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Research Article

BIO-EFFICACY OF SOME NEW GENERATION INSECTICIDES ON *Plutella xylostella* L IN AND TOXICITY ON TWO NATURAL ENEMIES

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Abstract- Present investigation reports on effect of some newer molecular insecticides *viz*., Novaluron 10 EC @ 75 g a.i./ha , Flubendiamide 20 WG @ 40 g a.i./ha, Indoxacarb 4.5 SC + Novaluron 5.25 SC @ 80 g a.i./ha, Indoxacarb 14.5 SC @ 60 g a.i./ha , Acephate 75 SP @ 600 g a.i./ha, Cartap hydrochloride 50 SP @ 450 g a.i./ha and Rynaxypyr 18.5 SC @ 30 g a.i./ha was tested against *Plutella xylostella* (Linnaeus) on cauliflower during Aug-Dec, 2014-15 at Thondamutur, Coimbatore, Tamil Nadu. Cartap hydrochloride@ 450 g a.i./ha was found most effective in reducing the larval population(91.53%) and also recorded highest yield(27.25 t/ha) among all the 7 insecticides tested. Minimal yield was observed in the control plots (14.00 t/ha).Cartap hydrochloride also showed highest acute toxicity towards both the parasitoids with LC $_{50}$ value (0.0099& 0.0043) for *Trichogramma chilonis* Ishii and *Chrysoperla zastrovi silemi (*Esben-Petersen*)*respectively.

Keywords- *Plutella xylostella,* Cauliflower, Newer molecules, Parasitoids

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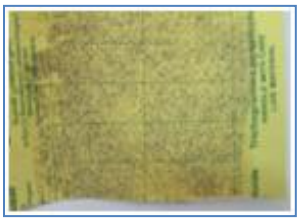
Introduction

Cauliflower (*Brassica oleracea* L. var. *botrytis*) is an important winter vegetable grown in India with an area of 2, 78,800 hectares, belonging to the family Cruciferae [1].Bihar, Uttar Pradesh, West Bengal, Orissa, Assam, Haryana, Rajasthan and Maharashtra are the major cauliflower growing states in India. Being a good source of vitamin A and C, minerals and carbohydrates and low in fat, cauliflower is used as part of dietary food in India. It is consumed as vegetable in curries, soups and pickles. In India, the major constraints for production in cauliflower are physiological disorders, pests and diseases, of which, insect pests are prime important as it cause serious economic damage to the crop. Among insect-pests affecting cauliflower Diamond Back Moth (DBM), *Plutella xylostella* is pests around the world [2, 3,4].For controlling this pest huge number of chemical pesticides are coming day by day. These chemical pesticides causes toxicity to natural enemies present in natural ecosystem. Among those natural enemies *Trichogramma*and *Chrysoperla* are extensively used bio-control agents for management insect pests in different crop ecosystems but they die due to indiscriminate use of toxicants. To overcome these problems new molecules with low residual toxicity are now gaining importance [5].

Materials and methods

The field experiment was laid out in Randomized Block Design (RBD) comprising 8 treatments including control with 3 replications for each. Total area of each plot was of 15 sq. m (5 m X 3 m) and total number of plots was 24. The 31 days aged seedlings of cabbage (Variety- Kimaya) were transplanted in the main field on 21st Aug, 2014. The seedlings were transplanted at a spacing of 50 X 50 cm. First spray was given with the appearance of target pests around 45-50 days after transplanting and subsequently second spray was applied after 15 days of first spray. Insecticides were applied with pneumatic knapsack sprayer using spray volume @ 500 litres/ha. Pretreatment count of DBM larvae were recorded from randomly selected 10 tagged plants/plot and subsequently post treatment observations were recorded on 5, 10 days after each spraying. Yield data was recorded on the basis of head weight after harvesting. The critical difference (CD) at 5% level of significance was worked out from the data of pest population build up before and after each treatment of two consecutive sprays and mean of the pest population was worked out [6]

Field experiment



Trichogramma

Insecticide treated Chrysoperla eggs

Chrysoperla adult

On the other hand the eggs of rice meal moth, *Corcyra cephalonica* Stainton wereused as host for laboratory rearing of the egg parasitoid, *T. chilonis* and predator, *C. zastrowi silemi* whereas adults are fed with honey and sugar solution .The toxicity effect of selected toxicants on two natural enemies were evaluated at five different concentrations. At first primary stock solution was prepared and the desired concentrations were obtained by successive dilution of the primary stock solution for each of the toxicants. For the experiment egg cards after parasitization were kept for the development of the parasitoids inside the host eggs. These small cards were dipped in insecticidal solutions removed immediately and dried under fan. In control, treatment eggs were dipped in water. The egg cards were then kept separately in glass vials to allow the emergence of adult parasitoids and the mouth of glass vials were plugged with cotton. The mortality of the parasitoids was recorded after adult emergence and the pupae from which no adult has emerged were considered as dead. But for Chrysoperla eggs were treated with different concentration of insecticidal solution and then observed for mortality. Each treatment was replicated three times and observations were taken under binocular stereo microscope on 30 parasitized eggs in each replication (10 from three different locations of the card). Percent mortality was calculated with the following formula [7].

$$\%\ \text{mortality} = \frac{\text{Number of dead insects}}{\text{Number of treated insects}} \times 100$$

The data was subjected to Probit analysis after correcting the mortality using Abbot's formula…

$$\text{.Corrected Mortality} = \frac{P-P_0}{100-P_0} \times 100$$

Where, P= % observed mortality, P_0= % control mortality

Statistical Analysis

The data on percentage were transformed into arc sine values and the population number into Square root transformation ($\sqrt{x+0.5}$) before statistical analysis. The data obtained from laboratory experiments were analysed in completely randomized design (CRD), while the same from field experiments were analysed in randomized block design (RBD) (8). The mean values were separated using Least square Difference (LSD). The median lethal dose (LD_{50}) and Median lethal concentration (LC_{50}) of insecticides used were determined by Finney's probit analysis (9).

Results and Discussion

In the present investigation Cartap hydrochloride @ 450 g a.i./ha was found best by achieving 91.53% reduction in DBM population followed by Rynaxypyr @ 30g a.i./ha, (88.05 %), Indoxacarb + Novaluron@ 80 g a.i./ha (85.96 %), Indoxacarb@ 60 g a.i./ha (83.67%), Novaluron @ 75 g a.i./ha , (81.26 %), Acephate @ 600 g a.i./ha (79.92%) and Flubendiamide@ 40g a.i./ha (75.36%). It is found from the observations at 5 days and 10 days after 1st spray that in all the cases population of DBM larva was decreasing except control plots where it was increasing. In contradictory the high efficacy of Flubendiamide against *Plutella xylostella* in cabbage was reported by [10].

All the treatments showed significant increase in yield over control. Highest yield was recorded from Cartap hydrochloride @ 450 g a.i./ha treated plots (27.25 t/ha)which was 89.83% increase over control closely followed by Rynaxypyr @ 30 g a.i./ha treated plots with yield 27 t/ha (87.89 % increase over control). Control plots showed yield of 14.37 t/ha.[11] recorded the greatest yield of cabbage (233.30 q/ha in 1996 and 245.23 q/ha in 1997) from cartap hydrochloride treatment 500 g a.i/ha. [12] showed that Rynaxypyr 20 SC @ 20 g a.i./ha were superior in recording less larval populations, of *H. armigera* in okra.

[13] reported the effectiveness of novaluron against *Plutella xylostella.* [14]observed that the larvae of *P. xylostella* became lethargic due to novaluron treatment, followed by termination of feeding.

The LC_{50} value and relative toxicity of the synthetic chemicals shown in [Table-2 and 3] along with heterogeneity, regression equation and fiducial limits for *Trichogramma chilonis* Ishii and *C. zastrowi silemi* (Esben-Petersen) Wesmael respectively. Cartap hydrochloride showed the lowest LC_{50} value (0.0099) and (0.0043) indicating as most toxic to *Trichogramma* and *Chrysoperla* respectively. Novaluron showed the highest LC_{50} value (0.0190) indicating as least toxic to *Trichogramma.* On the basis of LC_{50} values Cartap hydrochloride, Rynaxypyr, Indoxacarb + Novaluron, Indoxacarb, Acephate and Flubendiamide were found to be about 1.9, 1.16, 1.28, 1.12, 1.65 and 1.5 times as toxic as Novaluron [Table-2]. The present investigation results were on par with [15] documented toxic effect of cartap hydrochloride on natural enemies. [16]reported that Rynaxypyr, Acephate were harmless but in present investigation acephate was found toxic to *Chrysoperla.* On the basis of LC_{50} values of Cartap hydrochloride, Rynaxypyr, Indoxacarb +Novaluron, Indoxacarb ,Novaluron and Flubendiamide were found to be about 1.9, 1.16, 1.28, 1.12, 1.65 and 1.5 times as toxic as Novaluronto *Chrysoperla* [Table-3].

Selectivity towards natural enemies based on the order of relative safety (ORS) of different synthetic insecticides were Novaluron> Indoxacarb> Rynaxypyr> Indoxacarb + Novaluron> Flubendiamide> Acephate> Cartap hydrochloride.

[17] reported that Flubendiamide is considerably safe for *T. chilonis.* [18] reported that indoxacarb was not toxic and can be incurred in IPM. Indoxacarb appeared to be very safe for *T. pretiosum* reported by [19].

Table-1 *Effect of different synthetic insecticides on cauliflower Plutella xylostella (Linnaeus)*

Treatment	Dose g a.i./ha	Pre treatment count for 1st spray (mean population)	Percent reduction/increase(+) after 1st spray		Mean %reduction or increase(+) after 1st spray	Pre treatment count for 2nd spray (mean population)	Percent reduction/increase(+) after 2nd spray		Mean %reduction or increase(+) after 2nd spray	Overall mean %reduction or increase(+)	Yield t/ha	Percent increase in yield over control
			5 DAS*	10 DAS			5 DAS	10 DAS				
Indoxacarb 14.5 SC	60	6.0	81.33 (64.04)	85.59 (67.69)	83.46	1.92	81.61 (64.70)	86.12 (68.13)	83.87	83.67	26.48 (30.97)	84.27
Rynaxypyr 18.5 SC	30	6.1	84.80 (67.05)	87.50 (69.30)	86.15	1.62	89.13 (70.75)	90.76 (72.30)	89.95	88.05	27 (31.31)	87.89
Novaluron 10 EC	75	5.7	79.21 (62.87)	84.68 (66.96)	81.95	2.13	78.63 (62.47)	82.48 (65.25)	80.56	81.26	25.98 (30.64)	80.79
Acephate 75 SP	600	6.3	72.54 (58.40)	80 (63.43)	76.27	2.34	77.66 (61.55)	81.46 (64.49)	79.56	79.92	25.36 (30.24)	76.47
Flubendiamide 20 WG	40	6.25	66.31 (54.52)	77.87* (61.94)	72.09	2.99	76.53* (61.35)	80.73* (63.96)	78.63	75.36	25.04 (30.03)	74.60
Cartap hydrochloride 50 SP	450	6.2	88.89 (70.53)	88.98* (70.61)	88.94	1.79	93.83* (75.68)	94.38* (76.29)	94.11	91.53	27.25 (37.47)	89.83
Untreated control		6.3	+12.34 (00)	+28.14 (00)	+20.24	8.35	+15.00 (00)	+34.11 (00)	+24.55	+22.39	14.37 (00)	
S. Em ±			0.19	0.23			0.19	0.18			0.26	
CD at 5%		NS	0.57	0.69		NS	0.58	0.55			0.88	

DAS = Days after spray, Figures in the parentheses are the angular transformed values, NS = Non significant, * = significant at 5% level, S. Em ± =Standard error of mean, CD= Critical Difference

Table-2 *LC_{50} values and relative toxicity of some synthetic insecticides against Trichogramma chilonis Ishii*

Insecticides	Heterogenity	Regression(Y=a+bx)	LC 50(%)	Fiducial limit	Relative toxicity	Order of relative safety
Indoxacarb 14.5 SC	8.33	6.783+1.010X	0.017204	-1.7643±0.0093	1.12	2
Cartap hydrochloride 50 SP	11.62	7.055+1.018X	0.009959	-2.0181±0.0107	1.9	7
Indoxacarb 4.5 SC + Novaluron 5.25 SC	2.33	6.309+0.716X	0.014846	-1.8283±0.0076	1.28	4
Rynaxypyr 18.5 SC	1.68	6.219+0.683X	0.016405	-1.7850±0.0074	1.16	3
Flubendiamide 20 WG	1.91	6.052+0.555X	0.012722	-1.8954±0.0071	1.5	5
Novaluron 10 EC	4.55	6.438+0.836X	0.019059	-1.7198±0.0081	1.0	1
Acephate 75 SP	3.57	5.834+0.030X	0.011534	-1.9380±0.0067	1.65	6

Table-3 *LC_{50} values and relative toxicity of some synthetic insecticides against C. zastrovi silemi (Esben-Petersen)*

Insecticide	Heterogenity	Regression(Y=a+bx)	LC 50(%)	Fiducial limit	Relative toxicity	Order of relative safety
Indoxacarb 14.5 SC	7.0745	7.0880+0.8896X	0.0044	-2.3469±0.0114	1.31	5
Cartap hydrochloride 50 SP	2.5375	6.8571+0.7878X	0.0043	-2.3572±0.0100	1.34	7
Novaluron 10 EC	1.6099	6.7222+0.7315X	0.0044	-2.3544±0.0093	1.32	6
Indoxacarb 4.5 SC + Novaluron 5.25 SC	0.5741	6.5859+0.6846X	0.0048	-2.3166±0.0087	1.21	4
Rynaxypyr 18.5 SC	2.5868	6.6357+0.7078X	0.0048	-2.3109±0.0089	1.2	3
Flubendiamide 20 WG	2.5094	6.4508+0.6319X	0.0050	-2.2959±0.0082	1.16	2
Acephate 75 SP	2.4615	6.2658+0.5674X	0.0058	-2.2307±0.0076	1	1

Conclusion

All these observations indicate that newer generation molecules toxic to DBM. At the same time it also shows toxicity to natural enemies. Among the newer generation insecticides tested cartap hydrochloride formulation shows maximum reduction of DBM population and also shows highest toxicity to natural enemies.

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Author Contributions

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Ethical approval: Experiments were conducted in closed animal entry free condition. During the research period no animals and human resources were subjected to harmful condition.

Conflict of Interest: None declared

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