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Effect of Persistent Toxicity of Different Plant Protection Products (Insecticides) on the Biotic Potential of *Chrysoperla Carnea*

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Abstract **– The green lacewing *Chrysoperla carnea* (Stephens) (Chrysopidae; Neuroptera) is a generalist biological agent commonly used to control insect pests. Toxic effects of eight commercial insecticides were evaluated on green lacewing through laboratory bioassays and field experiments. Biological parameters viz., fecundity, fertility, larval period, pupal period and adult emergence were recorded. Under present investigation the effect of persistent toxicity (sub lethal residual toxicity) of different selected insecticides on various parameters taken in to account of biotic potential were found significant. All the tested insecticides influenced negatively to different parameters studies under biotic potential in comparison to untreated control. The minimum impacts on various parameters were observed by NSKE and nimbecidine. Further, demonstrate that the effect of persistent toxicity on biotic potential parameter of different tested insecticides were maximum on one day after treatment and minimum on five days after treatment.**

Keywords **– Biopesticides, Biotic Potential, *Chrysoperla Carnea*, Insecticides.**

I. INTRODUCTION

India is basically an agro-economy dependent country and its total agriculture production is the prime asset for the growth of its GDP. Till date synthetic chemicals are the main stay in the plant protection sector of the Indian agriculture. It is very well reflected with the estimated use of 25,929 MT (technical grade) insecticides alone in agriculture sector during 2004-05*. Though the synthetic insecticides have several credentials yet, the use of chemicals, as a pest control measure, is a two edged sword with negative impacts on human beings and their environment due to direct and residual toxicity. Despite the advantage of convenience, simplicity, effectiveness, flexibility and economics, the pesticide use has resulted in several problems such as insect pest resistance, resurgence, outbreak of secondary pests, adverse effects of non- target organisms and other externalities (1)

Individual insect that survive intensive spraying usually reproduce and leading to resistance. The disruption of inherent and biological process of pest management and the frequency of insecticide induced pest problems suggest that dependent on pesticide, as a dominant means of controlling pest is not a durable solution (2). The hazards of insecticides to natural enemies vary in several ways, depending upon their exposure (3), behavior of chemical (4), application coverage (5) and the intrinsic toxicity of the chemical (6).The selective chemicals are less toxic to natural enemies than to target pests help in the integration of biological and chemicals control methods (7).

The common green lacewing, *Chrysoperla carnea* is a potential biological control agent which belongs to family: Chrysopidae, Order: Neuroptera.It is widely used in various situations to control many different types of pests, because, it is ecologically sound, environmentally benign, self-perpetuation, no harmful effects on human, livestock's and other organisms (8). (9) reported in their studied that toxic effects of five commercial insecticides *viz*., carbosulfan, leufenuron, cyfluthrin, methomyl and fenpropathrin were evaluated on green lacewing through laboratory bioassays. Following insecticide exposure, *C. carnea* mortality was greatest for life stages treated directly and decreased during subsequent life stages. Methomyl, cyfluthrin and fenpropathrin caused about 95% mortality when 1st instar was exposed to chemicals. Methomyl and fenpropathrin remained effective and caused 92% mortality when 2nd instar was exposed to chemicals. All chemicals caused about 60-70% mortality, when applied to 3rd instar. Mortality of adults was highest 57% for fenpropathrin. All materials had greatest effect on longevity and fecundity of adults.

Susceptibility of natural enemies to insecticides leads to drastic reduction in natural enemy population in agro-ecosystem and causing resurgence of pest population. The published literature on the effect of different insecticides on varies natural enemies were vary scanty and only few fragments of information have been made by some workers. Keeping above points in mind the present investigations were carried out to determine the effect of (lethal and sub lethal) some commonly used insecticides (plant protection products) on *Chrysoperla carnea* Stephens, an important bio agent that have been effectively used to manage the various insect pests in different agro-ecosystem.

II. MATERIALS AND METHODS

The studies were carried out under semi field conditions in the year 2009 in the department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, U.P., India under following heads.

1. Production of *Corcyra cephalonica* eggs
2. Mass Production of *Chrysoperla carnea*
3. Treatments

Under present study, two botanicals based NSKE and nimbecidine and nine commonly used synthetic

insecticides from different groups *i.e.* carbaryl, chlorpyriphos, malathion, monocrotophos, dimethoate, oxydemeton methyl, cypermethrin and imidacloprid were selected in different crops. The experiments were carried out using standard methods developed within the framework of the IOBC/WPRS working group Pesticides and Beneficial Organism (10) Hassan *et al.*, 2000).

Procedure

The live larvae obtained from different treatments were left for pupation in rearing chamber and after pupation they were transferred to adult rearing jars separately. After emergence of adults from the pupae obtained from different treatments were observed for following observations: Fecundity, Per cent hatchability, Larval duration, Pupal duration and Adult emergence (per cent). The emerged adults obtained from each treatment were examined critically and on the basis of shape of the abdomen counted as male and female separately and 3 pairs were housed in each ovipositional jar measuring 20 x 15 cm. The top of the jar are covered with black cloth to facilitate the egg laying. Under present investigation total 120 such jars were used to accommodate eight treatments and three replications for five days.

The adults in ovipositional jar were fed daily on diet prepared by mixing the equal quantity of protinex + fructose + powdered yeast + honey dissolved in small quantity of water and castor / maize pollen. The diet thus prepared was soaked in cotton swab which was provided in each ovipositional jar (kept in petridish) as adult food. Soon after caging, the adults observations were recorded at 24 h intervals on fecundity (start of egg laying till their death) and adult longevity (soon after the emergence of the adult till their death). The average number of eggs laid by one female during her lifetime was determined by counting the total number of eggs laid (by three pairs) per jar divided by three. For counting the eggs laid, the top of each jar was replaced daily (at 24 h intervals) the process was continued till the death of female adults. Hatchability calculated on the basis of total number of eggs kept for study and number of eggs hatched. Larval duration of *C. carnea* on different treatments, newly hatched larvae (ten in each larval rearing cell) were transferred with the help of soft and moist camel hairbrush along with sufficient food (*C. cephalonica*) in larval rearing cell. The food of each cell was changed daily. Similarly, from the transformation of full grown larva in cocoon (pupa) till its emergence as adult was also recorded to know the pupal period. The per cent adult emergence from pupae was determined on the basis of total number of pupae observed and number of adults emerged. All the above experiments were replicated five times except fecundity. The observations in all cases were recorded at 24 hours interval. For statistical analysis original data were used for analysis of variance (two-way ANOVA).

III. Result and Discussion

In addition to death of *C. carnea* on exposure to different insecticides may result in simultaneous manifestation of multiple sub-lethal effects on fecundity, hatchability, larval and pupal duration, per cent adult emergence. Hence, experiments were conducted to study the sub lethal effect of different insecticides on biotic potential of *C. carnea* under following heads:

Effect on Fecundity: The effect of residual toxicity of different insecticides at different days after treatment on the fecundity of *C. carnea* was assessed on the basis of average number of eggs laid per female under different treatments. The data on average number of eggs laid per female under different treatments are presented in table 1. All the tested insecticides had affected the fecundity of *C. carnea* significantly over untreated control. Maximum reduction in fecundity was observed due to endosulfan (559.82 eggs per female) followed by cypermethrin > imidacloprid > oxydemeton methyl > dimethoate > nimbecidine and NSKE with on an average of 561.64, 565.49, 569.79, 571.37, 576.20 and 578.66 eggs per female respectively.

The residual effect of endosulfan differs significantly with rest of the treatments at both the levels of significance except cypermethrin. However, the effect of cypermethrin was differ significantly with rest of treatments except imidacloprid. The difference in effect of cypermethrin and imidacloprid was found significant. The effect of imidacloprid was found more with 565.49 eggs per female than rest of the treatments whereas, the effects of oxydemeton methyl and dimethoate on fecundity of *C. carnea* were found statistically at par but both differ significantly with other treatments. Similarly there was no significant difference in the performance of nimbecidine and NSKE. This table also revealed that the residual toxicity of all the tested insecticides reduced gradually over a period of time. The maximum effect on fecundity (563.54 eggs per female) of *C. carnea* was observed on 1st day after treatment (1 DAT) followed by 2, 3, 4 and 5 DAT. The data contained in table 1 also demonstrate that the effect of residual toxicity on fecundity of *C. carnea* decreases as the days after treatment increase. There were significant difference in number of eggs laid per female on different days after treatment except 3 and 4 days after treatment.

Further, it has been also concluded from the data of table 1 that endosulfan affect the fecundity of *C. carnea* significantly at all the date of observation in comparison with untreated control, whereas, the differences found in number of eggs laid at different days after treatment were statistically not significant. The effect of oxydemeton methyl at 1 and 2 DAT differ significantly with untreated control at both the levels of significance but the differences in number of eggs laid after 4 days was found significantly less than untreated control. There was no significant difference between number of eggs laid at 5 DAT and untreated control. The effect of residual toxicity of dimethoate on fecundity of *C. carnea* last up to 4 DAT and differ significantly from untreated control at 5 per cent level of significance. There was no effect on 5 DAT as the difference in number of eggs found in treatment and untreated control was statistically not significant. The effect of cypermethrin on fecundity of *C. carnea* was found significant but on 5 DAT the difference with control

was found significant. Similarly, imidacloprid reduces the fecundity of *C. carnea* significantly at all the date of observation but the differences with control were found significant up to 3 DAT and at 4 and 5 DAT.

However, nimbecidine affected the fecundity of *C. carnea* only on 1 and 2 DAT. On 1 DAT its affect was found significant only on 2 DAT. Thereafter on 3, 4 and 5 DAT the number of eggs laid by *C. carnea* were statistically at par with untreated control. Though, the number of eggs laid by *C. carnea* exposed to NSKE treated plants were less than the female of untreated control yet, the differences were statistically not significant.

Effect on Hatchability: Table 2 clearly demonstrates that all the tested insecticides had affect the hatchability (per cent) of eggs of *C. carnea* significantly over untreated control. Among the tested insecticides, the residual effect on hatchability of eggs of *C. carnea* was found maximum due to oxydemeton methyl followed by imidacloprid > dimethoate > cypermethrin > endosulfan > nimbecidine > NSKE.

The maximum effect on hatchability of *C. carnea* eggs was found due to residual toxicity of oxydemeton methyl which differ significantly with dimethoate and imidacloprid and over rest of the treatments. However, the per cent hatchability recorded from the treatments of imidacloprid and dimethoate were statistically at par but both the treatments affect the hatchability of *C. carnea* more in comparison to rest of the insecticidal treatments. Eggs obtained from the adults exposed to nimbecidine and NSKE showed statistically at par in per cent hatchability but the hatchability under both the treatments were found significantly less than untreated control. It is also evident from the data of table 2 that the effect of persistent toxicity on hatchability of eggs decreased significantly as the time of observation increased. The maximum effect on hatchability of eggs was observed on 1 day after treatment followed by 2 > 3 > 4 and 5 days after treatment. The differences in hatchability differ significantly among themselves. There were no significant differences in hatchability on 1, 2 and 3 DAT. The effect of persistent toxicity of dimethoate on hatchability last for 3 DAT. The effect observed on 1 and 2 DAT were found statistically at par with the effect recorded on 3 DAT and differ significantly with the hatchability obtained under untreated control. Insecticides like cypermethrin and imidacloprid affect the hatchability up to 3 DAT. There was no significant difference in per cent hatchability at different date of observation under nimbecidine and NSKE treatment with untreated control except the hatchability observed on 1 DAT in case of NSKE.

Effect on Larval Duration: The developmental period is an index of suitability for any bio-agents as a component of IPM. The larval durations are very much governed not only by food media but also affected by chemicals sprayed in field. Hence, present study was initiated to study the effect of different insecticides due to persistent toxicity. The data thus generated after different days of treatment are presented in table 3. The persistent toxicity of different selected insecticides affect the larval duration. The minimum larval duration was observed due to persistent toxicity of dimethoate followed by imidacloprid < endosulfan < cypermethrin < oxydemeton methyl < nimbecidine and NSKE. The effect of persistent toxicity of dimethoate on larval duration was found statistically at par with imidacloprid and endosulfan at both the levels of significance. The impact of persistent toxicity of imidacloprid was differ significantly with cypermethrin and over rest of the treatments. The effect of endosulfan, oxydemeton methyl and cypermethrin did not differ significantly among themselves but these three insecticides affected the larval duration significantly in comparison with rest of the insecticidal treatments *i.e.* nimbecidine and NSKE. The difference observed in larval duration of *C. carnea* under nimbecidine and NSKE was statistically significant.

The figures contained in table 3 also demonstrate that the effect of persistent toxicity was maximum on 1 DAT with larval duration of 11.04 days followed by 2, 3, 4 and 5 DAT with 11.17, 11.22, 11.25, and 11.37 days, respectively. The impact on larval duration on 1 DAT differs significantly with the larval duration recorded on other observational periods. However, the larval duration recorded on 2 DAT differ significantly with larval duration of 3 DAT and over rest of the period. There was no significant difference between the larval duration observed on 3 and 4 DAT but the larval duration on these periods were differ significantly from the larval duration of 5 DAT. Further, it is also evident from the table 3 that the persistent toxicity of endosulfan affect the larval duration significantly up to 4 DAT. The differences in larval duration observed on 1, 2, 3 and 4 DAT did not differ significantly among themselves but differ significantly with larval duration recorded on 5 DAT and under untreated control. There was no significant difference between the larval duration observed on 5 DAT and untreated control. The larval durations found on different DAT under the oxydemeton methyl treatment were statistically at par but differ significantly with untreated control. The impact of persistent toxicity on larval duration due to the application of dimethoate last up to 5 DAT and differ with untreated control. However, the differences found on 1, 2 and 3 DAT were statistically not significant but the larval duration obtained on 1 DAT differ significantly with larval duration recorded on 4 DAT and on 5 DAT. There was no significant difference in the larval duration recorded at 2, 3, 4 and 5 DAT. The effect of residual toxicity of imidacloprid on larval duration persist up to 5 DAT and found significantly less than untreated control at both the levels of significance. The larval duration observed on 1 DAT was found statistically at par with the larval duration recorded on 2, 3 and 4 DAT but differ significantly with the larval duration obtained on 5 DAT. Similarly, the larval duration recorded on 2 DAT under imidacloprid treatment differ significantly with the larval duration observed on 5 DAT. There were no significant difference between the larval durations found on 3, 4 and 5 DAT. The larval duration recorded on 4 and 5 DAT due to residual toxicity of nimbecidine were found less than the larval duration of

untreated control. There was no impact on persistent toxicity of NSKE on larval duration as the larval durations recorded on different DAT and under untreated control were found statistically at par.

Effect on Pupal Duration: The observations recorded on the pupal duration of *C. carnea* as influenced by residual effect of different insecticides at different days after treatment are presented in table 4. The persistent toxicity of all the tested insecticides significantly influence on the pupal duration except NSKE. The impact of persistent toxicity of NSKE on pupal duration was found statistically at par with untreated control. Among the tested insecticides, the persistent toxicity of cypermethrin was found maximum followed by endosulfan > imidacloprid > oxydemeton methyl > dimethoate > nimbecidine > NSKE.

The effect of persistent toxicity on pupal duration due to the application of cypermethrin and endosulfan with 6.86 and 7.35 days respectively differ significantly among themselves as well as with other treatments. There was no statistical difference in the influence of imidacloprid and oxydemeton methyl on population duration. The pupal duration due to the persistent toxicity of NSKE was found statistically at par with the pupal duration found in untreated control. It is also demonstrated in table 4 that the maximum impact of persistent toxicity on pupal duration was found on 1 DAT followed by 2 > 3 > 4 and 5 DAT.
Further the data presented in table 4 also demonstrate that pupal period recorded under different treatments on different DAT did not differ significantly among them but all have influenced the pupal duration significantly in comparison to untreated control at both the levels of significance except endosulfan, nimbecidine and NSKE. The effect of persistent toxicity on pupal duration due to endosulfan last up to 4 DAT. The effect of persistent toxicity of nimbecidine on pupal duration recorded on 1 and 2 DAT differ with the pupal duration of untreated control.

Effect on Adult Emergence: It is apparent from table 5 that persistent toxicity of all the tested insecticides had significant effect over untreated control. The maximum effect (minimum adult emergence) was observed due to persistent toxicity of endosulfan (70.80 per cent) followed by cypermethrin > dimethoate > imidacloprid > oxydemeton methyl > nimbecidine > NSKE. The persistency effect of endosulfan, cypermethrin and dimethoate on per cent adult emergence was differed significantly among themselves and recorded statistically less percentage of adult emergence in comparison to persistent toxicity of other treatments. Similarly, the effect of imidacloprid on per cent adult emergence was found less than per cent emergence under oxydemeton methyl and nimbecidine. Though the effect of persistent toxicity of oxydemeton methyl, nimbecidine and NSKE were found statistically at par yet, they differed significantly from the per cent adult emergence recorded under untreated control.

It is also evident from table 5 that the persistency of different insecticides last more than 5 days after treatment. The percentage of adult emergence recorded on different days after treatments were differed significantly among themselves with minimum adult emergence on 1 DAT followed by 2 < 3 < 4 and 5 DAT respectively. Further, it has been also concluded that the effect of persistent toxicity of endosulfan on per cent adult emergence at 1, 2 and 3 DAT did not differ significantly among themselves but the per cent adult emergence recorded on these days after treatments differ with per cent adult emergence observed on 4 and 5 DAT at 5 per cent level of significant and over untreated control at both 5 and 1 per cent levels of significance. The effect of persistent toxicity of oxydemeton methyl on adult emergence last up to 1 DAT and found significantly less than untreated control at 5 per cent level of significance only. However, the persistency effect observed on 1 DAT did not differ significantly with the per cent adult emergence recorded on 2, 3, and 4 DAT but differ significantly at 5 per cent level of significance only. Whereas, the per cent adult emergence recorded on 2, 3, 4 & 5 and untreated control were found statistically at par. Similarly, the effect of persistence toxicity with the treatment of dimethoate was found statistically at par up to 4 DAT and differ significantly at 5 per cent with the per cent adult emergence recorded on 5 DAT. But the effect of persistent toxicity on adult emergence due to dimethoate treatment last up to 4 DAT. In case of cypermethrin the per cent adult emergence recorded at different observational periods were found statistically at par but the effect recorded on 1 and 2 DAT differ significantly with untreated control at both 5 and 1 per cent levels of significance, whereas, effect observed on 3 and 4 DAT were differed at 5 per cent only with untreated control. The per cent adult emergence recorded on different days after treatment under the treatment of imidacloprid was found statistically at par. However, the effect of persistent toxicity on adult emergence recorded on 1DAT differs significantly with untreated control. There were no significant difference between adult emergence recorded on different DAT under nimbecidine, NSKE and untreated control except the per cent adult emergence recorded on 1 DAT under the NSKE treatment. The effect of NSKE on 1 DAT differs significantly with untreated control. (11) emphasized on the selection of pesticides least toxic to the natural enemies, but effective against the pest, for a better crop pest management.

Further, the effect of persistent toxicity of selected insecticides on various parameters were found diluted as the time passed after applications *i.e.* maximum effect was observed on 1 DAT and minimum or no effect on 5 DAT in all cases. This might be due to the differential effect of various insecticides on physiological metabolic processes of the insect. The sub lethal doses of various groups of insecticides (Chlorinated hydrocarbons, organophosphates, carbonates, synthetic pyrethroids, and botanicals) after the physiology of target insect differentially. The metabolites thus formed can change the neural hyperactivity that may lead to altered hormonal production in the body of affected organism. Such changes may either mitigate or activate various growth and developmental processes of targeted insect(s). Under the present investigation minimum effect on various parameters were obtained by NSKE followed

by nimbecidine and rest of the insecticides after different DAT showed differential impact. Similar reports were also made by (12) and (9). They all reported the differential impact on different parameters of biotic potential by different insecticides. In addition to death, exposure of insecticides may result in simultaneous manifestation of multiple sub lethal effects such as shortened life span and changes in fertility rates, behavior, developmental rates etc.

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AUTHOR'S PROFILE

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Table 1: Effect of persistent (residual) toxicity of selected insecticides on fecundity and hatchability of *Chrysoperla carnea*

Insecticides	Average* Number of Eggs Laid (Per Female) at Different Days after Treatment (DAT)					Mean	Hatchability (Per Cent)* of C. Carnea Eggs at Different Days after Treatment (DAT)					Mean
	1	2	3	4	5		1	2	3	4	5	
Endosulfan	551.11	553.11	563.44	565.11	566.33	559.82	62.00	65.00	64.00	69.00	70.00	66.00
Oxydemeton Methyl	560.44	567.44	571.66	572.88	576.55	569.79	57.00	61.00	61.00	69.00	68.00	63.20
Dimethoate	570.00	570.11	570.22	571.00	575.55	571.37	61.00	61.00	65.00	66.00	69.00	64.40
Cypermethrin	556.55	558.22	561.44	563.55	568.44	561.64	59.00	62.00	65.00	69.00	73.00	65.60
Imidacloprid	556.11	562.44	568.11	568.88	571.88	565.49	61.00	62.00	64.00	67.00	68.00	64.40
Nimbecidine	549.55	572.78	580.33	587.44	590.89	576.20	70.00	66.00	67.00	69.00	71.00	68.00
NSKE	577.11	575.77	577.33	579.44	583.66	578.66	62.00	68.00	70.00	70.00	72.00	68.40
Control	587.44	580.66	594.77	589.77	593.22	589.17	69.00	70.00	70.00	71.00	72.00	71.60
Mean	563.54	567.57	573.41	574.76	578.32		62.63	64.38	65.75	68.75	70.38	

Sources of variation	C.D. at			
	5 per cent	1 per cent	5 per cent	1 per cent
Treatment (T)	3.165	4.198	1.007	1.330
Days (D)	1.978	2.624	0.630	0.831
T x D	15.826	20.989	5.036	6.649

*Average of three replications, each replication contained 3 females

*Average of five replications, each replication contained 20 eggs

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Table 2: Effect of persistent (residual) toxicity of selected insecticides on larval duration and pupal period of *Chrysoperla carnea*

Insecticides	Larval Duration* of *C. Carnea* at Different Days After Treatment (DAT)					*Mean*	Pupal period* of *C. Carnea* at Different Days After Treatment (DAT)					*Mean*
	1	2	3	4	5		1	2	3	4	5	
Endosulfan	10.96	11.16	11.16	11.20	11.70	11.04	7.38	7.46	7.48	7.54	7.90	7.35
Oxydemeton Methyl	11.06	11.10	11.10	11.10	11.12	11.10	7.38	7.48	7.52	7.54	7.54	7.49
Dimethoate	10.64	10.96	10.97	11.08	11.16	10.97	7.44	7.46	7.50	7.56	7.58	7.51
Cypermethrin	10.92	10.92	11.12	11.16	11.16	11.06	6.90	6.74	6.84	6.86	6.96	6.86
Imidacloprid	10.72	10.88	11.00	11.04	11.28	10.98	7.42	7.46	7.44	7.50	7.54	7.47
Nimbecidine	10.96	11.16	11.28	11.32	11.32	11.21	7.80	7.84	7.90	7.88	7.90	7.86
NSKE	11.24	11.28	11.32	11.36	11.40	11.32	8.02	7.98	8.04	8.08	8.06	8.04
Control	11.82	11.88	11.78	11.74	11.82	11.81	7.96	8.04	8.04	8.10	8.10	8.05
Mean	11.04	11.17	11.22	11.25	11.37		7.54	7.56	7.60	7.63	7.70	

Sources of variation	C.D. at 5 per cent	C.D. at 1 per cent	C.D. at 5 per cent	C.D. at 1 per cent
Treatment (T)	0.075	0.099	0.039	0.052
Days (D)	0.047	0.062	0.024	0.032
T x D	0.374	0.494	0.196	0.258

*Average of five replications, each replication contained 10 larvae

*Average of five replications, each replication contained 10 pupae

Table3: Effect of persistent (residual) toxicity of selected insecticides on the adult emergence of *Chrysoperla carnea*

Insecticides	Adult emergence (per cent)* of *C. Carnea* At Different Days After Treatment (DAT)					*Mean*
	1 DAT	2 DAT	3 DAT	4 DAT	5 DAT	
Endosulfan	66.00	68.00	68.00	76.00	76.00	70.80
Oxydemeton Methyl	76.00	80.00	82.00	84.00	86.00	82.80
Dimethoate	72.00	74.00	78.00	78.00	82.00	76.80
Cypermethrin	68.00	72.00	76.00	76.00	76.00	74.00
Imidacloprid	76.00	80.00	80.00	80.00	84.00	80.60
Nimbecidine	82.00	82.00	82.00	84.00	84.00	82.80
NSKE	78.00	80.00	86.00	88.00	94.00	83.20
Control	84.00	86.00	88.00	88.00	92.00	87.60
Mean	75.25	77.75	80.00	82.25	83.75	

Sources of variation	C.D. at 5 per cent	C.D. at 1 per cent
Treatment (T)	1.855	2.449
Days (D)	1.159	1.531
T x D	9.275	12.245

*Average of five replications, each replication contained 10 pupae