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Combined Effect of *Chrysoperla carnea* Stephen (Neuroptera: Chrysopidae) and *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae) on *Helicoverpa armigera* Eggs in the Presence of Insecticides

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Abstract.- Efficacy of different insecticides to *Chrysoperla carnea* Stephen (Neuroptera: Chrysopidae) and *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae) was evaluated under semifield conditions. Nine insecticides conventionally used on cotton for the control of *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) were applied under prevailing conditions of temperature and relative humidity. White and brown eggs of *H. armigera*, green and grey eggs of *C. carnea,* and parasitoid *T. chilonis* in host eggs (near to emergence) were exposed to each insecticide. Out of nine insecticides tested, the *Bacillus thuringiensis,* spinosad, thiodicarb and indoxacarb exhibited selectivity for beneficial insects, particularly for *C. carnea.* The beneficial insects damaged 19.667, 19.000, 18.000 and 17.667 number of eggs out of the 20 eggs of *H. armigra*, when exposed to these insecticides. Insecticides like chlorfenapyr, cypermethrin, and endosulfan were also found selective for *C. carnea* but toxic for *T. chilonis*. Profenofos was found toxic to both the beneficial insects.

Keywords: Insecticides, *Chrysoperla carnea*, *Trichogramma chilonis, Helicoverpa armigera.*

INTRODUCTION

Despite the advantages of convenience, simplicity, effectiveness, flexibility, and economics, the pesticide use may lead to problems such as pest resistance, outbreak of secondary pests, adverse effects on non-target organisms and other externalities (Ruesink, 1975). The disruption of inherent and biological process of pest management and the frequency of insecticide induced pest problems suggest that dependence on pesticide as the dominant means of controlling pests is not a durable solution (NRC, 1996). Hoping (1997) stated that pesticide reduction programs started by World Wildlife Fund (WWF) include the biointensive IPM system that works with, and enhances nature's pest management mechanisms through primary reliance on biological and cultural methods. When selected pesticides are used in conjunction with natural enemies, secondary pest outbreaks are reduced, the interval between the sprays is typically extended, and selection pressure for insecticide resistance is reduced (Croft, 1990).

The present study is an endeavor to evaluate the insecticides that can be safer to the beneficials like *Chrysoperla carnea* and *Trichogramma chilonis*.

MATERIALS AND METHODS

The experiments were conducted at the Research Farm of University College of Agriculture (UCA), Bahauddin Zakaryia University, Multan. Cotton veriety (CIM 446) purchased from the Punjab Seed Corporation, was grown in 100 pots (20 cm deep and 22.5 cm in diameter). White and brown eggs of *H. armigera*, green and grey eggs of *C. carnea* and parasitoid *T. chilonis* in host eggs (near to emergence) were obtained from IPM laboratory of UCA. The experiment was conducted in a completely randomized design (CRD). Pesticides included in this program with trade names, formulations and concentrations tested (active ingredient) are listed in Table I.

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Table I.- Common names, trade names and concentration of insecticides tested

Trade Name	Common Name	Dose g/h^{-1}	Conc. (ppm)
Agrimec ® 1.8 EC	abamectin	18	7.2
Larvo-Bt ® 26.4 FL	*Bacillus thuringiensis*	39.6	158
Pirate® 36 SC	chlorfenapyr	297	1180
Thiodan® 35 EC	endosulfan	1050	4200
Larvin® 80 DF	thiodicarb	800	3200
Arrivo® 10 EC	cypermethrin	62.5	250
Steward® 15 EC	indoxacarb	62.6	250.5
Curacron® 50 EC	profenofos	1250	5000
`Tracer® 4.8 SC	spinosad	7.2	28.8

Table II.- Treatment combinations of parasitoid and predator with different insecticides.

C1	*C.carnea* + abamectin
C2	*T.chilonis* + abamectin
C3	*C.carnea* + *T. chilonis* + abamectin
C4	*C.carnea* + chlorfenapyr
C5	*T.chilonis* + chlorfenapyr
C6	*C.carnea* + *T. chilonis* + chlorfenapyr
C7	*C.carnea* + cypermethrin
C8	*T.chilonis* + cypermethrin
C9	*C.carnea* + *T. chilonis* + cypermethrin
C10	*C.carnea* + indoxacarb
C11	*T.chilonis* + indoxacarb
C12	*C.carnea* + *T.chilonis* + indoxacarb
C13	*C.carnea* + *B. thuringiensis*
C14	*T.chilonis* + *B. thuriengiensis*
C15	*C.carnea* + *T.chilonis* + *B. thuringiensis*
C16	*C.carnea* + endosulfan
C17	*T.chilonis* + endosulfan
C18	*C.carnea* + *T.chilonis* + endosulfan
C19	*C.carnea* + thiodicarb
C20	*T.chilonis* + thiodicarb
C21	*C.carnea* + *T.chilonis* + thiodicarb
C22	*C.carnea* + profenofos
C23	*T.chilonis* + profenofos
C24	*C.carnea* + *T. chilonis* + profenofos
C25	*C.carnea* + spinosad
C26	*T.chilonis* + spinosad
C27	*C.carnea* + *T. chilonis* + spinosad
C28	*C.carnea* + water
C29	*T.chilonis* + water
C30	*C.carnea* + *T. chilonis* + water

Thirty treatments with different combinations were designed as shown in Table II. Ninety healthy plants with bolls, flowers and squares were selected. Three plants formed a treatment, taking each plant as a replicate. The solutions of insecticides were prepared in tap water, following the recommendations of manufacturer for use in the field. The plants were sprayed with the respective insecticide solution to run off, using lady hand sprayer. Counted number of eggs, (10+10) of each *H. armigera* (white+brown), *C. carnea* (green+grey) and *T. chilonis* (100 parasitized eggs of *Sitotroga cerealella*) with substrate were stapled evenly on the experimental plants. All the plants were safely caged in cages, made of aluminum wire frame, covered with organdy. Mean temperature and humidity were 37°C and 55% RH, respectively. Studies were conducted in semifield conditions. Predation and parasitizing ability of *C. carnea* and *T. chilonis,* respectively, were evaluated separately and in combination in the presence of different chemicals by calculating the egg mortality of *H.armigera* after 48 hours. Data were analyzed by analysis of variance (ANOVA) and differences between means were compared using LSD.

RESULTS AND DISCUSSION

Percentage mortality of *H. armigera* eggs when exposed to different combinations of predator, parasite and chemicals was observed (Table III). The maximum mortality *viz.*, 19. 7, 19.0 and 19.0 eggs out of the 20 eggs, was in treatments C28, C15 and C25, respectively, where *C. carnea* was combined with water, Larvo-*Bt* + *T. chilonis* and spinosad. It showed *Bt* and spinosad harmless to *C. carnea.* According to Moar *et al.* (1994) *B. thuringiensis* was not effective against *H. armigra* larvae. Treatment combinations C30, C27, C19 and C12 showed mortalities of 18.3, 18.0, 17. 7 and 17.3 eggs, respectively, indicating that spinosad, thiodicarb and indoxacarb had little effect on *C. carnea*. However, Ruberson and Tillman (1999) reported that survival of *T. pretiosum* in spinosad treatments was significantly reduced. Sansone and Minzenmayer (2000) described that steward treated plots have significantly lower number of predators than spinosed treated plots. Holloway and Forester (1999) and Hammes *et al*. (1998) stated that the indoxacarb had a favourable environment profile, selectivity towards beneficials, and high insecticidal efficacy against a range of target pests. Mortality of the eggs in C4, C21 and C13 was 16.7 for each and in C16 was 16.3. Chlorfenapyr and endosulfan were also selective to *C. carnea* but toxic to *T. chilonis*. Previous studies by Nasreen *et al.* (2000) described the similar results for chlorfenapyr and *B. thuringiensis*.

Table III.- Analysis of Variance for egg mortality of *Helicoverpa armigera* in different treatment combinations.

Source	DF	SS	MS	F	P
Factor	29	1893	65.3	41.4	0.00
Error	60	94.7	1.58		
Total	89	1987.8			

Comparison of treatment means by LSD

C28	C15	C25	C30	C27	C19
19.7	19.3	19.0	18.3	18.0	16.7
a	ab	ab	abc	abc	abc
C12	C4	C21	C13	C16	C7
17.3	16.7	16.7	16.7	16.3	15.0
c	cd	cd	cde	def	def
C11	C10	C18	C1	C29	C14
15.0	14.7	14.3	14.0	13.7	12.7
def	defg	efgh	fgh	fgh	ghij
C9	C6	C22	C3	C24	C26
12.7	12.3	11.7	10.7	9.3	8.3
ghij	hij	j	jk	kl	lm
C20	C23	C2			
7.7	7.3	6.7			
lm	lm	mn			

Treatment combinations C11 and C10, where predator and parasitoid were exposed to indoxacarb, indicated that it was safer to *T. chilonis* as compared to *C. carnea*. Due to this reason, combined action of both beneficials caused higher egg mortality (C12) as compared to their separate applications. Our findings confirm the results of Nasreen *et al.* (2000) that oxadiazine was slight toxic to *T. chilonis* under laboratory conditions. Abamectin in C1, C2 and C3 and profenofos in C22, C23 and C24 treatments were found toxic to both *T. chilonis* and *C. carnea*.

Treatment combinations with spinosad and indoxacarb seem to be selective for beneficials. The insecticides that are selective to beneficials and effective against cotton bollworm can be useful in IPM programmes because the pest will also be suppressed further with biocontrol agents. The present study needs further evaluation under field conditions.

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