

**BIOEFFICACY OF PHOSPHAMIDON 40 SL AGAINST SUCKING
PESTS OF RICE, COTTON AND BRINJAL**

*Thesis submitted in part fulfilment of the requirements for the award of the degree of
Master of Science (Agriculture) in Agricultural Entomology to the
Tamil Nadu Agricultural University, Coimbatore -3*

By

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**DEPARTMENT OF AGRICULTURAL ENTOMOLOGY
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TAMILNADU AGRICULTURAL UNIVERSITY
COIMBATORE – 641 003**


2000

CERTIFICATE

This is to certify that the thesis entitled "BIOEFFICACY OF PHOSPHAMIDON 40 SL AGAINST SUCKING PESTS OF RICE, COTTON AND BRINJAL" submitted in part fulfilment of the requirements for the award of the degree of MASTER OF SCIENCE (AGRICULTURE) IN AGRICULTURAL ENTOMOLOGY to the Tamil Nadu Agricultural University, Coimbatore is a record of *bonafide* research work carried out by Mr. T. SRINIVASAN under my supervision and guidance and that no part of this thesis has been submitted for the award of any other degree/diploma/ fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journal or magazine.

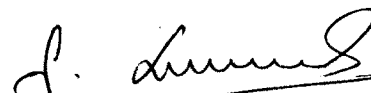
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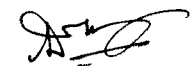

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Abstract

ABSTRACT

BIOEFFICACY OF PHOSPHAMIDON 40 SL AGAINST SUCKING PESTS OF RICE, COTTON AND BRINJAL

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Studies were carried out to evaluate the bioefficacy of phosphamidon 40 SL as foliar application against sucking pests of rice, cotton and brinjal, toxicity to natural enemies, phytotoxic effect and safety to non-target organisms.

Results of the field experiments conducted in rice, at two locations revealed that phosphamidon 40 SL at 500 g a.i/ha was effective against green leafhopper (GLH), brown planthopper (BPH) and white backed planthopper (WBPH) and was on par with phosphamidon 85 WSC @500 g a.i/ha. The effect persisted for 10 days and a second application was necessary after 15 days to prevent further population build up of the sucking pests.

Results of the studies on cotton indicated that phosphamidon 40 SL at 300 g a.i/ha was effective against leafhopper, aphid and whitefly and was on par with that of phosphamidon 85 WSC @300 g a.i/ha for a period of one week. However, a second spraying at 15 days interval was necessary to prevent heavy population build-up.

In case of brinjal, the population of sucking pests were significantly reduced by the application of phosphamidon 40 SL at 300 g a.i/ha. However, the chemical was not as effective as monocrotophos 36 WSC which recorded higher per cent reduction of population. Phosphamidon 85 WSC @300 g a.i/ha was found to be on par with monocrotophos 36 WSC.

The results of the toxicity of phosphamidon 40 SL to natural enemies of rice ecosystem indicated that, negligible levels of toxicity was noticed for phosphamidon 40 SL @ 500 g a.i/ha and the chemical was almost non-toxic to the predatory coccinellids. In cotton and brinjal ecosystem too, phosphamidon 40 SL @300 g a.i/ha recorded lower levels of toxicity to spiders.

Foliar application of phosphamidon 40 SL at four times the normal dosage did not cause any phytotoxic symptoms on rice, cotton and brinjal.

Persistent toxicity studies on rice with phosphamidon 40 SL @500 g a.i/ha showed a persistence of 9 days for BPH and WBPH. With regard to cotton leafhopper and aphid, the persistence was 13 and 17 days respectively for phosphamidon 40 SL @300 g a.i/ha. The chemical at 300 g a.i/ha against aphid and leafhopper of brinjal exhibited a persistence of 15 days. However, phosphamidon 85 WSC @500 g a.i/ha and 300 g a.i/ha excelled phosphamidon 40 SL against all the pests tested.

Laboratory studies revealed that, phosphamidon 40 SL at all doses, were less toxic to *Chrysoperla carnea* Stephens allowing higher egg hatchability, lesser grub mortality, higher rates of pupation and adult emergence. With regard to *Trichogramma chilonis* Ishii. too, phosphamidon 40 SL at all the doses allowed higher rates of parasitisation and adult emergence.

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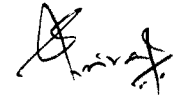
To my affectionate family members to whom I owe everything for their dedicated efforts and loving encouragement, I take this opportunity to extend my thanks with utmost devotion.

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Introduction

CHAPTER I

INTRODUCTION

One of the major causes for the low yield in cultivated crops is the damage caused by insect pests. Although, many insect species live and feed on crops, only a few sucking pests such as leaf and planthoppers, whiteflies and aphids cause significant damage by reducing the vitality. Several insecticides of different groups *viz.*, chlorinated hydrocarbons, organophosphate compounds, carbamates and synthetic pyrethroids were used from time to time to control the sucking pests.

Organophosphorus compounds such as phosphamidon, monocrotophos, chlorpyrifos, etc. with contact and systemic action have been used for the control of sucking pests (David and Kumaraswami, 1991; Falerio and Patil, 1991; Mall et al. 1997; Gupta et al. 1999) since the advent of chemical pesticides. Continuous use of chemicals like phosphamidon 85 WSC in larger quantities, resulted in problems to non-target organisms and beneficial organisms and also pose environmental threats, because of the high active ingredient in the formulation. Nevertheless, phosphamidon is one of the most effective chemicals for the control of sucking pests of rice (Biswas and Mandal, 1992; Rabbi et al. 1993; Korat et al. 1997), cotton (Santhini and Uthamasamy, 1997; Javaid Iqbal et al. 1997; Brar et al. 1999; Gupta et al. 1999) and brinjal (Shashi Verma, 1992; Dhamdhare and Mathur, 1994; Mall et al. 1997). Very recently, on 31st March, 2000, phosphamidon 85 WSC was banned in India in response to a circular issued by GOI.

M/s. Sudharshan Chemical Industries Ltd. reviewed the above results and came forward with a new formulation of phosphamidon *viz.*, 40 SL, which has a reduced active ingredient than the previous formulation and with the same bioefficacy, with an intention to reduce hazards to human beings (through dermal exposure) and natural enemies.

Rice (*Oryza sativa* L.) is the staple food crop of our country occupying an area of 42.7 million hectares with productivity of 2.8 tonnes/ha (Anon, 2000). However, the yield of rice has to increase by 25-30 per cent from its present level to meet the growing needs of food requirement. This lag in the yield level is attributed to many reasons and problems due to pests is one among them. The crop is attacked by a wide array of pests and among the sucking pests, green leafhopper, *Nephotettix virescens* (Dist.), brown plant hopper, *Nilaparvatha lugens* (Stal.) and white backed plant hopper *Sogatella furcifera* (Horvath) cause substantial damage effecting severe yield losses.

Cotton (*Gossypium hirsutum* L.), the king of fibre crops is cultivated in about 8.3 million hectares (Anon,2000) and sustains about 60 million people in our country. In spite of improved crop production technologies, the average cotton yield in our country is only 277 kg/ha (Anon, 1989). The major constraint in achieving higher productivity is the loss due to insect pests including leaf hopper, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius), aphid, *Aphis gossypii* Glover and thrips, *Thrips, tabaci* Lind.

Brinjal (*Solanum melongena* Linn.) the poor man's vegetable crop is cultivated in about 4.47 million ha. with a productivity of 13.08 tonnes/ha. The crop is a breeding ground for a variety of sucking pests such as leaf hopper, *Amrasca biguttula biguttula* (Ishida.), white fly, *Bemisia tabaci* (Gennadius), aphid, *Aphis gossypii* Glover,etc. which cause significant yield losses.

Keeping in view, the effectiveness of phosphamidon 85 WSC in controlling the sucking pests on one hand, and the various hazards caused by this insecticide to non-target organisms on the other hand, the present study is focussed on the following objectives based on the protocol supplied by M/s. Sudharshan Chemical Industries Ltd., Pune.

1. To evaluate the bioefficacy of phosphamidon 40 SL against sucking pests of rice, cotton and brinjal, its toxicity to natural enemies and phytotoxicity, if any, under field conditions.
2. To study the safety of phosphamidon 40 SL to natural enemies *viz.*, *Trichogramma chilonis* (Ishii.) and *Chrysoperla carnea* Stephens under laboratory conditions.
3. To evaluate the persistent toxicity of phosphamidon 40 SL against sucking pests of rice, cotton, and brinjal under green house conditions.

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

Among all available pesticides, the organophosphorus group occupies an important position as pest control agents. Of the 900 pesticides in use, globally, about 250 are of organophosphorus group in India. The use of organophosphorus pesticides started in 1960's. In the beginning, the pesticides were imported with the availability of indigenous phosphorus. Cynamid (India) Ltd. erected a plant in 1963 to manufacture malathion (Roy and Gupta, 1995). Since then, other organophosphorus insecticides are also being manufactured. Gharda chemicals, Excel Industries Ltd., Montari Industries Ltd., Rallis India Ltd., Sudharshan Chemical Industries Ltd. and other industries are also actively involved in developing indigenous technologies for organophosphorus insecticides. In the search for new pesticides, to replace old and obsolete ones, a large number of new organophosphorus compounds have been synthesised and evaluated for insecticidal properties.

The dominant influence of sucking pests poses problems, in monocrop systems. The pest management practices rely mainly on insecticides, because of their quick knock down effect even though they have certain drawbacks. Information available on the toxicity of organophosphorus insecticides against sucking pests of rice, cotton and brinjal, effect of such insecticides on parasitoids and predators are reviewed hereunder.

2.1. Effectiveness of insecticides against sucking pests of rice

Rice is the staple food crop for more than one half of the world's population and the production of rice in India is limited by many factors and the important one being the severe outbreak of insect pests and diseases. Organophosphorus insecticides such as phosphamidon, monocrotophos and chlorpyrifos have been successfully used for the control of sucking pests *viz.*, green leaf hopper, brown plant hopper and whitebacked plant hopper (Rao and Rao, 1984).

2.1.1. Green leafhopper (GLH) *Nephotettix virescens* (Distant)

Dahipale et al. (1979) observed 70 per cent reduction in leaf hopper population when a mixture of urea and phosphamidon were applied. Lakshmanan et al. (1985) recommended a mixture of one per cent urea and phosphamidon 85 EC (320 ml/ha) at 20 and 35 days after transplanting (DAT) for effective control of GLH. The survival of GLH on rice seedlings was affected due to application of phosphamidon and carbofuran (Narasimhan and Mariappan, 1988).

Velusamy and Subramanian (1987) reported that phosphamidon at 210 g a.i/ha effectively controlled green leafhopper population. Krishniah and Ghosh (1988) in their studies with organophosphorus insecticides reported that monocrotophos and phosphamidon at 0.05 per cent were less effective in controlling *Nephotettix sp.* But Biswas and Mandal (1992) reported that soaking seeds for 12 h in 0.02 per cent solution of phosphamidon, monocrotophos or chlorpyriphos or spraying with 0.05 per cent monocrotophos effectively controlled GLH. Rabbi et al. (1993) found out that phosphamidon (Pilacron 100 SL) and monocrotophos (Megaphos 40 SL) were effective under green house conditions against GLH but were not satisfactory in field tests.

Kalode et al. (1970) reported that foliar spraying of monocrotophos and chlorpyriphos were effective against green leafhopper adults. Hseieh (1976) and Mani and Jayaraj (1977) confirmed the efficacy of monocrotophos against green leafhoppers. Observations made under field conditions revealed that monocrotophos was effective against green leafhoppers (Fabellar and Mochida, 1985). The knockdown effect and persistence was found to be higher for monocrotophos (Krishniah and Kalode, 1986).

Macatula et al. (1987) reported that monocrotophos @0.75 g a.i/ha and 0.37 g a.i/ha gave good control of GLH and the yield was also higher. Shukla and Kaushik (1994) compared monocrotophos @0.5 kg a.i/ha with neem products and found out that the

former was effective in controlling GLH. Field studies conducted in Orissa revealed that GLH population can be better managed by integrating neem derivatives at 20 and 70 DAT along with monocrotophos @0.4 kg a.i/ha (Mahapatra and Nanda, 1998).

2.1.2. Brown planthopper (BPH), *Nilaparavatha lugens* Stal.

Kalode (1976) recommended monocrotophos and phosphamidon at 0.4 kg a.i/ha for brown planthopper control. Krishniah and Kalode (1987) observed that monocrotophos and phosphamidon at recommended dosages were effective against BPH. Phosphamidon brought down the population of BPH during an outbreak in Thanjavur District in 1987 (Natarajan et al. 1988).

Studies conducted in Philippines revealed that 0.04 per cent monocrotophos spray was found to be more effective against BPH (Anonymous, 1968). Lim and Ong (1978) recommended foliar spraying of monocrotophos against nymphs of brown planthopper. According to Velusamy et al. (1978), foliar spray of monocrotophos was found to be effective against BPH when applied at 70 and 77 days after transplanting. Bhudhasami et al. (1979) and Nattar (1979), too, reported that monocrotophos was effective against BPH. Krishniah et al. (1982) observed that foliar sprays of carboxyl and monocrotophos were the better insecticides for greater knockdown effect and longer persistence against BPH. Other workers like Acquino and Heinrichs, (1980) and Krishnamoorthy et al. (1984), have also proved the effectiveness of monocrotophos in the control of BPH. A mixture of neem oil and monocrotophos gave greater reduction in survival of nymphs than insecticides alone (Krishniah et al. 1993).

The egg hatchability of BPH was also affected by monocrotophos at 0.5 kg a.i/ha (Senguttuvan and Gopalan, 1990). Gubbiah et al. (1990) reported that monocrotophos was found to be inferior to synthetic pyrethroids in controlling BPH. According to Mahapatra et al. (1991) monocrotophos was most toxic to BPH followed by chlorpyrifos.

Mao and Ling (1992) proved that BPH was susceptible to monocrotophos while Dash et al. (1996) reported that monocrotophos @0.5 kg a.i/ha was effective against BPH at 47 and 70 DAT.

The effectiveness of chlorpyrifos 0.1 per cent concentration as seedling root dip for 1min. in the control of BPH has been reported by Rao and Rao (1982). Jena et al. (1986) reported that, seed treatment of chlorpyrifos (Dursban) prevented attack by BPH for upto 26 days.

2.1.3. Whitebacked planthopper (WBPH), *Sogatella furcifera* (Horvath)

Saha (1986) reported that chlorpyrifos @0.5 kg a.i/ha and phosphamidon at 0.5 kg a.i/ha were effective against WBPH. Laboratory experiments conducted by Ramaraju et al. (1987) indicated that phosphamidon @ 0.05 per cent had high ovicidal action and caused a reduction in reproductive rates. Korat et al. (1997) proved that phosphamidon and phorate were effective against WBPH and the grain yield was also higher in treated plots.

Foliar spraying with monocrotophos at 80 DAT gave effective control of WBPH adults had been observed by Kushawa et al. (1986). Panda et al. (1989) compared monocrotophos with synthetic pyrethroids and proved that monocrotophos was effective against WBPH. Haq et al. (1991) observed that monocrotophos gave the highest mortality of WBPH after 72 h. The efficacy of monocrotophos (Monocil) was studied by Khan and Kushawa (1991) against WBPH at various stages of development and they confirmed that protection at earhead stage was the most economic and was essential to prevent yield losses. Field experiments conducted by Panda et al. (1991) proved that monocrotophos @500 g a.i/ha gave the best control for upto 90 days after treatment. Mao and Ling (1992) reported that WBPH was more susceptible to monocrotophos, while Shukla and Kaushik (1994) reported that sprays of monocrotophos at 0.5 kg a.i/ha

resulted in 91.3 per cent reduction of WBPH. Sontakke et al. (1994) compared neem products with insecticides and proved that monocrotophos and chlorpyriphos excelled the neem products in controlling WBPH. Akbar et al. (1996), too compared the neem products with monocrotophos and methyl parathion and confirmed that monocrotophos was the most effective chemical against nymphs and adults of WBPH. The efficacy of monocrotophos at 0.5 kg a.i/ha in checking the WBPH population was reported by Sontakke (1993) and Dash et al. (1996).

Sasmal et al. (1984) reported that sprays of insecticides, chlorpyriphos and monocrotophos @ 0.5 kg a.i/ha caused 90 per cent mortality of WBPH within 24 h of application.

2.2. Effectiveness of insecticides against sucking pests of cotton

Cotton is an important fibre crop and is attacked by numerous pests such as leafhoppers, aphids, whiteflies, etc. which may account for an yield loss of 4.6 per cent (Satpute et al. 1988). Several insecticides such as dimethoate, monocrotophos and phosphamidon, have been proved effective against these sucking pests.

2.2.1. Leafhopper, *Amrsasca biguttula biguttula* Ishida.

Bhamburkar (1986) proved that phosphamidon @0.34 kg a.i/ha and methamidophos @ 0.8 kg a.i/ha were effective against leaf hoppers under dryland conditions and the yield was also higher. In contrast, Hande and Dhanorkar (1985) reported that synthetic pyrethroids were superior to phosphamidon in the control of leaf hoppers. Phosphamidon 100 EC @ 0.05 per cent was recommended for the control of leafhoppers by Raju and Reddy (1988). Javaid Iqbal et al. (1997) noticed highest mortality of leaf hoppers at 24 and 48 h after spraying with monocrotophos (Nuvacron 40 WSC) and phosphamidon (Dimecron 100 WSC) respectively. Laboratory studies conducted by Santhini and Uthamasamy (1997) revealed that leaf hoppers have developed tolerance to methyl demeton, dimethoate and phosphamidon.

Gupta et al. (1999) evaluated the efficacy of different insecticidal schedules and reported that foliar sprays of dimethoate (0.05%) methyl demeton (0.04%) and phosphamidon (0.04%) were effective against leafhoppers, whiteflies and aphids.

Patil et al. (1991) reported that better control of leafhoppers was achieved with monocrotophos @360 g a.i/ha and dimethoate @ 555 g a.i/ha. Several other authors have reported that monocrotophos was effective in controlling leaf hoppers (Karuppuchamy et al. 1986; Dhawan et al. 1988; Dhandapani et al. 1988; Patel and Bhalani 1988; Surulivelu and Kumaraswamy, 1989; Patil et al. 1991; Banbote et al. 1995; Patel and Yadav, 1995; Javaid Iqbal, 1997; Patel, 1999)

Dimethoate 30 EC @250 ml/acre was found to be effective in controlling jassids. (Dhawan and Simwat, 1992). Ali and Karim (1993) recorded 73-80 per cent reduction of leafhopper population by applying dimethoate (Polygor 40 EC). Singh and Gupta (1993) and Yagdirwar et al. (1994) have also proved the efficacy of dimethoate against leafhoppers. The population of leaf hoppers was kept below EIL level for 15-17 days on application of dimethoate (Ram Singh and Gupta, 1994). Radke et al. (1996) reported that spraying 0.03 per cent dimethoate at 15 days fixed intervals gave the best level of control of leafhoppers.

Senapati and Behera (1989) reported that methyl demeton at 0.5 kg a.i/ha at 20 days interval provided good control of leaf hoppers. Similarly methyl demeton was recommended by Manisegarane and Kumaraswami (1994), Santhini and Uthamasamy (1997) and Gupta et al. (1999).

Oxydemeton methyl, as an effective insecticide for the control of leafhopper was reported by Ali and Karim (1990) and Nagia et al. (1992).

2.2.2. Whitefly, *Bemisia tabaci* (Gennadius)

Purohit and Deshpande (1991) reported that an optimum dose of fertilizer combined with insecticides like monocrotophos and phosphamidon registered lower densities of whiteflies. Gupta et al. (1999) conducted experiments on the insecticidal spray schedules and reported that phosphamidon (0.04%), methyl demeton (0.04%) and dimethoate (0.05%) were effective in controlling whiteflies.

Dahiya and Ram Singh (1982) observed that monocrotophos, dimethoate and oxydemeton methyl were effective in the control of whiteflies. Dimethoate @400 g a.i/ha was found to be effective against the nymphal stages of whiteflies (Renou and Chenet, 1989). The efficacy of dimethoate was confirmed by Dhawan and Simwat (1992). In contrast, Prasad et al. (1993) noticed development of resistance for dimethoate in whiteflies. A four spray schedule with dimethoate, monocrotophos, cypermethrin and endosulfan was found to prevent the whitefly population from crossing ETL and increased yields were achieved (Singh and Gupta, 1993). The efficacy of dimethoate for the control of whiteflies was recently reported by Gupta et al. (1999).

Dhandapani et al. (1988) studied on the compatibility of insecticides and fertilizers and observed that monocrotophos was effective in controlling whiteflies when combined with 1 per cent diammonium phosphate. Spraying organophosphorus insecticides like chlorpyrifos, monocrotophos and oxydemeton methyl at 250, 175 and 300 g a.i/ha respectively were effective in the control of whiteflies (Nagia et al. 1992). Banbote et al. (1995) reported the efficacy of monocrotophos (0.06%) against pupae and adults of whiteflies.

2.2.3. Aphid, *Aphis gossypii* Glover.

Phosphamidon (Dimecron) was found to be effective against cotton aphids (Khalil and Watson, 1983). Patel et al. (1984) reported that phosphamidon resulted 99.8 per cent mortality of aphids after 2 days. Bhamburkar et al. (1986) reported the efficacy

of phosphamidon (0.34 kg a.i/ha) and dimethoate (0.6 kg a.i/ha) against aphids. Gupta et al. (1999) reported that three rounds of foliar sprays including dimethoate (0.05%), methyl demeton (0.04%) and phosphamidon (0.04%) were effective against aphids.

Laboratory studies with *A. gossypii* revealed that monocrotophos, dimethoate and formotion were the most effective chemicals based on their persistence and toxicity (Bodhade et al. 1987). Ramalho and Jesus (1988) conducted field experiments and stated that demeton-S-methyl at 50 g a.i/ha was effective in controlling aphids. Senapati and Behera (1989) reported that seven insecticidal schedules with demeton methyl and monocrotophos at 0.5 kg a.i/ha at 20 days interval resulted in good control of aphids. Manisegarane and Kumaraswami (1994) proved the superiority of methyl demeton over methomyl and EPN for the control of aphids.

The efficacy of monocrotophos in controlling aphids was reported by several authors (Karuppuchamy et al. 1986; Surulivelu and Kumaraswamy, 1989; Banbote et al. 1995).

2.3. Efficacy of insecticides against sucking pests of brinjal

Brinjal is an important vegetable crop and is attacked by several insect pests throughout the crop growth. In the early stages of the crop, the sucking pests *viz.*, leafhoppers, whiteflies and aphids cause heavy loss by sucking the cell sap from the leaves, thereby reducing the yield. Several organophosphorus insecticides such as monocrotophos and dimethoate (Shashi Verma, 1992) have been tested and found to be effective against these pests.

2.3.1. Leafhopper, *Amrasca biguttula biguttula* Ishida.

Singh and Lakra (1989) reported that phosphamidon and dimethoate persisted for 15 days and was keeping leafhoppers in check. Field experiments conducted on persistence of insecticides against leafhoppers revealed that monocrotophos and phosphamidon persisted for

7 and 15 days respectively and effectively reduced the hopper population (Shashi Verma, 1992). Mall et al. (1997) reported that monocrotophos and phosphamidon showed better control of aphids, jassids, etc.

Monocrotophos at 0.05 per cent was recommended for effective control of leafhoppers by several workers (Bhandarkar and Borle, 1980; Mote, 1981; Dhandapani and Kumaraswami, 1982). Shah et al. (1990) reported that monocrotophos at 0.036 per cent was the most effective chemical after 24 and 48 h after spraying. Naria et al. (1993) reported that combination of monocrotophos with Mancozeb or carbendazim controlled leafhopper infestations on brinjal.

Several authors have reported about the effectiveness of dimethoate against leafhoppers (Prakash et al. 1981; Prakash and Verma, 1985; Singh and Kavadia, 1989).

2.3.2. Aphid, *Aphis gossypii* Glover

The efficacy of phosphamidon and dimethoate in controlling aphids was reported by Patel et al. (1980) while the superiority of monocrotophos in controlling aphids was reported by several authors (Bhandarkar and Borle, 1980; Patel et al. 1980; Bodhade et al. 1992; Mishra, 1996; Mall et al. 1997). Dhamdhare and Mathur (1994) reported that oxydemeton methyl (0.05%) was found to be effective against aphids.

2.3.3. Whitefly, *Bemisia tabaci* (Gennadius)

Foliar sprays with disulfoton and dimethoate reduced infestations of whiteflies on brinjal (Prakash et al. 1981 and 1985).

2.4. Toxicity to Natural Enemies

2.4.1. Field studies

Phosphamidon was found to be the most toxic compound to the predatory coccinellids in rice fields (Patnaik, 1983). In contrast, Rabbi et al. (1993) reported low mortality of coccinellid predator in phosphamidon treated plots. Raman and Uthamasamy (1983)

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reported 76 per cent mortality of spiders and 74 per cent of mirid bugs with 0.04 per cent phosphamidon. Monocrotophos (0.35 or 0.50 kg a.i/ha) followed by phosphamidon (0.5 kg a.i/ha) was found in the order of least toxicity and safe to spiders in the field (Rajendran, 1987). Population of spiders and coccinellids were found to be less in phosphamidon treated plots (Natarajan et al. 1988). Highest toxicity of phosphamidon at 0.4 per cent against spiders was reported by Shunmugavelu and Palanisamy (1991) and Ganeshkumar and Velusamy (1997) reported that phosphamidon was less toxic to spiders.

The predator and parasitoid populations were found to be decreasing with application of monocrotophos and chlorpyrifos (Borak and Saharia, 1989; Patel et al. 1997). Mohan et al. (1991) proved reduction in spider and mirid bug populations in plots treated with monocrotophos. Safety of monocrotophos to spider and mirid bug population was proved by Sontakke (1993). The toxicity of monocrotophos at 0.04 per cent to *Chrysopa scelestes* Banks in cotton ecosystem was proved by Patel and Yadav (1995). Sasmal et al. (1995) reported that monocrotophos at 450 g a.i/ha was more toxic to mirid bugs. Gerling et al. (1997) proved that populations of *Chrysoperla carnea* Stephens. were unaffected by applying monocrotophos.

Chu et al. (1976 a,b) and Chiu and Cheng (1976) reported that monocrotophos showed lesser toxicity to the spiders in rice ecosystem. Krishandoss and Abdulkareem (1983) found that phenthoate 0.1 per cent and monocrotophos 0.05 per cent were more toxic to predatory bug, *Cyrtorhinus lividipennis* Reuters.

Ramalho and Jesus (1988) reported less toxicity of demeton-S-methyl to the predators of cotton ecosystem. Dimethoate and oxydemeton methyl were non - toxic to the natural enemy population (Ali and Karim, 1990).

2.4.2. Laboratory studies

2.4.2.1. Predatory green lacewing, *Chrysoperla carnea* Stephens

The larvae and adults of *C. carnea* were killed by the residues of the most of the organophosphorus compounds (Bartlett, 1964). Lingren and Ridgway (1967) revealed the toxic nature of phosphamidon to the larva and adults of *C. carnea*. However, Plapp and Bull (1978) investigated that populations of *C. carnea* have shown resistance to organophosphorus compounds. Krishnamoorthy (1985) reported the susceptibility of newly hatched *C. scelestes* to phosphamidon at 0.05 per cent.

In laboratory cultures, resistance of *C. carnea* larvae to organophosphorus insecticides declined approximately ten times, over 3 years of continuous rearing suggesting that careful quality control is required for laboratory mass rearing programmes (Pree et al. 1989).

Navarajan Paul et al. (1979) noticed monocrotophos and phosalone to be less toxic to *Trichogramma brasiliensis* Ashmead. Least toxicity of endosulfan and monocrotophos to *Trichogramma japonicum* Ashmead was observed by Gupta et al. (1984). Xu et al. (1986) found a strain of *T. japonicum* resistant to phosphamidon. Santharam and Kumaraswami (1985) observed that endosulfan and monocrotophos had little effect upon *T. chilonis*. Less parasitism of *T. brasiliensis* (26-64%) was reported by Singh and Verma (1986), on exposure to monocrotophos. Paul and Agarwal (1990) reported less persistent toxicity of monocrotophos against *T. brasiliensis*. A 60 per cent mortality of *T. chilonis* due to phosphamidon and dimethoate was observed by Brar et al. (1991). Mandal and Somchoudhury (1992) studied the toxicity of 3 insecticides et al. monocrotophos, carboxyl and phosphamidon and reported that phosphamidon was least toxic to *T. chilonis*.

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

Experiments were conducted to evaluate phosphamidon 40 SL for the control of sucking pests of rice, cotton and brinjal its toxicity to natural enemies and the details of the experiments are described in this chapter.

3.1. Field experiments

3.1.1. Evaluation of bioefficacy

3.1.1.1. Evaluation of bioefficacy against sucking pests of rice

Two field experiments were conducted at Tamil Nadu Rice Research Institute, Aduthurai, with rice cultivars, ADT 36 and ADT 43, and another at Rice Research Station, Tirur, with the rice cultivar, Co 43.

a. Experimental details

Two randomized and replicated trials were conducted, one at Aduthurai during June-October, 1999 and the other at Tirur, during September, 1999 - January, 2000.

The nine treatments included were as follows.

T ₁	-	Phosphamidon 40 SL @ 200 g a.i/ha
T ₂	-	Phosphamidon 40 SL @ 350 g a.i/ha
T ₃	-	Phosphamidon 40 SL @ 500 g a.i/ha
T ₄	-	Phosphamidon 85 WSC @ 200 g a.i/ha
T ₅	-	Phosphamidon 85 WSC @ 350 g a.i/ha
T ₆	-	Phosphamidon 85 WSC @ 500 g a.i/ha
T ₇	-	Monocrotophos 36 WSC @ 360 g a.i/ha
T ₈	-	Chlorpyrifos 20 EC @ 250 g a.i/ha
T ₉	-	Control

The first round of spraying was given 25 days after transplanting and the spraying was repeated once at 15 days interval. The plot size was 20 m² with three replicates. Spraying was carried out with a high volume knapsack sprayer, fitted with NMD nozzle, using 500 litres of spray fluid per hectare.

b. Method of assessment

The damage due to green leaf hopper, brown plant hopper and white backed planthopper was assessed prior to spraying and 1, 3, 5, 7 and 10 days after spraying. The population of these insects as total number of nymphs and adults on ten randomly selected plants per plot was observed.

3.1.1.2. Evaluation of bioefficacy against sucking pests of cotton

Field experiment was conducted at Cotton Breeding Station, Tamil Nadu Agricultural University, Coimbatore with cultivar LRA 5166.

a. Experimental details

A randomized and replicated trial was conducted during August 1999 to January 2000 with the following nine treatments.

T ₁	-	Phosphamidon 40 SL @ 200 g ai/ha
T ₂	-	Phosphamidon 40 SL @ 250 g ai/ha
T ₃	-	Phosphamidon 40 SL @ 300 g ai/ha
T ₄	-	Phosphamidon 85 WSC @ 200 g ai/ha
T ₅	-	Phosphamidon 85 WSC @ 250 g ai/ha
T ₆	-	Phosphamidon 85 WSC @ 300 g ai/ha
T ₇	-	Oxydemeton methyl 25 EC @ 125 g ai/ha
T ₈	-	Dimethoate 30 EC @ 150 g ai/ha
T ₉	-	Control

The first round of spraying was given 25 days after sowing and the spraying was repeated once at 15 days interval. The plot size was 20 m² and replicated thrice. Spraying was carried out using a high volume knapsack sprayer, fitted with NMD nozzle, using 500 litres of spray fluid per hectare.

b. Method of Assessment

The population of sucking pests, viz., leaf hopper, whitefly and aphid was observed on top, middle and bottom leaves of ten randomly selected plants per plot, prior to application and 1, 3, 5, 7 and 10 days after spraying.

3.1.1.3. Evaluation of bio efficacy against sucking pests of Brinjal

Two field experiments were conducted viz., one at Orchard, Tamil Nadu Agricultural University, Coimbatore with variety Co 2 and the other at Thondamuthur village in Coimbatore district in a farmer's holding with a local variety.

a. Experimental details

Two randomized and replicated trials were conducted one at orchard during September 1999 – January 2000 and the other in a farmer's field during July-November 2000. The eight treatments included for the study were as follows.

T ₁	-	Phosphamidon 40 SL @ 200 g ai/ha
T ₂	-	Phosphamidon 40 SL @ 250 g ai/ha
T ₃	-	Phosphamidon 40 SL @ 300 g ai/ha
T ₄	-	Phosphamidon 85 WSC @ 200 g ai/ha
T ₅	-	Phosphamidon 85 WSC @ 250 g ai/ha
T ₆	-	Phosphamidon 85 WSC @ 300 g ai/ha
T ₇	-	Monocrotophos 36 WSC @ 360 g ai/ha
T ₈	-	Control

The first round of spraying was taken up at 25 days after transplanting and the second at 15 days interval. The plot size was 20 m² and replicated thrice. Spraying was carried out with a high volume knapsack sprayer, fitted with NMD nozzle, using 500 litres of spray fluid per hectare.

b. Method of Assessment

The populations of sucking pests *viz.*, leaf hopper, whitefly and aphid was recorded on top, middle and bottom leaves of ten randomly selected plants per plot prior to spraying and 1, 3, 5, 7 and 10 days after spraying.

3.1.2. Evaluation of toxicity to natural enemies

3.1.2.1. Evaluation of toxicity to natural enemies in rice ecosystem

A trial was conducted at Tamil Nadu Rice Research Institute, Aduthurai, during June to October 1999 with the variety ADT 36 for evaluating the toxicity of phosphamidon 40 SL to natural enemies. The seven treatments included were as follows.

T ₁	-	Phosphamidon 40 SL @ 200 g ai/ha
T ₂	-	Phosphamidon 40 SL @ 350 g ai/ha
T ₃	-	Phosphamidon 40 SL @ 500 g ai/ha
T ₄	-	Phosphamidon 85 WSC @ 200 g ai/ha
T ₅	-	Phosphamidon 85 WSC @ 350 g ai/ha
T ₆	-	Phosphamidon 85WSC @ 500 g ai/ha
T ₇	-	Control

A single spray was given 25 days after transplanting. The plot size was 20 m² and the study was replicated three times. Spraying was carried out with a high volume knapsack sprayer, fitted with NMD nozzle, using 500 litres of spray fluid per hectare.

a. Method of assessment

The number of spiders and coccinellids were recorded prior to phosphamidon application and 1, 3, 5, 7 and 10 days after spraying on ten randomly selected plants per plot.

3.1.2.2. Evaluation of toxicity to natural enemies in cotton ecosystem

A trial was conducted at Cotton Breeding Station, Tamil Nadu Agricultural University, Coimbatore during August 1999 - January 2000, with the variety LRA 5166 for evaluating the toxicity of phosphamidon 40 SL to natural enemies. The seven treatments included for this study were as follows.

T ₁	-	Phosphamidon 40 SL @ 200 g ai/ha
T ₂	-	Phosphamidon 40 SL @ 250 g ai/ha
T ₃	-	Phosphamidon 40 SL @ 300 g ai/ha
T ₄	-	Phosphamidon 85 WSC @ 200 g ai/ha
T ₅	-	Phosphamidon 85 WSC @ 250 g ai/ha
T ₆	-	Phosphamidon 85 WSC @ 300 g ai/ha
T ₇	-	Control

A single spray was given 25 days after sowing. The plot size was 20 m² and the study was replicated three times. Spraying was carried out with a high volume knapsack sprayer, fitted with NMD nozzle, using 500 litres of spray fluid per hectare.

a. Method of Assessment

The number of spiders were recorded prior to insecticide spray and 1, 3, 5, 7 and 10 days after spraying on ten randomly selected plants per plot.

3.1.2.3. Evaluation of toxicity to natural enemies in brinjal ecosystem

A trial was conducted in a farmer's holding at Thondamuthur, Coimbatore during September 1999 - January 2000, with a local variety for evaluating the toxicity to natural enemies. The treatment details, spray schedule and method of assessment are similar to that mentioned under section 3.1.2.2.

3.1.3. Evaluation of phytotoxicity

3.1.3.1. Evaluation of phytotoxicity in rice

A trial was conducted at Tamil Nadu Rice Research Institute (TRRI), Aduthurai with the variety, ADT 42, during July - November 1999, to evaluate the phytotoxicity of phosphamidon 40 SL. The six treatments included were as follows.

T ₁	-	Phosphamidon 40 SL @ 500 g ai/ha
T ₂	-	Phosphamidon 40 SL @ 1000 g ai/ha
T ₃	-	Phosphamidon 40 SL @ 2000 g ai/ha
T ₄	-	Phosphamidon 85 WSC @ 2000 g ai/ha
T ₅	-	Blank @ 5000 ml/ha
T ₆	-	Control

One round of spraying was given on 30 days after transplanting. The plot size was 15 m² and the study was replicated four times. The spraying was carried out with a high volume knapsack sprayer, fitted with NMD nozzle, using 500 litres of spray fluid per hectare.

a. Method of Assessment

The symptoms like scorching, vein clearing etc., were observed from ten randomly selected plants per plot. The number of leaves showing phytotoxicity symptoms were expressed in percentage and the extent of phytotoxicity was recorded based on the following scale (as per the protocol provided by M/s. Sudharshan Chemical Industries Ltd.).

Grade	Phytotoxicity symptoms (%)
0	No phytotoxicity symptoms
1	1-10
2	11-20
3	21-30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

3.1.3.2. Evaluation of phytotoxicity in cotton

A trial was conducted at Cotton Breeding Station, Tamil Nadu Agricultural University, Coimbatore with LRA 5166 during August 1999 - January 2000, for evaluating the phytotoxicity of phosphamidon 40 SL. The five treatments included were as follows.

- T₁ - Phosphamidon 40 SL @ 300 g ai/ha
- T₂ - Phosphamidon 40 SL @ 600 g ai/ha
- T₃ - Phosphamidon 40 SL @ 1200 g ai/ha
- T₄ - Blank @ 3000 ml/ha
- T₅ - Phosphamidon 85 WSC @ 1200 g ai/ha
- T₆ - Control

One round of spraying was given on 30 days after sowing. The plot size was 15 m² and the study was replicated four times. The spraying was carried out with a high volume knapsack sprayer, fitted with NMD nozzle, using 500 litres of spray fluid per hectare.

a. Method of Assessment

The assessment of phytotoxicity is similar to that described under the section 3.1.3.1.(a)

3.1.3.3. Evaluation of phytotoxicity in brinjal

A trial was conducted in a farmer's holding at Thondamuthur, Coimbatore, with a local variety during September 1999 to January 2000, for evaluating the phytotoxicity. The treatments are similar to that mentioned under section 3.1.3.2.

One round of spraying was given on 30 days after planting. The plot size was 15 m² and the study was replicated four times. The spraying was carried out with a high volume knapsack sprayer, fitted with NMD nozzle, using 500 litres of spray fluid per hectare.

a. Method of assessment

The phytotoxicity symptoms are assessed similar to that described under the section 3.1.3.1.(a)

3.2. Laboratory experiments

Experiments were conducted to evaluate the persistent toxicity of phosphamidon 40 SL against sucking pests of rice, cotton and brinjal.

3.2.1. Persistent toxicity studies in rice

In Rice persistent toxicity studies were conducted for BPH and WBPH.

3.2.1.1. Insect culture maintenance

a. Culturing of the hoppers

The culturing of plant hoppers was done as per the method described by Meenakshisundaram (1991). Basic population of brown plant hopper (BPH) *Nilaparvatha lugens* Slal. and white backed plant hopper (WBPH), *Sogatella furcifera* Horvath. were collected from the fields of Paddy Breeding Station, TNAU, Coimbatore. In order to maintain an uniform and continuous culture of the hoppers for the use in experiments, the

Plate 1. Persistent toxicity studies - Rice



Plate 2. Microcage for persistent toxicity studies - Cotton



insects were mass cultured in potted TN 1 rice plants. Ten days old rice seedlings were transplanted in 10 cm clay pots @ five seedlings per pot. Thirty days after transplanting, outer leaf sheaths and dried parts were removed to destroy any possible oviposition by other insects. The plants were then covered with cylindrical mylar film cages (9 cm. dia. 45 cm ht.) with fine mesh screen windows. About twenty matured females along with five males were released inside each mylar cage for oviposition. The potted plants provided for oviposition were transferred to a large wooden cage and observed for hatching of the eggs. This was followed throughout the experimental period for the continuous supply of the test insects. During the whole process of culturing, the potted plants were placed in the plastic basins with 10-15 cm depth of water. By this way, the relative humidity to the growing plants was maintained. The plants showing wilting symptoms due to nymphal feeding were replaced regularly with healthy seedlings from the rearing cages.

3.2.1.2. Method of Assessment

a. Plant hoppers

Thirty days old TN 1 rice seedlings raised in 10 cm clay pots were first sprayed with different concentrations of formulations using a baby sprayer. The treatments included for the study were as follows:

- | | | |
|----------------|---|--------------------------------------|
| T ₁ | - | Phosphamidon 40 SL @ 200 g ai/ha |
| T ₂ | - | Phosphamidon 40 SL @ 350 g ai/ha |
| T ₃ | - | Phosphamidon 40 SL @ 500 g ai/ha |
| T ₄ | - | Phosphamidon 85 WSC @ 200 g ai/ha |
| T ₅ | - | Phosphamidon 85 WSC @ 350 g ai/ha |
| T ₆ | - | Phosphamidon 85WSC @ 500 g ai/ha |
| T ₇ | - | Monocrotophos 36 WSC @ 360 g a.i./ha |
| T ₈ | - | Control |

Plate 3. Persistent toxicity studies - Cotton



Plate 4. Persistent toxicity studies - Brinjal



The treated seedlings were covered with cylindrical mylar film cages of 9 cm dia. and 45 cm ht (Plate 1). The individuals of third instar BPH and WBPH were released separately in each treated pots. Three replications were maintained for each treatment.

The number of surviving insects in each pot was counted daily and fresh set of 10 individuals were released on each day of count after removing the insects released on the previous day. The procedure was followed, till no mortality on the treated plants was observed. (Meenakshisundaram, 1991).

3.2.2. Persistent toxicity studies in cotton

In cotton persistent toxicity studies were conducted for leafhopper and aphid.

3.2.2.1. Insect culture maintenance

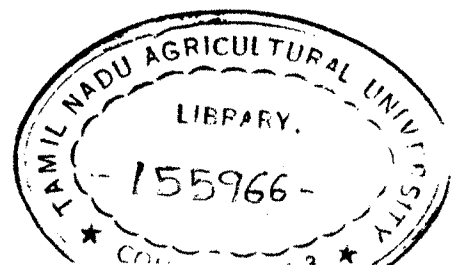
a. Leaf hopper (*Amrasca biguttula biguttula* Ishida)

A. biguttula biguttula was mass cultured under screen house conditions using susceptible variety (MCU 5) as described by Parameswaran (1998).

Cotton seeds were sown in tumbler pots and the plants were allowed to grow. When the plants were 20-25 days old, field collected leaf hopper adults were allowed on young plants @ 5 nos./pot and the pots were caged. The pots were placed on moist sand, to maintain high humidity and watered regularly. High humidity helped in building up of leaf hopper population. This provided continuous supply of isogenic test insects for different studies.

b. Aphid (*Aphis gossypii* Glover)

The cotton aphid was mass cultured as per the method described by Sivasubramian (1998). The highly susceptible cotton variety MCU 5 seedlings were raised in pots of size 20 x 35 cm. Colonies of *A. gossypii* collected from the field were introduced on thirty day old plants and were allowed to establish. From this basic culture, aphids were regularly collected. The potted plants were covered with mylar cages to avoid predation by coccinellid beetles.



3.2.2.2. Method of Assessment

The six treatments included were as follows.

T ₁	-	Phosphamidon 40 SL @ 200 g ai/ha
T ₂	-	Phosphamidon 40 SL @ 250 g ai/ha
T ₃	-	Phosphamidon 40 SL @ 300 g ai/ha
T ₄	-	Phosphamidon 85 WSC @ 300 g ai/ha
T ₅	-	Dimethoate 30 EC @ 150 g a.i./ha
T ₆	-	Control

a. Leaf hopper

The clip-on micro cages of 3-4 cm dia. (Plate 2) made out of transparent mylar film sheets were used for confining the test insects on leaves after treating them with treatments mentioned above. The culturing of insects and the tests were carried out in green house at 29 - 33°C (Plate 3).

The number of surviving insects in each pot was counted daily and fresh set of 10 individuals were released on each day of count after removing the insects released on the previous day. The procedure was followed till no mortality in the treated plants was observed.

b. Aphid

The clip-on blister pack tablet covers of 1 cm dia. were used for confining the aphids on leaves after treating them with insecticides. Mortality observations were taken as per the procedure discussed under section 3.2.2.2 (a). The experiment was carried out in green house at 29-33°C.

3.2.3. Persistent toxicity studies in brinjal

In brinjal persistent toxicity studies were conducted for leafhopper and aphid.

3.2.3.1. Insect culture maintenance

The culturing of leaf hopper *A. biguttula biguttula* and aphid *A. gossypii*, was done similar to the methods described under the section 3.2.2.1. (a) and 3.2.2.1 (b).

3.2.3.2. Method of Assessment

The persistent toxicity was assessed similar to the methods described under the section 3.2.2.2 (a) and 3.2.2.2 (b) (Plate 4).

3.2.4. Evaluation of safety to natural enemies

Laboratory experiments were conducted to assess the safety of phosphamidon 40 SL to the egg parasitoid *Trichogramma chilonis* (Ishii) and the predatory green lace wing *Chrysoperla carnea* (Stephens).

The treatment details were as follows:

Treatment	Details
T ₁	- Phosphamidon 40 SL @ 200 g a.i./ha
T ₂	- Phosphamidon 40 SL @ 250 g a.i./ha
T ₃	- Phosphamidon 40 SL @ 300 g a.i./ha
T ₄	- Phosphamidon 85 WSC @ 300 g a.i./ha
T ₅	- Monocrotophos 36 WSC @ 360 g a.i./ha
T ₆	- Untreated control

3.2.4.1. *Trichogramma* Culture Maintenance

a) Culturing of *Corcyra cephalonica* Stainton

C. Cephalonica was reared following the procedure of Navarajan Paul (1973). The adult moths were allowed inside an oviposition cage of 21 x 25 cm size which was covered with wire mesh at the bottom and two windows made of wire mesh on the sides

for ventilation. Adults were fed with 50 per cent honey. The eggs were collected from these cages daily for four days and cleaned. The cleaned eggs were then sprinkled over half ground cumbu grains, at the rate of one cc per 2.5 kg of grains, fortified with 10 g of yeast taken in a plastic basin of 11 x 37.5 cm of size and covered with kada cloth. Care was taken to maintain the culture free of storage mite and diseases by mixing 5 g of wettable sulphur (80%) and spraying streptomycin sulphate 0.5 per cent respectively. The emerged adults were collected and used again for culturing both prey (*Corcyra*) and predator (*Chrysopa*). The culture was maintained at room temperature ($26 \pm 4^\circ\text{C}$).

b) Culturing of *Trichogramma chilonis* Ishii

The egg parasitoid, *Trichogramma chilonis* was mass cultured on the eggs of rice moth, *Corcyra cephalonica* (Stainton) as per the method developed by Prabu (1991). Fresh *Corcyra* eggs collected in the early morning were sterilized under UV radiation of 15 W capacity for 20 min duration at a distance of 15 cm to avoid the emergence of *Corcyra* larvae. Then these eggs were pasted on paper cards of 20 x 30 cm size having thirty 7 x 2 cm rectangles. These egg cards were placed in polythene bags along with nucleus card at 6:1 ratio for parasitisation by egg parasitoids. The parasitised egg cards were cut into one cm² bits and three days old, hundred per cent parasitised eggs (eggs appearing black and plumpy) were sprayed with insecticides at different concentrations mentioned under the section 3.2.4. For the control, distilled water alone was sprayed. The treated egg cards were shade dried for 10 min. and then kept inside a test tube of 20 x 1.5 cm size.

i) Method of Assessment

The number of parasitoids emerged from each treatment was recorded and per cent emergence was worked out. Fresh eggs were provided to these parasitoids at 6:1 ratio and per cent parasitisation was also recorded.

3.2.4.2. Predatory green lace wing, *Chrysoperla carnea*

Eggs and larvae of *C. carnea* were obtained from the biocontrol laboratory, Tamil Nadu Agricultural University, Coimbatore for safety tests.

a. Ovicidal action

Laboratory studies were conducted to assess the effect of insecticides mentioned under the section 3.2.4. on the eggs of *C. carnea*.

The eggs along with stalk collected in brown paper strips were sprayed with insecticides using an atomizer. Each treatment was replicated three times with 50 eggs per treatment. A control was maintained by spraying distilled water. The number of grubs hatched out from each treatment was recorded and per cent survival worked out.

b. Larval feeding method

Eggs of *C. cephalonica* were exposed to UV rays for 15 min to kill the embryos and then sprayed with different concentrations of insecticides mentioned under 3.2.4. with a hand atomizer. The eggs were shade dried for 10 min and transferred to test tubes of size 20 x 35 cm. For control, the eggs were sprayed with distilled water. First instar grubs of *C. carnea* were transferred to these test tubes at the rate of 10 per test tube. After the grubs completely fed the treated eggs, they were provided with untreated *Corcyra* eggs until pupation. Observations were made on the grub mortality, per cent pupation and adult emergence.

3.4. Statistical analysis

The corrected per cent reduction of sucking pests was worked out by using the formula given by Henderson and Tilton (1955) and then statistically analysed according to the design of the experiment.

$$\text{Corrected per cent reduction} = \frac{T_a \times C_b}{T_b \times C_a} \times 100$$

Where,

- T_a = Number of insects in the treatment after spraying
 T_b = Number of insects in the treatment before spraying
 C_b = Number of insects in the untreated check before spraying
 C_a = Number of insects in the untreated check after spraying

The corrected per cent mortality for laboratory studies was worked out by using Abbott's correction (Abbott, 1925).

$$\text{Corrected per cent mortality} = \frac{P_o - P_c}{100 - P_c} \times 100$$

Where,

- P_o = Observed mortality in treatment
 P_c = Observed mortality in untreated check

The values of corrected per cent reduction and corrected per cent mortality were transformed using arcsine transformation for normalisation of data (Panse and Sukhatme, 1967). The persistent toxicity index was worked out following the method described by Pradhan (1967)

Experimental Results

CHAPTER IV

EXPERIMENTAL RESULTS

The results of field experiments conducted to assess the bioefficacy, against sucking pests of rice, cotton and brinjal, toxicity to natural enemies and phytotoxicity of phosphamidon 40 SL, safety tests and pot culture experiments to assess the persistence of phosphamidon 40 SL are presented in this chapter.

4.1. Field Evaluation of phosphamidon 40 SL

4.1.1. RICE

4.1.1.1. Experiment - I

a. Green leaf hopper (GLH)

The pretreatment population of GLH ranged from 18.00 to 21.00 per 10 hills, before the first spray (Table 1). At 3 DAT, the per cent reduction ranged from 29.53 to 88.69 at 5 DAT. The maximum reduction of GLH population (95.07%) was recorded in T₈ (chlorpyrifos 20 EC) at 5 DAT followed by 94.97 per cent in T₆ (phosphamidon 85 WSC @ 500 g a.i./ha), and 93.19 per cent in T₃ (phosphamidon 40 SL @ 500 g a.i./ha). At 7 DAT, the maximum reduction (94-95%) was observed in T₆, T₇ (monocrotophos 36 WSC) and T₈ which were on par in their effects followed by T₃ (93.14%). Similar trend was observed on 10 DAT.

The pretreatment count of GLH ranged from 14.67 to 16.33 per 10 hills, before the second spray. The maximum per cent reduction of GLH population was recorded in phosphamidon 85 WSC @ 500 g a.i./ha (T₆) at 1,3,5 and 7 DAT (Table 2). Phosphamidon 40 SL @ 500 g a.i./ha (T₃) was on par with T₆ at 3 and 5 DAT and at 1 and 7 DAT, phosphamidon 40 SL recorded 64.66 and 95.80 per cent reduction respectively. The lowest per cent reduction (40.08%) was recorded in phosphamidon 40 SL @ 200 g a.i./ha (T₁). Due to incessant rains the observations on 10 DAT were not taken.

Table 1. Field efficacy of phosphamidon 40 SL against rice-green leaf hopper - I spray. (Location I)

Treatments	Pretreatment count	(Mean of three observations)											
		1 DAT		3 DAT		5 DAT		7 DAT		10 DAT			
		No.	P	No.	P	No.	P	No.	P	No.	P		
T ₁	18.00	13.33	13.68 ^d (21.57)	11.67	29.53 ^c (31.72)	8.67	53.22 ^c (46.86)	8.67	53.92 ^d (47.26)	19.00	7.21 ^d (15.24)		
T ₂	19.00	8.67	46.57 ^c (43.03)	4.00	78.01 ^{ab} (62.05)	2.67	86.49 ^b (68.56)	2.67	86.55 ^{bc} (68.60)	12.33	42.88 ^{bc} (40.89)		
T ₃	18.67	6.67	58.01 ^{ab} (49.65)	2.33	86.26 ^{ab} (68.49)	1.33	93.19 ^{ab} (75.08)	1.33	93.14 ^{ab} (75.06)	8.33	60.64 ^{ab} (51.19)		
T ₄	20.00	9.67	43.45 ^c (41.21)	5.00	73.74 ^b (59.18)	3.00	85.66 ^b (67.76)	4.33	79.45 ^c (63.06)	13.00	42.93 ^c (40.42)		
T ₅	21.00	8.33	53.71 ^b (47.14)	4.00	79.03 ^{ab} (63.04)	2.33	89.45 ^{ab} (71.11)	2.00	90.82 ^{ab} (72.78)	11.67	51.09 ^{ab} (45.63)		
T ₆	19.00	6.00	63.03 ^a (52.62)	2.00	88.69 ^a (70.39)	1.00	94.97 ^{ab} (77.04)	1.00	94.99 ^a (77.07)	7.33	66.01 ^a (54.39)		
T ₇	18.00	8.33	44.16 ^c (41.64)	3.00	82.69 ^{ab} (65.51)	2.00	89.25 ^{ab} (71.33)	1.00	94.73 ^a (79.26)	9.00	55.99 ^a (48.46)		
T ₈	19.00	9.00	44.91 ^c (42.07)	3.00	78.97 ^{ab} (63.01)	1.00	95.07 ^a (79.65)	1.00	95.01 ^a (77.09)	8.33	61.39 ^a (51.65)		
T ₉	19.00	16.33	-	18.00	-	20.00	-	20.00	-	21.67	-		

No. - Population number per 10 hills; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 2. Field efficacy of phosphamidon 40 SL against rice green leafhopper - II spray. (Location I)
(Mean of three observations)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT	
		No.	P	No.	P	No.	P	No.	P
T ₁	14.67	7.33	42.97 ^{cd} (40.88)	6.00	43.50 ^b (41.13)	8.00	25.02 ^d (29.14)	6.00	40.08 ^d (38.90)
T ₂	16.00	7.33	48.01 ^{bc} (43.81)	4.33	62.44 ^a (52.55)	3.33	70.82 ^{bc} (57.50)	1.67	82.58 ^c (67.08)
T ₃	16.33	5.00	64.66 ^{ab} (53.63)	3.33	72.32 ^a (58.39)	0.00	100.00 ^a (89.81)	0.33	95.80 ^{ab} (83.07)
T ₄	14.67	11.33	11.74 ^c (19.01)	5.00	54.96 ^{ab} (47.86)	4.33	58.51 ^c (50.02)	2.67	73.63 ^c (59.60)
T ₅	15.33	5.00	62.41 ^{ab} (52.43)	4.00	64.61 ^a (53.66)	2.67	75.52 ^b (60.61)	1.00	90.18 ^{bc} (72.18)
T ₆	15.67	4.33	68.65 ^a (56.03)	3.00	74.55 ^a (59.88)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)
T ₇	16.33	8.33	41.05 ^{cd} (39.80)	4.00	66.88 ^a (55.01)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)
T ₈	15.67	9.67	21.40 ^d (32.60)	4.00	64.82 ^a (53.88)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)
T ₉	16.00	14.00	-	12.00	-	12.00	-	13.00	-

No. - Population number per 10 hills ; DAT -- Days after treatment
 Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction
 Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

The order of relative efficacy is

$$(T_6 = T_3 = T_7 = T_8) > (T_5 = T_2) > T_4 > T_1$$

b. Brown plant hopper (BPH)

The BPH population ranged from 11.67 to 13.33 per 10 hills (Table 3) before the first round of spray. All the treatments significantly reduced the pest at 1 DAT. The maximum per cent reduction was observed in T_3 and T_6 at 1, 3, 5, 7 and 10 DAT. At 5 DAT, cent per cent reduction in BPH population was recorded in T_3 which was on par with T_6 (97.44), T_7 (97.62) and T_8 (97.44). At 7 DAT, too, T_3 and T_6 recorded 100 per cent reduction of BPH population.

Before the second round of spray, the BPH population fluctuated between 12.00 and 16.00 per 10 hills. At 1 DAT, maximum per cent reduction (95.10%) was recorded in T_6 followed by 92.69 per cent reduction in T_3 (Table 4). A cent per cent reduction was noticed in T_6 at 3 DAT which was followed by 95.3 per cent reduction in T_3 . At 5 DAT, T_6 , T_3 and T_7 recorded cent per cent reduction and were on par with T_8 and T_5 . The observations on 10 DAT were not taken due to incessant rains.

The order of relative efficacy of insecticides is

$$(T_6 = T_3 = T_7 = T_8) > (T_5 = T_2) > T_4 > T_1.$$

c. White backed plant hopper (WBPH)

The pretreatment count ranged from 40.00 to 43.67 per 10 hills before the first round of spray. The highest per cent reduction in WBPH population was observed in T_6 (Table 5) at 1, 3, 5, 7 and 10 DAT. At 1 DAT, T_3 recorded 64.84 per cent reduction in WBPH population which was on par with T_6 , T_7 , T_8 and T_2 . At 3 DAT, T_6 recorded 83.94 per cent reduction followed by 81.49 per cent reduction in T_3 . A similar trend was reflected on 5 DAT, where T_6 recorded 87.30 per cent reduction followed by T_3 (85.97%). At 7 DAT, the highest per cent reduction was achieved in T_7 (Monocrotophos) which was on par with T_6 (94.62%) and T_3 (93.68%).

Table 3. Field efficacy of phosphamidon 40 SL against rice brown planthopper - I spray. (Location I)
(Mean of three observations)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT		10 DAT	
		No.	P	No.	P	No.	P	No.	P	No.	P
T ₁	12.00	5.67	50.01 ^d (44.98)	3.33	70.91 ^{bc} (56.96)	3.33	71.27 ^c (57.87)	5.33	58.81 ^d (50.13)	4.33	68.44 ^{cd} (55.94)
T ₂	13.00	2.67	78.07 ^b (62.23)	2.33	80.96 ^{abc} (64.25)	1.67	86.07 ^{bc} (68.44)	2.67	80.16 ^c (63.89)	4.00	72.47 ^{cd} (58.66)
T ₃	11.67	1.33	87.95 ^a (69.96)	0.67	93.99 ^a (78.36)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	0.33	98.10 ^a (85.39)
T ₄	13.00	4.00	67.58 ^c (55.34)	5.00	59.89 ^c (50.84)	2.67	78.07 ^c (62.19)	4.67	65.38 ^d (54.23)	5.33	64.07 ^d (53.22)
T ₅	12.67	2.67	77.16 ^b (61.65)	2.00	83.52 ^{ab} (66.44)	0.67	93.95 ^{ab} (78.31)	2.33	83.25 ^{bc} (65.85)	4.33	76.20 ^{cd} (61.07)
T ₆	11.67	1.67	84.90 ^{ab} (67.39)	0.67	93.51 ^a (77.88)	0.33	97.44 ^a (84.63)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)
T ₇	12.67	2.33	80.71 ^{ab} (64.00)	1.00	91.66 ^a (73.22)	0.33	97.62 ^a (84.63)	1.33	90.13 ^b (72.00)	1.33	90.56 ^b (72.49)
T ₈	13.00	2.00	83.79 ^{ab} (66.26)	1.00	91.73 ^a (76.42)	0.33	97.44 ^a (84.63)	1.67	87.64 ^{bc} (69.85)	2.67	81.58 ^{bc} (64.89)
T ₉	13.33	12.67	-	12.67	-	12.67	-	14.67	-	15.67	-

No. - Population number per 10 hills ; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 4. Field efficacy of phosphamidon 40 SL against rice brown planthopper - II spray. (Location I)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT	
		No.	P	No.	P	No.	P	No.	P
T ₁	12.00	6.67	45.74 ^e (42.55)	4.67	61.47 ^d (51.66)	2.67	79.22 ^b (62.06)	3.33	72.32 ^d (58.27)
T ₂	12.67	2.67	79.11 ^c (62.94)	2.33	81.15 ^c (64.47)	0.67	90.48 ^a (79.68)	1.33	89.09 ^{bc} (71.11)
T ₃	13.67	1.00	92.69 ^{ab} (74.37)	0.67	95.30 ^b (79.77)	0.00	100.00 ^a (89.81)	0.33	97.26 ^a (84.45)
T ₄	12.33	5.00	59.58 ^d (50.64)	4.00	67.17 ^d (55.21)	2.00	80.95 ^b (66.50)	2.67	78.31 ^{cd} (62.35)
T ₅	12.00	1.33	88.82 ^b (70.82)	2.33	80.60 ^c (63.95)	0.67	90.48 ^a (78.52)	1.00	91.64 ^b (73.20)
T ₆	13.67	0.67	95.10 ^a (79.51)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	0.33	97.41 ^a (84.60)
T ₇	14.33	4.00	72.30 ^c (58.51)	1.00	93.01 ^b (74.67)	0.33	100.00 ^a (89.81)	1.00	92.78 ^b (74.42)
T ₈	15.33	4.00	74.26 ^c (59.54)	1.33	91.08 ^b (72.96)	0.67	92.38 ^a (79.98)	1.33	91.24 ^b (73.04)
T ₉	16.00	16.33	-	16.00	-	15.67	-	16.00	-

No. - Population number per 10 hills ; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 5. Field efficacy of phosphamidon 40 SL against rice white backed planthopper - I spray. (Location I)
(Mean of three observations)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT		10 DAT	
		No.	P	No.	P	No.	P	No.	P	No.	P
T ₁	40.00	27.67	34.21 ^c (35.66)	14.33	65.32 ^d (53.93)	11.00	73.89 ^e (59.31)	9.33	77.69 ^e (61.84)	23.00	44.09 ^e (41.60)
T ₂	43.33	17.67	61.39 ^a (51.67)	11.33	74.75 ^c (59.87)	8.00	82.60 ^{ab} (65.56)	4.00	91.11 ^a (72.76)	16.00	64.16 ^b (51.23)
T ₃	40.33	15.00	64.84 ^a (53.64)	7.67	81.49 ^{ab} (64.63)	6.00	85.97 ^{ab} (68.04)	2.67	93.68 ^a (75.49)	11.33	72.46 ^a (58.45)
T ₄	41.33	20.33	53.60 ^b (47.07)	14.00	67.28 ^d (55.12)	9.33	78.81 ^{bc} (62.76)	6.67	84.65 ^b (67.16)	20.67	51.42 ^c (45.81)
T ₅	42.33	18.00	59.92 ^{ab} (50.73)	10.00	77.21 ^{bc} (61.51)	7.67	82.97 ^{ab} (65.68)	4.33	90.24 ^a (71.89)	13.33	69.42 ^{ab} (56.47)
T ₆	42.00	15.00	66.23 ^a (54.49)	7.00	83.94 ^a (66.47)	5.67	87.30 ^a (69.13)	2.33	94.61 ^a (76.95)	10.33	76.10 ^a (60.73)
T ₇	43.00	16.67	63.38 ^a (52.77)	9.33	79.08 ^{abc} (62.78)	6.67	85.39 ^{ab} (68.09)	3.33	94.62 ^a (74.25)	12.00	72.75 ^a (58.57)
T ₈	43.67	17.00	63.29 ^a (52.71)	10.00	77.97 ^{bc} (62.02)	7.00	84.94 ^{ab} (69.18)	3.00	93.34 ^a (75.22)	12.67	71.79 ^a (57.96)
T ₉	43.00	45.67	-	44.67	-	45.67	-	45.00	-	44.33	-

No. - Population number per 10 hills; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Before the second round of spray, the pretreatment population ranged from 7.33 to 9.33 per 10 hills. At one DAT, the highest per cent reduction (74.69 %) was noticed in T₆ and the lowest (27.17 %) in T₁ (Table 6). A cent per cent reduction in T₃ and T₆ was observed on 5 DAT and 7 DAT. Due to incessant rains the 10th day observations were not taken.

The order of relative efficacy of insecticides is

$$(T_6 = T_3 = T_7 = T_8) > T_5 > T_2 > T_4 > T_1.$$

4.1.1.2. Experiment - II

a. Green leaf hopper (GLH)

The pretreatment population before the first spray ranged from 30.33 to 35.67 per 10 hills (Table 7). At 3 DAT, T₃ recorded the highest per cent reduction (83.10%) which was on par with T₆ (79.24%) while T₈ recorded the highest per cent reduction (83.61%) at 5 DAT which was on par with T₃, T₆ and T₇ (77.48 – 80.16 %). At 7 DAT, T₆ recorded the maximum per cent reduction of 96.50 which was found to be on par with T₃ (96.44%). There was a significant reduction in GLH population in all the treatments (88.57 – 100 %) and a cent per cent reduction in GLH population was observed on 10th day after spraying in T₆ which was on par with T₃ (99.09 %).

The order of relative efficacy is

$$(T_6 = T_3) > T_7 = T_8 > (T_5 = T_2) > T_4 > T_1$$

b. Brown plant hopper (BPH)

The pretreatment population of BPH before spraying varied between 6.67 to 9.00 per 10 hills. At one DAT, treatments T₂, T₃, T₅ and T₆ gave significant per cent reduction, with T₆ being the best recording 80 per cent (Table 8). At 3 DAT, T₃ registered 86.90 per cent reduction followed by T₆ (85.32%). At 5 DAT, T₃, T₅, T₆, T₇ and T₈ recorded 100 per cent reduction. At 7 DAT T₃ and T₆ were on par with each other and recorded more than 90 per cent reduction.

Table 6. Field efficacy of phosphamidon 40 SL against rice white backed planthopper - II spray. (Location I)
(Mean of three observations)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT	
		No.	P	No.	P	No.	P	No.	P
T ₁	7.67	6.00	27.17 ^d (30.88)	3.67	57.68 ^d (49.47)	2.33	70.56 ^d (57.40)	1.33	83.96 ^c (66.97)
T ₂	7.33	4.67	39.95 ^{cd} (39.07)	2.33	71.86 ^{bcd} (57.98)	1.00	87.18 ^{bcd} (69.03)	0.67	90.87 ^{abc} (75.55)
T ₃	8.00	2.67	69.17 ^{ab} (56.32)	1.00	88.71 ^{ab} (70.38)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)
T ₄	8.33	5.33	40.66 ^{cd} (39.61)	3.00	65.86 ^{cd} (54.74)	1.67	81.61 ^{cd} (65.23)	1.00	89.31 ^{bc} (71.02)
T ₅	8.33	4.00	53.09 ^{bc} (46.73)	2.33	71.94 ^{bcd} (58.63)	0.67	91.83 ^{abc} (76.38)	0.33	94.76 ^{ab} (82.22)
T ₆	8.67	2.33	74.49 ^a (59.85)	0.67	91.67 ^a (76.21)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)
T ₇	8.33	3.33	62.82 ^{ab} (52.47)	1.67	81.32 ^{abc} (64.84)	0.33	92.89 ^{abc} (77.29)	0.67	92.52 ^{abc} (76.96)
T ₈	8.67	3.67	60.56 ^{ab} (51.13)	1.67	82.77 ^{abc} (65.69)	0.33	95.83 ^{ab} (83.10)	0.67	93.30 ^{abc} (77.69)
T ₉	9.33	10.00	-	10.33	-	10.00	-	10.67	-

No. - Population number per 10 hills; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 7. Field efficacy of phosphamidon 40 SL against rice green leaf hopper - I spray. (Location II)

Treatments	Pretreatment count	(Mean of three observations)											
		1 DAT		3 DAT		5 DAT		7 DAT		10 DAT			
		No.	P	No.	P	No.	P	No.	P	No.	P		
T ₁	30.33	19.00	25.23 ^c (28.28)	14.33	37.34 ^d (37.60)	15.33	50.35 ^e (45.20)	7.00	80.17 ^d (63.44)	4.00	88.57 ^d (70.37)		
T ₂	30.67	16.00	37.62 ^{bc} (37.40)	8.67	60.95 ^{bc} (51.46)	11.67	62.75 ^b (52.41)	4.67	86.65 ^c (68.64)	1.33	96.23 ^{bc} (78.98)		
T ₃	31.67	11.33	58.27 ^a (49.77)	4.33	83.10 ^a (65.94)	7.00	78.00 ^a (62.17)	1.33	96.44 ^a (79.21)	0.33	99.09 ^a (86.83)		
T ₄	32.67	17.33	36.59 ^{bc} (36.72)	11.00	54.45 ^{cd} (47.58)	12.67	62.11 ^b (52.02)	5.33	85.67 ^c (67.83)	2.33	93.85 ^{cd} (75.71)		
T ₅	31.00	15.33	42.52 ^{ab} (40.68)	7.33	69.33 ^{abc} (56.51)	10.67	66.03 ^b (54.57)	4.33	87.74 ^c (69.58)	1.33	96.32 ^{bc} (79.08)		
T ₆	33.00	11.33	58.40 ^a (50.32)	5.33	79.24 ^a (62.99)	6.67	80.16 ^a (63.63)	1.33	96.50 ^a (79.36)	0.00	100.00 ^a (89.81)		
T ₇	33.67	13.00	54.46 ^a (47.70)	6.00	76.13 ^{ab} (60.80)	7.67	77.48 ^a (61.77)	2.00	94.80 ^{ab} (76.84)	0.67	98.29 ^{ab} (83.87)		
T ₈	35.67	14.33	52.48 ^{ab} (46.46)	7.00	75.73 ^{ab} (62.11)	6.00	83.61 ^a (66.15)	3.33	91.93 ^b (73.50)	0.67	98.44 ^{ab} (84.14)		
T ₉	34.67	30.00	-	26.67	-	35.67	-	40.00	-	40.00	-		

No. - Population number per 10 hills; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 8. Field efficacy of phosphamidon 40 SL against rice brown planthopper - I spray. (Location II)
(Mean of three observations)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT		10 DAT	
		No.	P	No.	P	No.	P	No.	P	No.	P
T ₁	8.33	5.67	20.40 ^b (26.39)	3.33	54.94 ^c (47.86)	2.00	80.41 ^c (64.20)	5.00	56.23 ^{cd} (48.59)	10.00	13.79 ^{cd} (19.14)
T ₂	6.67	2.00	61.52 ^a (52.52)	2.00	65.02 ^{bc} (54.39)	0.67	91.38 ^b (75.99)	3.00	64.18 ^{bed} (53.69)	7.67	18.65 ^c (25.44)
T ₃	7.67	1.33	77.33 ^a (62.39)	1.00	86.90 ^a (72.60)	0.00	100.00 ^a (89.81)	1.00	90.02 ^a (71.65)	3.33	69.31 ^{ab} (56.37)
T ₄	7.00	4.33	26.25 ^b (30.45)	2.67	54.76 ^c (47.95)	0.67	92.55 ^b (77.01)	4.67	49.84 ^d (44.89)	9.33	4.80 ^d (10.36)
T ₅	7.67	2.00	69.25 ^a (56.75)	2.00	69.71 ^{abc} (56.69)	0.00	100.00 ^a (89.81)	2.00	79.63 ^{ab} (63.79)	6.00	43.73 ^b (41.36)
T ₆	8.00	1.33	80.00 ^a (63.73)	1.00	85.32 ^{ab} (67.57)	0.00	100.00 ^a (89.81)	1.00	90.27 ^a (71.87)	2.67	75.50 ^a (60.51)
T ₇	7.00	4.00	31.19 ^b (33.29)	1.33	77.58 ^{abc} (62.24)	0.00	100.00 ^a (89.81)	2.67	71.25 ^{bc} (57.65)	4.67	51.70 ^{ab} (46.10)
T ₈	8.33	4.67	32.81 ^b (34.24)	1.67	77.91 ^{abc} (62.00)	0.00	100.00 ^a (89.81)	2.67	75.47 ^b (60.38)	3.33	70.63 ^a (57.30)
T ₉	9.00	7.67	-	8.00	-	11.00	-	12.00	-	12.67	-

No. - Population number per 10 hills; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

The order of relative efficacy is

$$(T_6 = T_3) > (T_7 = T_8) > (T_5 = T_2) > T_4 > T_1$$

c. White backed plant hopper (WBPH)

Before the application of insecticides, the population of WBPH fluctuated between 21.67 and 24.33 per 10 hills (Table 9). The highest per cent reduction at all days of observation was recorded by T_6 which was on par with phosphamidon 40 SL @ 500 g a.i./ha, confirming the superiority of phosphamidon 85 WSC over other treatments. At 3 DAT, T_3 and T_5 were on par with T_6 , T_7 and T_8 with 94.61 per cent reduction in T_6 and 93.69 per cent in T_3 . Cent per cent reduction resulted on 5th day after treatment in T_3 , T_6 , T_7 and T_8 . At 7 DAT, T_6 recorded 96.84 per cent reduction followed by T_3 which recorded 95.50 per cent reduction. The population reduction followed a declining trend at 10 DAT with 91.88 per cent reduction in T_6 and 89.03 per cent in T_3 .

The order of relative efficacy is

$$(T_6 = T_3) > (T_7 = T_8) > (T_5 = T_2) > T_4 > T_1$$

4.1.1.3. Field Experiment III

a. Green leaf hopper (GLH)

The initial incidence of GLH population ranged from 8.33 to 10.00 per 10 hills (Table 10) before imposing treatments. At one DAT, T_6 and T_8 recorded the maximum per cent reduction (54.88%) while T_1 recorded the minimum (28.91%). At 3 DAT, T_6 recorded cent per cent reduction, while T_3 recorded 92.96% reduction which were on par. Cent per cent reduction was also noticed on 5th day after spraying in T_3 , T_5 , T_6 , T_7 and T_8 . At 7 DAT, T_6 alone recorded cent per cent reduction and showed its superiority over all the other treatments.

The order of relative efficacy is

$$T_6 > (T_3 = T_7 = T_8) > (T_5 = T_2) > T_4 > T_1.$$

Table 9. Field efficacy of phosphamidon 40 SL against rice white backed planthopper - I spray. (Location II)
(Mean of three observations)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT		10 DAT	
		No.	P	No.	P	No.	P	No.	P	No.	P
T ₁	23.00	8.67	62.33 ^d (52.21)	5.00	77.69 ^c (61.84)	3.00	87.52 ^d (69.89)	5.00	79.08 ^d (62.84)	8.67	64.22 ^f (53.30)
T ₂	24.33	5.67	76.30 ^c (61.07)	3.67	91.11 ^a (72.76)	1.00	95.77 ^{bc} (78.17)	2.67	89.28 ^{bc} (70.92)	6.00	76.26 ^{de} (60.99)
T ₃	22.67	3.33	85.59 ^{ab} (67.72)	1.67	93.69 ^a (75.49)	0.00	100.00 ^a (89.81)	1.00	95.50 ^{ab} (77.84)	2.67	89.03 ^{ab} (70.68)
T ₄	21.67	7.67	64.44 ^d (53.50)	4.33	84.64 ^b (67.16)	2.00	91.06 ^{cd} (72.80)	3.67	82.27 ^{cd} (65.44)	7.00	69.46 ^{ef} (56.49)
T ₅	22.33	5.00	78.27 ^{bc} (62.23)	3.67	90.24 ^a (71.89)	0.67	96.63 ^b (81.35)	2.33	89.50 ^{bc} (71.25)	5.00	79.27 ^{cd} (63.02)
T ₆	23.67	3.00	86.28 ^a (68.88)	1.00	94.61 ^a (76.95)	0.00	100.00 ^a (89.81)	0.67	96.84 ^a (81.73)	2.00	91.88 ^a (73.51)
T ₇	23.33	4.00	82.62 ^{abc} (65.51)	3.00	92.62 ^a (74.25)	0.00	100.00 ^a (89.81)	1.67	92.40 ^b (74.44)	3.33	86.53 ^{abc} (68.50)
T ₈	22.67	4.67	79.88 ^{abc} (63.40)	2.67	93.34 ^a (75.22)	0.00	100.00 ^a (89.81)	1.67	92.91 ^b (74.64)	3.67	84.68 ^{bc} (67.12)
T ₉	24.00	24.33	-	24.00	-	23.67	-	24.33	-	25.33	-

No. - Population number per 10 hills; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 10. Field efficacy of phosphamidon 40 SL against rice green leafhopper - I spray. (Location III)
(Mean of three observations)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT		10 DAT	
		No.	P	No.	P	No.	P	No.	P	No.	P
T ₁	8.33	6.33	28.91 ^c (32.49)	2.00	76.60 ^c (61.10)	1.00	88.33 ^b (73.66)	2.33	75.06 ^b (60.20)	5.67	41.62 ^c (40.15)
T ₂	9.00	6.00	36.41 ^{bc} (36.93)	1.33	85.39 ^{bc} (67.87)	0.33	96.30 ^{ab} (83.51)	1.67	82.43 ^b (65.80)	5.00	52.32 ^{bc} (46.34)
T ₃	9.00	5.33	44.32 ^{abc} (41.72)	0.67	92.96 ^{ab} (77.36)	0.00	100.00 ^a (89.81)	1.00	90.03 ^b (71.66)	4.00	61.72 ^{ab} (51.79)
T ₄	10.00	6.00	43.94 ^{abc} (41.49)	1.00	90.24 ^{bc} (71.81)	0.67	93.64 ^{ab} (78.01)	1.67	85.05 ^b (67.56)	5.33	54.31 ^{bc} (47.48)
T ₅	10.00	5.33	48.71 ^{ab} (44.23)	0.67	93.27 ^{ab} (77.66)	0.00	100.00 ^a (89.81)	1.33	88.75 ^b (70.45)	4.33	62.53 ^{ab} (52.31)
T ₆	9.00	4.33	54.88 ^a (47.81)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	3.33	67.39 ^a (55.33)
T ₇	8.67	4.67	50.34 ^{ab} (45.19)	0.33	96.29 ^{ab} (83.51)	0.00	100.00 ^a (89.81)	0.33	96.63 ^a (83.82)	3.67	63.27 ^{ab} (52.79)
T ₈	9.67	4.67	54.88 ^a (47.81)	0.00	96.67 ^{ab} (83.86)	0.00	100.00 ^a (89.81)	0.33	97.50 ^a (84.70)	4.00	64.85 ^{ab} (53.69)
T ₉	9.67	10.33	-	10.00	-	10.67	-	11.00	-	11.33	-

No. - Population number per 10 hills ; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

b. Brown plant hopper (BPH)

The pretreatment count of BPH ranged from 13.67 to 15.67 per 10 hills before spraying. At one DAT, a maximum of 57.29 per cent reduction was observed in T₈ (Table 11). At 3 DAT, T₆ and T₇ recorded 93.84 per cent and 93.71 per cent reduction respectively and were significantly superior over other treatments. The BPH population was absent at 5 DAT in T₃, T₆, T₇ and T₈. However, at 7 DAT, T₆ alone recorded 100 per cent reduction followed by T₇ (97.94%) and T₈ (98.16%).

The order of relative efficacy is

$$T_6 > (T_3 = T_7 = T_8) > (T_5 = T_2) > T_4 > T_1.$$

4.1.2. COTTON

4.1.2.1. Experiment - I

a. Leaf hopper

The results of the observations on the leaf hopper population in the field experiments conducted during 1999 are presented in the table 12 and 13. The pretreatment count of cotton leaf hopper ranged from 12.67 to 14.33 per 10 plants before first round of spray (Table 12). At one DAT, 76.52 per cent reduction in the leaf hopper population was recorded in T₆ followed by 74.90 per cent reduction in T₃. On 3rd day after spraying, T₃ recorded 88.05 per cent reduction which was on par with T₆ (88.36%). At 5 DAT, T₆ recorded a maximum per cent reduction of 62.82 and T₅ and T₃ were on par with T₆. The same trend was reflected at 7 DAT. The observations were not taken on 10 DAT because of rains.

A significant control was achieved in all the treatments and T₃ was on par with T₆ at one and 3 DAT of second spray (Table 13). At 5 DAT, cent per cent reduction was noticed in T₃ and T₆. At 7 and 10 DAT, the reduction assumed a declining trend with T₃ recording higher per cent reduction (62.50 – 79.45%) than T₆ (61.68 – 73.56%).

The order of relative efficacy is

$$(T_3 = T_6) T_5 > (T_7 = T_8) > T_2 > T_4 > T_1.$$

Table 11. Field efficacy of phosphamidon 40 SL against rice brown planthopper - I spray. (Location III)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT		10 DAT	
		No.	P	No.	P	No.	P	No.	P	No.	P
T ₁	15.33	9.00	43.67 ^{ab} (41.31)	3.33	79.76 ^c (63.41)	1.33	92.70 ^b (77.12)	2.00	88.55 ^c (70.22)	4.33	75.42 ^d (60.37)
T ₂	13.67	8.33	41.96 ^b (40.35)	3.00	79.83 ^c (63.34)	1.00	93.43 ^b (75.16)	1.33	91.48 ^{bc} (73.23)	3.67	76.79 ^{cd} (61.28)
T ₃	14.00	7.67	47.34 ^{ab} (43.49)	2.00	86.79 ^{bc} (68.73)	0.00	100.00 ^a (89.81)	0.67	95.98 ^{abc} (80.52)	3.00	81.43 ^{abcd} (64.51)
T ₄	14.33	8.33	44.01 ^{ab} (41.47)	2.67	83.45 ^{bc} (66.60)	0.67	96.22 ^{ab} (80.82)	1.00	93.85 ^{bc} (75.65)	3.33	79.96 ^{bcd} (63.46)
T ₅	15.67	7.67	53.05 ^{ab} (46.76)	2.00	88.20 ^{ab} (69.96)	0.67	96.18 ^{ab} (80.80)	1.00	94.24 ^{abc} (78.78)	3.00	83.46 ^{abcd} (66.03)
T ₆	15.00	6.67	57.19 ^a (49.19)	1.00	93.84 ^a (75.66)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	2.00	88.55 ^a (70.63)
T ₇	14.67	6.67	56.10 ^a (48.53)	1.00	93.71 ^a (75.50)	0.00	100.00 ^a (89.81)	0.33	97.94 ^{ab} (85.20)	2.00	88.28 ^{ab} (70.38)
T ₈	15.67	7.00	57.29 ^a (49.21)	1.67	90.29 ^{ab} (72.03)	0.00	100.00 ^a (89.81)	0.33	98.16 ^{ab} (85.47)	2.67	85.62 ^{abc} (67.91)
T ₉	14.33	15.00	-	15.67	-	16.00	-	16.33	-	16.67	-

No. - Population number per 10 hills; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 12. Field efficacy of phosphamidon 40 SL against cotton leafhopper - I spray. (Location I)
(Mean of three observations)

Treatments	Pretreatment t count	1 DAT		3 DAT		5 DAT		7 DAT	
		No.	P	No.	P	No.	P	No.	P
T ₁	12.67	10.33	30.36 ^d (32.57)	8.00	52.48 ^c (46.42)	10.67	36.10 ^d (36.89)	11.33	37.73 ^c (37.76)
T ₂	13.33	5.67	62.07 ^{bc} (52.17)	3.33	80.58 ^{bc} (63.91)	7.67	54.33 ^{ab} (47.55)	7.67	57.61 ^{ab} (49.48)
T ₃	12.67	3.67	74.90 ^{ab} (60.20)	2.00	88.05 ^a (69.79)	6.67	59.80 ^a (50.71)	7.00	61.96 ^a (51.93)
T ₄	13.67	8.00	51.27 ^c (45.73)	4.67	74.49 ^{cd} (59.71)	8.67	51.58 ^{abc} (45.91)	9.00	52.65 ^{ab} (46.62)
T ₅	14.33	4.67	72.13 ^{ab} (58.31)	2.67	85.90 ^{ab} (68.05)	7.33	60.83 ^a (51.29)	8.67	57.22 ^{ab} (49.28)
T ₆	13.00	3.67	76.52 ^a (61.05)	2.00	88.36 ^a (70.47)	6.33	62.82 ^a (52.46)	7.00	62.63 ^a (52.36)
T ₇	13.67	8.00	51.07 ^c (45.61)	5.67	68.71 ^d (56.05)	9.33	47.47 ^{bc} (43.48)	9.67	50.19 ^b (45.14)
T ₈	13.33	7.67	52.16 ^c (46.24)	8.67	50.72 ^c (45.41)	10.00	41.84 ^{cd} (40.15)	9.67	48.91 ^b (44.35)
T ₉	13.67	16.33	-	18.00	-	18.00	-	19.67	-

No. - Population number per 10 plants ; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 13. Field efficacy of phosphamidon 40 SL against cotton leafhopper - II Spray. (Location I)
(Mean of three observations)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT		10 DAT	
		No.	P	No.	P	No.	P	No.	P	No.	P
T ₁	16.33	8.00	51.85 ^d (46.06)	8.00	40.99 ^e (39.43)	3.33	78.32 ^e (62.32)	10.00	40.12 ^e (37.30)	14.33	29.75 ^{cd} (32.75)
T ₂	17.00	3.67	78.89 ^{ab} (62.65)	2.67	82.42 ^{abc} (65.28)	0.67	96.17 ^{abc} (80.82)	6.33	64.04 ^{ab} (53.89)	11.33	46.52 ^{abc} (42.99)
T ₃	16.00	3.00	80.64 ^a (64.24)	1.33	90.45 ^{ab} (72.33)	0.00	100.00 ^a (89.81)	3.67	79.45 ^a (63.63)	7.67	62.50 ^a (52.26)
T ₄	15.33	6.67	55.76 ^{cd} (48.37)	5.67	58.56 ^{de} (49.95)	2.67	81.44 ^{de} (64.69)	8.33	52.97 ^{bc} (46.78)	15.67	20.31 ^d (26.67)
T ₅	15.00	4.33	70.61 ^{ab} (57.39)	2.00	85.60 ^{ab} (67.98)	0.33	98.04 ^{ab} (85.32)	5.67	66.42 ^{ab} (55.10)	9.67	49.71 ^{ab} (44.83)
T ₆	13.67	2.67	80.04 ^a (63.66)	1.00	91.78 ^a (73.36)	0.00	100.00 ^a (89.81)	4.33	73.56 ^{ab} (59.14)	6.67	61.68 ^a (51.83)
T ₇	16.00	5.00	69.29 ^{abc} (56.43)	3.33	76.83 ^{bcd} (61.25)	1.33	90.83 ^{bcd} (75.49)	6.67	65.43 ^{ab} (54.05)	12.00	41.21 ^{bc} (39.87)
T ₈	16.67	5.67	66.13 ^{bc} (54.43)	4.67	68.38 ^{cd} (56.05)	2.00	87.56 ^{cde} (69.74)	7.33	62.55 ^{ab} (52.40)	12.67	40.26 ^{bc} (39.31)
T ₉	16.33	16.33	-	14.67	-	15.67	-	17.00	-	21.00	-

No. - Population number per 10 plants; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

b. Aphid

The pretreatment population before first round of spraying ranged from 61.00 to 68.67 per 10 plants (Table 14). At one DAT, T₅ registered the highest per cent reduction (37.01%) and the lowest (25.85%) was recorded in T₁. Cent per cent reduction was recorded in T₂, T₃, T₅ and T₆ at 3 DAT and at 5 DAT, the reduction assumed a decreasing trend, with a maximum of 98.84 per cent reduction in T₆. Due to incessant rains, observations were not recorded on 10 DAT.

The pretreatment count before second round of spraying was between 31.00 to 34.33 per 10 plants. The treatments T₃ and T₆ registered a remarkable cent per cent reduction on first day after second round of spraying (Table 15). At 3 DAT, cent per cent reduction was observed in T₂, T₃, T₅, T₆ and T₇. From 5th day after treatment, the reduction in aphid population followed a decreasing trend, with T₆ registering 97.59 per cent reduction followed by T₃ and T₂ which recorded 96.64 and 95.77 per cent reduction respectively.

The order of relative efficacy is

$$(T_6 = T_3) > (T_5 = T_2) > (T_7 = T_8) > T_1 > T_1.$$

c. Whitefly

Before spraying, the the population of whiteflies varied between 10 to 11.33 per 10 plants. At 3 DAT no whiteflies were observed in T₂, T₃, T₅ and T₆ (Table 16). On 5th day onwards, the efficacy showed a moderate decline with 93.27 per cent reduction in T₆ at 5 DAT and 85.29 per cent reduction in T₆ at 7 DAT. Observations were not recorded on 10 DAT due to incessant rains.

The population of whitefly fluctuated between 8.00 and 10.33 per 10 plants before the second round of spray (Table 17). Considerable reduction in pest population was expressed at 3 DAT, with cent per cent reduction in T₂, T₃, T₅ and T₆, which confirmed the superiority of phosphamidon 40 SL and 85 WSC over other treatments. At 7 DAT, T₃ was found to be the best treatment with a maximum of 81.10 per cent reduction (Table 17).

Table 14. Field efficacy of phosphamidon 40 SL against cotton aphid - I spray. (Location I)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT	
		No.	P	No.	P	No.	P	No.	P
T ₁	61.00	44.67	25.85 ^b (30.51)	1.67	97.19 ^b (80.44)	6.00	89.79 ^c (71.71)	14.33	73.50 ^e (59.02)
T ₂	61.00	43.33	34.48 ^{ab} (35.94)	0.00	100.00 ^a (89.81)	1.67	97.31 ^{abc} (80.69)	9.33	84.19 ^{bc} (66.61)
T ₃	64.67	41.00	35.93 ^{ab} (36.75)	0.00	100.00 ^a (89.81)	1.00	98.34 ^{ab} (83.17)	7.33	87.25 ^{ab} (69.08)
T ₄	65.67	43.67	32.80 ^{ab} (34.81)	1.33	97.90 ^b (81.78)	2.33	96.25 ^{bed} (79.09)	11.67	80.01 ^d (63.44)
T ₅	68.67	42.67	37.01 ^a (37.41)	0.00	100.00 ^a (89.81)	1.33	97.94 ^{ab} (81.85)	8.67	85.61 ^{ab} (67.82)
T ₆	63.67	40.00	36.54 ^{ab} (37.18)	0.00	100.00 ^a (89.81)	0.67	98.84 ^a (84.95)	7.00	87.57 ^a (69.41)
T ₇	63.00	44.33	28.72 ^{ab} (32.34)	1.00	98.32 ^b (83.98)	3.00	94.81 ^{cd} (77.00)	10.00	82.02 ^{cd} (64.96)
T ₈	64.67	45.33	29.04 ^{ab} (32.56)	1.00	98.39 ^b (82.73)	3.67	93.98 ^d (75.87)	10.33	81.87 ^{cd} (64.88)
T ₉	66.00	65.33	-	47.00	-	61.67	-	58.67	-

No. - Population number per 10 plants; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

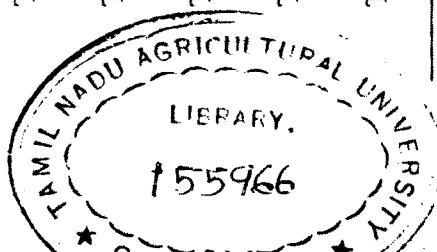


Table 15. Field efficacy of phosphamidon 40 SL against cotton aphid – II spray. (Location I)

Treatments	Pretreatment count	(Mean of three observations)																	
		1 DAT			DAT			5 DAT			7 DAT			10 DAT					
		No.	P	No.	P	No.	P	No.	P	No.	P	No.	P	No.	P				
T ₁	32.67	4.33	85.54 ^c (68.02)	2.33	91.89 ^c (73.55)	8.00	73.60 ^d (59.14)	13.00	58.07 ^d (49.65)	18.67	30.27 ^d (32.86)								
T ₂	33.67	1.00	97.11 ^{ab} (82.04)	0.00	100.00 ^a (89.81)	1.33	95.77 ^{ab} (78.28)	6.67	79.19 ^b (62.89)	13.00	52.98 ^{ab} (46.75)								
T ₃	32.00	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	1.00	96.64 ^{ab} (79.45)	4.67	84.60 ^a (66.94)	9.67	63.71 ^a (52.99)								
T ₄	31.33	3.00	89.38 ^c (71.37)	1.00	95.91 ^b (80.65)	3.67	87.60 ^c (69.46)	9.67	67.63 ^c (55.33)	16.33	37.09 ^{cd} (37.27)								
T ₅	31.67	0.67	97.91 ^{ab} (84.98)	0.00	100.00 ^a (89.81)	1.67	94.37 ^b (76.42)	5.33	82.21 ^{ab} (65.89)	11.00	56.98 ^{ab} (49.10)								
T ₆	31.00	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	0.67	97.59 ^a (82.69)	4.33	85.19 ^a (67.42)	8.67	66.03 ^a (54.43)								
T ₇	32.33	1.67	94.23 ^{bc} (76.43)	0.00	100.00 ^a (89.81)	4.33	86.06 ^c (68.17)	8.33	72.67 ^c (58.52)	14.00	47.15 ^{bc} (43.35)								
T ₈	33.67	2.00	93.78 ^{bc} (75.84)	0.67	97.53 ^{ab} (82.51)	5.00	83.76 ^c (66.37)	9.00	71.88 ^c (57.97)	15.33	44.86 ^{bc} (42.03)								
T ₉	34.33	32.67	-	30.33	-	32.00	-	32.67	-	28.67	-								

No. - Population number per 10 plants; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 16. Field efficacy of phosphamidon 40 SL against cotton whitefly - I spray. (Location I)

Treatments	Pretreatment count	(Mean of three observations)											
		1 DAT		3 DAT		5 DAT		7 DAT		5 DAT		7 DAT	
		No.	P	No.	P	No.	P	No.	P	No.	P	No.	P
T ₁	10.67	2.67	76.69 ^d (61.41)	1.67	84.94 ^c (67.95)	2.67	77.46 ^b (62.20)	6.00	47.89 ^c (43.79)				
T ₂	10.33	0.33	97.33 ^{ab} (84.52)	0.00	100.00 ^a (89.81)	1.67	84.94 ^{ab} (67.94)	2.67	76.45 ^{ab} (60.78)				
T ₃	10.33	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	1.33	89.63 ^{ab} (71.33)	3.33	70.30 ^{bc} (57.03)				
T ₄	10.67	1.00	91.18 ^{bcd} (72.85)	0.33	97.65 ^{ab} (84.87)	2.33	83.48 ^{ab} (66.08)	4.33	59.30 ^{bc} (50.55)				
T ₅	10.00	0.67	91.94 ^{abc} (80.18)	0.00	100.00 ^a (89.81)	1.67	85.56 ^{ab} (68.00)	3.00	71.75 ^{abc} (58.09)				
T ₆	10.00	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	0.67	93.27 ^a (77.67)	1.33	85.29 ^a (71.58)				
T ₇	11.33	1.67	85.37 ^{cd} (68.08)	0.67	94.72 ^{abc} (79.37)	2.00	85.73 ^{ab} (68.04)	4.67	59.61 ^{bc} (50.69)				
T ₈	10.67	1.33	88.12 ^{bcd} (70.31)	1.00	89.53 ^{bc} (74.65)	2.33	82.61 ^{ab} (65.71)	5.33	53.37 ^{bc} (46.95)				
T ₉	11.00	12.00	-	12.67	-	13.00	-	11.67	-				

No. - Population number per 10 plants; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 17. Field efficacy of phosphamidon 40 SL against cotton whitefly - II spray. (Location I)

Treatments	Pretreatment count	(Mean of three observations)											
		1 DAT		3 DAT		5 DAT		7 DAT		10 DAT			
		No.	P	No.	P	No.	P	No.	P	No.	P		
T ₁	8.00	6.67	31.67 ^e (34.13)	3.33	66.63 ^d (55.57)	3.67	62.88 ^d (52.79)	7.00	33.70 ^d (34.94)	9.33	21.42 ^c (26.97)		
T ₂	9.67	3.67	67.73 ^{bc} (55.72)	0.00	100.00 ^a (89.81)	0.67	94.95 ^{ab} (79.40)	4.67	63.82 ^{abc} (53.25)	8.33	40.85 ^{ab} (39.60)		
T ₃	10.33	2.00	83.94 ^a (66.45)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	2.67	81.10 ^a (64.34)	7.00	52.02 ^a (46.05)		
T ₄	8.33	4.33	56.81 ^{cd} (48.79)	2.33	79.92 ^{cd} (63.78)	2.33	79.17 ^{cd} (63.29)	6.33	43.78 ^{cd} (41.19)	9.33	24.06 ^{bc} (28.03)		
T ₅	9.33	2.67	76.74 ^{ab} (68.25)	0.00	100.00 ^a (89.81)	0.67	94.50 ^{ab} (78.88)	3.67	71.62 ^{ab} (57.94)	7.67	44.35 ^a (41.56)		
T ₆	8.00	1.33	82.10 ^a (65.56)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	2.33	79.22 ^a (63.35)	6.33	47.38 ^a (43.49)		
T ₇	9.67	5.33	55.11 ^d (47.94)	1.00	92.22 ^b (76.98)	1.67	86.26 ^{bc} (68.65)	5.33	57.04 ^{bc} (49.18)	8.67	39.19 ^{abc} (38.64)		
T ₈	10.33	6.00	54.05 ^d (47.33)	1.67	88.24 ^{bc} (90.17)	1.67	88.03 ^{bc} (69.95)	6.33	56.05 ^{bc} (48.53)	8.67	45.45 ^a (42.37)		
T ₉	8.67	10.67	-	11.67	-	11.33	-	12.00	-	13.00	-		

No. - Population number per 10 plants; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

The order of relative efficacy is

$$(T_3 = T_6) > (T_7 = T_8) > (T_2 > T_5) > T_4 > T_1.$$

4.1.3. BRINJAL

4.1.3.1. Experiment - I

a. Leaf hopper

The pretreatment count ranged from 28.00 to 30.00 per 10 plants before spraying (Table 18). The monocrotophos 36 WSC treatment (T₇) recorded the highest per cent reduction (93.99%) at one DAT. AT 3 DAT too, T₇ recorded 94.20 per cent reduction and was on par with T₃ and T₆ and a similar trend was observed on 5 DAT. At 5 DAT, T₇ registered 97.66 per cent reduction followed by 94.01 and 91.65 per cent in T₆ and T₃ respectively. Due to incessant rains the 10th day observations were not taken.

Before the second round of spray, the population of leaf hopper fluctuated between 30.33 and 32.33 per 10 plants (Table 19). Among the treatments T₆ recorded a maximum of 71.78 per cent reduction at 1 DAT. At 3 DAT, T₆ and T₇ recorded a maximum per cent reduction (97.02%) while that was the lowest (71.76%) in T₁. At 5 DAT, cent per cent reduction was expressed in T₆ and T₇, followed by 96.90 per cent reduction in T₃. At 7 DAT, the reduction assumed a declining trend. (41.14 – 76.13%)

The order of relative efficacy is

$$T_7 > (T_6 = T_3) > (T_5 > T_2) > T_4 > T_1.$$

b. Aphid

Before spraying, the aphid population on brinjal varied from 35.33 to 38.00 per 10 plants. At one DAT, T₆ recorded the highest per cent reduction (89.35%) and it was on par with T₇ and T₃ (Table 20). At 3 DAT, cent per cent reduction was recorded in all the treatments except T₁ and T₄. No aphid population was observed in T₃, T₆ and T₇ at 5 DAT also. At 7 DAT, the highest per cent reduction (97.16%) was noticed in T₆ as against the lowest (90.21%) in T₁. Due to incessant rains the 10th day observations were not recorded.

Table 18. Field efficacy of phosphamidon 40 SL against brinjal leafhopper - I spray. (Location I)

Treatments	Pretreatment count	(Mean of three observations)											
		1 DAT		3 DAT		5 DAT		7 DAT					
		No.	P	No.	P	No.	P	No.	P				
T ₁	28.00	14.33	46.21 ^e (42.81)	7.33	73.85 ^e (59.24)	5.67	79.57 ^d (63.13)	11.33	59.92 ^d (50.72)				
T ₂	29.00	5.33	80.69 ^c (64.03)	2.67	90.76 ^{ab} (72.39)	3.67	86.96 ^{bed} (69.07)	8.00	72.03 ^{cd} (58.21)				
T ₃	28.67	3.67	86.55 ^{bc} (68.55)	2.00	92.91 ^a (74.95)	2.33	91.65 ^{bc} (73.34)	3.67	86.78 ^b (69.02)				
T ₄	28.33	7.33	72.55 ^d (58.50)	3.67	87.02 ^b (68.94)	4.33	84.58 ^{cd} (66.89)	9.33	67.19 ^{cd} (55.07)				
T ₅	30.00	4.67	83.83 ^c (66.35)	2.67	91.12 ^{ab} (72.73)	3.00	90.02 ^{bc} (71.69)	6.67	77.74 ^{bc} (61.91)				
T ₆	28.33	2.33	91.34 ^{ab} (72.97)	1.67	94.16 ^a (76.15)	1.67	94.01 ^b (76.00)	1.33	95.37 ^a (77.71)				
T ₇	28.67	1.67	93.99 ^a (75.92)	1.67	94.20 ^a (76.21)	0.67	97.66 ^a (82.80)	1.33	95.61 ^a (80.09)				
T ₈	29.67	28.33	-	29.67.	-	29.33	-	30.00	-				

No. - Population number per 10 plants ; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 19. Field efficacy of phosphamidon 40 SL against brinjal leafhopper - II spray. (Location I)

Treatments	Pretreatment count	(Mean of three observations)											
		1 DAT		3 DAT		5 DAT		7 DAT		10 DAT			
		No.	P	No.	P	No.	P	No.	P	No.	P		
T ₁	30.33	14.00	33.03 ^f (34.85)	5.67	71.76 ^d (58.12)	3.67	81.36 ^d (64.48)	7.33	63.46 ^d (52.81)	12.33	41.14 ^f (39.87)		
T ₂	30.67	10.00	53.00 ^d (46.72)	3.00	85.30 ^{bcd} (67.70)	1.00	95.00 ^{bc} (77.08)	4.67	76.99 ^e (61.45)	8.67	59.29 ^d (50.35)		
T ₃	31.33	7.67	64.80 ^{bc} (53.65)	1.33	92.04 ^{ab} (73.85)	0.67	96.90 ^b (81.69)	2.67	87.08 ^{ab} (69.09)	6.67	69.68 ^{bc} (56.59)		
T ₄	31.00	11.67	45.72 ^e (42.50)	4.33	79.49 ^{cd} (63.18)	2.33	88.52 ^{cd} (70.29)	6.67	67.77 ^d (55.45)	10.33	52.21 ^e (46.27)		
T ₅	31.33	8.67	60.49 ^c (51.06)	2.33	89.00 ^{bc} (70.73)	1.00	95.45 ^b (79.80)	3.67	82.41 ^{bc} (65.28)	7.33	66.59 ^c (54.70)		
T ₆	32.00	6.33	71.78 ^a (57.97)	0.67	97.02 ^a (81.87)	0.00	100.00 ^a (89.81)	2.67	91.05 ^a (72.84)	5.67	74.95 ^{ab} (59.99)		
T ₇	32.00	7.33	68.76 ^{ab} (56.11)	0.67	97.02 ^a (81.87)	0.00	100.00 ^a (89.81)	2.67	87.80 ^{ab} (69.59)	5.33	76.13 ^a (60.85)		
T ₈	32.33	23.00		22.33	-	21.67	-	22.00	-	23.00			

No. - Population number per 10 plants; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 20. Field efficacy of phosphamidon 40 SL against brinjal aphid. - I spray . (Location I)

Treatments	Pretreatment count	(Mean of three observations)											
		1 DAT		3 DAT		5 DAT		7 DAT					
		No.	P	No.	P	No.	P	No.	P				
T ₁	35.67	8.00	77.96 ^c (62.03)	4.00	88.97 ^c (70.67)	3.67	89.62 ^d (71.21)	3.33	90.21 ^c (71.86)				
T ₂	38.00	6.00	84.37 ^{abc} (66.80)	0.00	100.00 ^a (89.81)	2.00	94.63 ^b (76.61)	2.00	94.68 ^{ab} (76.88)				
T ₃	37.33	4.67	87.75 ^{ab} (69.59)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	1.00	97.22 ^a (80.40)				
T ₄	36.33	7.00	82.76 ^{bc} (65.51)	1.33	96.26 ^b (79.08)	2.67	92.44 ^c (74.15)	2.67	92.32 ^{bc} (74.01)				
T ₅	35.33	6.00	83.30 ^{abc} (66.01)	0.00	100.00 ^a (89.81)	1.33	96.12 ^b (78.88)	1.67	95.02 ^{ab} (77.31)				
T ₆	36.67	4.00	89.35 ^a (71.01)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	1.00	97.16 ^a (80.31)				
T ₇	36.67	4.00	89.13 ^a (70.89)	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	1.67	95.26 ^{ab} (77.58)				
T ₈	37.67	38.33	-	38.00	-	37.00	-	36.33	-				

No. - Population number per 10 plants ; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

The order of relative efficacy is

$$(T_6 = T_7) > T_3 > (T_5 > T_2) > T_4 > T_1.$$

c. Whitefly

The pretreatment count varied between 12.33 to 14.67 per 10 plants before first round of spray. At one DAT, T_6 recorded the highest per cent reduction (72.06%) followed by T_3 (68.33) and T_7 (67.55) which were on par (Table 21) and the same trend was observed at 3 DAT. Cent per cent reduction was observed in T_3 , T_6 and T_7 at 5 DAT, while at 7 DAT the population reduction showed a declining trend with 56.32 to 86.09 per cent. The 10th day observations were not taken due to incessant rains.

As in the case of first round of application, T_6 recorded the highest per cent reduction (84.32%) from one to 10 DAT (Table 22). At 5 DAT, T_3 , T_6 , and T_7 registered cent per cent reduction, while at 10 DAT, all the treatments were on par with each other except T_1 .

The order of relative efficacy is

$$(T_3 = T_6 = T_7) > (T_2 = T_5) >> T_4 > T_1.$$

4.1.3.2. Experiment - II

a. Leaf hopper

The leaf hopper infestation level, before first spray ranged from 24.33 to 26.67 per 10 plants. At one DAT, all the treatments resulted in significant reduction of leaf hopper population with a maximum being 90.18 per cent in T_6 (Table 23). At 3 DAT, a cent per cent reduction was observed in T_6 followed by T_7 (94.84%). However, at 5 DAT, T_6 registered higher reduction (94.72%) followed by 90.79 per cent reduction in T_7 . The same trend was reflected at 7 DAT too with 79.36 and 76.94 per cent reduction in T_7 and T_6 respectively. Observations on 10th day were not recorded because of rains.

The order of relative efficacy is

$$T_6 > (T_7 = T_3) > (T_5 > T_2) > T_4 > T_1.$$

Table 21. Field efficacy of phosphamidon 40 SL against brinjal whitefly - I spray. (Location I)

Treatments	Pretreatment count	1 DAT			3 DAT			5 DAT			7 DAT		
		No.	P	No.	P	No.	P	No.	P	No.	P	No.	P
T ₁	13.00	10.67	27.95 ^c (31.87)	7.00	54.95 ^d (47.86)	3.67	75.67 ^c (66.60)	6.33	56.32 ^c (48.69)				
T ₂	13.67	7.33	52.71 ^b (46.56)	4.33	73.17 ^{bc} (58.85)	1.00	93.82 ^b (75.61)	5.00	68.22 ^{bc} (55.80)				
T ₃	13.33	4.67	68.33 ^a (55.49)	2.67	83.22 ^{ab} (65.87)	0.00	100.00 ^a (89.81)	3.00	79.50 ^{ab} (63.46)				
T ₄	12.33	8.67	37.76 ^c (37.69)	5.00	65.58 ^{cd} (54.17)	3.00	79.34 ^c (63.20)	5.67	59.22 ^c (50.36)				
T ₅	14.33	6.67	58.50 ^{ab} (50.03)	3.67	78.65 ^b (62.58)	0.67	95.82 ^b (80.14)	3.67	77.99 ^{ab} (62.06)				
T ₆	14.67	4.67	72.06 ^a (58.11)	2.00	88.44 ^a (70.14)	0.00	100.00 ^a (89.81)	2.33	86.00 ^a (68.15)				
T ₇	14.00	5.33	67.75 ^a (55.45)	3.00	82.75 ^{ab} (65.65)	0.00	100.00 ^a (89.81)	2.67	84.01 ^a (66.51)				
T ₈	13.67	16.33	-	17.00	-	17.00	-	16.33	-				

No. - Population number per 10 plants; DAT - Days after treatment
 Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction
 Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 22. Field efficacy of phosphamidon 40 SL against brinjal whitefly - II spray. (Location I)

Treatments	Pretreatment count	(Mean of three observations)											
		1 DAT		3 DAT		5 DAT		7 DAT		10 DAT			
		No.	P	No.	P	No.	P	No.	P	No.	P		
T ₁	21.00	7.67	64.85 ^d (53.73)	6.00	71.36 ^c (57.92)	4.67	79.20 ^d (62.92)	5.67	73.54 ^c (59.14)	8.67	59.17 ^b (50.34)		
T ₂	21.33	5.67	75.19 ^{bc} (60.13)	4.33	80.02 ^{abc} (63.54)	2.00	90.66 ^c (72.82)	3.33	84.51 ^{ab} (67.16)	5.67	73.28 ^a (59.11)		
T ₃	22.00	4.33	81.42 ^{ab} (64.50)	2.67	87.89 ^a (69.84)	0.00	100.00 ^a (89.81)	2.33	89.49 ^{ab} (71.25)	4.67	79.56 ^a (63.17)		
T ₄	22.67	7.00	70.04 ^{cd} (57.05)	4.33	77.13 ^{bc} (61.57)	3.67	84.96 ^d (67.23)	4.67	79.43 ^{bc} (63.49)	7.00	69.77 ^a (61.94)		
T ₅	21.33	5.00	78.47 ^{abc} (62.41)	3.33	85.14 ^{ab} (67.47)	1.00	95.57 ^b (77.91)	3.33	84.94 ^{ab} (67.18)	5.00	77.37 ^a (61.63)		
T ₆	22.00	3.67	84.32 ^a (66.73)	2.67	88.41 ^a (70.12)	0.00	100.00 ^a (89.81)	1.67	92.28 ^a (74.22)	4.00	81.89 ^a (65.06)		
T ₇	21.00	3.67	83.56 ^{ab} (66.11)	2.33	89.87 ^a (70.99)	0.00	100.00 ^a (89.81)	2.33	88.85 ^{ab} (70.71)	4.00	80.55 ^a (64.19)		
T ₈	20.33	21.67	-	21.00	-	22.00	-	21.00	-	21.00	-		

No. - Population number per 10 plants; DAT - Days after treatment
 Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction
 Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 23. Field efficacy of phosphamidon 40 SL against brinjal leafhopper - I spray. (Location II)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT	
		No.	P	No.	P	No.	P	No.	P
T ₁	25.33	7.00	72.12 ^c (58.13)	7.67	70.36 ^c (57.07)	8.33	66.92 ^d (54.92)	11.00	56.07 ^d (48.52)
T ₂	26.00	4.67	81.31 ^b (64.63)	4.00	85.15 ^{cd} (67.38)	5.33	79.09 ^c (62.90)	7.67	70.35 ^{bc} (57.04)
T ₃	25.00	3.33	86.48 ^{ab} (68.47)	2.33	90.94 ^{bc} (72.54)	3.33	86.50 ^{abc} (68.54)	6.33	74.52 ^{ab} (59.72)
T ₄	26.67	5.33	80.03 ^{bc} (63.51)	4.67	82.18 ^d (65.34)	5.67	78.75 ^c (62.55)	9.67	63.50 ^{cd} (52.85)
T ₅	24.33	4.00	83.37 ^{ab} (65.84)	3.33	86.58 ^{cd} (68.57)	4.67	80.85 ^{bc} (64.06)	7.33	69.88 ^{bc} (56.72)
T ₆	24.67	2.33	90.18 ^a (71.92)	0.00	100.00 ^a (89.81)	1.33	94.72 ^{ab} (71.06)	5.67	76.94 ^{ab} (61.34)
T ₇	25.33	3.33	86.64 ^{ab} (68.62)	1.33	94.84 ^b (77.06)	2.33	90.79 ^a (72.41)	5.67	79.36 ^a (63.19)
T ₈	26.33	26.00	-	27.00	-	26.33	-	26.33	-

No. - Population number per 10 plants; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

b. Aphid

The initial population level ranged from 28.33 to 30.33 per 10 plants. At 1 and 3 DAT, cent percent reduction was recorded in T₃, T₆ and T₇ (Table 24) while at 5 DAT the T₃ emerged as the best treatment recording 98.85 per cent reduction. At 7 DAT, the treatments T₃ and T₇, again assumed an increasing effectiveness with a cent per cent reduction. Due to incessant rains on 10 DAT observations were not taken.

The order of relative efficacy is

$$(T_6 = T_7) > T_3 > (T_2 > T_5) > T_4 > T_1.$$

c. Whitefly

The pretreatment population of whiteflies fluctuated between 27.00 to 29.67 per 10 plants (Table 25). After insecticide spray, there was a significant reduction in the population on first day. At 3 DAT, T₆ and T₇ recorded the highest per cent reduction of 95.37 and 95.19 per cent respectively, while T₁ recorded the lowest (77.02%). At 5 DAT, T₃, T₆ and T₇ recorded cent per cent reduction followed by T₅ (96.25%) and T₂ (94.17%). At 7 DAT, monocrotophos (T₇) performed better than all the other treatments recording 93.24 per cent reduction. The readings were not recorded on 10 DAT due to incessant rains.

The order of relative efficacy is

$$(T_6 = T_7) > T_3 > (T_5 > T_2) > T_4 > T_1.$$

4.2. Toxicity of phosphamidon 40 SL to natural enemies

Experiments were conducted to assess the toxicity of phosphamidon 40 SL to natural enemies in rice, cotton and brinjal ecosystem.

4.2.1. RICE

4.2.1.1. Experiment - I

a. Spiders

The spider population before spraying ranged from 4.33 to 6.00 per 10 hills. At 1 DAT, all the treatments were significantly different from control indicating a certain

Table 24. Field efficacy of phosphamidon 40 SL against brinjal aphid – I spray. (Location II)

(Mean of three observations)

Treatments	Pretreatment count	1 DAT		3 DAT		5 DAT		7 DAT	
		No.	P	No.	P	No.	P	No.	P
T ₁	28.33	3.33	87.98 ^c (69.80)	1.67	94.27 ^c (76.24)	3.00	89.26 ^c (71.00)	4.67	83.43 ^c (66.04)
T ₂	30.00	0.67	97.84 ^b (83.10)	0.00	100.00 ^a (89.81)	0.67	97.85 ^{ab} (83.10)	1.33	95.77 ^b (80.27)
T ₃	29.00	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	0.33	98.85 ^a (86.43)	0.00	100.00 ^a (89.81)
T ₄	29.33	2.00	93.21 ^c (75.17)	0.67	97.85 ^b (83.09)	2.00	93.17 ^{bc} (75.10)	3.33	88.32 ^c (70.12)
T ₅	29.33	0.67	97.61 ^b (82.74)	0.00	100.00 ^a (89.81)	1.00	96.50 ^{abc} (79.21)	1.00	96.54 ^b (81.31)
T ₆	30.00	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	0.33	98.77 ^a (86.30)	0.00	100.00 ^a (89.81)
T ₇	30.33	0.00	100.00 ^a (89.81)	0.00	100.00 ^a (89.81)	0.67	97.70 ^{ab} (82.87)	1.33	95.55 ^b (77.99)
T ₈	30.00	29.67	-	30.33	-	29.33	-	29.67	-

No. - Population number per 10 plants; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

Table 25. Field efficacy of phosphamidon 40 SL against brinjal whitefly- I spray. (Location II)

Treatments	Pretreatment count	1 DAT			3 DAT			5 DAT			7 DAT		
		No.	P	No.	P	No.	P	No.	P	No.	P	No.	P
T ₁	27.00	10.33	61.23 ^d (51.49)	6.00	77.02 ^d (61.47)	3.67	86.56 ^d (68.59)	7.67	71.97 ^c (58.04)				
T ₂	28.67	7.00	75.25 ^{bc} (60.17)	3.67	86.82 ^{bc} (68.82)	1.67	94.17 ^{bc} (76.19)	5.00	82.76 ^{cd} (65.54)				
T ₃	28.67	5.33	80.97 ^{ab} (64.27)	2.00	92.74 ^{ab} (74.37)	0.00	100.00 ^a (89.81)	3.00	89.61 ^{abc} (71.37)				
T ₄	29.33	8.67	69.90 ^c (56.75)	5.00	82.33 ^{cd} (65.42)	3.00	89.75 ^{cd} (71.32)	6.33	78.58 ^{de} (62.51)				
T ₅	27.67	6.33	76.70 ^{bc} (61.17)	3.00	88.45 ^{bc} (70.40)	1.00	96.25 ^b (80.77)	3.67	85.92 ^{bcd} (68.16)				
T ₆	29.67	4.67	83.91 ^a (66.42)	1.33	95.37 ^a (77.71)	0.00	100.00 ^a (89.81)	2.33	92.28 ^{ab} (73.91)				
T ₇	29.67	4.67	83.91 ^{ab} (64.13)	1.33	95.19 ^a (77.59)	0.00	100.00 ^a (89.81)	2.00	93.24 ^a (75.30)				
T ₈	28.00	27.67	-	27.00	-	28.00	-	28.33	-				

No. - Population number per 10 plants; DAT - Days after treatment

Figures in parentheses are arcsin \sqrt{P} transformed values; where P is corrected per cent reduction

Means followed by a same letter in a column are not significantly different by DMRT (P=0.05)

degree of toxicity of the insecticides to spiders, with a maximum of 42.86 per cent reduction of spider population in T₆ over control (Table 26). At 3 DAT, T₆ registered higher toxicity (50% reduction), and was followed by 33.38 per cent reduction T₃. At 5 DAT T₆ registered 46.14 per cent reduction (4.67per10 hills) over control. At 7 DAT, T₃ recorded only 20.68 per cent reduction in population and at 10 DAT all the treatments were on par with control indicating a negligible level of toxicity.

The order of relative toxicity is

$$T_6 > T_3 > (T_5 = T_4 = T_2) > T_1 > T_7.$$

b. Coccinellids

The predatory coccinellid population before the initial round of spray was low ranging from 2.00 to 3.00 per 10 hills. At 1, 3, 5 and 7 DAT, none of the treatments had significant influence upon the coccinellid population. Only on 10th day after treatment, T₆ recorded 19.28 per cent reduction while the other treatments higher numbers of predators (Table 27).

The order of relative toxicity is

$$T_6 > (T_3 = T_4 = T_5) > (T_2 = T_1) > T_7 \text{ (control)}.$$

4.2.1.2. Experiment - II

a. Spiders

The spider population initially ranged from 4.33 to 6.33 per 10 hills. At one DAT, none of the treatments had any significant effect upon the natural enemies (Table 28). At 3 DAT, T₆ exhibited a low level of toxicity (28.57% reduction). At 5 DAT, treatments T₆ and T₃ were equally toxic recording 5.67 spidersper 10 hills, as against 7.00 in untreated control. At 7 and 10 DAT, there was no significant toxicity to spiders in any of the treatments.

The order of relative toxicity is

$$T_6 > (T_4 = T_5) > T_3 > (T_1 = T_2) > T_7 \text{ (control)}.$$

Table 26. Toxicity of phosphamidon 40 SL to spiders in rice ecosystem (Location I)

Treatments	Pretreatment count	(Mean of three observations)					
		1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	
		No.	No.	No.	No.	No. *	
T ₁	5.33	5.33 ^b (2.41)	8.00 ^a (2.91)	8.00 ^{ab} (2.91)	9.33 ^{ab} (3.13)	9.00 ^a (3.08)	
T ₂	4.33	5.33 ^b (2.41)	7.00 ^{ab} (2.73)	7.67 ^{ab} (2.86)	8.67 ^{abc} (3.03)	8.67 ^a (3.03)	
T ₃	4.67	5.00 ^b (2.34)	5.33 ^c (2.41)	6.00 ^c (2.54)	8.00 ^{bcd} (2.91)	8.00 ^a (2.91)	
T ₄	5.00	4.67 ^b (2.27)	6.33 ^{bc} (2.61)	7.00 ^{bc} (2.73)	7.67 ^{cd} (2.86)	7.67 ^a (2.96)	
T ₅	5.33	4.67 ^b (2.27)	6.00 ^{bc} (2.54)	6.67 ^{bc} (2.67)	7.33 ^{cd} (2.79)	8.00 ^a (2.91)	
T ₆	5.00	4.00 ^b (2.11)	4.00 ^d (2.11)	4.67 ^d (2.26)	6.67 ^d (2.67)	8.33 ^a (2.96)	
T ₇	6.00	7.00 ^a (2.73)	8.00 ^a (2.91)	8.67 ^a (3.03)	9.67 ^a (3.19)	8.67 ^a (3.02)	

No. - Number of insects per 10 hills ; DAT - Days after treatment.

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values

Means followed by a common letter are not significantly different by DMRT (P=0.05).

* - Not significant

Table 27. Toxicity of phosphamidon 40 SL to coccinellids of rice ecosystem (Location I)

Treatments	Pretreatment count	(Mean of three observations)				
		1 DAT	3 DAT	5 DAT	7 DAT	10 DAT
		No. *	No. *	No. *	No. *	No.
T ₁	2.00	2.67 ^a (1.77)	3.00 ^a (1.86)	3.00 ^a (1.86)	3.00 ^a (1.86)	4.33 ^a (2.20)
T ₂	2.33	2.33 ^a (1.68)	2.67 ^a (1.77)	2.67 ^a (1.77)	3.33 ^a (1.95)	4.33 ^a (2.20)
T ₃	2.00	1.67 ^a (1.46)	2.33 ^a (1.68)	2.33 ^a (1.65)	3.00 ^a (1.86)	3.67 ^{ab} (2.04)
T ₄	2.33	1.67 ^a (1.46)	2.00 ^a (1.56)	2.33 ^a (1.68)	2.67 ^a (1.76)	3.67 ^{ab} (2.04)
T ₅	3.00	2.00 ^a (1.56)	2.67 ^a (1.77)	2.67 ^a (1.77)	3.33 ^a (1.95)	3.33 ^{ab} (1.95)
T ₆	2.67	2.00 ^a (1.56)	2.67 ^a (1.77)	2.33 ^a (1.68)	3.67 ^a (2.04)	3.00 ^b (1.86)
T ₇	2.00	2.67 ^a (1.77)	3.33 ^a (1.95)	3.33 ^a (1.95)	3.67 ^a (2.04)	4.33 ^a (2.20)

No. - Number of insects per 10 hills ; DAT - Days after treatment.

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values

Means followed by a common letter are not significantly different by DMRT (P=0.05).

* - Not significant

Table 28. Toxicity of phosphamidon 40 SL to spiders of rice ecosystem (Location II)

Treatments	Pretreatment count	(Mean of three observations)					
		1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	
		No.	No.	No.	No. *	No. *	
T ₁	4.33	5.67 ^a (2.48)	6.67 ^{ab} (2.68)	7.00 ^a (2.73)	7.33 ^a (2.79)	6.00 ^a (2.54)	
T ₂	5.00	5.67 ^a (2.48)	6.63 ^{ab} (2.61)	5.33 ^a (2.41)	7.33 ^a (2.79)	6.00 ^a (2.54)	
T ₃	5.67	5.33 ^a (2.41)	6.00 ^{ab} (2.54)	5.67 ^{bc} (2.48)	7.00 ^a (2.73)	6.00 ^a (2.54)	
T ₄	5.33	5.00 ^a (2.34)	5.33 ^{ab} (2.41)	6.00 ^{abc} (2.54)	6.67 ^a (2.68)	6.33 ^a (2.61)	
T ₅	6.33	4.67 ^a (2.27)	5.67 ^{ab} (2.48)	6.67 ^{ab} (2.68)	7.00 ^a (2.73)	5.67 ^a (2.48)	
T ₆	6.00	4.33 ^a (2.20)	5.00 ^b (2.34)	5.67 ^{bc} (2.48)	7.00 ^a (2.73)	6.33 ^a (2.61)	
T ₇	5.67	6.00 ^a (2.54)	7.00 ^a (2.73)	7.00 ^a (2.73)	7.67 ^a (2.86)	6.33 ^a (2.61)	

No. - Number of insects per 10 hills ; DAT - Days after treatment.

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values

Means followed by a common letter are not significantly different by DMRT (P=0.05).

* - Not significant

b. Coccinellids

The pretreatment population of predatory coccinellids ranged from 3.00 to 3.67 per 10 hills. Upto 10 DAT, none of the treatments showed any toxicity against the predatory coccinellids. However, in all days, T₆ recorded the least population of coccinellids indicating a minimal level of toxicity (Table 29) among the different concentrations evaluated.

The order of relative toxicity is

$$T_6 > (T_1 = T_2 = T_3 = T_4 = T_5) > T_7.$$

4.2.2. Cotton

4.2.2.1. Experiment I

a. Spiders

The pretreatment population of spiders ranged from 5.33 to 7.00 per 10 plants. At one DAT, T₆ recorded minimum number of spiders (4.00 per 10 plants) while T₄ and T₁ harboured 6.00 spiders per 10 plants on the same day.(Table 30). At 5 DAT also, T₆ recorded the highest toxicity (42.02% reduction over control) followed by T₅ and T₃ (25.87%), however after six days no chemical was found to be toxic to spiders (Table 30).

The order of relative toxicity is

$$(T_2 = T_3 = T_5) > (T_2 = T_1) > T_7 \text{ (control)}.$$

4.2.3. Brinjal

4.2.3.1. Experiment - I

a. Spiders

The pretreatment population of spiders ranged from 8.00 to 9.67 per 10 plants before spraying (Table 31). AT one DAT, T₆ exhibited 25.89 per cent reduction over control in population followed by T₃ (18.56%). The same trend had been observed on 3 DAT with T₆ followed by T₃ exhibiting highest toxicity. However, at 7 and 10 DAT, none of the treatments were considerably toxic to spiders and the population in all the treatments were on par with control.

Table 29. Toxicity of phosphamidon 40 SL to coccinellids of rice ecosystem (Location II)

Treatments	Pretreatment count	(Mean of three observations)					
		1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	
		No. *	No. *	No. *	No. *	No. *	
T ₁	3.33	3.33 ^a (1.95)	4.00 ^a (2.11)	4.00 ^a (2.11)	4.33 ^a (2.20)	3.33 (1.95)	
T ₂	3.67	3.33 ^a (1.95)	3.67 ^a (2.04)	4.00 ^a (2.11)	4.33 ^a (2.20)	3.00 (1.86)	
T ₃	3.33	3.00 ^a (1.85)	3.33 ^a (1.95)	3.67 ^a (2.04)	4.00 ^a (2.11)	3.67 (2.04)	
T ₄	3.00	2.67 ^a (1.77)	3.00 ^a (1.86)	3.33 ^a (1.95)	3.67 ^a (2.04)	3.67 (2.04)	
T ₅	3.67	2.33 ^a (1.65)	3.00 ^a (1.86)	3.00 ^a (1.86)	3.33 ^a (1.95)	3.67 (2.04)	
T ₆	3.67	2.33 ^a (1.67)	2.67 ^a (1.77)	3.00 ^a (1.86)	3.33 ^a (1.95)	3.33 (1.95)	
T ₇	3.33	3.67 ^a (2.04)	4.33 ^a (2.19)	4.33 ^a (2.20)	4.00 ^a (2.11)	3.67 (2.04)	

No. - Number of insects per 10 hills; DAT - Days after treatment.

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values

Means followed by a common letter are not significantly different by DMRT (P=0.05).

* - Not significant

Table 30. Toxicity of phosphamidon 40 SL to spiders of cotton ecosystem

Treatments	Pretreatment count	(Mean of three observations)					
		1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	
		No.	No.	No.	No. *	No. *	
T ₁	5.33	6.00 ^a (2.54)	5.67 ^{ab} (2.48)	6.33 ^{ab} (2.61)	6.00 ^a (2.54)	6.67 ^a (2.67)	
T ₂	6.33	5.67 ^{ab} (2.48)	5.33 ^{ab} (2.41)	6.00 ^{ab} (2.54)	6.33 ^a (2.61)	6.33 ^a (2.61)	
T ₃	7.00	5.33 ^{ab} (2.41)	5.00 ^{ab} (2.34)	5.67 ^{ab} (2.48)	6.00 ^a (2.54)	6.33 ^a (2.61)	
T ₄	7.00	6.00 ^a (2.54)	5.67 ^{ab} (2.48)	6.33 ^{ab} (2.61)	6.67 ^a (2.67)	6.00 ^a (2.54)	
T ₅	6.33	5.00 ^{ab} (2.33)	4.67 ^{bc} (2.26)	5.67 ^{ab} (2.48)	6.00 ^a (2.54)	6.33 ^a (2.61)	
T ₆	6.00	4.00 ^b (2.11)	3.67 ^c (2.04)	5.00 ^b (2.34)	5.33 ^a (2.41)	6.00 ^a (2.54)	
T ₇	6.33	6.67 ^a (2.66)	6.33 ^a (2.61)	7.00 ^a (2.73)	6.67 ^a (2.67)	7.33 ^a (2.80)	

No. - Number of insects per 10 plants ; DAT - Days after treatment.

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values

Means followed by a common letter are not significantly different by DMRT (P=0.05).

* - Not significant

Table 31. Toxicity of phosphamidon 40 SL to spiders of brinjal ecosystem

Treatments	Pretreatment count	(Mean of three observations)					
		1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	
		No.	No.	No.	No. *	No. *	
T ₁	8.00	8.67 ^a (3.02)	8.00 ^a (2.91)	8.33 ^{ab} (2.97)	9.00 ^a (3.08)	9.33 ^a (3.13)	
T ₂	8.67	8.00 ^{ab} (2.91)	7.33 ^{ab} (2.79)	8.00 ^{ab} (2.91)	8.67 ^a (3.03)	9.67 ^a (3.19)	
T ₃	8.33	7.33 ^{ab} (2.80)	7.00 ^{abc} (2.73)	7.67 ^{ab} (2.86)	8.33 ^a (2.97)	9.00 ^a (3.08)	
T ₄	9.00	8.33 ^{ab} (2.97)	7.33 ^{ab} (2.79)	8.33 ^{ab} (2.97)	9.00 ^a (3.08)	8.67 ^a (3.03)	
T ₅	9.67	8.00 ^{ab} (2.97)	6.33 ^{bc} (2.61)	7.67 ^{ab} (2.86)	8.33 ^a (2.97)	8.67 ^a (3.03)	
T ₆	8.67	6.67 ^b (2.67)	6.00 ^c (2.54)	7.00 ^b (2.73)	8.00 ^a (2.91)	9.00 ^a (3.07)	
T ₇	9.33	9.00 ^a (3.08)	8.33 ^a (2.97)	8.67 ^a (3.02)	9.33 ^a (3.13)	10.33 ^a (3.29)	

No. - Number of insects per 10 plants ; DAT - Days after treatment.

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values

Means followed by a common letter are not significantly different by DMRT (P=0.05).

* - Not significant

4.3. Phytotoxicity of phosphamidon 40 SL on Rice, Cotton and Brinjal

The results of the investigations on the phytotoxic effect of phosphamidon 40 SL as foliar application to rice, cotton and brinjal are furnished in the Table 32. It was observed that the plants were normal in all the doses of phosphamidon 40 SL treated plots similar to the control. During the entire period of observations, the mean grade of "O" was recorded for all the treatments. Based on the observations, all the treatments, irrespective of the doses, did not show any phytotoxic effect on rice, cotton and brinjal.

4.4. Evaluation of persistent toxicity of phosphamidon 40 SL in green house experiments

4.4.1. RICE

4.4.1.1. Brown Plant hopper (BPH)

Results of the persistent toxicity of phosphamidon 40 SL (200, 350 and 500 g ai/ha) and phosphamidon 85 WSC (200, 350 and 500 g a.i/ha) against rice BPH revealed that persistence was greater for phosphamidon 85 WSC @ 350 & 500 g a.i/ha as their persistence being 11 days with a persistent toxicity index (PTI) score of 593.45 and 649.77 respectively (Table 33). The PTI of phosphamidon 40 SL was 399.91 (7 days) for 200 g a.i/ha, 435.54 (7 days) for 350 g a.i/ha and 527.31 (9 days) for 500 g a.i/ha.

The order of persistence in days being monocrotophos 36 WSC (11) = phosphamidon 85 WSC @ 500 g a.i/ha (11) = phosphamidon 85 WSC @ 350 g a.i /ha > phosphamidon 85 WSC @ 200 g a.i/ha (9) = phosphamidon 40 SL @ 500 g a.i/ha (9) > phosphamidon 40 SL 350 g a.i/ha > phosphamidon 40 SL 200 g a.i/ha (Fig.1).

4.4.1.2. White backed planthopper (WBPH)

Table 34. revealed the superiority of phosphamidon 85 WSC @ 500 g a.i/ha which persisted for 11 days with a PTI of 575.08. Phosphamidon 40 SL @ 500 g a.i/ha persisted for 9 days similar to that of phosphamidon 85 WSC @ 350 g a.i/ha.

Table 32. Phytotoxicity of phosphamidon 40 SL on rice, cotton and brinjal

(Mean of four observations)

Crop	1 DAT						3 DAT						5 DAT						7 DAT						10 DAT					
	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F
Rice																														
T ₁	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₂	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₃	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₄	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₅	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₆	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cotton																														
T ₁	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₂	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₃	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₄	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₅	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₆	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brinjal																														
T ₁	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₂	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₃	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₄	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₅	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T ₆	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

A - Phytotoxicity

B - Scorching

C - Vein Clearing

D - Epinasty

E - Hyponasty

F - Leaf injury

Table 33. Persistent toxicity of phosphamidon 40 SL against rice brown planthopper

(Mean of three observations)

Treatments	Dose g a.i./ha	Corrected Mortality (%) Days after spraying						Per cent mortality (T)	Period in days (P)	PT value	Order of Relative Efficacy (ORE)
		1	3	5	7	9	11				
Phosphamidon 40 SL	200	93.33	80.00	41.48	13.70	0.00	0.00	57.13	7	399.91	7
Phosphamidon 40 SL	350	93.33	83.83	51.85	20.37	0.00	0.00	62.22	7	435.54	6
Phosphamidon 40 SL	500	100.00	86.67	61.85	34.44	10.00	0.00	58.59	9	527.31	4
Phosphamidon 85 WSC	200	100.00	86.67	58.15	30.74	6.67	0.00	56.45	9	508.05	5
Phosphamidon 85 WSC	350	100.00	90.00	69.26	41.11	16.67	6.67	53.95	11	593.45	3
Phosphamidon 85 WSC	500	100.00	93.33	72.59	48.52	30.00	10.00	59.07	11	649.77	2
Monocrotophos 36 WSC	360	100.00	96.67	76.30	51.48	33.33	16.67	62.41	11	686.51	1

Fig. 1. Effect of phosphamidon 40 SL against rice brown planthopper

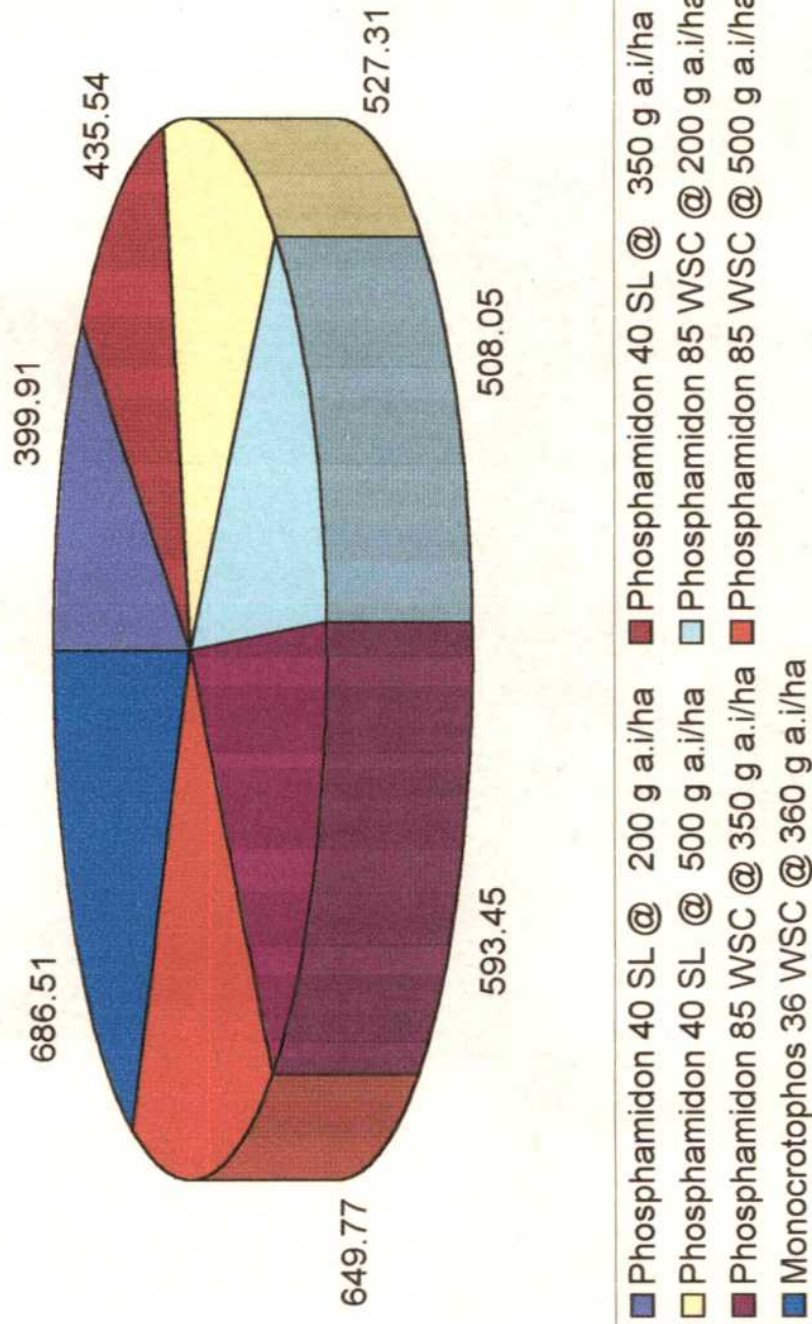
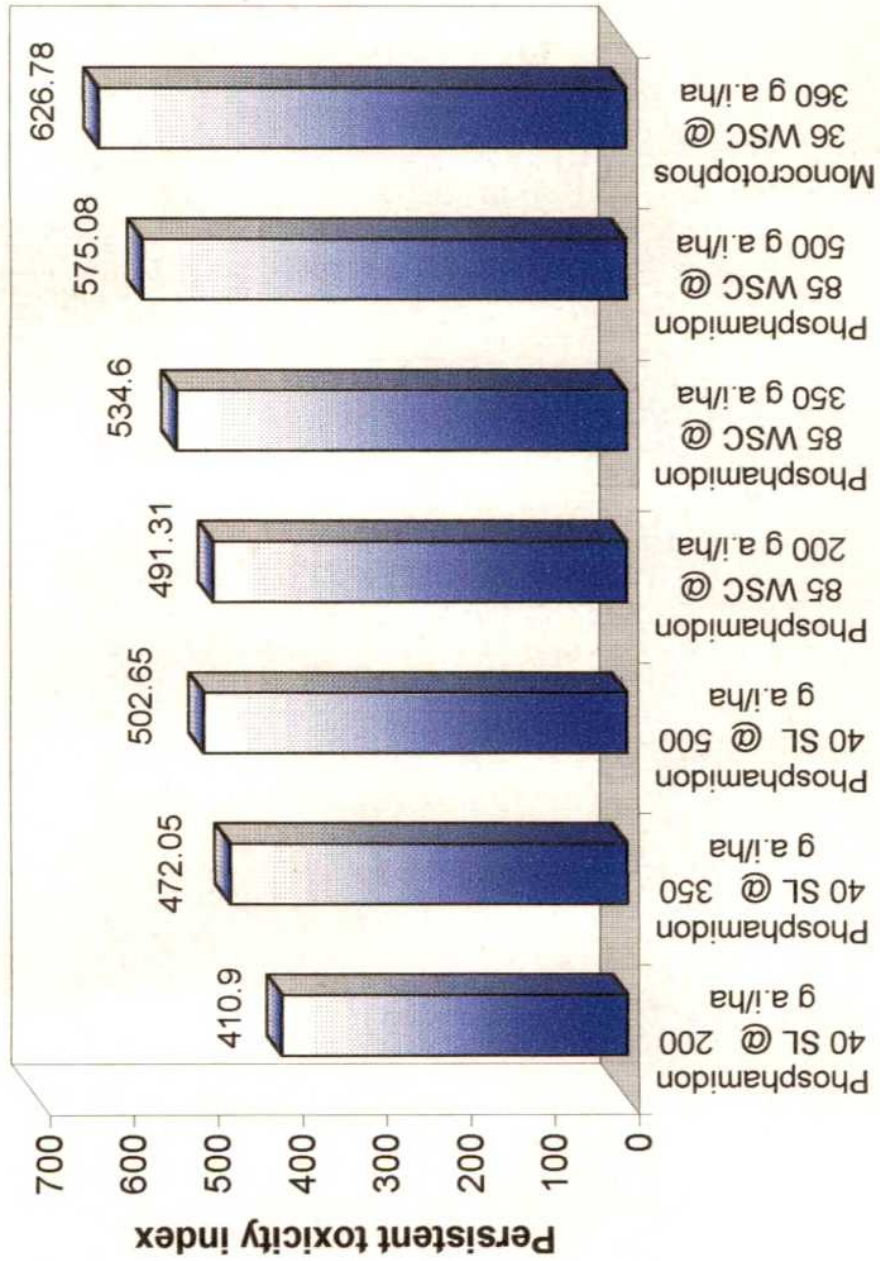


Table 34. Persistent toxicity of phosphamidon 40 SL against white backed planthopper of rice

(Mean of three observations)

Treatments	Dose g a.i/ha	Corrected Mortality (%) Days after spraying						Per cent mortality (T)	Period in days (P)	PT value	Order of Relative Efficacy (ORE)
		1	3	5	7	9	11				
Phosphamidon 40 SL	200	93.33	82.96	44.44	14.07	-	-	58.70	7	410.90	7
Phosphamidon 40 SL	350	96.67	86.30	51.48	21.11	6.67	-	52.45	9	472.05	6
Phosphamidon 40 SL	500	100.00	89.63	58.89	20.74	10.00	-	55.85	9	502.65	4
Phosphamidon 85 WSC	200	96.67	85.93	55.19	25.18	10.00	-	54.59	9	491.31	5
Phosphamidon 85 WSC	350	100.00	89.63	61.85	32.22	13.33	-	59.40	9	534.60	3
Phosphamidon 85 WSC	500	100.00	92.59	65.56	35.55	16.67	3.33	52.28	11	575.08	2
Monocrotophos 36 WSC	360	100.00	96.67	75.56	42.96	20.00	6.67	56.98	11	626.78	1

Fig. 2. Effect of phosphamidon 40 SL against white backed planthopper of rice



The order of persistence (in days) is as follows (Fig.2) : Monocrotophos 36 WSC (11) = Phosphamidon 85 WSC (9) 500 g a.i/ha (11) > phosphamidon 85 WSC (200=250 g a.i/ha (9) = phosphamidon 40 SL (200=350) g a.i/ha (9) > phosphamidon 40 SL (9) 200 g a.i/ha (7).

4.4.2. COTTON

4.4.2.1. Leafhopper

The average per cent mortality at different days after treatment and the persistence of chemicals against cotton leafhopper were presented in (Table 35). Phosphamidon 85 WSC @ 500 g a.i/ha remained toxic for upto 15 days whereas, phosphamidon 40 SL at the same dose persisted only for 13 days with a PTI of 601.84. Phosphamidon 40 SL @ 200 & 250 g a.i/ha were persistent for 11 days similar to that of dimethoate. However, phosphamidon 40 SL @ 250 g a.i/ha recorded a PTI of 557.46 indicating its superiority over dimethoate (Fig.3).

4.4.2.2. Aphid

Results of persistent toxicity of phosphamidon 40 SL @ 200, 250 & 300 g a.i/ha), phosphamidon 85 WSC (300 g a.i/ha) and dimethoate against aphids of cotton revealed that phosphamidon 85 WSC had the highest PTI (1143.61) as their persistence being 19 days (Table 36). The next in order was phosphamidon 40 SL @ 300 g a.i/ha (17 days). The PTI of phosphamidon 40 SL @ 250 g a.i/ha (877.05) was found to be higher than that for dimethoate (829.80) although, either of them persisted for 15 days (Fig.4).

4.4.3. Brinjal

4.4.3.1. Leafhopper

The average per cent mortality of leafhoppers revealed that phosphamidon 85 WSC at 300 g a.i/ha was the most effective treatment remaining toxic to leafhoppers for 17 days with a PTI of 822.80. Phosphamidon 40 SL @ 300 g a.i/ha and dimethoate,

Table 35. Persistent toxicity of phosphamidon 40 SL against cotton leaf hopper

(Mean of three observations)

Treatments	Dose g a.i/ha	Corrected Mortality (%) Days after spraying								Per cent mortality (T)	Period in days (P)	PT value	Order of Relative Efficacy (ORE)
		1	3	5	7	9	11	13	15				
Phosphamidon 40 SL	200	89.63	74.82	57.04	27.78	10.37	6.67	-	-	44.39	11	488.24	5
Phosphamidon 40 SL	250	92.96	78.15	60.37	34.81	21.11	16.67	-	-	50.68	11	557.46	3
Phosphamidon 40 SL	300	92.96	81.85	63.71	37.78	24.44	20.00	3.33	-	46.30	13	601.84	2
Phosphamidon 85 WSC	300	96.30	85.19	64.08	51.48	24.81	20.00	6.67	3.33	43.98	15	659.64	1
Dimethaote 30 EC	150	92.96	75.19	64.08	41.11	20.74	6.67	-	-	50.13	11	551.38	4

Fig. 3. Effect of phosphamidon 40 SL against cotton leafhopper

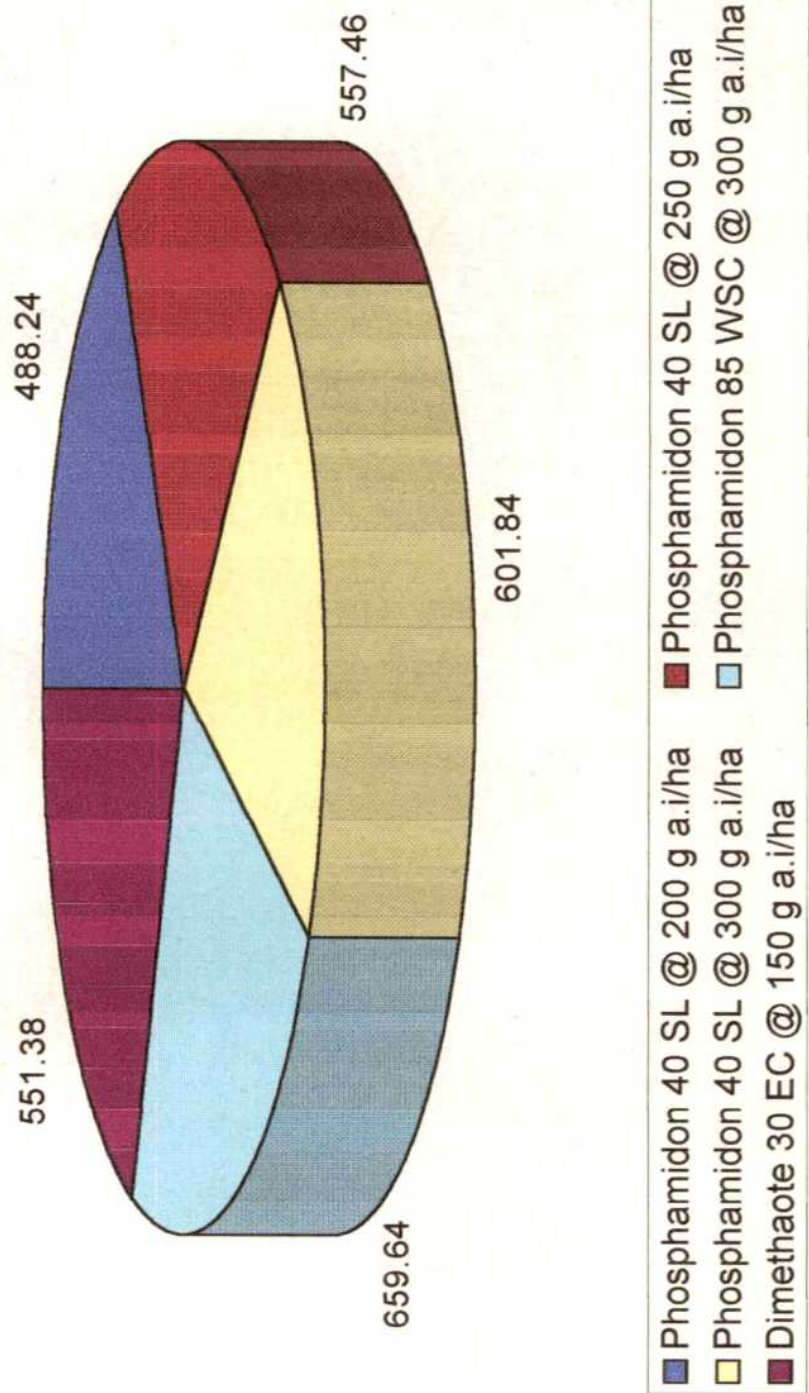
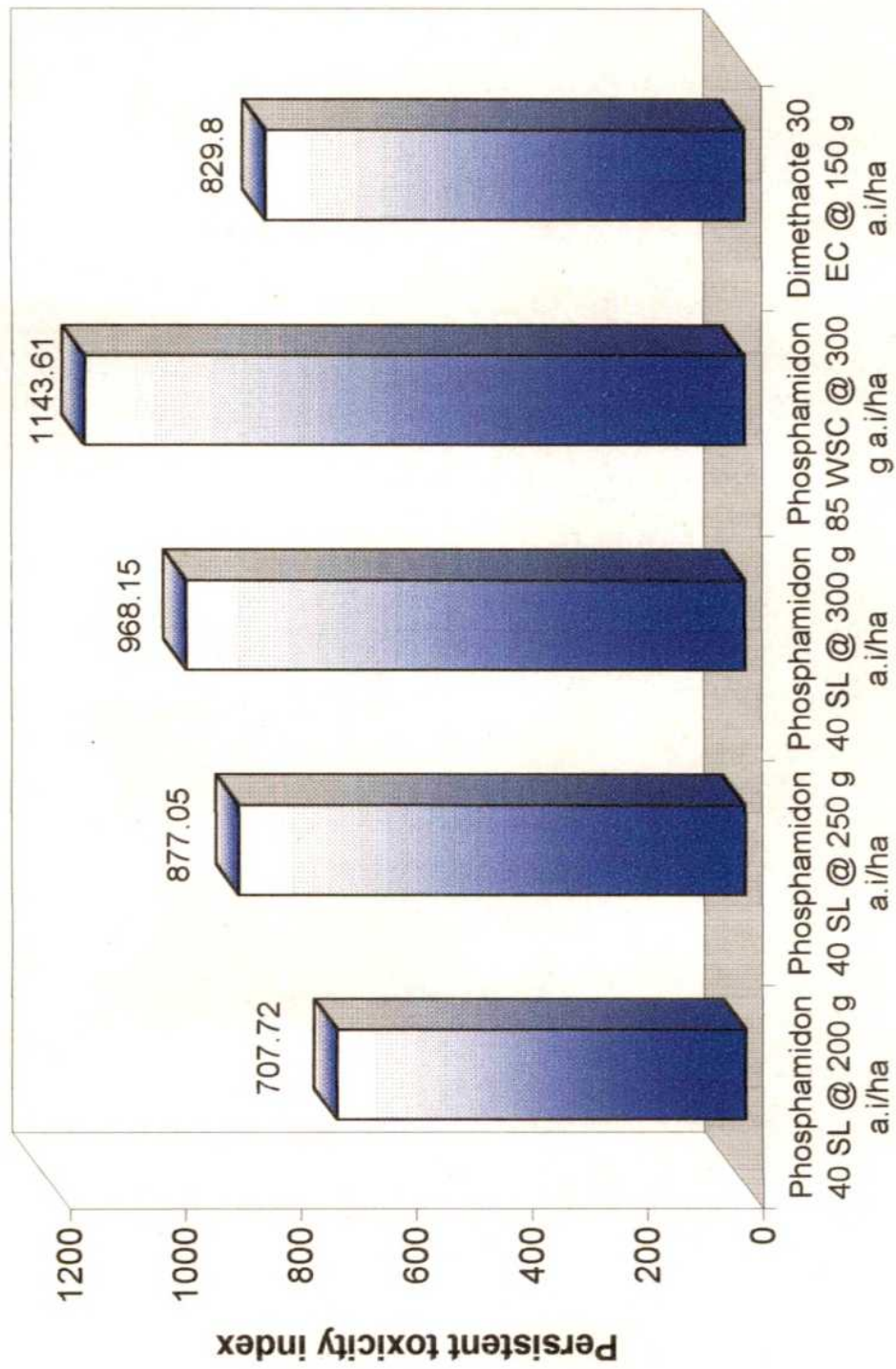


Table 36. Persistent toxicity of phosphamidon 40 SL against cotton aphid

(Mean of three observations)

Treatments	Dose g a.i/ha	Corrected Mortality (%) Days after spraying										Per cent mortality (T)	Period in days (P)	PT value	Order of Relative Efficacy (ORE)
		1	3	5	7	9	11	13	15	17	19				
Phosphamidon 40 SL	200	100.00	89.63	72.22	53.33	44.81	17.78	3.33	-	-	-	54.44	13	707.72	5
Phosphamidon 40 SL	250	100.00	100.00	82.59	74.82	55.19	35.18	16.67	3.33	-	-	58.47	15	877.05	3
Phosphamidon 40 SL	300	100.00	100.00	89.26	78.52	62.22	42.59	23.33	13.33	3.33	-	56.95	17	968.15	2
Phosphamidon 85 WSC	300	100.00	100.00	96.67	82.22	72.59	53.71	40.00	30.00	20.00	6.67	60.19	19	1143.61	1
Dimethaote 25 EC	150	100.00	100.00	75.93	53.33	44.81	28.52	30.00	10.00	-	-	55.32	15	829.80	4

Fig. 4. Effect of phosphamidon 40 SL against cotton aphid



although, were persistent for 15 days the former ranks first based on its PTI (713.25). The next in order were phosphamidon 40 SL @ 250 & 200 g a.i/ha which persisted for 13 and 11 days respectively (Fig. 5).

The order of persistence being phosphamidon 85 WSC > Dimethoate = phosphamidon 40 SL @ 300 g a.i/ha > phosphamidon 40 SL @ 250 g a.i/ha > phosphamidon 40 SL @ 200 g a.i/ha (Table 37).

4.4.3.2. Aphid

Table 38 revealed the superiority of phosphamidon 85 WSC @ 300 g a.i/ha which persisted for 15 days with a PTI of 1014.60. Though phosphamidon 40 SL @ 300 g a.i/ha and dimethoate persisted for 15 days similar to that of phosphamidon 85 WSC, their PTI were lesser than the latter (Fig.6).

The order of persistence in days being phosphamidon 85 WSC = phosphamidon 40 SL @ 300 g a.i/ha = Dimethoate > phosphamidon 40 SL (200=250 g a.i/ha) (13 days).

4.5. Safety tests

4.5.1. *Chrysoperla carnea* Stephens

Laboratory experiments were conducted to study the safety of phosphamidon 40 SL on the eggs, grubs and adults of predatory green lace wing.

4.5.1.1. Ovicidal action

The results revealed that phosphamidon 40 SL (200, 250 & 300 g a.i/ha) did not cause any remarkable reduction on the hatchability of *Chrysoperla* eggs. But, monocrotophos and phosphamidon 85 WSC @ 300 g a.i/ha caused a maximum mortality (9.33% and 7.33%) of eggs (Table 39).

Table 37. Persistent toxicity of Phosphamidon 40 SL against brinjal leafhopper

(Mean of three observations)

Treatments	Dose g a.i/ha	Corrected Mortality (%) Days after spraying										Per cent mortality (T)	Period in days (P)	PT value	Order of Relative Efficacy (ORE)		
		1	3	5	7	9	11	13	15	17							
Phosphamidon 40 SL	200	93.33	76.67	57.04	34.07	13.33	3.33	-	-	-	-	-	-	46.30	11	509.30	5
Phosphamidon 40 SL	250	93.33	80.00	60.74	37.41	20.37	13.70	6.67	-	-	-	-	-	44.60	13	579.80	4
Phosphamidon 40 SL	300	96.67	83.33	64.08	54.81	34.07	24.07	16.67	6.67	-	-	-	-	47.55	15	713.25	2
Phosphamidon 85 WSC	300	96.67	86.67	75.19	65.19	44.44	27.41	20.00	13.33	6.67	-	-	-	48.40	17	822.80	1
Dimethaote 30 EC	500 ml/ha	93.33	86.67	71.48	55.10	34.07	17.04	10.00	3.33	-	-	-	-	46.38	15	695.70	3

Fig. 5. Effect of phosphamidon 40 SL against brinjal leafhopper

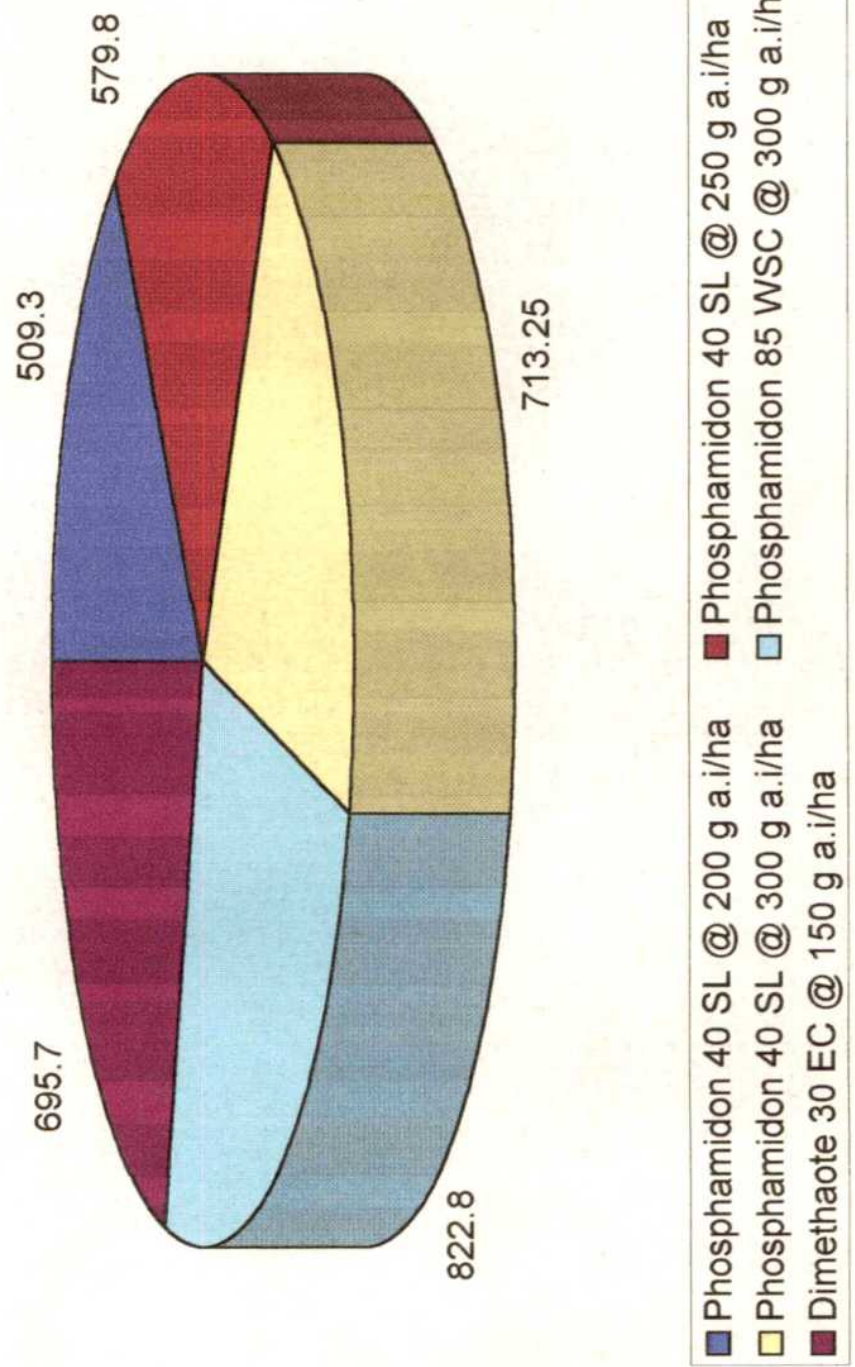


Table 38. Persistent toxicity of phosphamidon 40 SL against brinjal aphids

(Mean of three observations)

Treatments	Dose g a.i/ha	Corrected Mortality (%) Days after spraying									Per cent mortality (T)	Period in days (P)	PT value	Order of Relative Efficacy (ORE)
		1	3	5	7	9	11	13	15					
Phosphamidon 40 SL	200	100.00	92.96	74.82	53.33	35.55	14.81	3.33	-	40.26	13	523.38	5	
Phosphamidon 40 SL	250	100.00	100.00	85.56	71.48	53.33	29.63	13.33	-	64.76	13	841.88	4	
Phosphamidon 40 SL	300	100.00	100.00	88.89	74.82	64.08	40.74	20.00	3.33	61.48	15	922.20	2	
Phosphamidon 85 WSC	300	100.00	100.00	96.30	85.93	67.41	48.15	33.33	10.00	67.64	15	1014.60	1	
Dimethaote 30 EC	150	100.00	100.00	92.96	78.52	57.04	33.33	20.00	3.33	60.65	15	909.75	3	

Fig. 6. Effect of phosphamidon 40 SL against brinjal aphid

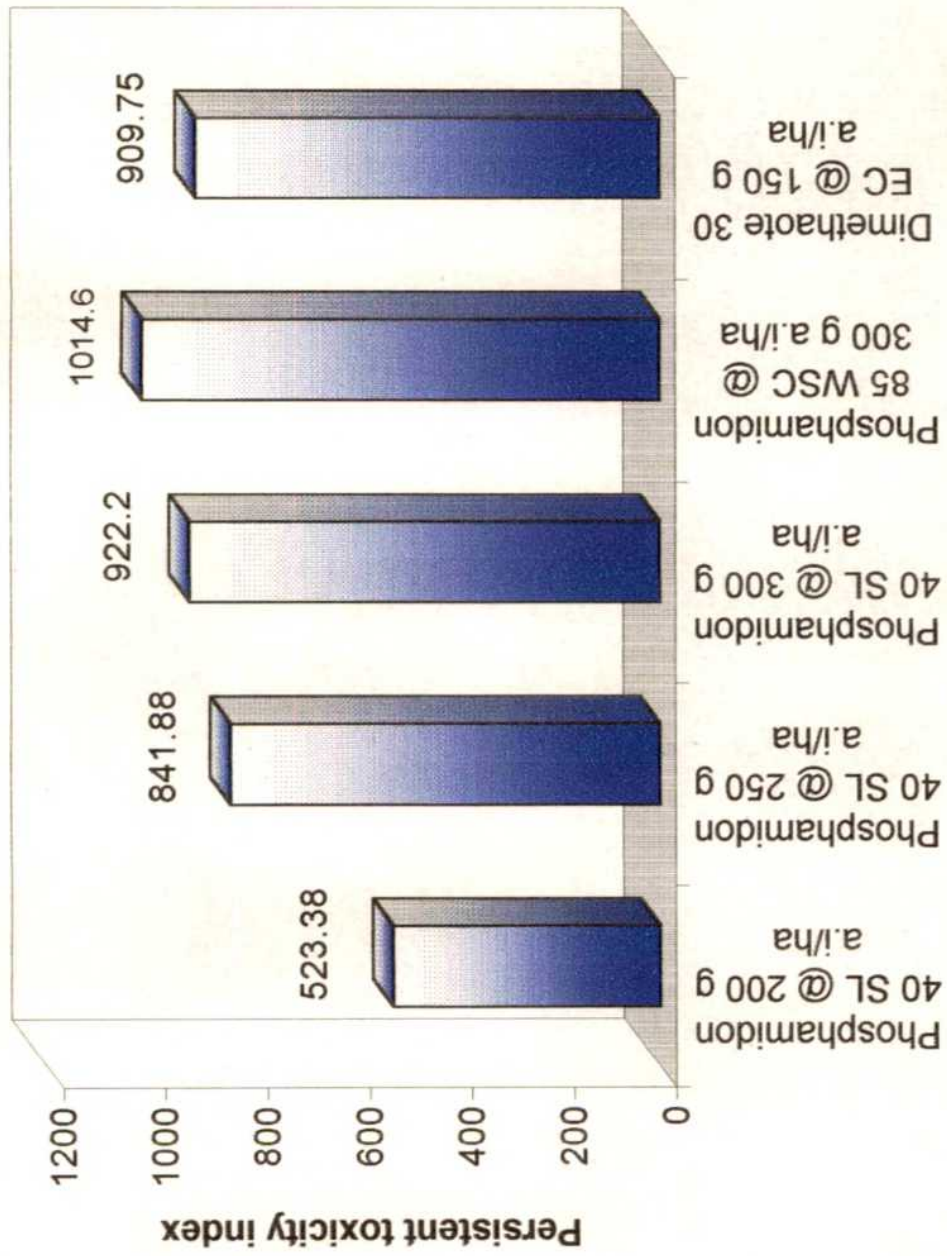


Table 39. Effect of phosphamidon 40 SL on *Chrysoperla carnea* Stephens

(Mean of three observations)

Treatments	Dose g a.i/ha	Hatchability (%) *	Mortality of eggs (%)	Grub mortality (%)	Grubs pupated (%)	Adult emergence (%)
Phosphamidon 40 SL	200	96.67 (81.43)	3.33 ^{ab} (8.57)	15.00 ^b (22.60)	85.00 ^b (67.40)	53.33 ^b (49.91)
Phosphamidon 40 SL	250	96.00 (80.68)	4.00 ^{ab} (9.32)	25.00 ^c (29.93)	75.00 ^c (60.07)	48.33 ^{bc} (44.04)
Phosphamidon 40 SL	300	94.00 (76.42)	6.00 ^{ab} (13.58)	33.33 ^c (35.22)	66.67 ^c (54.78)	41.67 ^c (40.18)
Phosphamidon 40 WSC	300	92.67 (75.06)	7.33 ^b (14.94)	50.00 ^d (45.00)	50.00 ^d (45.00)	33.33 ^d (35.25)
Monocrotophos 36 WSC	360	90.67 (72.29)	9.33 ^b (17.71)	60.00 ^d (50.79)	40.00 ^d (39.21)	28.33 ^d (32.14)
Control	-	98.00 (85.27)	2.00 ^a (4.73)	6.67 ^a (14.76)	93.33 ^a (75.24)	91.67 ^a (73.40)

* - Not significant

4.5.1.2. Larval feeding method

The results revealed that, the highest grub mortality (60%) was recorded in monocrotophos 36 WSC, followed by phosphamidon 85 WSC @ 500 g a.i/ha (50%) (Table 39). But phosphamidon 40 SL @ 300 g a.i/ha resulted in a grub mortality of 33.33 per cent only. Observations made on pupation of grubs showed that monocrotophos treatment accounted for the lowest pupation (40%). The same trend was also reflected in adult emergence, where monocrotophos recorded the least adult emergence (28.33%). Phosphamidon 40 SL at all doses recorded higher per cent pupation and emergence of adults than phosphamidon 85 WSC and monocrotophos.

4.5.2. Effect of phosphamidon 40 SL on *Trichogramma chilonis* Ishii.

The adult emergence and per cent parasitisation by *Trichogramma* spp. as influenced by phosphamidon 40 SL are presented in Table 40.

4.5.2.1. Per cent parasitisation

Per cent parasitisation by *T. chilonis* was the highest in the control (93.00%) followed by phosphamidon 40 SL at 200 (73.67), 250 (70.0) and 300 (67.00) g a.i/ha with 73.67, 70.00 and 67.00 per cent parasitisation respectively. The parasitisation was significantly lower (59%) in monocrotophos treatment.

4.5.2.2. Adult emergence

Monocrotophos 36 WSC @ 360 g a.i/ha resulted in less adult emergence (70.33%) when compared to phosphamidon treatments.(Table 40). Phosphamidon 40 SL at all the doses exhibited more adult emergence (78.67 – 83.00) whereas, phosphamidon 85 WSC treatment @ 300 g a.i/ha showed 75.67 per cent adult emergence.

Table 40. Effect of phosphamidon 40 SL on *Trichogramma chilonis* Ishii

(Mean of three observations)

Treatments	Dose g a.i./ha	Parasitisation (%)	Adult emergence (%)
Phosphamidon 40 SL	200	73.67 ^b (59.13)	83.00 ^b (65.73)
Phosphamidon 40 SL	250	70.00 ^{bc} (56.80)	80.67 ^b (63.95)
Phosphamidon 40 SL	300	67.00 ^{cd} (54.94)	78.67 ^b (62.52)
Phosphamidon 85 WSC	300	62.00 ^{de} (51.96)	75.67 ^{bc} (60.46)
Monocrotophos 36 WSC	360	59.00 ^e (50.20)	70.33 ^c (57.04)
Control	-	93.00 ^a (74.86)	91.00 ^a (73.01)

Discussion

CHAPTER V

DISCUSSION

The results obtained from the field and laboratory studies conducted with phosphamidon 40 SL on its bioefficacy against sucking pests of rice, cotton and brinjal, toxicity against natural enemies and phytotoxicity effect are discussed in this chapter. Since, phosphamidon 40 SL is in the early stage of evaluation and no literature is available, its performance has been compared with other standard organophosphorus insecticides.

5.1. Field Studies

5.1.1. Bioefficacy against sucking pests

5.1.1.1. Rice

Field observations made during the present study have indicated that phosphamidon 40 SL is equally effective as that of phosphamidon 85 WSC. The results of the three field experiments conducted on the bioefficacy of phosphamidon 40 SL on the sucking pests population in rice *viz.*, green leaf hopper (GLH), brown plant hopper (BPH) and white backed plant hopper (WBPH) are presented in tables 1–11. At three days after treatment (DAT) phosphamidon 40 SL at 200, 300 and 500 g a.i/ha reduced the GLH population to 29.93–43.50, 60.95–78.01 and 72.32–86.26 per cent respectively, while it was 54.45–73.74, 64.61–79.03 and 74.55–88.69 per cent in phosphamidon 85 WSC at 200, 350 and 500 g a.i/ha respectively. This clearly indicated that the pest suppression effect of phosphamidon 40 SL is more or less equal to phosphamidon 85 WSC. Similar trend was observed on 5, 7 and 10 DAT. The standard check monocrotophos reduced the GLH population to 66.88–82.69, 77.48–100.00, 94.73–100.00 and 98.29–100.00 per cent on 3,5,7 and 10 DAT respectively, while that of chlorpyrifos was 64.82–78.97, 83.61–100.00, 91.93–100.00 and 61.39–98.44 per cent respectively. Similar results have been reported by Reddy et al. (1984) who proved that chlorpyrifos resulted in reduction of GLH population to an extent of 89.39–94.67 per cent.

The results on the bioefficacy of phosphamidon 40 SL in the control of BPH on rice revealed that phosphamidon 40 SL @500 g a.i/ha was on par with phosphamidon 85 WSC @500 g a.i/ha and monocrotophos 36 WSC @360 g a.i/ha and chlorpyrifos 20 EC @125 g a.i/ha, while phosphamidon 40 SL @350 g a.i/ha was on par with phosphamidon 85 WSC @350 g a.i/ha on 3 and 5 DAT. These results were in consonance with the findings of Krishniah and Kalode (1987) who reported the effectiveness of monocrotophos and phosphamidon in checking the pest and Gubbiah et al. (1990) and Mao and Ling (1992) who reported that foliar spray of monocrotophos resulted in effective control of BPH.

The results of the efficacy of phosphamidon 40 SL on both adult and nymphal populations of WBPH are presented in tables 5, 6 and 9. At 3 days after treatment, phosphamidon 40 SL at 200, 350 and 500 g a.i/ha reduced the WBPH population to 57.68–77.69, 71.86–91.11 and 81.49–93.69 per cent respectively, while phosphamidon 85 WSC at similar doses resulted in 65.86–84.64, 71.94–90.24, 83.94–94.61 per cent reduction respectively at 3 DAT. The trend was similar on 5, 7 and 10 DAT. This is a clear indication that phosphamidon 40 SL is more or less equal to phosphamidon 85 WSC in its pest suppressing effect. Similar results were earlier reported by Saha (1986) who proved that chlorpyrifos and phosphamidon at 0.5 kg a.i/ha were effective in controlling WBPH and Korat et al. (1997) who confirmed the efficacy of phosphamidon against WBPH. Monocrotophos and chlorpyrifos at 3 DAT resulted in 79.08–92.62 and 77.97–93.34 per cent reduction respectively which were in consonance with the findings of Sontakke et al. (1994) and Akbar et al. (1996).

5.1.1.2. Cotton

The results from the field studies on the efficacy of phosphamidon 40 SL on sucking pests of cotton *viz.*, leaf hopper and whitefly are presented in the tables 12–17.

The cotton leaf hopper population was effectively reduced by all the treatments. However, phosphamidon 85 WSC @500 g a.i/ha was considered the best, with 88.36–91.78, 62.82–100.00 and 62.63–73.56 per cent reduction on 3, 5 and 7 DAT respectively. Phosphamidon 40 SL @500 g a.i/ha was found to perform on par with phosphamidon 85 WSC with 88.05–90.45, 59.80–100.00 and 61.96–79.45 per cent reduction on 3, 5 and 7 DAT respectively. Similar findings were reported by Bhamburkar (1986), Raju and Reddy (1988), Patil et al. (1991) and Santhini and Uthamasamy (1997) who reported that phosphamidon at 0.04 and 0.05 per cent were effective in controlling cotton jassids.

All the treatments effected significant reduction in the population of aphids. Phosphamidon 85 WSC @300 g a.i/ha at 3, 5, 7 and 10 DAT resulted in 100, 97.59–98.84, 85.19–87.57 and 66.03 per cent reduction respectively. Phosphamidon 40 SL at 300 g a.i/ha was found to be equally effective with 100, 96.64–98.34, 84.60–87.25 and 63.71 per cent reduction on 3, 5, 7 and 10 days respectively.

Also, phosphamidon 40 SL @250 and 300 g a.i/ha were on par with phosphamidon 85 WSC @250 and 300 g a.i/ha and both the chemicals were superior to methyl demeton and dimethoate, the proven chemicals for the control of aphids of cotton. Similar findings were obtained by Bhamburkar (1986), Khalil and Watson (1983) and Gupta et al. (1999) who reported on the efficacy of phosphamidon in the control of aphids.

With regard to cotton whiteflies, phosphamidon 85 WSC @200, 250 and 300 g a.i/ha resulted in 79.92–97.65, 100 and 100 per cent respectively on 3 days after treatment while that of phosphamidon 40 SL at similar doses was 66.63–84.94, 100 and 100 per cent reduction respectively on 3 DAT. The efficacy of phosphamidon 85 WSC in the control of whiteflies was proved by Purohit and Deshpande (1991) and Gupta et al. (1999). The lesser efficacy of

dimethoate when compared to phosphamidon 40 SL and 85 WSC in the present study may be attributed to the resistance mechanism developed in whiteflies against dimethoate (Prasad et al. 1993).

5.1.1.3. Brinjal

The results on the bioefficacy of phosphamidon 40 SL on sucking pests of brinjal are presented in Tables 18–25.

With regard to leafhoppers of brinjal, the pest was effectively controlled by monocrotophos and phosphamidon 85 WSC @300 g a.i/ha. In both the trials, monocrotophos gained superiority over phosphamidon 85 WSC. At 3 DAT, monocrotophos registered 94.20-97.02 per cent reduction of whitefly population which was on par with phosphamidon 85 WSC @300 g a.i/ha (94.16–100%) and phosphamidon 40 SL @300 g a.i/ha (90.94–92.01%). Similar results were obtained in the previous studies conducted by Deshpande et al. (1974), Mote (1981), Shah et al. (1990) and Sharma et al. (1999) who proved the efficacy of monocrotophos in the control of brinjal jassid.

The aphid population was more susceptible to phosphamidon 85 WSC @300 g a.i/ha and monocrotophos @360 g a.i/ha, both recording cent per cent reduction at 5 DAT. These facts were well documented earlier by Patel et al. (1980), Mall et al. (1997) and Mishra (1996). In the present investigations, phosphamidon 40 SL @ 300 g a.i/ha was found to be equally effective recording cent per cent reduction at 5DAT.

Phosphamidon 85 WSC @300 g a.i/ha resulted in 88.41–95.37 per cent reduction of whitefly population at 3 DAT, while monocrotophos @360 g a.i/ha recorded 82.75-95.19 per cent reduction indicating the superiority of monocrotophos and phosphamidon in checking the population. However, phosphamidon 40 SL @ 300 g a.i/ha was found to be equally effective with 83.22–92.74 per cent reduction at 3 DAT.

Similar trend was observed on 5 and 7 DAT. These results were in accordance with the findings of Dahiya and Ramsingh (1982), who proved the efficacy of monocrotophos against whitefly and Purohit and Deshpande (1991), on the efficacy of phosphamidon in controlling whiteflies.

The results of the above field experiments indicated that application of phosphamidon 40 SL @500/300 g a.i/ha is sufficient to reduce the sucking pests of rice, cotton and brinjal as an alternative to phosphamidon 85 WSC, monocrotophos 36 WSC, chlorpyrifos 20 EC and dimethoate 30 EC.

5.1.2. Toxicity to natural enemies

5.1.2.1. Rice

The results of the toxicity evaluation studies on rice are presented in the tables 26–31. In the present studies phosphamidon 85 WSC @500 g a.i/ha recorded the maximum per cent reduction of spiders (50%) on 3 DAT. These results were in consonance with the findings of Natarajan et al. (1988) who observed reduction in spider population in plots treated with phosphamidon. However, from 5th day onwards, the toxicity was reduced and the population of spiders remained at higher numbers. From these results it is evident that phosphamidon is toxic to spiders to a certain degree for 3–5 days after spraying. Later, the chemical shows lesser extent of toxicity. Similar findings were reported by Sontakke (1993) and Ganeshkumar and Velusamy (1997) who observed less toxicity of phosphamidon to spiders. Meanwhile, phosphamidon 40 SL maintained higher numbers of spider population throughout the course of study.

With regard to coccinellid predators, none of the treatments were initially toxic and at 10 DAT, phosphamidon 85 WSC recorded only 30.72 per cent reduction (Table 28). These findings were in accordance with Patnaik (1983) and Rabbi et al. (1993). However, phosphamidon 40 SL was found to be less toxic, maintaining higher population of coccinellids on all days of observations.

5.1.2.2. Cotton

With regard to spiders of cotton ecosystem, phosphamidon 85 WSC was the most toxic compound which recorded a maximum of 42.02 per cent reduction at 5 DAT (Table 30). But, the population attained higher numbers on further days of observation. Regarding phosphamidon 40SL, the chemical was less toxic to spiders. The results were similar to spiders of brinjal ecosystem (Table 31), where phosphamidon 40 SL proved to be less toxic to spiders.

The results of the toxicity of phosphamidon 40 SL to beneficial organisms of rice, cotton and brinjal ecosystem had indicated that, phosphamidon 85 WSC exhibited certain amount of toxicity to the natural enemy population while phosphamidon 40 SL was comparatively less toxic to the natural enemy population than phosphamidon 85 WSC formulation.

5.1.3. Phytotoxicity

From the field experiments, to assess the phytotoxicity of phosphamidon 40 SL as foliar spray, it was evident that phosphamidon 40 SL even at 2000 g a.i/ha (for rice) and 1200 g a.i/ha (for cotton and brinjal) i.e. four times the normal dose, did not produce any phytotoxicity symptoms on the crops evaluated.

5.2. Laboratory Studies

5.2.1. Persistent toxicity

5.2.1.1. Rice

The results of the persistent toxicity studies conducted with BPH and WBPH as test insects are presented in tables 33–38. With regard to BPH, phosphamidon 85 WSC @500 g a.i/ha persisted for 11 days, while phosphamidon 40 SL @500 g a.i/ha persisted for 9 days.

In case of WBPH, phosphamidon 85 WSC @500 g a.i/ha was found to be the best chemical retaining the toxicity upto 11 days whereas phosphamidon 40 SL @300 g a.i/ha persisted for 9 days. These findings were in conformity with the earlier results of Koshiya et al. (1989) who reported a persistence of 8 days for phosphamidon 85 WSC.

5.2.1.2. Cotton

The studies with cotton leafhopper exhibited a persistence of 15 days for phosphamidon 85 WSC @300 g a.i/ha. This was followed by phosphamidon 40 SL @ 300 g a.i/ha which had a persistence of 13 days.

In case of aphids, phosphamidon 85 WSC @300 g a.i/ha remained persistent for upto 19 days while it was 17 days for phosphamidon 40 SL @300 g a.i/ha.

5.2.1.3. Brinjal

Phosphamidon 85 WSC @300 g a.i/ha was also effective against leafhoppers of brinjal with persistence of 17 days. In the present study, phosphamidon 40 SL @ 300 g a.i/ha was persistent for 15 days and was superior to dimethoate which registered a persistence of 15 days.

The variation in persistence in rice, cotton and brinjal may be due to the phenology of the crop and the surface area to hold the spray particles.

5.2.2. Safety Evaluation for Natural Enemies

The results of the safety tests with *Chrysoperla carnea* Stephens have indicated that monocrotophos was the most toxic compound recording 9.33 per cent egg mortality, 60 per cent grub mortality and 28.33 per cent adult emergence. All the chemicals were significantly non-toxic to the eggs. Phosphamidon 40 SL @300 g a.i/ha was less toxic, when compared to phosphamidon 85 WSC and the former recorded 6 per cent egg mortality, 33.33 per cent grub mortality and 41.67 per cent adult emergence, while that of

phosphamidon 85 WSC was 7.33, 50.00 and 33.33 per cent respectively. Similar results were obtained by Lingren and Ridgway (1967) and Krishnamoorthy (1985) who reported that phosphamidon 85 WSC was highly toxic to larva and adults of *C. carnea*.

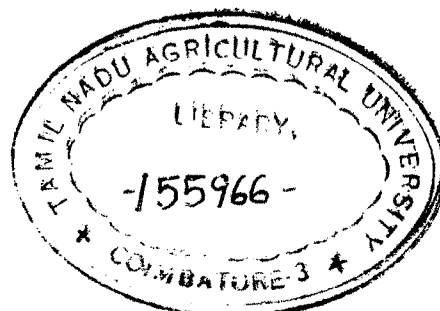
Safety tests with *Trichogramma chilonis* have indicated that adult emergence was highly influenced by monocrotophos followed by phosphamidon 85 WSC. Phosphamidon 40 SL allowed higher rates of adult emergence ranging from 78.67 to 83 per cent. Regarding the per cent parasitisation also, monocrotophos allowed only 59 per cent followed by phosphamidon 85 WSC (62%). Phosphamidon 40 SL at all doses allowed higher rates of parasitisation (67–73.67%) as against 93 per cent in control. These findings were in consonance with that of Singh and Verma (1986) who reported 26–64 per cent parasitism by *Trichogramma brasiliensis* Ashmead. under laboratory conditions. Rajendran and Gopalan (1996) also reported higher mortality of *T. chilonis* within 24 hrs. The toxicity of phosphamidon to *T. chilonis* was also reported by Brar et al. (1991) and Mandal and Somchoudhury (1992).

Summary

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CHAPTER VI

SUMMARY

The results of the investigation carried out on bioefficacy of phosphamidon 40 SL against sucking pests of rice, cotton and brinjal, toxicity of the chemical to natural enemies, phytotoxicity and safety to natural enemies are summarised below.

The maximum reduction of green leafhopper population (95.07%) was recorded at 5 DAT in chlorpyrifos 20 EC followed by phosphamidon 85 WSC @500 g a.i/ha (94.97%) and phosphamidon 40 SL @500 g a.i/ha (93.19%). After a second round of spray, phosphamidon 40 SL @500 g a.i/ha was found to be performing on par with phosphamidon 85 WSC @500 g a.i/ha. In another experiment too, phosphamidon 40 SL @500 g a.i/ha was on par with phosphamidon 85 WSC @500 g a.i/ha.

With regard to brown plant hopper population, cent per cent reduction was noticed in phosphamidon 40 SL @500 g a.i/ha at 5 DAT which was on par with phosphamidon 85 WSC @ 500 g a.i/ha, monocrotophos 36 WSC and chlorpyrifos 20 EC. Similar trend was reflected after a second round of spray. The other experiment also revealed similar results with cent per cent reduction in T₃, T₆, T₇ and T₈ at 5 DAT.

The white backed plant hopper population was also effectively controlled by phosphamidon 40 SL and phosphamidon 85 WSC. At 5 DAT and 7 DAT, cent per cent reduction in the population was recorded in higher doses (T₃ and T₆).

Though, all the doses controlled the cotton leafhopper population effectively the highest dose used for phosphamidon 40 SL and 85 WSC was maintaining superiority over other treatments. At 3 DAT, maximum per cent reduction was observed in T₃ (88.05%) and T₆ (88.36%) and both were on par. After a second round of spray, T₃ and T₆ recorded cent per cent reduction.

Application of phosphamidon 40 SL @250 and 300 g a.i/ha and phosphamidon 85 WSC @250 and 300 g a.i/ha resulted in cent per cent reduction of aphid at 5 DAT. Phosphamidon 40 SL at 300 g a.i/ha and phosphamidon 85 WSC @300 g a.i/ha recorded cent per cent reduction at 1 DAT itself, after second round of spray, since the initial population was low before the second round of spraying. Cent per cent reduction was maintained till 3 DAT in phosphamidon 40 SL @250 and 300 g a.i/ha and phosphamidon 85 WSC @200, 250 & 300 g a.i/ha.

The whitefly population was considerably reduced at 3 DAT (cent per cent reduction). The results were similar after the second round of spray also (with cent per cent reduction) in phosphamidon 40 SL @250 and 300 g a.i/ha and phosphamidon 85 WSC @ 250 and 300 g a.i/ha.

In case of brinjal, monocrotophos was found to be the effective insecticide to leafhopper recording 93.99 per cent reduction at 1DAT. Though phosphamidon 40 SL @300g a.i/ha and phosphamidon 85 WSC @300 g a.i/ha were inferior to monocrotophos, were on par with the latter. After a second application, cent per cent reduction was expressed in phosphamidon 85 WSC @300 g a.i/ha followed by phosphamidon 40 SL @ 300 g a.i/ha registering 91.05 per cent reduction. In another experiment too, similar trend was reflected.

Regarding aphids of brinjal, cent per cent reduction was observed in phosphamidon 40 SL @300 g a.i/ha, phosphamidon 85 WSC @300 g a.i/ha and monocrotophos 36 WSC at 5 DAT. Similar trend was reflected in the second experiment with cent per cent reduction in the above mentioned treatments at 1 and 3 DAT.

Whitefly population of brinjal was effectively controlled by application of phosphamidon 85 WSC @300 g a.i/ha and monocrotophos. At 5 DAT, cent per cent reduction was noticed in T₃, T₆ and T₇ and the results were similar after second round of spray. The results were similar in the second experiment too.

Experiments conducted to evaluate the toxicity of phosphamidon 40 SL to natural enemies indicated that, phosphamidon 40 SL at 500 g a.i/ha was found to be less toxic to spiders than phosphamidon 85 WSC at 500 g a.i/ha. However at 10 DAT, no treatment was found to be significantly toxic to spiders.

The predatory coccinellid population of the rice ecosystem was found to be less influenced by application of insecticides. The results indicated that none of the treatments were significantly toxic upto 7 DAT. At 10 DAT, a maximum of 19.28 per cent reduction in the coccinellid population was observed in phosphamidon 85 WSC @500 g a.i/ha.

With regard to spiders of cotton and brinjal ecosystem, no treatment was found to be significantly toxic at 7 and 10 DAT. Moderate levels of toxicity (25-43%) were however noticed with phosphamidon 85 WSC @300 g a.i/ha.

Phosphamidon 40 SL applied at 500, 1000 and 1500 g a.i/ha to rice and at 300, 600 and 1200 g a.i/ha to cotton and brinjal did not show any phytotoxic effect on the crops tested.

Persistent toxicity studies in rice have indicated that phosphamidon 40 SL @ 500 g a.i/ha was effective upto 9 days against BPH and WBPH while phosphamidon 85 WSC at the same dose was effective upto 11 days against the aforesaid pests.

The results of persistent toxicity studies on cotton showed that phosphamidon 40 SL @300 g a.i/ha remained toxic for upto 13 and 17 days for leafhopper and aphid respectively.

In case of leafhopper of brinjal, phosphamidon 40 SL @300 g a.i/ha persisted for upto 15 days while phosphamidon 85 WSC at the same dosage remained effective upto 17 days. Regarding aphid, though phosphamidon 40 SL and phosphamidon 85 WSC @ 300 g a.i/ha persisted for 15 days, the latter ranked first based on the PT value.

Safety tests under laboratory condition revealed that, none of the treatments did cause any remarkable reduction on the hatchability of *Chrysoperla* eggs. Observations on grub mortality, per cent pupation and per cent adult emergence have also indicated that phosphamidon posed lower toxicity to *Chrysoperla carnea* Stephens than monocrotophos.

The per cent parasitisation by *Trichogramma chilonis* Ishii. was also less influenced by phosphamidon 40 SL at all doses. The chemical also allowed higher rates of adult emergence (78.7-85%) as against 70.3 per cent emergence in monocrotophos treatment.

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* Originals not seen

