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The Insecticidal Action of the Premix Formulation of Spinetoram and Methoxyfenozide against Non-target Insects of Pigeon Pea

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was conducted to investigate the efficacy of premix formulation of spinetoram and methoxyfenozide towards predatory insects viz., coccinellids and spiders. Many insecticides have been evaluated against these pests without considering the specificity to manage these pests besides increasing residues, environment hazards and toxic to non-target organisms. An

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experiment was conducted at Agricultural Research Station, Virinjipuram, Vellore during 2019-20 and 2020-21 to study the bioefficacy of premix formulation of (spinetoram 6% + methoxyfenozide 30%) to gram podborer, *H. armigera* and spotted podborer, *M. vitrata* in pigeonpea and its safety to natural enemies viz., coccinellids and spiders, along with phytotoxicity studies. Analysis is performed using R 3.2.1 and Box-Cox method is applied to determine the transformation function when needed, Residual Vs fitted value plots and Q-Q plots were checked to ensure the Equal variance and normality assumptions are satisfied. There was a significant difference in the population of natural enemies among the treatments, none of the treatments were reported with zero occurrence of natural enemies which is toxic to non-target organisms and there was an increase in the population of natural enemies in treated as well as untreated plots gradually with respect to increase in the host population.

Keywords: Premix formulation; spinetoram + methoxyfenozide; safety; coccinellids; spiders.

1. INTRODUCTION

Pigeonpea or Red gram (*Cajanus cajan* L.) is one of the most important grain legume crops of tropical and subtropical countries. India is the world,s largest producer and consumer of pulses including pigeonpea. About 90 % of the global area is in India (4.9 million ha.) and contributing 93 % of the global production (Anonymous, 2011). About 250 insect species have been found to infest from seedling to harvest in pigeonpea. Among all, the podborer complex is reported to reduce the yield up to 27.77 per cent (Sahoo et al., 2002; Muchhadiya et al., 2024). Many insecticides have been evaluated against these pests without considering the specificity to manage these pests besides increasing residues, environment hazards and toxic to non-target organisms (Sharma, 2016; Sharma et al., 2010; Kambrekar & Jahagirdar, 2021). Therefore, keeping these views in mind, present study was also conducted the efficacy of premix formulation of spinetoram and methoxyfenozide towards predatory insects *viz*., coccinellids and spiders.

2. MATERIALS AND METHODS

An experiment was conducted at Agricultural Research Station, Virinjipuram, Vellore during 2019-20 and 2020-21 to study the bioefficacy of premix formulation of (spinetoram 6% + methoxyfenozide 30%) to gram podborer, *H. armigera* and spotted podborer, *M. vitrata* in pigeonpea and its safety to natural enemies such as coccinellids and spiders, along with phytotoxicity studies. CO 7 variety was sown during late *kharif* season in a plot size of 5m x 4m with 45 cm (R-R) and 30 cm (P-P) spacing. An experiment was laid out in randomized block design (RBD) with three replications and eight treatments. Three doses of (spinetoram 6% + methoxyfenozide 30%) combinations (350, 375 & 400ml ha^{-1}) along with single dose of their individual components *viz*., spinetoram 12% (200 ml ha^{-1}) and methoxyfenozide 24% (517 ml ha^{-1}), emamectin benzoate 5% (220 g ha^{-1}) and Spinosad 45% (162 ml ha^{-1}) were sprayed to assess its efficacy against podborers. During the cropping season, two rounds of spraying were applied, the first round was applied at 50% flowering, and the second round was applied at intervals of 15 days using a knapsack sprayer and 500 litres of spray fluid per hectare.

Impact on natural enemies of combinations (350, 375, and 400 ml) of (spinetoram 6% + methoxyfenozide 30%) was also studied to know its safety nature. The number of coccinellids and spiders from ten randomly selected plants from each plot was counted before application (pre-treatment) and again at 1, 3, 7, and 10 days after spraying (DAS) was observed. Data from multiple trial is analyzed using Linear mixed model with treatment as fixed factor and trial and rep as random factor and all Pair wise comparison of treatments was done using Turkey adjustment at significance level of 0.05 (Alpha). Analysis is performed using R 3.2.1 and Box-Cox method is applied to determine the transformation function when needed, Residual Vs fitted value plots and Q-Q plots were checked to ensure the Equal variance and normality assumptions are satisfied.

3. RESULTS AND DISCUSSION

Prior to the application of treatments, the adult population of coccinellids and pre-count non-target grubs varied throughout all experimental plots, ranging from 1.1 to 4.0. Ten days following the initial application, the population in T_8: untreated was 3.1, then T_7: spinosad 45%@162 ml ha^{-1} (2.1), T_6: emamectin benzoate 5%@220

Table 1. Effect of Spinetoram 6% w/v (5.66%w/w) + Methoxyfenozide 30% w/v (28.33%w/w) on coccinellids

Natural Enemies	Application	Treatment Evaluation Interval	T_{1-3}:Spinetoram+Methoxyfenozide						T_4: Spinetoram		T_5: Methoxyfenozide		T_6:Emamectin benzoate		T_7: Spinosad		T_8: Untreated check
			350 ml ha^{-1}		375 ml ha^{-1}		400 ml ha^{-1}		200 ml ha^{-1}		517 ml ha^{-1}		220 g ha^{-1}		162 ml ha^{-1}		
			Count	Percent Control	Count	Percent Control	Count	Percent Control	Count	Percent Control	Count	Percent Control	Count	Percent Control	Count	Percent Control	Count
Coccinellids (NO/PLANT)	Application 1	**Precount**	1.2^{a}	6.5	1.2^{a}	7.2	1.2^{a}	15.7	0.7^{a}	40.0	1.3^{a}	6.9	1.2^{a}	7.2	0.8^{a}	38.4	1.3^{a}
		1DAS	0.9^{ab}	57.5	0.4^{a}	69.9	0.4^{ab}	75.0	1.1^{abc}	55.7	1.3^{bc}	45.4	0.8^{ab}	60.8	1.1^{abc}	56.0	2.8^{c}
		3DAS	0.7^{abc}	76.2	0.3^{a}	89.0	0.4^{ab}	85.8	1.3^{c}	54.0	1.6^{c}	47.4	1.0b^{c}	66.0	1.1^{c}	61.6	2.9^{d}
		7DAS	1.5^{ab}	40.6	1.1^{a}	58.6	0.9^{a}	62.6	1.9^{b}	22.4	2.0^{b}	25.8	2.7^{b}	14.2	2.1^{b}	18.9	2.6^{b}
		10DAS	1.0^{b}	61.3	0.3^{a}	88.7	0.4^{a}	86.4	1.3^{bc}	50.5	1.9^{cd}	30.8	1.2^{bc}	55.3	1.6^{bcd}	42.1	2.7^{d}
	Application 2	**Precount**	2.4^{ab}	63.1	2.1^{a}	68.0	2.5^{ab}	62.6	2.2^{a}	67.4	3.2^{bc}	51.6	4.1^{c}	38.9	4.1^{c}	38.8	6.7^{d}
		1DAS	0.8^{bc}	57.7	0.3^{a}	82.9	0.4^{ab}	76.5	1.4^{de}	14.9	1.8^{e}	6.6	0.9^{cd}	51.3	1.4^{de}	17.0	1.7^{e}
		3DAS	1.1^{ab}	37.9	0.7^{a}	55.6	0.7^{a}	60.7	1.3^{ab}	35.4	1.4^{ab}	27.8	1.2^{ab}	36.8	1.1^{ab}	44.5	2.3^{b}
		7DAS	1.4^{bc}	48.9	1.0^{ab}	65.5	0.8^{a}	70.6	1.8^{cd}	35.9	2.0^{cd}	29.0	2.3^{cd}	19.8	2.5^{cd}	20.8	2.8^{d}
		10DAS	1.4^{bc}	52.3	0.6^{ab}	81.0	0.4^{a}	87.4	1.4^{c}	52.0	2.3^{cd}	27.1	3.0^{cd}	26.7	2.9^{cd}	23.3	3.1^{d}

Means followed by same letter or symbol do not significantly differ (P=.05, Tukey's HSD). DAS- Days after spraying.

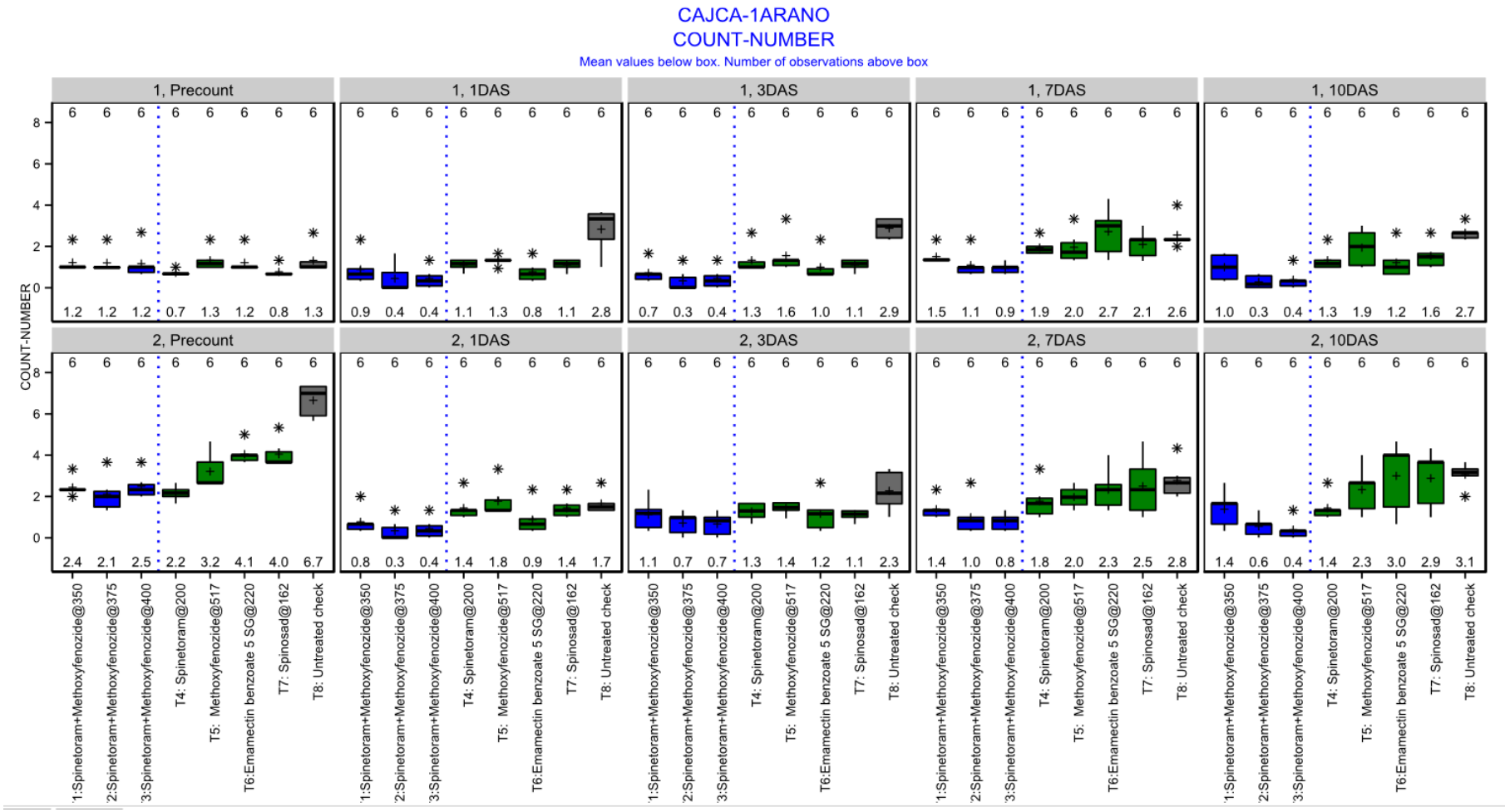

Fig. 1. Evaluation of (Spinetoram 6% w/v (5.66%w/w) + Methoxyfenozide 30% w/v (28.33%w/w)) on cocciellids

DAS- Days after spraying.

Table 2. Effect of Spinetoram 6% w/v (5.66%w/w) + Methoxyfenozide 30% w/v (28.33%w/w) on spiders

Natural Enemies	Application	Treatment Evaluation Interval	T_{1-3}:Spinetoram+Methoxyfenozide						T4: Spinetoram		T_5: Methoxyfenozide		T_6:Emamectin benzoate		T_7: Spinosad		T_8: Untreated check
			350 ml ha^{-1}		375 ml ha^{-1}		400 ml ha^{-1}		200 ml ha^{-1}		517 ml ha^{-1}		220 g ha^{-1}		162 ml ha^{-1}		
SPIDERS NO/PLANT)	Application 1	Precount	1.5^{a}	46.7	1.1^{a}	58.0	1.1^{a}	56.2	1.6^{a}	45.6	2.2^{a}	35.0	2.7^{a}	21.5	2.3^{a}	35.8	4.0^{a}
		1DAS	1.2^{a}	0.8	1.2^{a}	1.3	0.8^{b}	28.0	0.8^{b}	27.8	1.2^{a}	2.8	1.2^{a}	1.5	0.7^{b}	28.6	1.0^{a}
		3DAS	1.0^{a}	9.9	1.2^{a}	2.1	0.8^{b}	34.6	1.1^{a}	7.1	1.2^{a}	0.5	1.2^{a}	0.7	1.0^{a}	10.5	1.2^{a}
		7DAS	1.5^{a}	22.7	1.2^{b}	40.0	1.5^{a}	22.3	1.7^{a}	8.1	1.7^{a}	8.5	1.5^{a}	22.5	1.5^{a}	22.8	2.0^{a}
		10DAS	1.8^{bc}	39.8	1.8^{bc}	38.4	1.7^{c}	42.9	1.7^{bc}	41.5	1.5^{d}	51.0	1.8^{bc}	40.0	2.1^{ab}	29.6	3.1^{a}
	Application 2 Application	Precount	1.4^{a}	20.8	1.4^{a}	19.8	1.5^{a}	21.8	1.3^{a}	28.4	1.2^{a}	27.8	1.4^{a}	16.4	1.4^{a}	21.1	1.8^{a}
		1DAS	1.2^{a}	3.2	1.1^{ab}	5.9	0.8^{c}	32.3	0.9^{bc}	24.7	1.2^{a}	3.9	1.2^{a}	0.5	0.9^{bc}	25.3	1.2^{a}
		3DAS	1.4^{b}	5.7	1.2^{ab}	13.5	0.9^{a}	31.2	1.4^{b}	0.0	1.5^{b}	0.0	1.3^{ab}	7.3	1.2^{ab}	9.7	1.4^{b}
		7DAS	1.4^{ab}	48.5	1.1^{a}	56.7	1.0^{a}	62.2	1.8^{ab}	37.9	2.1^{abc}	29.6	2.1^{abc}	31.6	2.3^{bc}	25.1	3.3^{c}
		10DAS	1.7^{a}	41.4	1.3^{a}	54.4	1.4^{a}	44.4	1.8^{a}	34.6	2.1^{a}	33.0	2.5^{a}	30.3	2.5^{a}	27.9	3.8^{a}

Means followed by same letter or symbol do not significantly differ (P=.05, Tukey's HSD). DAS- Days after spraying.

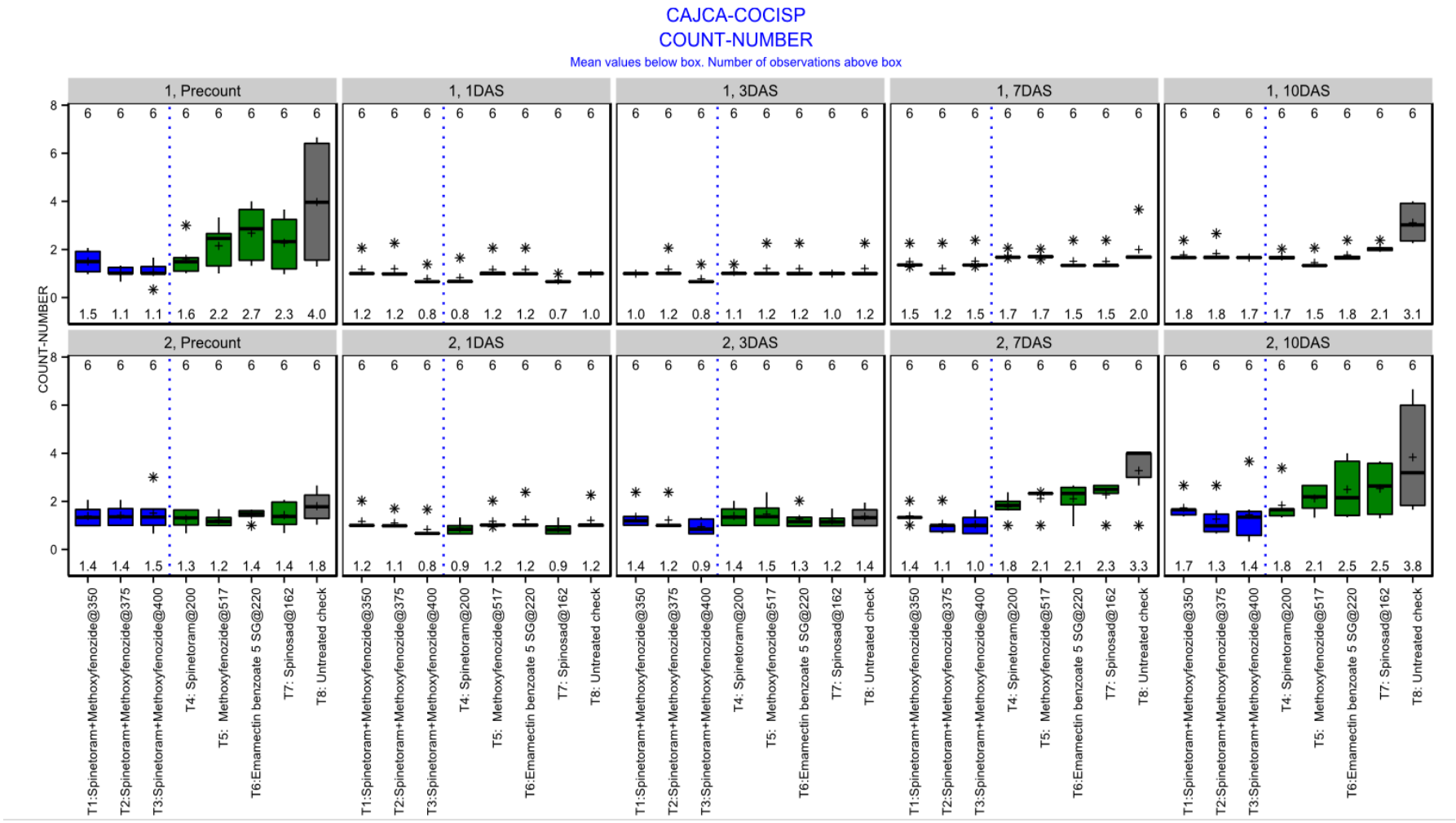

Fig. 2. Evaluation of (Spinetoram 6% w/v (5.66%w/w) + Methoxyfenozide 30% w/v (28.33%w/w)) on spiders

g ha-1 (1.8), and T_1 & T_2: spinetoram 6% w/v (5.66%w/w) + methoxyfenozide 30% w/v @ 350 & 375 ml ha^{-1} (1.8) and T_3: spinetoram 6% w/v (5.66%w/w) + methoxyfenozide 30% w/v @ 400 ml ha^{-1} (1.7). Following a second application, reports of the same trend of population safety for coccinellids were made (Table 1 & Fig. 1).

Prior to the application of treatments, the pre-count non-target spider population in each of the experimental plots varied from 0.7 to 1.3. No discernible variation exists between the treatments. Ten days following the initial application, the population in T_8: untreated was 2.7, followed by T_5: methoxyfenozide 24% @ 517 ml ha^{-1} (1.9), T_7: spinosad 45% @ 162 ml ha^{-1} (1.6) and T_6: emamectin benzoate 5% @ 220 g ha^{-1} (1.2). Additionally, T_1: spinetoram 6% w/v (5.66%w/w) + methoxyfenozide 30% w/v @ 350 ml ha^{-1} (1.0) and T_2 & T_3: spinetoram 6% w/v (5.66%w/w) + methoxyfenozide 30% w/v @ 375- & 400-ml ha^{-1} (0.3 & 0.4, respectively). Following a second application, reports of the same trend of population safety for coccinellids were made (Table 2 & Fig. 2). Even though, there was a significant difference in the population of natural enemies among the treatments, none of the treatments were reported with zero occurrence of natural enemies which is toxic to non-target organisms and there was an increase in the population of natural enemies in treated as well as untreated plots gradually with respect to increase in the host population.

Individual insecticidal activity of methoxyfenozide is highly specific to lepidopteran pests but has a low toxicity towards other insect orders (Smagghe et al., 2003). Safety of methoxyfenozide 24 SC was reported by Pavviya and Muthukrishnan (Pavviya & Muthukrishnan, 2017) with maximum population of coccinellids in untreated check followed by methoxyfenozide @ 180 and 210 g.a.i/ha with 2.9 and 2.8 no.s /plant, respectively. Methoxyfenozide appears to be safer for beneficial organisms than conventional products were reported by Medina et al., (2004); Schneider et al., (2004) and Baur et al., (2003).

4. CONCLUSION

There was a significant difference in the population of natural enemies among the treatments, none of the treatments were reported with zero occurrence of natural enemies which is toxic to non-target organisms and there was an increase in the population of natural enemies in treated as well as untreated plots gradually with respect to increase in the host population. With so many benefits, premix formulation insecticides aid in improved target toxicity, safety against natural enemies, environmental friendliness, and a low rate of target organism resistance development.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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