Indian J. Agric. Res., **46** (2) : 141 - 147, 2012

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com / indianjournals.com

MANAGEMENT OF *SPILARCTIA OBLIQUA* (WALKER) CONSIDERING USAGE OF DIFFERENT AGROCHEMICALS AND THEIR COMBINATIONS

Garima Gupta* and S.R. Yadav

Department of Entomology,
G.B.Pant Univ. of Agricultural & Technology, Pantnagar-263541, India

Received : 07-05-2011 Accepted : 02-12-2011

ABSTRACT

The role of agrochemicals in an integrated manner with the use of biorational insecticides in combination with other agrochemicals (fungicide, Plant growth regulator PGR) for the control of first instar larvae of *Spilarctia oblique* was studied under laboratory conditions at GBPUAT, Pantnagar, during 2004 and 2005. The results revealed that mortality of larvae started from 48 h on all fortified artificial diets except two mixtures, (Mancozeb 1X + Miraculan 1X) and (Mancozeb 1X + Miraculan 1X + diflubenzuron 0.5X). Dipel 0.5X showed quick lethal effect on larvae within 2 days among all the combinations. The treatments with dipel; (Miraculan 1X + dipel 0.5X), (Mancozeb 1X + Miraculan 1X + Dipel 0.5X), (Mancozeb 1X + Miraculan 1X + Dipel 0.5X + diflubenzuron 0.5X), (Mancozeb 1X+ Dipel 0.5X + diflubenzuron 0.5X), (Miraculan 1X + Dipel 0.5X), (diflubenzuron 0.5X + Dipel 0.5X) and (Miraculan 1X + Dipel 0.5X + diflubenzuron 0.5X), showed less than 50 per cent larval survival, which indicated that all the above combinations even with half dose of dipel are effectively lethal to the pest than dipel alone at recommended dose. Similar observations were also recorded when these treatments were repeated with larvae exposed to treated castor leaves, which proved that the lethal effect of miraculan and mancozeb remained stable when sprayed with dipel or diflubenzuron on plant leaves.

Key words: Plant growth regulator, Fungicide, Combination products, *Spilarctia obliqua.*

INTRODUCTION

The Bihar hairy caterpillar, *Spilarctia obliqua* (Walker) (*Spilosoma obliqua* Walker) is considered as a dominant polyphagous pest of various crops including soybean, pulses, oilseeds, legumes etc. (Bhattacharya and Rathore, 1977). This pest has been recorded in India, Pakistan, Sri Lanka, eastern Asia, Borneo, China and Japan (Biswas 2006). Use of various pesticides is widespread among farmers and plantation growers for the control of this pest. If other agrochemicals which are usually applied in the field for other purposes then controlling insects, and have insecticidal activity, then their use in combination to lesser concentration of insecticide can be incorporated in IPM module for the first instar larvae of this pest. Though, a large amount of literature is available for the management of this pest but there is a lot of variation is found among dosage used of different insecticides. This may be the reason that insects develop resistance to particular insecticide and so the labeled dose keeps on changing with time. Present research investigation has been focused on the role of agrochemicals in an integrated manner with the use of bio-rational insecticides in combination with other agrochemicals (fungicide, Plant growth regulator PGR) for the control of this pest.

MATERIALS AND METHODS

Culture: A nucleus culture of *Spilarctia obliqua* (Walker) (=*Spilosoma obliqua*) was established in the laboratory by collecting larvae from the soybean field at the Crop Research Centre of GBPUA&T, Pantnagar, in the month of June-July, 2004 and 2005. These larvae were reared on castor leaves at $30\pm1^{0}C$ and relative humidity 80±5 per cent. All rearing was carried out in glass jars (21´15 cm) covered with muslin cloth. Adults obtained from this culture were kept in glass jars (21 x 15 cm) lined with filter paper and covered with muslin cloth, for

*Present adress- Department of Zoology, Punjab University, Chandigarh-160 014.

egg laying. Sucrose solution (10 per cent) was provided for adults, as food, by placing the soaked absorbent cotton in a small glass petri dishes in the bottle of glass jars. Eggs obtained from these adults were kept in glass petri dishes. Newly hatched larvae (0-24 h old) were obtained for experiments.

Bioassay of insecticides

Fifteen commonly used and recommended insecticides belonging to different groups (endosulfan, methomyl, chlorpyriphos, dichlorvos, dimethoate, monocrotophos, phenthoate, prophenophos, quinalphos, triazophos, cypermethrin, deltamethrin, lambda-cyhalothrin, fenvalerate and alphamethrin) and two combination products (chlorpyriphos 50 EC + cypermethrin 5 EC and prophenophos 40 EC + cypermethrin 4 EC), were used in this investigation. The insecticides used with their common names, formulations, source and the doses are shown in Table 1. The commercial formulations of different insecticides provided from respective firms were diluted to desired concentration by using water. All insecticides were tested as contact poison. This investigation was carried out with 3-4 days old larvae. For assessing the toxicity of different insecticides, larvae were selected from the culture so that, they were all at the start of the instar to ensure that none would moult during the test period. These larvae were approximately of same size. Each treatment was replicated three times and ten larvae were used in each replication. Each concentration was sprayed with the help of potter's tower, on the larvae which were kept in the glass petri dish (100 x 17 mm) at the base of the spraying tower. Only 1 ml of spray solution was sprayed at 24 psi to get uniform fine atomized drops of liquid. One insecticide was used at a time starting from lower to higher concentration. The treated larvae kept under the fan for 5 minute for drying the sprayed liquid. Thereafter, larvae coated with insecticides were transferred to a clean plastic vial and fresh cleanly washed untreated castor leaves were supplied as food.

The mortality data on the test insects were recorded 24, 48 and 72 hours after spraying. Insects were adjudged to be dead if they did not respond to probing with a camel hair brush or slight heating under the table lamp. Median lethal doses (LC_{50}) values were calculated by the computer programme developed by Mondal *et al.* (2001).

Bio efficacy of agrochemicals by diet incorporation method

Dithane M-45 (X= 0.25%), Miraculan (X= 0.0125%), diflubenzuron (X= 0.00001%) and Dipel (X= 0.05%) were selected for the bioassay experiments. Eleven possible combinations of these selected chemicals (Dithane M-45 + Miraculan, Dithane M-45 + diflubenzuron, Dithane M-45 + Dipel, Dithane M-45 + Miraculan + Dipel, Dithane M-45 + Miraculan + Dipel + diflubenzuron, Dithane M-45 + Dipel + diflubenzuron, Miraculan + diflubenzuron, Miraculan + Dipel, diflubenzuron + Dipel, Miraculan + Dipel + diflubenzuron and Dithane M-45 + Miraculan + diflubenzuron, were incorporated with artificial diet. Both the biorational insecticides (diflubenzuron and dipel), were taken at half the recommended dose when combined with other chemicals.

Artificial diet preparation: The composition of artificial diet was 13.2 g of boiled wheat, 4.42 g of boiled soybean, 3.1 g yeast powder, 0.31 g sodium ascorbate, 0.31 g methyl paraben, 0.15 g sorbic acid, 1.5 g agar, 0.15 ml 10% formaldehyde, 76.8 ml distilled water (Tiwari and Bhattacharya, 1987). These grains were boiled in distilled water for 60 min and transferred to a Warring Blender with half the quantity of distilled water. Yeast powder, methyl-p-hydroxybenzoate, sorbic acid, formaldehyde (10 %) and sodium ascorbate were added to this mixture and blending was continued for about 2-3 min. Agar was boiled with remaining quantity of water and added to above mixture and then agrochemicals were added. This diet was poured in large plastic containers and allowed to cool at room temperature and stored in the refrigerator. For bioassays, a small amount of diet was placed at the bottom of plastic vial (2.5 cm x 2.5 cm), which was provided with a screw cap having brass wire mess for aeration. Initially, 10 newly emerged larvae (0-12 h old), were transferred to the diet with a camel hair brush. After 10 days, they were separated in individual vials and diets were provided *ad-libitum*. The experiments were conducted at 28 ± 1^0C and 75±5% r.h. Each treatment was replicated three times. Artificial diet alone was used as control. Survival data of the larvae was recorded at one day interval.

Bio efficacy of agrochemicals when sprayed on castor leaves

Dithane M-45 (X= 0.25%), Miraculan (X= 0.0125%), diflubenzuron (X= 0.1 ppm) and Dipel (X= 500 ppm) were selected for the bioassay experiments. Eleven possible combinations of these selected chemicals (Dithane M-45 + Miraculan, Dithane M-45 + diflubenzuron, Dithane M-45 + Dipel, Dithane M-45 + Miraculan + Dipel, Dithane M-45 + Miraculan + Dipel + diflubenzuron, Dithane M-45 + Dipel + diflubenzuron, Miraculan + diflubenzuron, Miraculan + Dipel, diflubenzuron + Dipel, Miraculan + Dipel + diflubenzuron and Dithane M-45 + Miraculan + diflubenzuron, were incorporated with artificial diet. Both the biorational insecticides (diflubenzuron and dipel), were taken at half the recommended dose when combined with other chemicals. Each concentration was sprayed with the help of potter's tower, on the castor leaf, kept in the glass Petri dish (100 x 17 mm) at the base of the spraying tower. Only 1 ml of spray solution was sprayed at 24 psi to get uniform fine atomized drops of liquid. Castor leaves were sprayed on both the sides and after drying, 0-24 hr old larvae were released on them. Three replications for each concentration were kept. Castor leaves sprayed with water were used as control. Treated castor leaves were provided to the larvae *ad libitum.* Larval survival data was recorded at one day interval.

RESULTS AND DISCUSSION

Comparison of insecticides on the basis of their relative toxicity:

Table 2 revealed the relative contact toxicity of seventeen conventional and non-conventional insecticides belonging to different groups of chemicals against 3-4 day old larvae of *S. obliqua* at 24, 48 and 72 h. Deltamethrin was most toxic as its relative toxicities were 920, 3400 and 13750 times at 24, 48 and 72 h, respectively as toxic as dimethoate. The order of relative toxicity was: deltamethrin > λ-cyhalothrin > alphamethrin > cypermethrin > fenvalerate > chlorpyriphos > quinalphos > Prophenophos + Cypermethrin > dichlorvos > triazophos > methomyl > prophenophos > monocrotophos > endosulfan> phenthoate> Chlorpyriphos + Cypermethrin > dimethoate. All the five synthetic pyrethroids as well as chlorpyriphos, quinalphos, Prophenophos + Cypermethrin, dichlorvos, triazophos, methomyl, prophenophos, monocrotophos were more toxic than dimethoate. However, phenthoate, Chlorpyriphos + Cypermethrin and dimethoate were less toxic than dimethoate.

Sinha *et al*. (1984) found quinalphos (0.05%), fenitrothion (0.05%) and dichlorvos (0.05%) gave the best performance when they compared thirteen conventional insecticides, as contact poisons against grown up larvae of this pest. Kundu (1991) found monocrotophos (0.04%) and malathion (0.05%) were more effective than endosulfan (0.01%) controlling infestation of *S. obliqua* on soybean. Goel and Kumar (1991) also found Deltamethrin as the most potent insecticide followed by cyperthrin agaisnt *S. obliqua* and *Achrontia styx.* Efficacy of cypermethrin, deltamethrin, fenvalerate and fenpropethrin was determined against third instar larvae of *S. litura* and *S. obliqua* by Jaglan and Sircar (1997). Nagia *et al.* (1990a) tested nine insecticides against fourth and fifth instar larvae of *S. obliqua* and recorded good results with deltamethrin, cypermethrin and fenvalerate at 0.016 per cent a.i. and with parathion methyl and endosulfan at 0.08 per cent a.i. Monocrotophos, acephate, triazophos and diazinon proved less toxic to this pest. The LC_{50} for deltamethrin, cypermethrin, fenpropathrin, fenvalerate, fluvalinate, endosulfan, parathion methyl and monocrotophos were 0.00313, 0.00601, 0.00952, 0.01556, 0.01914, 0.02057 and 0.02786, respectively (Nagia *et al*., 1990b). Therefore, besides lower concentration it was also found that synthetic pyrethroids and combination products had faster effects than other insecticides tested. Hence, the present investigation suggested that judicious use of synthetic pyrethroids (deltamethrin, λ-cyhalothrin, cypermethrin, alphamethrin and fenvalerate), and combination product (Prophenophos + Cypermethrin) could be incorporated in the integrated pest management programme against *S. obliqua*.

Effect of mixtures of field dose of agrochemicals other than insecticides by diet incorporation method

Mortality of larvae started from 48 h on all fortified diets except two mixtures, (Mancozeb 1X + Miraculan 1X) and (Mancozeb 1X + Miraculan

Table 1: List of agrochemicals and insecticides with their common name, trade name, manufacturers and doses used.

Chemical name	Trade name	Manufacture	Doses (%)
Mancozeb	Dithane M-45 WP	Northern Minerals Ltd., Haryana	0.015, 0.031, 0.062, 0.125, 0.25, 0.05, Control
Tricontanol	Miraculan 0.05 EC	De-nocil Crop Protection Pvt. Limited, Mumbai	0.003, 0.006, 0.012, 0.025, 0.05, 0.10, Control
Diflubenzuron	Diflubenzuron 25 WP	Gharda Chemicals Limited, Mumbai	0.025, 0.05, 0.1, 0.2, 0.4, 0.8, 1.0, 2 ppm, Control
Dipel	Dipel 8L	Cheminova India Limited, Mumbai	7.8, 15.6, 31.3, 62.5, 125, 260, 500 ppm, Control
Chlorpyriphos	Commando 20 EC	Meerut Agrochemical Industry Limited, Meerut	0.12, 0.06, 0.03, 0.15, 0.0075, 0.00375, 0.001875, Control
Dichlorvos	Nuvan 76 CC	Syngenta India Limited, Mumbai	0.1, 0.05, 0.25, 0.125, 0.00625, 0.00312, 0.00156, Control
Dimethoate	Dhangon 30EC	Meerut Agrochemical Industry Limited, Meerut	0.4, 0.2, 0.1, 0.05, 0.025, 0.0125, 0.00625, Control
Monocrotophos	Dhanphos 36SL	Meerut Agrochemical Industry Limited, Meerut	0.16, 0.08, 0.04, 0.02, 0.01, 0.005, 0.0025, Control
Phenthoate	Anusan 50 EC	Anu Product Pvt. Limited, Faridabad	0.2, 0.1, 0.05, 0.025, 0.0125, 0.00625, 0.003125, Control
Prophenophos	Curacaron 50 EC	Syngenta India Limited, Mumbai	0.2, 0.1, 0.05, 0.025, 0.125, 0.00625, 0.00312, Control
Quinalphos	Dhanlux 25 EC	Meerut Agrochemical Industry Limited, Meerut	0.1, 0.05, 0.025, 0.0125, 0.00625, 0.003125, 0.00156, Control
Triazophos	Hostathion 40 EC	Aventis Crop Sciences Pvt. Limited, Mumbai	0.2, 0.1, 0.05, 0.025, 0.125, 0.00625, 0.00312, Control
Methomyl	Lannate 40 SP	EI Dupont India Pvt. Limited, Gurgaon	0.3, 0.15, 0.075, 0.0375, 0.1875, 0.0093, 0.0046, Control
Endosulfan	Dhansulphan 35 EC	Meerut Agrochemical Industry Limited, Meerut	0.14, 0.07, 0.035, 0.0175, 0.00875, 0.004375, 0.00218, Control
Cypermethrin	Dhanrin 25 EC	Meerut Agrochemical Industry Limited, Meerut	0.008, 0.004, 0.002, 0.001, 0.0005, 0.00025, 0.000125, Control
Deltamethrin	Decis 2.8 EC	Syngenta India Limited, Mumbai	0.0004, 0.0002, 0.0001, 0.00005, 0.000025, 0.000012, 0.000006, Control
λ-Cyhalothrin	Karate 5EC	Syngenta India Limited, Mumbai	0.001, 0.0005, 0.00025, 0.00012, 0.00006, 0.00003, 0.000015, Control
Fenvalerate	Dhanfen 20 EC	Meerut Agrochemical Industry Limited, Meerut	0.006, 0.003, 0.0015, 0.00075, 0.00037, 0.00018, 0.000093, Control
Alphamethrin	Shooter 10 EC	Meerut Agrochemical Industry Limited, Meerut	0.004, 0.002, 0.001, 0.0005, 0.00025, 0.00012, 0.000062, Control
Chlorpyriphos + Cypermethrin	C-505 50+5% EC	Meerut Agrochemical Industry Limited, Meerut	2, 1, 0.5, 0.25, 0.125, 0.062, 0.031, Control
Prophenophos + Cypermethrin	Prokill 40+4% EC	Meerut Agrochemical Industry Limited, Meerut	0.08, 0.04, 0.02, 0.01, 0.005, 0.0025, 0.00125, Control

1X + diflubenzuron 0.5X). Dipel 0.5X showed quick lethal effect on larvae within 2 days among all the combinations. The treatments with dipel; (Miraculan 1X + dipel 0.5X), (Mancozeb 1X + Miraculan 1X + Dipel 0.5X), (Mancozeb 1X + Miraculan 1X + Dipel 0.5X + diflubenzuron 0.5X), (Mancozeb 1X+ Dipel 0.5X + diflubenzuron 0.5X), (Miraculan 1X + Dipel 0.5X), (diflubenzuron 0.5X + Dipel 0.5X) and (Miraculan 1X + Dipel 0.5X + diflubenzuron 0.5X), showed less than 50 per cent larval survival (Table 3), which indicated that all the above combinations even with half dose of dipel were effectively lethal to the pest than dipel alone at recommended doses. Complete larval mortality was recorded on fourth day among all the above treatments in which Dipel was included. This indicated that diflubenzuron, Miraculan and Mancozeb were also contributing to larval mortality and/ or they have synergistic effect to dipel.

Combinations of Diflubenzuron 0.5X with miraculan and mancozeb showed that the larval survival at 2 days was higher than 50 per cent. When mancozeb was added with diflubenzuron 0.5X, 40 and 87 per cent larval mortality was recorded on second and fourth day, respectively in the artificial diets of this insect. However, when miraculan was added with diflubenzuron, 70 and 20 per cent larval survival was recorded on second and fourth day, respectively and on sixth day complete larval mortality was recorded. This showed that even at half recommended dosage; diflubenzuron showed the same toxicity to the target pest when combined with any of these two agrochemicals. When miraculan and mancozeb were mixed together 100, 50, and 17 per cent larval survival was recorded at second, fourth and sixth days, respectively.

In earlier research, it was investigated non-target effects of triacontanol (Miraculan), a plant growth regulator (Gupta *et al.*, 2009); and dithane M-45 (Mancozeb), a fungicide (Gupta *et al.*, 2007); on survivorship and developmental parameters of *Spilarctia obliqua* Walker (Lepidoptera: Arctiidae). Miraculan, interestingly revealed a significant reduction in pest survivorship at almost all levels (0.25 x –4 x) of doses fortified with artificial diet. LC_{50} for miraculan was computed as 0.206%. However, miraculan did not cause any significant difference in larval and pupal periods at all doses tested. Mancozeb caused complete larval mortality within four days on diets containing 0.25 to 0.5 per cent of this fungicide. EC_{50} was calculated as 0.051%. In addition, chronic sublethal effects of diflubenzuron (Gupta *et al.*, 2008) and *B. thuringiensis*, Dipel (Gupta and Bhattacharya, 2006); were also investigated against *S. obliqua.* Newly hatched larvae were reared on artificial diet fortified with eight levels of diflubenzuron (0.025, 0.05, 0.1, 0.2, 0.4, 0.8, 1.0 and 2 ppm) and seven levels of dipel (7.8, 15.6, 31.3, 62.5, 12.5, 250 and 500 ppm). Diflubenzuron showed complete larval mortality at 1 and 2ppm on sixth day and at 0.8, 0.4, 0.2 and 0.1 ppm on eighth day. All the adults emerged were deformed on diflubenzuron treated diets. On the other hand, dipel showed prolongation of larval period on 7.8 to 125ppm treated diets.

Efficacy of agrochemicals other than insecticides at recommended doses when sprayed on castor leaves

All the above-mentioned insecticides were tested against first instar larvae of *S. obliqua*. Dipel 1X, diflubenzuron 1X, Miraculan1X and Mancozeb 1X were included in addition to the above-mentioned nine insecticide combinations (Table 4). Dipel when alone showed 100, 70, 63, 57, and 30 per cent larval survival at second, fourth, sixth, eighth, and tenth day on treated castor leaves. However, in combinations with diflubenzuron, miraculan, and mancozeb, it showed lethal effect even at two days and almost complete larval mortality was obtained at sixth day. Similarly, diflubenzuron when applied alone

Table 2. Relative toxicity of different insecticides against 3-4 day old larvae of *S. obliqua* at 24, 48 and 72 h.

Insecticide	*24 hrs*		*48 hrs*		*72 hrs*	
	LC_{50}	Relative Toxicity	LC_{50}	Relative Toxicity	LC_{50}	Relative Toxicity
Dimethoate	0.0920	1	0.0340	1	0.1100	1
Phenthoate	0.0220	4	0.0180	2	0.0140	8
Prophenophos	0.0270	3	0.0070	5	0.0050	22
Dichlorvos	0.0090	10	0.0060	6	0.0050	22
Triazophos	0.0350	3	0.0230	2	0.0120	9
Quinalphos	0.0130	7	0.0020	17	0.0020	55
Monocrotophos	0.0240	4	0.0120	3	0.0070	16
Chlorpyriphos	0.0009	102	0.0001	340	0.00007	1571
Cypermethrin	0.0009	102	0.0003	113	0.0002	550
λ-Cyhalothrin	0.0001	920	0.00001	3400	0.000006	18333
Deltamethrin	0.0001	920	0.00001	3400	0.000008	13750
Fenvalerate	0.0025	37	0.0005	68	0.0003	367
Alphamethrin	0.0020	46	0.00004	850	0.00004	2750
Methomyl	0.0260	3	0.0140	2	0.0090	12
Endosulfan	0.0420	2	0.0260	1	0.0190	6
Prophenophos + Cypermethrin	0.0050	18	0.0020	17	0.0020	55
Chlorpyriphos + Cypermethrin	0.0570	2	0.0570	1	0.0480	2

Table 3: Larval survival of *S. obliqua* on diets fortified with different agrochemicals and insect growth regulators formulation during different days.

Combination	Days after exposure 2	4	6	8
MZ 1X + MN 1X	10±0.0	5±1.0	1.7±0.6	0
MZ 1X + DF 0.5X	6±1.0	1.3±0.6	0	0
MZ 1X + DP 0.5X	3.7±0.6	0.3±0.6	0	0
MZ 1X + MN 1X + DF 0.5X	8.3±1.5	2±1.0	0	0
MZ 1X + MN 1X + DP 0.5X	6.7±1.5	0.3±0.6	0	0
MZ 1X + DP 0.5X + DF 0.5X	5±1.0	1±1.0	0	0
MZ 1X + DF 0.5X	7±1.0	2±10	0.3±0.6	0
DF 0.5X + DP 0.5X	3.7±1.5	0	0	0
MN 1X + DP 0.5X	4±1.0	0.3±0.6	0	0
Control A.D.	10±0.0	9.7±0.6	9.7±0.6	9.7±0.6
Control castor	10±0.0	10±0.0	10±0.0	10±0.0
P, F (df = 10, 22)	*20.6, <0.0001*	*79.4, <0.0001*	*507.1, <0.0001*	*1567.0, <0.0001*

Where, MZ = Dithane M-45, MN = Miraculan, DF = diflubenzuron and DP = Dipel.

Table 4: Larval survival expressed in percentage of *S. obliqua* on castor leaf sprayed with field dose of Dipel, diflubenzuron, Miraculan and Dithane M-45.

DaysAgrochemical	2	4	6	8	10	12
Dipel (DP 1X)	10±0.0	7±1.0	6.3±0.6	5.7±0.5	3±1.0	2.3±0.6
Diflubenzuron (DF 1X)	9.7±0.5	61.0	5±1.0	3.7±0.6	2.7±0.6	2.3±1.1
Miraculan (MN 1X)	9±1.0	4.71.5	2.7±0.6	1.3±0.6	0	0
Mancozeb (MZ 1X)	7±1.0	3±1.0	1.3±0.6	0.3±0.6	0	0
MZ 1X + MN 1X	100.0	6.3±0.5	4±1.0	2.3±06	1±1.0	0.3±0.6
MZ 1X + DF 0.5X	6±1.0	6.71.5	2.3±0.6	0	0	0
MZ 1X + DP 0.5X	3.7±0.5	4±1.0	0.3±0.6	0	0	0
MZ 1X+MN 1X+DF 0.5X	8.3±1.5	2.7±0.5	0.3±0.6	0	0	0
MZ 1X+MN 1X+DP 0.5X	6.7±1.5	2.30.6	0	0	0	0
MZ 1X+DP 0.5X+DF 0.5X	5±1.0	1.71.1	0	0	0	0
MN 1X+ DF 0.5X	7±1.0	4±1.0	0.7±0.6	0	0	0
MN 1X+ DP 0.5X	3±1.0	2.7±0.6	1±1.0	0	0	0
DF 0.5X+ DP 0.5X	3.7±1.5	0.30.6	0	0	0	0
Castor control	10±0.0	10±0.0	10±0.0	10±0.0	10±0.0	10±0.0
P, F (df = 13,28)	19.6, <0.0001	21.9, <0.0001	69.4, <0.0001	220.9, <0.0001	134.7, <0.0001	153.3, <0.0001

Where, MZ = Dithane M-45, MN = Miraculan, DF = diflubenzuron and DP = Dipel.

showed 97, 60, 50, 37, and 27 per cent larval survival at second, fourth, sixth, eighth and tenth day on treated castor leaves. The combination with mancozeb and miraculan, showed complete larval mortality at eighth day. These observations were similar to those obtained on above explained artificial diet incorporation method, which proved that the lethal effect of miraculan and mancozeb remained stable when sprayed in combination with dipel or diflubenzuron on plant leaves. Shukla and Lal (1988) indicated that testing of combinations of fungicides with insecticides *viz.*, karathane + endosulfan, bavistin + monocrotophos and sulfex + monocrotophos, were not only biologically compatible but also superior to the other treatments tested and provided effective control of *Erysiphe polygoni* and *Etiella zinckenella*. Mancozeb @ 1500 g a.i. per ha used for the control of *Alternaria solani* also controlled *Aphis gossypii* and *Myzus persicae* (Nagia *et al.*, 1994). Singh and Bhattacharya (2001) observed detrimental effect of miraculan at 0.025, 0.05 and 0.1 per cent on the larval survival of *S. litura* when reared on a diet fortified with miraculan. Dosari *et al.* (1996) reported that in two out of four trials, conducted in onion field for the control of *Thrips tabaci* by coapplication of insecticides with the fungicide formulation chlorotholonil (Bravo 720) reduced the pest population.

Therefore, it can be concluded from above experiments that given names of best chemicals and their doses here are toxic to the larvae of *S. obliqua*. These findings could be helpful to the farmers for formulating appropriate management techniques and to reduce insect and disease infestation with single application.

Acknowledgement: This research is a part of thesis submitted to GBPUA&T, Pantanagar, UA, India, in 2005 and authors are thankful to the University authorities for providing financial assistance and facilities during the course of investigation.

REFERENCES

Bhattacharya A.K. and Rathore Y.S. (1977) Survey and study of the bionomics of major soybean insects and their chemicals control. Research Bulletin No. 107, G.B. Pant University of Agriculture and Technology, Pantnagar, India.

Biswas G.C. (2006) Incidence and management of hairy caterpillar (*Spilarctia obliqua* Walker) on sesame. *J. Agric. Rural Develop.* 4: 95-100.

Dosari SAA, Cranshaw WS and Schweissing FC (1996) Effects on control of onion thrips from co-application of onion pesticides. *Southwest. Entomol.,* 21(1) : 49-54.

Goel SC and Kumar S (1991) Efficacy of synthetic pyrethroids and quinalphos against Bihar hairy caterpillar, *Spilosoma obliqua* (Walker) and *Sesamum sphinx*, *Acherontia styx* (Westwood) infesting *sesamum* (*Sesamum indicum* L.). *J. Ent. Res.* 15(1): 15-19.

Gupta G. and Bhattacharya AK (2006) Bioefficacy of *Bacillus thuringiensis* formulations on *Spilarctia obliqua* (Walker) (Lepidoptera: Arctiidae)' *J. Eco-friendly Agric.* 1(1): 16-22.

Gupta G, Yadav SR and Bhattacharya AK (2008) Lethal and sublethal effect of diflubenzuron and lufenuron on *Spilarctia obliqua* Walker (Lepidoptera: Arctiidae)' *J. Eco-friendly Agric.* 2(1): 145-149.

Gupta G, Yadav SR and Bhattacharya AK (2009) Influence of plant growth regulators on survivorship and developmental parameters of *Spilarctia obliqua* Walker (Lepidoptera: Arctiidae). *J. Pest Sci.* 82(1): 41-46.

Jaglan RS and Sircar P (1997) Relative toxicity of synthetic pyrethroid emulsion formulations against larvae of *Spilosoma obliqua* (Walker) and *Spodoptera litura* (Fab.). *J. Insect Sci.* **10**(1): 52-54.

Kundu GG (1991) Bihar hairy caterpillar, *Spilosoma obliqua* Walker (Lepidoptera: Arctiidae) on soybean. *Indian J. Ent.* **53**(3): 491-493.

Mondal P, Bhattacharya AK, Tewari SC and Biswas PG (2001) A new computer programme for probit analysis: Effect of *Beauveria bassiana* on *Helicoverpa armigera*. *Indian J. Ent.* **63**: 295-308.

Nagia DK, Kumar S and Saini ML (1990a) Relative toxicity of some important insecticides to Bihar hairy caterpillar, *Spilosoma obliqua* walker (Arctiidae: Lepidoptera*). J. Ent. Res.* **14**(1): 60-62.

Nagia DK, Kumar S and Saini, ML (1990b) Laboratory evaluation of some insecticides against Bihar hairy caterpillar, *Spilosoma obliqua* (Walker) (Arctiidae: Lepidoptera) on castor (Ricinus communis L.). *Pl. Protec. Bull. Faridabad* **42**(1-2): 13-16.

Nagia DK, Mallik F, Kumar S, Saleem M, Prasad D and Saini ML (1994) Field evaluation of insecticides and fungicides against aphid, *Aphis gossypii* (Glover), *Myzus persicae* (Sulzer) and early blight *Alternaria solani* (Ellis and Martin) Jones and grout of potato. *Pl. Protec. Bull. Faridabad*, **46**: 28- 30.

Shukla P and Lal SS (1988) Effect of combined application of fungicides and insecticides on the powdery mildew and pod borer of field pea. *Pesticides* **22**(3): 5-7.

Singh H and Bhattacharya AK (2001) Role of plant growth regulators on the developmental profile of *Spodoptera litura:* Effect of plant growth stimulants. *Indian J. Ent.* **63**: 329-339.

Sinha PK., Singh R, Yadav RP and Kumar K (1984) Relative effectiveness of some insecticides for the control of Bihar hairy caterpillar, *Discrisa obliqua* Walker infesting sweet potato. *Indian J. Ent.* **46**(3): 331-335.

Tiwari SN and Bhattacharya AK (1987) Formulation of artificial diets for Bihar hairy caterpillar, *Spilosoma obliqua* Walker (Lepidoptera: Arctiidae). Memoir No. 12. Memoir of the Entomological Society of India, Division of Entomology. I.A.R.I., New Delhi-110012, India.