (1991) and Goel *et al.* (1992) and present findings are in agreement. The next best effective treatment was profenofos and the results obtained in present study were in confirmity with Dhawan and Simwat (1994) who noticed less population of jassid on cotton in profenofos treated plots.

Carbaryl and spark gave 25.82 and 22.77 per cent reduction of jassid population respectively. Less efficacy of carbaryl was due to its short persistence nature. Among six insecticidal treatments tried, fenvalerate was found to be least effective. Fast degradation nature of fenvalerate might have resulted in its low efficacy.

5.1.2 Whiteflies

All insecticidal treatments were found to be superior over control (Table 5) in reducing the whitefly population.

Endosulfan showed supremacy in reducing (67.59%) whitefly population over other treatments. This efficacy is in agreement with, Thanki and Patel (1991) and Verma (1992) who also reported that endosulfan was most effective in controlling the whitefly population.

Plots which received spark registered 60.63% reduction of pest population and was the next best. Dhawan *et al.* (1991) reported superiority of Spark (Deltaphos) in keeping population of sucking pest below economic threshold

level in cotton. Its efficacy might be due to its component insecticide triazophos, which was found to be very effective insecticide against sucking pests.

Profenofos recorded 52.03 per cent reduction of whitefly population followed by polytrin. The efficacy of profenofos over polytrin shows that profenofos was more effective in alone than in combinations. These findings are found to be in close proximity with that of Narasimha Rao *et al.* (1996) who reported efficacy of profenofos and polytrin in checking the population of *B. tabaci* on brinjal. The treatment carbaryl gave only28.49 per cent reduction of whitefly population. It might be due to short persistance of carbaryl (also found in present investigation).

The treatment fenvalerate found to least effective (26.85% reduction) compared to other insecticidal treatments. It might be due to faster degradation of fenvalerate immediately after spraying

5.1.3 Shoot and fruit borer

All the insecticidal treatments were found to be significant over control by recording less per cent of fruit infestation (Table 6). The treatment spark at 180 g a.i/ha was found to be superior over other insecticidal treatments by recording only 10.0 per cent fruit infestation. The per cent reduction of infestation over untreated was 82.58 and was found to be highest over all other treatments. These findings are well supported by Srinivas and Clement Peter (1993), Walunj *et al.* (1998) who observed least damage by borer in plots treated with spark. Carbaryl found to be next best treatment showed 15.78 per cent damage followed by

endosulfan (16.70%). The present findings are in accordance with earlier reports of Singh and Kavadia (1989) and Bothara and Dethe (1991). The efficacy of polytrin was substantial and similar observatioin was made by Srinivas and Clement Peter (1993). The treatment profenofos showed 21.82 per cent infestation which was found to be more in comparison to other new insecticides. This was observed earlier by Mohan (1985).

The treatment fenvalerate was least effective showed 43.10 per cent infestation as against the 57.39 per cent in control. Paul and Ghosh (1990) reported fenvalerate was effective against *L. orbonalis* and our results are not in confirmity.

The low efficacy of fenvalerate against all 3 insect pests of brinjal needs some attention. This might be due to the development of insecticidal resistance, or low quality of the product. The inefficacy of fenvalerate against whitefly and lepidoptera bollworms of cotton is well known due to the development of insecticide resistance. In brinjal also its inefficacy is observed.

5.2 EFFECT OF INSECTICIDES ON YIELD OF BRINJAL FRUITS

All the insecticidal treatments showed increase in yield, over untreated (Table 7). The highest yields (6150 kg/ha) were obtained with spark (180 g a.i/ha) which is resulted due to the significant reduction of insect pests with this insecticidal treatment. The less fruit infestation is directly resulted in good yields. The per cent increase in yield over untreated check was nearly more than 2.5 times (275.69%). Walunj *et al.* (1998) observed increase in yield over untreated in plots treated with spark. Thanki and Patel (1991) and Patil *et al.* (1991) who obtained

greatest yield from endosulfan treated plots. The treatment carbaryl showed less damage by fruit borer (15.78%) than endosulfan but gave less yield (3770 kg/ha) than endosulfan, because of its less effectivity against sucking pest than endosulfan. This was best supported by Mohan (1985).

The next best yields (4020 kg/ha) were recorded with endosulfan which were observed due to reduction of fruit borer and sucking pests. These spark and endosulfan reduced jassids and whiteflies and allowed the crop to recover from sucking pests in early phase of the crop. Later with reduction of fruit borer, the direct healthy fruit yields were increased drastically.

The per cent increase in yields over untreated were 145.57, 130.29 with endosulfan, carbaryl respectively. Moderate increase was noticed with polytrin (83.57) and profenofos (77.46).

The yields of 3005 kg/ha and 2905 kg/ha were obtained with treatments polytrin and profenofos respectively and were at par. The slight increase in yields with polytrin might be due to phytotoxic effect of combination insecticide in addition to low fruit borer infestation. The least efficacy of fenvalerate resulted into low yields (2115 kg/ha). The per cent increase over untreated was very low (29.19). Endosulfan showed increase in yield over carbaryl. This slight increase in yield with endosulfan might be due to its effectivity against sucking pests and shoot and fruit borer, compared to carbaryl. Spark showed more increased in yield over carbaryl. This might be due to its high effectivity against shoot and fruit borer and sucking pests, especially on whiteflies. It also might be due to phytotonic effect of spark in addition to low fruit borer infestation.

5.3 DISSIPATION OF INSECTICIDES IN BRINJAL

The results of dissipation of three insecticides viz., endosulfan, carbaryl and fenvalerate on brinjal indicated their relative persistence and biodegradation. Safe periods are discussed hereunder.

5.3.1 Endosulfan

The present findings showed that the initial deposit of 5.35 mg/kg lost to about 59.63 per cent in 5 days (Table 8). These results were in close confirmity with those of Singh and Kavadia (1988) who observed the similar trend. The dissipation curve (Fig. 9) showed steep decline from zero to one day and thereafter slowly. Residues dissipated 100 per cent in 15 day. These findings are in agreement with reports of Sangama *et al.* (1991) who reported similar persistence of endosulfan.

The waiting period was calculated to be 3.25 days, which was found to be in close confirmity with 3 and 2.57 days, calculated by Dethe *et al.* (1988) and Raha *et al.* (1993) respectively.

5.3.2 Carbaryl

The experimental findings showed the dissipation of carbaryl on brinjal fruits to an extent of 96.76 per cent on 5th day (Table 8) and the residues were found to be below detectable level from 10 days onwards. The dissipation pattern (Fig. 9) indicated the shorter persistence of carbaryl in brinjal.

The initial deposit (4.01 mg/kg) itself recorded below MRL 5 ppm (Codex Alimentarius, 1998). The waiting period (T_{tol}) for carbaryl was worked out to be one day.

5.3.3 Fenvalerate

The present results showed the dissipation of fenvalerate on brinjal fruits to an extent of 72.10 per cent by 1st day itself (Table 8) which was found to be maximum, compared to other two tested insecticides for first day. Later it dissipated very slowly and showed persistance upto 15th day (Fig.9).

The waiting period (T_{tol}) for fenvalerate was worked out to be 1 day. These findings are in close confirmity with the studies of Raha et al.(1993) who report a waiting period of 0.14 day for fenvalerate on brinjal. The waiting periods suggested in the present studies are based on the MRL values. The decontamination studies of the three chemicals was taken up as the residues recorded in traces on fifth day, though residues were below MRL.

5.4 DECONTAMINATION OF INSECTICIDES IN BRINJAL

Dipping of brinjal fruits in 2 per cent salt solution for 10 minutes followed by tap water washing was employed for removal of insecticides from brinjal fruits after three sprayings of insecticides. Results obtained are discussed hereunder (Table 9).

5.4.1 Endosulfan

The treatment dipping of brinjal fruits in 2 per cent salt solution for 10 minutes followed by water wash reduced initial deposit of endosulfan 5.35 mg/kg

to a extent of 3.97 mg/kg (25.79%) at zero day and 2.00 mg/kg to 0.93 mg/kg (56.95%) at five days after third spraying.

5.4.2 Carbaryl

Studies on decontamination of carbaryl revealed that the treatment dipping of brinjal fruits in 2 per cent salt solution for 10 minutes followed by water wash reduced initial deposit of carbaryl 4.01 mg/kg to an extent of 1.59 mg/kg (60.35%) at zero day and 0.13 mg/kg to a extent of 0.098 mg/kg (24.62%) at five days after third spraying.

5.4.3 Fenvalerate

The result on decontamination of test insecticide fenvalerate revealed that the treatment dipping of brinjal fruits in 2 per cent salt solution for 10 minutes followed by water washing reduced initial deposit of fenvalerate 0.43 mg/kg to a extent of 0.12 mg/kg (72.1%) at zero day and 0.06 mg/kg to an extent of 0.04 (33.34%) at fifth day after third spraying.

Awasthi (1986) noticed reduction of residues with salt solution and water wash. The reduction of residues of carbaryl and fenvalerate was more and substantial with 2% salt solution, water wash whereas it was less in case of endosulfan. This reflected the nature of organochlorines. The decontamination percentages are worked out on the initial deposits i.e., first and fifth days separately. Further the retaining of the chemical on the fruit depends on the properties of pesticide and inert material. Hence the variation in removal per cent is observed.

Hence it is concluded from the present studies that the above decontamination procedure is effective in the removal of residues of endosulfan, carbaryl and fenvalerate from brinjal fruits to a considerable extent for attainment of acceptable residue levels.

SUMMARY

CHAPTER VI

SUMMARY

Field experiment was conducted using endosulfan @ 350 g a.i/ha, carbaryl @ 750 g a.i/ha, fenvalerate @ 100 g a.i/ha, profenofos @ 250 g a.i/ha, polytrin @ 220 g a.i/ha and spark @ 180 g a.i/ha to study the bioefficacy against pest complex of brinjal. The dissipation and decontamination study was also undertaken with endosulfan, carbaryl and fenvalerate. The findings are summarised hereunder.

Endosulfan @ 350 g a.i/ha was adjudged as the best treatment in controlling the jassid population followed by profenofos @ 250 g a.i/ha and polytrin @ 220 g a.i/ha. Fenvalerate @ 100 g a.i/ha was least effective against jassids when compared to other insecticidal treatments.

Endosulfan @ 350 g a.i/ha was also most effective in checking the whitefly population followed by spark @ 180 g a.i/ha and profenofos @ 250 g a.i/ha. Fenvalerate @ 100 g a.i/ha was found to be least effective against whiteflies when compared to other insecticidal treatments.

The brinjal shoot and fruit borer was effectively controlled by spark @ 180 g a.i/ha followed by carbaryl @ 750 g a.i/ha. Fenvalerate @ 100 g a.i/ha was found to be less effective against fruit and shoot borer when compared to other insecticidal treatments. Spark @ 180 g a.i/ha recorded maximum yield (6150 kg/ha) followed by endosulfan @ 350 g a.i/ha (4020 kg/ha).

Fenvalerate @ 100 g a.i/ha recorded least yield of (2115 kg/ha) when compared to other insecticidal treatments.

The initial deposits of endosulfan @ 350 g a.i/ha, carbaryl @ 750 g a.i/ha and fenvalerate @ 100 g a.i/ha recorded were 5.35, 4.01 and 0.43 mg/kg, respectively. Both endosulfan and carbaryl dissipated to below detectable level, and fenvalerate to 0.03 mg/kg by fifteenth day after third spraying in brinjal fruits. The waiting periods for endosulfan, carbaryl and fenvalerate were worked out to be 3.25, 1 and 1 days, respectively.

Dipping of brinjal fruits in 2 per cent salt solution for 10 minutes followed by water washing was found to be effective in the removal of residues of endosulfan, carbaryl and fenvalerate from brinjal fruits to a considerable extent for attainment of acceptable residue levels.

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5.3 DISSIPATION OF INSECTICIDES IN BRINJAL

The results of dissipation of three insecticides viz., endosulfan, carbaryl and fenvalerate on brinjal indicated their relative persistence and biodegradation. Safe periods are discussed hereunder.

5.3.1 Endosulfan

The present findings showed that the initial deposit of 5.35 mg/kg lost to about 59.63 per cent in 5 days (Table 8). These results were in close confirmity with those of Singh and Kavadia (1988) who observed the similar trend. The dissipation curve (Fig. 9) showed steep decline from zero to one day and thereafter slowly. Residues dissipated 100 per cent in 15 day. These findings are in agreement with reports of Sangama *et al.* (1991) who reported similar persistence of endosulfan.

The waiting period was calculated to be 3.25 days, which was found to be in close confirmity with 3 and 2.57 days, calculated by Dethe *et al.* (1988) and Raha *et al.* (1993) respectively.

5.3.2 Carbaryl

The experimental findings showed the dissipation of carbaryl on brinjal fruits to an extent of 96.76 per cent on 5th day (Table 8) and the residues were found to be below detectable level from 10 days onwards. The dissipation pattern (Fig. 9) indicated the shorter persistence of carbaryl in brinjal.

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All MRL values have been taken from Codex Alimentarius (1998).

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