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The selective toxicity of insecticides to the cabbage aphid *Brevicoryne brassica* Linnaeus (Hemiptera: Aphididae) and its parasitoid, *Diaeretiella rapae* (McIntosh): laboratory and field studies.

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Abstract

Effective management of the cabbage aphid, *Brevicoryne brassicae*, on cabbage plants depends on adequate insecticide efficacy and conservation of its parasitoid, *Diaeretiella rapae* and useful arthropods in cabbage ecosystem. Indoxicarb, imidacloprid, and emamectin benzoate were applied at laboratory with two methods of application (emmersion and thin layer technique) with several dosage rates on aphid and its parasitoids and in pots and small field plots on cabbage plants to determine the selectivity of these common insecticides against *Diaeretiella rapae* and to know their effect on the diversity and equitability on cabbage ecosystem. Results showed that the application of three tested insecticides caused satisfactory toxicity and rapid in aphid numbers when treated with thin layer and immersion technique and less toxic on the mommies of *D. rapae*. Imidacloprid and indoxicarb were highly selective against *D. rapae* (141.7and 127.4%) selective ratio. Emamectin benzoate was not selective (98.58%). The results of residual toxicity showed that no significant differences between insecticides treatments were observed when mommies treated with immersion method. All products were classed as IOBC category 2 slightly harmful) except emamectin benzoate after one day post treatment showed moderately harmful category. Results concluded that indoxicarb can be used in cabbage aphid integrated control in integration with parasite *D. rapae*, It was selective in the field test and medium selective on other beneficial arthropods and haven't any effect on diversity of beneficial arthropods and equitability in cabbage ecosystem.

1. Introduction

Cabbage aphids *Brevicoryne brassica* Linnaeus (Hemiptera: Aphididae) cause significant damage to many crops of the Brassicaceae. The cabbage aphid has agricultural significance due to it is a vector to 20 viral pathogens which cause diseases in crucifers **[1].** Its spread and damage can be prevented with chemical and biological control strategies. Severely infested plants become covered in a mass of small sticky aphids due to honeydew secretion, which cause leaf dying and decay **[2].**

Parasites and predators play an important role in regulating aphid populations. The endoparasite *Diaeretiella rapae* is a very common parasites on aphids applies eggs in nymphs and adults, and mummified them, forming a hard light brown shell around the aphid. **[1]**

Nowadays considerable greenhouse and field studies were done to manage many pests such as *Brevicoryne brassica* with beneficial insects. Meanwhile, pests that cannot be controlled with biological agents controlled with selective insecticides. In this research, we examine common insecticides that are either selective to artthropd species by their mode of action or hence innocuous to predators or parasites or have short residual toxicity and degraded before releasing biological agents.

Indoxacarb is a singular oxadiazine pro-insecticide that is recommended to control of Lepidoptera insects **[3].** It is transformed to a sodium channel blocker through bio-activation in target insects. It prevent feeding within a few hours after exposure, insects become less mobile and show slight tremors and convulsions. It may provide the opportunity to control pests with minimum adverse effects on non-target species.

Emamectin benzoate is a naturally occurring macro - cyclic lactones with nematocidal, insecticidal, and acaricidal properties. It acts as a GABA agonist. Its foliar uptake and translaminar activity against many pests and have a wide range of activity against pests. It degraded through oxidative and hydrolysis process in the presence of sunlight **[4]**

Imidacloprid is a neonicotinoid and systemic insecticide that works on the central nervous system of insects. It causes blocking nicotonic acetylcholine receptors, resulting in the insect's paralysis and eventual death **[5].** Imidacloprid breaks down rapidly in the presence of light **[6].**

The effective integration of *Diaeretiella rapae* as a biocontrol agent against *Brevicoryne brassica* necessitates additional information on the effects of insecticides on this parasitoid. The study was carried out to increase our information on the effects of the three recently insecticides on *Diaeretiella rapae*, and its host *Brevicoryne brassica*, and their potential use in IPM programs against *Brevicoryne brassica*. Also, to know if application of these insecticides can affect the diversity and equitability of beneficial arthropods in cabbage ecosystem. It is hoping that the acquired outcomes would possibly exhibit more information that could assist to choose an efficient insecticide, more eco-friendly and less hazardous which can maximize controlling aphids and minimize the adverse effect on non target species can be used as a good element in brassica pest management. Also, we hope to develop standardized techniques concerning both laboratory and field assessments to know the safety of insecticides to beneficial arthropods in accordance with IOBC guidelines.

2. Materials and Methods

2.1. Bioassay tests

2.1.1.Insect coloney

A colony of *D. rapae* was set up from mummies gathered from *Brevecoryne brassica* infesting brassica plants in the laboratory of the plant protection Dept., Faculty of Agriculture, Minia University in May 2020. A stock colony of *Brevecoryne brassica* was maintained on potted brassica, grown in pots filled with fertilized with animal compost poultry manure in green house at 28 ± 3° C, and 70-75% relative humidity, and a 14L.:10D. Photoperiod. When mummies formed after nearly nine days from infestation, Mummies have been removed carefully from plants and put in plastic petri dishes (9 cm diameter) till emergence. Adults fed with diluted honey on a cotton roll. All females had continuous access to food prior to testing and used in experiments when they were 72 ± 4 h old without prior exposure to aphids.

2.1.2. Thin film technique

Thin film technique was used with the adult aphids and parasite to test the selective effect of tested pesticides as contact poison. Four concentrations were prepared for each compound; three replicates and 10 aphid insect and 10 parasites / each replicate were used for each concentration. In a thin film test one ml was taken from each concentration and put in Petri dish. Petri dishes moved right and left for distribution and formation of a thin film from pesticide residual. Petri dishes left in laboratory at 28 ± 3° C, 65-75% RH to dry for 30 minutes before being offered to insects**.** The same technique used with the adults of *D. rapa*.

2.1.3. Immersion technique:

The immersion method also was used to determine the toxicity of the tested insecticides against different stages of aphids and mommies of the parasite. Sections of cabbage leaves infected with aphids, and sections of cabbage leaves containing live mummies of the parasite were dipped in the prepared pesticide solutions for 30 seconds and then left to dry under laboratory conditions for half an hour. Then the leaves were placed in petri dishes with a diameter of 10 cm after placing a paper of filter in each plate, two disks were placed in each plate and 3 replicates were used for each concentration of the tested insecticides. The control disks treated with water and the average mortality rate was estimated after 24 hours and after 48 hours. The corrected mortality estimated by Abbott equation **[7].** The corrected mortality subjected to probit analysis according to Finney **[8].** The variance in LC50 between compounds was determined by comparing the 95% fiducial limits. X^2 used to determine the statistical significance of the heterogeneity of the response. The selective ratio SR) of the compounds was calculated as

2.1.4. Preimaginal exposure

Cabbage leaves containing one hundred newly mummified aphids had been dipped in every insecticide solution (recommended dose). Four leaves per treatment, tap water applied as a control. Treated mummies had been then transferred to plastic petri dishes and allowed to dry for one hour, earlier than being transferred to a cage of rearing aphids on a seedling of cabbage under conditions of 28 ± 3° C and 70 ± 5% RH till the emergence of parasitoids about seven days later. % of aphid infestation was recorded after 15 days, and the mean was used as parasite reproductive potential in calculating the reduction coefficient Ex for pesticide x.

2.1.5. Adult exposure

The toxicity and persistence of insecticides against adult wasps (3-day old) were evaluated. The insecticides applied to potted cabbage with recommended dose using a hand sprayer until run-off. Pots placed in wood cells (50 X 50 cm) for exposure to adult parasitoids. 10 wasps were introduced into each cage in each interval (24h, 3, and 7 days) mortality were recorded after 24 h. and corrected with the abbot formula. Three replicates were performed for each treatment.

2.2. Statistical analysis

The experiment was arranged in a Randomized complete design (RCD) consisting of three replicates / treatment. Treatment mortalities adjusted for control mortality using Abbott's correction **(7).** Treatment effects analyzed using ANOVA and means were separated using Duncan's LSD test (software Costat application).

The corrected mortality of every tested insecticides were also expressed as the reduction coefficient E_x for pesticide

E_{fx} calculated using the following formula

$Efx = (100 - ((Fx/Fc) * 100))$ **[9]**

Where $\boldsymbol{F_x}$ is the mean parasite reproductive capacity for pesticide *x*

$\boldsymbol{F_c}$ is the parasite reproductive capacity recorded in the control group (untreated group).

The values (E_x) were calculated as following equation

$$E_x = 100\left\{1 - \left[\left(1 - \frac{E_{mx}}{100}\right)\left(1 - \frac{E_{fx}}{100}\right)\right]\right\}$$

Where E_x= Reduction coefficient

E_{mx} = Corrected mortality of adult wasps

E_{fx} = Reproductive capacity $= (100 - ((Fx/Fc) * 100))$

and then classified according to the standards of the International Organization of Biological Control (IOBC) which include 4 classes: harmless: E_x = or < 30%, slightly harmful: 30% < = E_x = < 80% ; moderately harmful: 80% .> or =E_x < 99%, and harmful: E_x = or > 99%. . The experiment was replicated twice and the average was used in calculation

2.3. Field tests

2.3.1. Field evaluation of the tested insecticides against parasite B. brassicae and beneficial arthropods and their residuals after 24, 3, and 7 days at cabbage field

A field of cabbage was chosen for this experiment. The cabbage plants received normal agriculture practices. Block randomized design carried out in field and, three replicates were used for each treatment (3 plants represent one replicate). The population densities of different stages of *Brevicoryne brassica* and *Diaeretiella rapae* estimated at three plants / replicate. The number of living nymphs / plant recorded in the pre and post treatment counts / replicate. Post treatment observations were made at 1day, 3days, and 7days after treatment. The percentage of reduction was calculated using **[Handerson and Tilliton 10]** formula. No. of biological agents were recorded and the reduction % were calculated. Metcalf scheme used to calculate selective degree. **[Metcalf 11].**

2.3.2. Biodiversity and equitability in cabbage ecosystem after application of pesticide: -

To know the degree of the impact of various insecticides in alternating diversity index have been used, ie. Interspecific diversity and equitability. Diversity is a complicated index of the structure of a system such as the quantitative relationship between the number of species and the number of individuals available inside them.
Pitfall traps were used for catching arthropods that run along the soil surface. Time work of the trap 24 hours traps were examined and identified according to **[12, 13, and 14].**

Sticky traps: yellow plastic traps, glued with adhesive "Temo Bi" Industrial Kollant Chemical S.P.A., Italy. Yellow plastic plates 15 x 20 cm were glued with a thin layer of adhesive. One trap /replicate. The numbers of beneficial arthropods were examined and recorded pre-treatment and 3, 5, and 7 days after application. Identification was done up to genus and in some cases to species level. Shannon- winner diversity index, (1959) **[15]** was used.

$$\mathbf{H`} = \sum_{n=1}^{1-i} (\mathbf{pi\ loge\ pi})$$

H`=diversity index, Pi= n\N where, n= number of individuals of each species, N= total number of individuals of all species. To know the way of individuals' distribution in various beneficial arthropods the equitability (E) was calculated according to Lioyd and Gheraldi, (1964) **[16]** as follows:

$$\mathbf{Equitability} = \left(\frac{S`}{S}\right) * \mathbf{100}$$

E= size of equitability, S= number of observed species, S`= theoretical number of species.

3. Results and Discussion

3.1. Results of Bioassay

3.1.1. Toxicity of three pesticides against adult of B. brassica and its parasite Diaeretiella rapae (M'Intosh) Using a thin film technique.

Data in Table (1) showed the toxicity of tested chemical insecticides indoxacarb, imidachlopride, and emamectin benzoate against the cabbage aphid, *B. brasscae*, and its parasites *D. rapae* when applied with thin technique method technique. Insecticides were rapid and highly toxic, in which compounds gave effects to calculate their LC50 values after 24 hours and were (49.28 ± 1.2, 52.02±4.2, and 176.0±6.three Ug/cm^2, respectively, without a large variations among LC50 values among indoxacarb and imidacloprid insecticide. Emamectin benzoate was the least toxic insecticide with significant differences when compared its fudicial limits of LC50 with indoxacarb and imidacloprid. The same trend observed when these insecticides were bioassayed with the same method of application against the endoparasite *D. rapae* mummies the values of LC_{50} recorded in Table (1). Indoxicarb appeared to be more effective than imidacloprid and emamectin benzoate LC_{50} were 62.8±3.6, 73.44±2.46 and 163.50±5.7 Ug/cm2 for indoxicarb, imidacloprid and emamectin benzoate respectively with no significant differences between the values of LC50 of indoxacarb and imidacloprid and significant differences between them and emamectin benzoate. The calculated selective ratio of these insecticides showed that imidacloprid was the most selective one gave selective ratio 141.7 % followed by indoxicarb (127.4 %), while emamectin benzoate was no selective (92.58%). The application of three tested insecticides in general, caused satisfactory toxicity in aphid numbers below that of the check when treated with thin layer technique and less toxic on the adult of *D. rapae*.

3.1.2. Toxicity of pesticides against adult of *B. brassica* and its parasite *Diaeretiella rapae* (M'Intosh) Using dipping technique.

When these insecticides were bio-assayed with immersion, technique the results in Table (2) showed the toxicity of tested chemical insecticides indoxacarb, imidacloprid, and emamectin benzoate against the cabbage aphid, *B. brasscae*, and its parasites *D. rapae* when applied with immersion technique. Insecticides were also highly toxic, after 24 hours and the values of LC50 were (1.65± 9.94, 3.16±9.29 and 5.01±9.22 PPM respectively. No significant differences were observed between LC_{50} values of indoxacarb and imidacloprid insecticide. Emamectin benzoate was the least toxic insecticide with significant differences when compared its LC50 with indoxacarb and imidacloprid. In addition, the toxicity was highly effect when treated with this method against the parasitoids but more less that the toxicity on aphids LC50 values were (27.13± 0.34, 24.17±0.36 and 25.4±0.36 PPM for indoxacarb, imidacloprid and emamectin benzoate respectively, without significant differences between them. The selective ratios were highly when compared with method of thin layer technique (1644.2%, 764.87, and 506.4%) for indoxicarb, imidacloprid and emamectin benzoate respectively.

Although indoxicarb, and imidacloprid, were effective against *B. brassicae* and selective in favor of parasite, the slopes of line log dose and probit values (LDP line) for *D. rapae* were higher than the slopes of LDP line for *B. brassicae*. These results indicate that minimum variations in the concentration of these insecticides cause higher mortality of the parasites. Therefore, the preservation of this parasite depends on the correct applied field dose of these insecticides because their selectivity to natural enemies can be lost or reduced at high concentrations.

3.1. 3. Toxicity of insecticides to adult of *Diaeretiella rapae* (three day-old) after different post-treatment intervals

The residual experiment, showed that significant differences between insecticide treatments when compared with e control treatment (corrected mortality %) (68.66, 67.66 and 50.00) Table (3) while it was significant after one and three days13.6, 57, and 90.00 % corrected mortality after one day from treatment and after 3 days post treatments the corrected mortality were 28.1, 18.6 and 77.00 for treatments with indoxicarb, imidacloprid, and emamectin benzoate respectively. The reproductive capacity of the parasite reduction % Table (3) were the least one in indoxicarb treatment (30.37%) followed by imidacloprid (47.04%) and the most effective one was emamectin benzoate (52.66%) while the third day residual effect imidacloprid gave the least reduction % in reproductive capacity of the parasite (18.6%) followed by indoxicarb and emamectin benzoate (28.1 and 77.00% respectively while the 7 days residual imidacloprid gave 8.8% followed by emamectin benzoate (22.4%) and the highest one was indoxicarb (52.5%). These results due to irrespective of the residue age and their oxidative photolysis.

3.1.4. Reduction coefficient E_x and IOBC category of the three tested insecticides, to Diaeretiella *rapae* (M'Intosh).

Reduction coefficient (Ex %) values on day 1 were 39.83, 77.64, and 95.23% for the first day residual for indoxicarb, imidacloprid and emamectin benzoate respectively. The third day residual (57.19, 58.38, 83.85) respectively, and 7-day old residues Ex% were 67.49, 38,49 and 61.3 % respectively. As shown from results all products were classed as IOBC category 2 (slightly harmful) except emamectin benzoate after one day post treatment showed moderately harmful category

Table 1: Toxicity of three pesticides against adult of *B. brassica* and its parasite *Diaeretiella rapae* (M'Intosh) using a thin film technique.

Insecticide	LC50± Se Ug/cm2		Fiducial limits				Selective ratio	slope		X2	
			Upper		Lower						
	Aphids	parasite	Aphid	parasite	Aphid	Parasite		Aphid	parasite	Aphid	parasite
Indoxicarb	49.28±1.2	62.8±3.6	78.4	82.5	34.6	48.7	127.4	1.9	2.1	3.2	3.99
Imidacloprid	52.02±4.2	73.44±2.5	65.7	68.8	42.2	44.4	141.17	2.4	2.9	2.6	4.9
Emamectin benzoate	176.6±6.3	163.5±5.7	216.8	211.1	151.3	143.4	92.58	3.8	2.9	4.5	3.9

Table 2: Toxicity of tested pesticides against adult of *B. brassica* and its parasite *Diaeretiella rapae* (M'Intosh) Using dipping technique.

Insecticide	LC50± Se PPM		Fiducial limits				selective ratio	slope		X^2	
			Upper		Lower						
	Aphids	parasite	Aphid	parasite	Aphid	parasite		Aphid	parasite	Aphid	parasite
Indoxicarb	1.65±9.9	27.13±0.34	4.26	35.47	0.67	20.75	1644.2	0.525	1.86	2.43	0.72
Imidacloprid	3.16±9.3	24.17±0.36	11.22	30.44	0.87	19.19	764.87	0.365	2.3	0.143	2
Emamectin benzoate	5.01±9.2	25.4±0.36	19.95	32.03	1.25	20.09	506.4	0.329	2.23	0.533	0.36

Table 3. Toxicity of three pesticides to adult of *Diaeretiella rapae* (three day-old) after different post-treatment intervals.

treatments	Percent of corrected mortality of adult waspe of D. ± SE and Reproductive capacity % post- treatment intervals								
	Post – treatment intervals								
	24 h.			3- days			7- days		
	Avg. no. of live mummies	(E_{mx})*	(E_{fx}) **	Avg. no. of live mummies	(E_{mx})	(E_{fx})	Avg. no. of live mummies	(E_{mx})	(E_{fx})
Indoxicarb	62.66	13.6±4.7^{ab}	30.37	57.33	28.1±6^{b}	40.46	68.66	52.5±2.2^{b}	31.56
Imidacloprid	47.66	57.0±3.6^{b}	47.04	66.66	18.6±8.4^{b}	30.77	67.66	8.8±4.6^{b}	32.56
Emamectin benzoate	42.6	90.0±0.5^{a}	52.66	67.6	77.0±6.5^{a}	29.80	50.00	22.4±2.9^{a}	50.14
control	90	---------	------	96.3			100.33		

E_{mx} = corrected mortality **E_{fx} = Reproductive capacity

Table 4: Results of reduction coefficient E_x and IOBC catagory of the three tested insecticides, to Diaeretiella *rapae* (M'Intosh).

Pesticide	24h. post treatment		3-days post treatment		7-days post treatment	
	E_x*	IOBC class*	E_x	IOBC class	E_x	IOBC class
Indoxicarb	39.83	2	57.19	2	67.49	2
Imidacloprid	77.64	2	58.38	2	38.49	2
Emamectin benzoate	95.23	3	83.85	3	61.3	2

Ex = Reduction coefficient

$$E_x = 100\left\{1 - \left[\left(1 - \frac{E_{mx}}{100}\right)\left(1 - \frac{E_{fx}}{100}\right)\right]\right\}$$

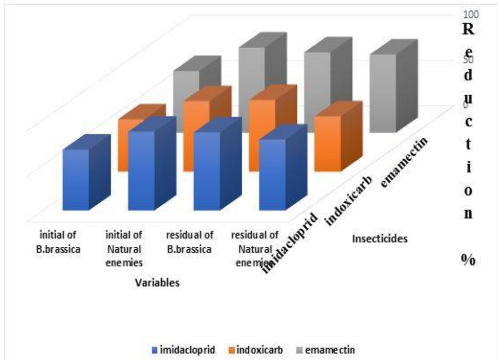

Fig. (1) Effect of tested insecticides against *B. brassica* and beneficial arthropods in cabbage field Minia Governorate 2022.

Table 5: Field evaluation of the tested insecticides against parasite *D. rapaea* and their residuals after 3, 5, and 7 days in at cabbage field.

Insecticides	Red.% after 1 day %	Red.% after 3 days %	Red.% after 5 days %	Red.% after 7-days %	General Avg.	Degree of selectivity
Imidacloprid	94.3	91.5	87.2	77.3	82.8 a	Slab selective
	100	96.4	92.2	81.3		
	89.2	87.6	82.9	73.8		
Avg	94.5 a	91.8 a	87.4 a	77.5 a		
Indoxacarb	57.8	62.8	48.9	30.3	49.5 b	Selective
	59.9	64.8	47.6	22.9		
	55.6	61.6	48.5	33.3		
Avg.	57.8 b	63.1 b	48.3 b	28.8 b		
Emamectin Benzoate	92.3	90.9	87.8	81.4	88.6 a	Slab selective
	100	97.4	94.4	86.8		
	86.2	86.1	82.5	76.9		
Avg	92.8 a	91.5 a	88.2 a	81.7 a		
LSD	15.89	12.9	13.3	14.3	13.7	

3.2. Field studies

3.2.1. Efficiency of insecticides against *B. brassicae* and natural enemies in cabbage field.

Results in Fig (1) shwoed the reduction percent of various stages of *B. brassicae* after 24 and an average of 3-,5 and 7-day post treatments. The acquired effects revealed that the reduction percent became improved progressively with the increasing time of exposure with inside the field. The reduction % confirmed significant variations among insecticides. The maximum potent insecticide was emamectin (83.8 reduction% as compared with control followed by imidacloprid (81.6 R%) the least toxic towards cabbage aphids was Indoxicarb (73.7%). While as their toxicity towards the parasite Table 5 showed that emamectin benzoate was the best at the parasite with an avg. reduction % of 88.6% followed by imidacloprid and the least toxic one was indoxicarb gave a discount % of 49.5%. Accordingly, indoxicarb had a degree of selectivity according to the Metcalf scheme (selective). Moreover, results of greenhouse showed that it has IOBC class 2 (slightly harmful). Thus, indoxicarb can be used in cabbage aphid integrated control in integration with parasite *D. rapae.*

3.2.2. Reduction in beneficial arthropods and selectivity in cabbage field ecosystem

3.2.2.1. Effect of application of pesticides on beneficial arthropods diversity in Cabbage field collected with sticky and pitiful traps, Minia governorate 2022

As shown in Table (6) Results discovered the presence of the subsequent predators: - *Paederus alfierii*, *Coccinella undecimpunctata*, *Chrysoperla carnea*, *Amblyseius sp*, *Syrphus spp.*, and the parasites had been *D. rapae*, *Aphidus sp*, Trichogrammatoidea and lots of species of true spiders. Data in Fig 1 confirmed the average reduction % from the data of field impact of the pesticides on useful arthropods gathered with yellow sticky and pitiful traps in cabbage field. Results confirmed the initial impact of pesticides after 24 h post-treatment. From the existing trials, it could be concluded that among the evaluated insecticides, the maximum efficacious insecticide identified to control *B. brassica* on cabbage is indoxicarb which may be utilized in cabbage aphid integrated control in integration with parasite *D. rapae*, It was selective in the field test and medium selective on other beneficial arthropods and haven't any effect on diversity of beneficial arthropods and equitability in cabbage ecosystem as shown in Table (7).

The achievement of an integrated pest management (IPM) is carefully linked with the survival of useful organisms within side the crop ecosystem. Beneficial's arthropods are very important in IPM regimes with selective insecticides. Complete records at the selectivity and viable aspect consequences of newly registered insecticide, is vital to preserve an IPM useful crops. The contact toxicities of indoxicarb and imidacloprid applied in thin layer technique are selective while emamectin was not selective and all insecticides when applied with dipping technique were selective with high ratio of selectivity and when applied with recommended dose were slightly harmful against the adult stage of *D. rapae* compared to control in pot experiments.

Youichi and Hiroshi. **(17)** Showed that initial residues of imidacloprid and emamectin benzoate, were less toxic against the pupae in mummies as compared with adult females. However, the three insecticides were only harmless against pupae in mummies. When treated with dipping technique. Turned into previously studies showed that pesticides commonly have a small impact on parasitoids inside cocoons **(6, 18, and 19),** our experimental consequences aid these existing effects.

We observed that mortality became especially excessive amongst 24-h post treatment (initial kill), and it became much less harmful after 3, 5, and seven days. Emamectin benzoate had a nearly deadly impact within the mummies; ensuing height reduction % in initial and residual impact with contrast indoxicarb confirmed a few prevalence of mortality at once after emergence. We consider that residual insecticide contact after emergence become accountable for many deaths after different periods of post treatments. It will be vital to conduct in addition experimentation on how age influences the pupae`s sensitivity to pesticides. From the evidence received on this study at the residual effects of 3 insecticides not unusual place pesticides at the adult females, we consider that similar effects could be seen under field trial conditions, specifically for emamectin benzoate, which exhibited a prolonged persistence. In contrast, indoxicarb and imidacloprid confirmed a relatively short-lived impact. Table (6) Survey of useful insect and natural beneficial arthropods associated with cabbage field during spring season 2022 in Minia

Taking into attention the well-known reality that imidacloprid and indoxicarb are swiftly degraded through ultraviolet light [**20].** We trust that this short residual impact became because of its speedy breakdown through ultraviolet radiation. Although indoxicarb and imidacloprid confirmed evidence of deadly results on *D. rapae*, if the timing in their utility is properly planned, then *D. rapae* used along with indoxicarb should play an effective element in an IPM strategy. All three common insecticides are slightly harmful according to IOBC classes.

Table 6 :Survey of useful insect and natural beneficial arthropods associated with cabbage field during spring season 2022 in Minia

Order	Family	Species	Status	Degree
Acarina	Arachnidae	*True spiders*	*	P
Mesostigmata	Phytoseiidae	*Amblyseius sp*	*	P
Hymenoptera	Trichogrammatidae	*Trichograma sp*	***	++++
	Braconidae	*D.rapae*	***	+++++
	Aphididae	*Aphidus sp*	***	++++
	Apidae	*Apis mellifera*	*	+
Homoptera	Aleyrodidae	*Bemisia tabaci*	**	++
	Aphididae	*Brevicoryne brassica*	***	+++
Diptera	Syrphidae	*Syrphus corollae*	***	++
	Tachinidae	*Tachina larvarum*	*	P
Lepidoptera	Noctuidae	*Tricoplosia ni*	***	++
Thysanopter	Thripidae	*Thrips tabaci*	*	P
Coleoptera	Coccinellidae	*Coccinella undecimpunctata*	***	+++
	Staphylinidae	*paederus alfierii*	*	p
	Carabidae	*Calosoma sp*	**	+
	Chrysomelidae	*Phyllotreta Cruciferae*	***	++++
Dermaptera	Labiduridae	*Labidura riparia*	*	+
Collembolla	Podulicidae	*Lepidocertinus incertus*	*	+
Neuroptera	Chrysopidae	*Chrysoperla carnea*	*	+

P= present 1 = number less than 5/Replicat = + no.is 5 to 10

= ++ No is more than 10 -20 = +++ more than 20 = ++++,
* Replicated 1-2 ** replicated 2-3 - *** replicated 3-5.

Although previous experiments have determined significant results, our study did now no longer discover statistically significant variations among indoxicarb and imidacloprid, despite the fact that small results observed. Although indoxicarb and imidacloprid did now no longer seem to have any considerable impact on *D. rapae* pupae in host mummies in dipping toxicity tests. Adult *D, rapae* parasitoids have been in large on cabbage field after treatment sticky trap numbers. In different studies, **[12,22]** indicated that outcomes of agrochemicals towards *A. colemani* confirmed excessive toxicities. In our study, comparable effects have been observed in *D. rapae* sensitivity to the 3 tested insecticides. Among the pesticides examined towards *D. rapae* indoxicarb had diverse results ranging from harmless towards mommies of the parasites to slightly harmful towards *D. rapae* adults. **A** great diversity in the toxicity of the neonicotinoid's insecticides to natural enemies, starting from the harmless impact on *Neoseiulus cucumeris* to the harmful impact on *Aphidius colemani*, those results accept as true with our paintings in the case of imidacloprid **[23].** Similar results had been obtained by **[24, 2006**]. Regarding the wide variety of mortality (30–79%) in toxicity class 2, that is slightly harmful in line with the IOBC category, using indoxicarb and imidacloprid within side the period of the presence of *D. rapae* mommies within side the field need to be carefully taken into consideration.

Table (7): Effect of application of pesticides on beneficial arthropods diversity in Cabbage field collected with sticky and pitiful traps, Minia governorate 2022.

N	Systemic groups	Check		Insecticides					
				emamactin		indoxicarb		imidacloprid	
		Pre-	Post	Pre-	post	Pre-	post	Pre-	Post
1	*Chrysoperla carnea*	1	0	1	0	1	0	0	0
2	*Coccinella undecimpunctata*	1	3	1	2	1	2	1	0
3	*Calosoma sp*	1	2	1	0	0	0	0	1
4	Apis mellifera	1	0	1	1	1	1	0	0
5	*D.rapae*	25	158	18	18	19	36	11	43
6	*Aphidus*	15	132	21	21	12	20	16	16
7	Trichograma	5	63	3	0	2	19	6	3
8	Parasite 3	0	45	0	0	2	11	8	1
9	*True spiders*	1	0	1	0	0	0	0	0
10	*Syrphus corollae*	3	4	2	3	0	3	3	0
11	*Tachina larvarum*	1	0	1	0	0	0	0	0
12	*paederus alfierii*	1	0	2	0	0	0	2	1
13	*Amblyseius sp*	1	0	0	0	0	0	0	1
14	*Labidura riparia*	1	1	1	0	0	0	0	0
	Total	57	408	53	45	36	81	47	66
Diversity indices Theoritical numbers of species		2.64 14.1	2.77 16.0	3.33 28.1	2.25 9.51	2.24 9.47	2.18 8.85	3.33 27.8	2.034 7.64
Equitability%		108.2	200.0	216.1	237.8	135.3	126.4	397.3	109.14
Avg. Reduction%		------------		88.14		68.57		80.38	

From a practical point of view, best the pesticides that had been classified as harmless or slightly harmful may be taken into consideration suitable to be used in an integrated pest program. In fact, the mortality of useful species higher than 80% is just too excessive to allow the useful species to regulate the dynamics of pest populations. Hence, moderately harmful insecticides do now no longer differ from the insecticides that had been classified as harmful concerning their actual effect on useful species. Our consequences convey other information to the mosaic of knowledge of the aspect results of pesticides and may be used for improving IPM in one-of-a-kind crops. Laboratory evaluation of the impact of insecticides on all useful arthropods that seem within side the cabbage field has to be done. If a farmer wishes to apply *D. rapae* (with inside the IPM cultivation program), care have to be taken concerning the chemical substances used, and person trying out is be recommended. Soon, we are hoping that this kind of Eco -

toxicological research can be performed on a regular basis to corroborate insecticide selectivity

4. Conclusion:

Indoxicarb and imidacloprid can be utilized in IPM structures of brassicas to control *B. brassicae* populations due to their performance towards *B. brassicae* and selectivity to the principle natural enemies. However, the encouraged subject quotes may also nevertheless cause a few mortality to useful arthropods species in cabbage field. To make sure selectivity, indoxicarb and imidaclopride sprays need to be timed to keep away from exposure of *D. rapae* to the insecticide. Thus, they can be sprayed while this parasite is much less active within side the field.

Conflict of Interest

No conflict of interest exists in this paper.

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