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Persistent toxicity of some readymix products against *Earias vittella* (Fab.)

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Abstract
The persistent toxicity of some readymix insecticides against *Earias vittella* (Fab.) on okra were conducted during 2016-17. The persistent toxicity studies revealed that, Indoxacarb 14.5% SC + Acetamiprid 7.7% SC recorded the highest Persistent Toxicity index (PTi) while Pyriproxifen 5% EC + Fenpropathrin 15% EC recorded the lowest PTi. Computation of PT_{50} values to determine time duration for 50% kill on residual toxicity revealed that Indoxacarb 14.5% SC + Acetamiprid 7.7% SC recorded highest residual toxicity while Pyriproxifen 5% EC + Fenpropathrin 15% EC recorded lowest the residual toxicity. Based on PTi and PT_{50} values readymix insecticide formulations can be arranged in descending order for their relative persistence as Indoxacarb 14.5% SC + Acetamiprid 7.7% SC > Profenophos 40% EC + Cypermethrin 4% EC > Novaluron 5.25% SC + Indoxacarb 4.5% SC > Pyriproxifen 5% EC + Fenpropathrin 15% EC.

Keywords: Persistent, readymix, *Earias vittella*

Introduction
The residual toxicity and persistence of insecticides resulting from foliar sprays is of great significance for pest as well as beneficial insect population on crop. These two aspect indicates an effective period over which an insecticide could persist in biologically active form especially if the crop is vegetable. In view of developed resistance to many insecticides in *Earias vittella* on okra and resurgence of minor pests it becomes necessary to know the residual toxicity and persistence of newer insecticides readymix products available in the market which are recommended for use on vegetable crops. Currently, few readymix insecticide formulations like Novaluron 5.25% SC + Indoxacarb 4.5% SC, Profenophos 40% EC + Cypermethrin 4% EC, Indoxacarb 14.5% SC + Acetamiprid 7.7% SC and Pyriproxifen 5% EC + Fenpropathrin 15% EC are readily available in the market. At present there is very little information available on persistent toxicity of these readymix insecticides against okra fruit borer *Earias vittella.* Taking into account an experiment was framed to know persistence of four readymix insecticide formulations against shoot and fruit borer *Earias vittella* on okra. The findings of the present investigation will be useful in selecting a proper insecticide readymix formulation for inclusion in the pest management module on okra. Similarly, the findings in the persistence studies will be useful in selecting an insecticide formulation in view of the ecofriendly and safer management with chemical pesticides on vegetable crop like okra.

Material and methods
The present investigation was conducted on early third instar larvae of *Earias vittella* (Fab). (Noctuidae: Lepidoptera) from the laboratory developed culture in Department of Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during the year 2016-17 with following experimental and treatment details.

Insecticides for treatments and their availability

Sr. No.	Readymix insecticide formulation	Trade name	Manufacturer	Field Dose (ml / L)
1	Novaluron 5.25% SC + Indoxacarb 4.5% SC	Plethora	Adama, Pvt.Ltd.	1.75
2	Profenophos 40% EC + Cypermethrin 4% EC	Profex super	Nagarjuna Agrichemicals	2.00
3	Indoxacarb 14.5% SC + Acetamiprid 7.7%SC	Kite	Gharda Chemicals	1.00
4	Pyriproxifen 5% EC + Fenpropathrin15% EC	Sumiprempt	Sumitomo India Pvt. Ltd.	1.00

Rearing of insect for bioassay studies

The laboratory culture of *Earias vittella* was established from field collected larvae using methodology described by Shinde and Shetgar (2011) [1] with some modifications in rearing material and their dimensions.

Insecticide persistence studies:

Spraying of insecticides in field

The plots were labeled properly for each insecticide and two sprays of each insecticides (as treatment) at recommended doses were applied in the labeled plot. The first application was given when the young tender fruits stars appearing on the okra plants. The second application was given 10 days after first application. A control plot with plain water spray was also maintained. The sprayings were done using knapsack sprayer.

Feeding treated fruits to test insect

Fresh tender okra fruits from each insecticide treated plots at 2, 4, 6 & 9 days of application were plucked along with peduncle and brought in the laboratory. They were placed in rearing jars (10 cm height X 16 cm width X 25 cm length) with their peduncle covered with a moistened cotton cloth. Ten 3rd instar larvae of *Earias vittella* from the laboratory grown culture were released on these treated fruits and allowed them to feed under ambient temperature and relative humidity conditions in the laboratory. Similarly, control was also maintained by releasing same number of *E. vittella* larvae on okra fruits from untreated plot. The observations on mortalities in treated and untreated fruits were recorded at regular interval upto 120 hours period. The larvae which did not responded to gentle touch of the camel hair brush were considered as dead and were separated out from the rearing container.

Data analysis

Working out relative persistence of insecticides

The procedure by Saini (1959) [2] and elaborated further by Pradhan (1967) [3] and Sarup *et al*., (1970) [4] were utilized. After compilation of the data on mortalities corrected percentage mortalities for each treatments were determined as per Abbott (1925) [5] and used for further computation of persistent toxicity values. The values of corrected percentage mortalities at various specified periods were added. This sum was then divided by number of observations to obtain an average percent mortality (T). The product (PT) of average percent mortality (T) and the period (P) of toxicity in days was used as an index of persistent toxicity (PTi). The persistent toxicity of each insecticide was worked out as per the criteria suggested by Pradhan and Venkatraman (1962) [6] in which PT (Persistent Toxicity) was taken as an index i.e,

$$PTi = P \times T$$

Where,

PTi - Persistent Toxicity index

P -The period for which some toxicity observed (time in days up to which some mortality observed)

T - Average percent mortality (mean corrected percent mortality of the period P).

Accordingly, Relative Persistence (RP) values were calculated as per Bharti et.al (2015) [7] as below

$$\text{Relative Persistence (RP)} = \frac{\text{PTi value of Insecticide}}{\text{Insecticide with lowest PTi value}}$$

The PT_{50} values in days for 3rd instar larvae of *Earias vittella* were determined by graphical method of Probit analysis as per Patil and Lingappa, (1999) [8] and confirmed further on a software.

The data, thus obtained, were tabulated and presented under respective subheads in following chapter for discussion and knowing the treatment significance.

Result and discussion

Persistence of insecticides after 1st spray

All insecticides showed persistent toxicity to the third instar larvae of *Earias vittella* on okra fruits for a period of 9 days after first spray. The mortalities were in the range of 60 to 90%, 50 to 80%, 40 to 60% and 30 to 50% during 2nd, 4th, 6th and 9th day of observation. The descending order of residual toxicity against the third instar larvae of *Earias vittella* on okra fruits based on Persistent Toxicity index (PTi) values were observed as Indoxacarb 14.5% SC + Acetamiprid 7.7% SC, Profenophos 40% EC + Cypermethrin 4% EC, Novaluron 5.25% SC + Indoxacarb 4.5% SC and Pyriproxifen 5% EC + Fenpropathrin 15% EC. The relative persistence (RP) computed taking into account the lowest PTi value recorded for Pyriproxifen 5% EC + Fenpropathrin 15% EC, revealed that readymix formulation viz. Indoxacarb 14.5% SC + Acetamiprid 7.7% SC, Profenophos 40% EC + Cypermethrin 4% EC and Novaluron 5.25% SC + Indoxacarb 4.5% SC were found 1.55, 1.44 and 1.27 fold more persistent, respectively, than Pyriproxifen 5% EC + Fenpropathrin 15% EC readymix formulation. Computation on PT_{50} values to determine time duration for 50% kill on residual toxicity revealed that Indoxacarb 14.5% SC + Acetamiprid 7.7% SC recorded highest residual toxicity with PT_{50} value of 8.17 days. It was followed by Profenophos 40% EC + Cypermethrin 4% EC, Novaluron 5.25% SC + Indoxacarb 4.5% SC and Pyriproxifen 5% EC + Fenpropathrin 15% EC.

Persistence of insecticides after 2nd spray

The results on persistence of insecticides after first spray against *Earias vittella* on okra (Table 1) unveiled that all insecticides showed persistent toxicity to the third instar larvae of *Earias vittella* on okra fruits for a period of 9 days. The percentage mortality ranges of third instar larvae of *Earias vittella* for different insecticide readymix products were 60 to 100%, 50 to 80%, 40 to 60% and 30 to 50% during 2nd, 4th, 6th and 9th day of observation which revealed that all the readymix insecticide products have high persistent toxicity. The descending order of residual toxicity against the third instar larvae of *Earias vittella* on okra fruits based on Persistent Toxicity index values (PTi) was observed as Indoxacarb 14.5% SC + Acetamiprid 7.7% SC, Profenophos 40% EC + Cypermethrin 4% EC, Novaluron 5.25% SC + Indoxacarb 4.5% SC and Pyriproxifen 5% EC + Fenpropathrin 15% EC. The relative persistence (RP) computed taking into account the lowest PTi value recorded for Pyriproxifen 5% EC + Fenpropathrin 15% EC, revealed that readymix formulation viz. Indoxacarb 14.5% SC + Acetamiprid 7.7% SC, Profenophos 40% EC + Cypermethrin 4% EC and Novaluron 5.25% SC + Indoxacarb 4.5% SC were found 1.50, 1.38 and 1.22 fold more persistent, respectively, than Pyriproxifen 5% EC + Fenpropathrin 15% EC readymix formulation. Computation on PT_{50} values to determine time duration for 50% kill on residual toxicity unveiled that Indoxacarb 14.5% SC + Acetamiprid 7.7% SC recorded highest residual toxicity with PT_{50} value of 7.42 days. It was followed by Profenophos 40% EC + Cypermethrin 4% EC

(7.02 days), Novaluron 5.25% SC + Indoxacarb 4.5% SC Pyriproxifen 5% EC + Fenpropathrin 15% EC.

Discussion

The persistence studies on okra crop were framed keeping in view the harvesting interval of okra fruits for market and period of protection required for quality harvest; accordingly the observation period was determined up to nine days beyond this period the old fruits become unacceptable to the early stage larvae of *E. vittella*. The observations on persistence suggested that the toxicity of all the readymix insecticide products shown persistent toxicity at 9th day of observation. The persistence toxicity index was highest for Indoxacarb 14.5% SC + Acetamiprid 7.7% SC readymix formulation during first and second spray application. This product also recorded highest relative toxicity as discussed earlier. The highest PT_{50} values of 8.17 days and 7.42 days, respectively during 1st and 2nd spray of Indoxacarb 14.5% SC + Acetamiprid 7.7% SC indicated that this particular readymix formulation keeps potential to kill 50% larval population even after 7-8 days of spraying which is quite promising as far as protection to okra fruits is concerned. Talking in terms of PT_{50} Profenophos 40 EC + Cypermethin 4 EC was recorded as next better persistent readymix formulation in the present study. Shinde *et al*. (2010) [9] reported that persistence index (PT) of Indoxacarb 17.8 EC alone was higher than systemic category insecticide like Imidacloprid against *E. vittella*. Bharati *et al*. (2015) [7], however, found that PT in case of Indoxacarb 17.8 EC alone was less than the systemic category insecticides like Imidacloprid 17.8 SL and Dimethoate 30 EC. However, when combined with systemic insecticide Indoxacarb 14.5% SC + Acetamiprid 7.7% SC readymix formulation found as most effective in management of *E. vittella* on okra as reported by Kamble *et al*. (2014) [10]. They also reported Profenophos 40% EC + Cypermethin 4% EC as next better readymix product for *E. vittella* management. Since the persistent toxicity resulting from foliar spray is an indication of an effective period over which an insecticide could persist in a biologically active state, the results in the management trials on lepidopterian larvae by Kamble *et al*. (2014) [10], Dharne and Kabre (2009) [11] and Mallapur *et al*. (2012) [12] regarding Indoxacarb 14.5% SC + Acetamiprid 7.7% SC and Profenophos 40% EC + Cypermethin 4% EC can partially, if not fully, support the outcome of the persistence studies in the present investigations. Workers like Ghosal *et al*. (2016a) [13], Ghosal *et al*. (2016b) [14], Patra *et al*. (2015) [15], Katti and Surpur (2015) [16], Das *et al*. (2015) [17] on efficacy of Novaluron 5.25% SC + Indoxacarb 14.5% SC, while Patel *et al*. (2015) [18] on effectiveness of Pyriproxifen 5% EC + Fenpropathrin 15% EC reported as efficacious in their management trails which, however, could not be compared here due to treatment differences as in the present investigation.

Table 1: Persistence of various insecticide readymix products against third instar larvae of *Earias vittella* applied as 1st spray

Sr. no	Insecticides	Dose (ml/L)	Corrected mortality (%) after DAS				P	T	PTi	ORP	PT_{50} (days)	RP
			2	4	6	9						
1	Novaluron 5.25% SC + Indoxacarb 4.5% SC	1.75	80	60	50	40	9	57.5	517.5	3	5.80	1.27
2	Profenophos 40% EC + Cypermethrin 4% EC	2.00	90	70	60	40	9	65	585	2	6.79	1.44
3	Indoxacarb 14.5% SC + Acetamiprid 7.7% SC	1.00	90	80	60	50	9	70	630	1	8.17	1.55
4	Pyriproxifen 5% EC + Fenpropathrin15% EC	1.00	60	50	40	30	9	45	405	4	3.48	1

DAS - Days after spraying **PT_{50}** - Persistent Toxicity **P** - Period of Observation in Days
T - Average percent Mortality **PTi** - Persistent Toxicity Index **ORP** - Order of Relative Persistence
RP - Relative persistence

Table 2: Persistence of various insecticide readymix products against third instar larvae of *Earias vittella* applied as 2nd spray

Sr. no	Insecticides	Dose (ml/L)	Corrected mortality (%) after DAS				P	T	PTi	ORP	PT_{50} (days)	RP
			2	4	6	9						
1	Novaluron 5.25% SC + Indoxacarb 4.5% SC	1.75	80	50	50	40	9	55	465	3	5.59	1.22
2	Profenophos 40% EC + Cypermethrin 4% EC	2.00	80	70	60	40	9	62.5	562.5	2	7.02	1.38
3	Indoxacarb 14.5% SC + Acetamiprid 7.7% SC	1.00	100	80	60	50	9	72.5	652.5	1	7.42	1.50
4	Pyriproxifen 5% EC + Fenpropathrin 15% EC	1.00	60	50	40	30	9	45	405	4	3.48	1

DAS - Days after spraying **PT_{50}** - Persistent Toxicity **P** - Period of Observation in Days
T - Average percent Mortality **PTi** - Persistent Toxicity Index **ORP** - Order of Relative Persistence
RP - Relative persistence

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