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Performance of New Insecticide Molecules Premix (Spinetoram + Methoxyfenozide) to Combat Dual Podborers in Red Gram, *Cajanus cajan* L.

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ABSTRACT

Background: Spinetoram has a wide spectrum of activity against a variety of insect pests and poses no hazard to humans or animals and provides safety to environment. Methoxyfenozide also poses oral toxicity to mammals and honeybees. With so many benefits, premix formulation insecticides aid in improved target toxicity, safety against natural enemies, environmental safety and a low rate of target organism resistance development.

Methods: In this field investigation were carried out 2019-2021 to evaluate the effectiveness of a premix insecticides spinetoram 6% and methoxyfenozide 30% combination against dual lepidoterans in Red gram. The larvae assessment was performed on ten randomly chosen plants from each plot before and after the treatments. The extent of pod damage and the reduction relative to the untreated control were determined.

Result: Our investigations shows that the premix combination of spinetoram 6% and methoxyfenozide 30% treatment demonstrated notable efficacy across all dosage levels. Notably, the highest dose of the combination treatment showcased superior performance with reduced pest incidence. Yield analysis further emphasized the effectiveness of the spinetoram-methoxyfenozide combination in enhancing Red gram productivity. This present work suggests that there exist synergistic effect between spinetoram and methoxyfenozide highlighting the potential for integrated pest management strategies in Red gram cultivation.

Key words: Bio-efficacy, Podborers, Premix formulation, Red gram, Spinetoram + Methoxyfenozide.

INTRODUCTION

One of the most important grain legume crops in tropical and sub-tropical regions is the Red gram, also known as Tur or Pigeonpea (*Cajanus cajan* L). India produces and consumes more pulses than any other country in the world. India contributes to 93 per cent in terms of global production of pulses and occupies 90 per cent of global Red gram area (Anonymous, 2011). Pulses production has remained stagnant for decades, despite significant contributions, owing to a variety of factors. About 250 insect species has been found to infest from seedling to harvest in Red gram. The pod borer complex is noted to decrease yield by as much as 27.77 per cent (Sahoo *et al.,* 2002). The gram pod borer, *Helicoverpa armigera* (Hubner), along with the spotted pod borer, *Maruca vitrata* (Geyer), are recognized as significant pests due to their harmful effects on Red gram yield, underscoring the necessity for effective management strategies for farmers.

The larvae of *M. vitrata* create webs on the leaves and inflorescences, feeding within the flowers, flower buds and pods (Sharma, 1998). According to Randhawa and Verma (2011), *M. vitrata* causes damage ranging from 26 to 28 per cent in red gram crops. numerous insecticides have been tested against these pests without regard for their specificity in pest management. The indiscriminate and hazardous use of insecticides poses a significant risk of developing insect resistance and has residual effects. Therefore, there is an urgent need to explore newer insecticides, combination products, or premix formulations that are effective and selective at lower doses to mitigate the development of resistance. To address the challenges posed by lepidopteran pests in red gram, an initiative was undertaken to combine two novel insecticide molecules that exhibit dual modes of action. Hence, for combating threatening lepidopterans in red gram, an attempt was made to combine two new insecticide molecules with dual mode of action.

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The initial category pertains to a novel class of pesticide derived from fermentation; spinetoram exhibits a broad range of effectiveness against numerous insect pests. Similar to spinosad, spinetoram poses no hazard to humans or animals and is safe for the environment. Because of this, it is regarded as a very efficient bioinsecticide that is reported to be more active than spinosad over an extended period of time. It has been used extensively to treat a variety of insect pests. The second group belongs to synthetic ecdysone, Methoxyfenozide, a biorational insecticide is considerably more hazardous to aquatic creatures but has modest oral toxicity to mammals and honeybees. With so many benefits, premix formulation insecticides aids in improved target toxicity, safety against natural enemies, environmental friendliness and a low rate of target organism resistance development.

The current study was designed to assess the bio-efficacy of a premix formulation containing novel insecticide molecules targeting the harmful pod borers affecting Red gram, taking into consideration the aforementioned perspectives.

MATERIALS AND METHODS

Two field experiments were conducted at Agricultural Research Station, Virinjipuram, Vellore, during *kharif* 2019-20 and 2020-21 to evaluate the bio-efficacy of a premix formulation containing 6% spinetoram and 30% methoxyfenozide (Fig 1 Graphical abstract) against the gram podborer, *H. armigera* and the spotted podborer, *M. vitrata*. The CO 7 variety was planted in the late *kharif* within a plot measuring 5 m × 4 m, using a 45-cm gap between rows and a 30 cm gap between plants. The experimental design employed was a randomized block design (RBD), consisting of three replications and eight distinct treatments. Three doses of (spinetoram 6% + methoxyfenozide 30%) combinations (350, 375 and 400 ml 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 pod borer. During the cropping season, two applications of spray were conducted. The initial application occurred at 50 per cent flowering, followed by a second application 15 days later, utilizing a knapsack sprayer and a total of 500 liters of spray solution per hectare. The larvae assessment was performed on ten randomly chosen plants from each plot before the treatment (pre-treatment assessment) and again at 1, 3, 7 and 10 DAS (Days After Spraying) to observe the populations of *H. armigera* and *M. vitrata*. The extent of pod damage and the reduction relative to the untreated control were determined. Yield data for each plot was gathered at the time of harvest, represented as grain yield and analyzed statistically using AGRES.

RESULTS AND DISCUSSION

Efficacy of premix insecticides against gram pod borer, *Helicoverpa armigera*

At the 50 per cent flowering stage, the pre-count larval population of *H. armigera* ranged from 3.00 to 3.50 individuals per plant. A significant reduction in larval population was observed across all chemical treatments evaluated one day after spraying (DAS). The lowest larval

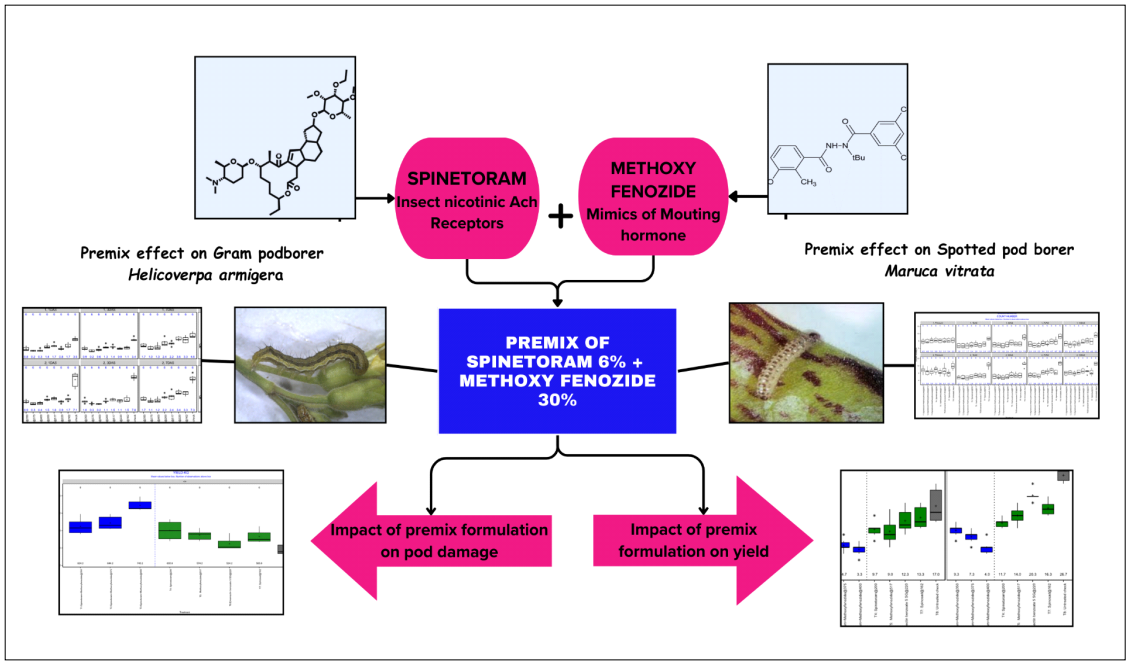


Fig 1: Grpahical representation of premix insecticides (Spinetoram 6% + Methoxyfenozide 30%) against major podborers in red gram.

count was noted in the T_3 treatment, which involved spinetoram at 6% (5.66% w/w), combined with methoxyfenozide at 30% (28.33% w/w) at a rate of 400 ml ha^{-1}, resulting in 0.28 individuals per plant. This was statistically comparable to the T_2 treatment, which used the same chemicals at 375 ml ha^{-1}, yielding 0.29 individuals per plant. The T_1 treatment, which applied spinetoram at 6% (5.66% w/w) and methoxyfenozide at 30% (28.33% w/w) at 350 ml ha^{-1}, recorded a higher count of 0.78 individuals per plant.

The efficacy was followed by T_5: methoxyfenozide 24% @ 517 ml ha^{-1} (1.22 Nos/ plant) and T_6: emamectin benzoate 5%@ 220 g ha^{-1} (1.27 Nos/ plant) treated plots and were found to be on par with each other. T_4: spinetoram 12% @ 200 ml ha^{-1} treated plots recorded with the larval population of 1.39 Nos per plant followed by T_7: spinosad 45% @162 ml ha^{-1} (1.67 Nos /plant) whereas untreated check recorded the highest population of 3.50 Nos per plant. At 3 DAS, treatments *viz.*, T_1, T_2 and T_3 treated plots recorded with lower incidence of *H. armigera* population (0.28-0.89 No/ plant) and all other treatments were found to be on par with each other with the population of 1.11-1.33 Nos per plant. At 7 and 10 DAS, there was an increase in the larval population in all the treated plots but still T_1, T_2 and T_3 treated plots recorded its lowest larval population from 1.11-1.72 Nos per plant. At fifteen days after first application, the pre-count larval population ranged from 2.22-7.00 Nos per plant, with its highest larval population in untreated check (7.00 Nos/ plant). There was a tremendous decrease in the population immediately at 1 DAS and T_3: spinetoram 6% w/v (5.66% w/w) + methoxyfenozide 30% (28.33%w/w) @ 400 ml ha^{-1} treated plots was found to be superior (0.28 No/plant) followed by T_2 and T_1 which recorded 0.45 and 0.89 No per plant, respectively. To control larval population of *H. armigera,* treatment *viz.*, T_3: spinetoram 6% w/v (5.66% w/w) + methoxyfenozide 30% (28.33% w/w) @ 400 ml ha^{-1} treated plots was found to be effective and consistently found to be superior to T_1 and on par with T_2 with the same combination spinetoram 6% w/v (5.66% w/w) + methoxyfenozide 30% (28.33%w/w). After two applications, with respect to standard checks tested T_6: emamectin benzoate 5%@ 220 g ha^{-1} and T_7: spinosad 45% @162 ml ha^{-1} tested were found to be on par with each other in combating larval population of *H. armigera* and recorded 3.83 and 3.72 Nos. per plant, respectively. At the end of the observation period, there was a gradual increase in population level in untreated check (3.50-7.78 Nos./plant) (Table 1).

Efficacy of premix insecticides against spotted pod borer, *Maruca vitrata*

Pooled data (Table 2) for 2020 and 2021 clearly showed that at 50 per cent flowering stage, the pre-count larval population of *M. vitrata* ranged from 4.55 to 5.61 Nos. per plant. In every chemical treatment examined, the number of larvae was significantly lower one day after spraying (DAS). T_3 had the lowest population (1.62 Nos/plant) among the 400 ml ha^{-1} treated plots spinetoram 6% (5.66%w/w) + methoxyfenozide 30% (28.33%w/w). This was followed by the same combination treatments T_1 and T_2 @ 350 and 375 ml ha^{-1} treated plots, which had 1.89 and 1.72 Nos. per plant, respectively and were found to be comparable. At the same time, T_5: methoxyfenozide 24% @ 517 ml ha^{-1} treated plots (2.22 Nos./ plant) and T_4: spinetoram 12% @ 200 ml ha^{-1} treated plots (2.39 Nos/ plant) were also found to be on par with T_1 and T_2 treatments. The following two treatments that showed significant results were T_6: emamectin benzoate 5% @ 220 g ha^{-1}; 2.44 Nos/plant and T_7: spinosad 45% @ 162 ml ha^{-1}; 2.83 Nos/plant. The highest population was reported by the untreated check, which was 6.55 Nos/plant. The T_3: spinetoram 6% (5.66% w/w) + methoxyfenozide 30% (28.33% w/w) @ 400 ml ha^{-1} treated plots at 3, 7 and 10 DAS showed the same trend of superiority in reducing the larval population of spotted pod borer.

At the end of the first spray, the untreated plots were loaded with a larval population of 9.15 Nos. per plant. There was a significant difference in the pre-count population at fifteen days after first application and the superior treatment T_3: spinetoram 6% (5.66%w/w) + methoxyfenozide 30% (28.33%w/w) @ 400 ml ha^{-1} was effective even after 15 DAS (5.40 Nos./plant). All the treatments tested, were found to be effective at 1 DAS after second application of treatments and T_3: spinetoram 6% (5.66%w/w) + methoxyfenozide 30% (28.33%w/w) @ 400 ml ha^{-1} treated plots recorded the lowest larval population (1.78 Nos./plant) and the same trend was followed even after second spray also. For three days, the treatments were found to be effective. After second application, the spotted pod borer population naturally increased at 3, 7 and 10 DAS. The superior treatments spinetoram 6% (5.66% w/w) + methoxyfenozide 30% (28.33% w/w) @ 400 ml ha^{-1} also showed an increase in population, with 4.66 Nos. per plant, while the untreated check showed the highest number of 11.50 Nos. per plant. T_7: spinosad 45% @162 ml ha^{-1} was the highest of the standard tests tested, recording 6.44 No.s per plant. T_6: emamectin benzoate 5% @ 220 g ha^{-1} also recorded 5.44 No.s per plant.

Effect of premix insecticides against marketable yield in redgram

Harvest time damage due to *H. armigera* and *M. vitrata* was recorded and presented in Table 3. The lowest mean gram pod borer damage of 3.33 per cent was recorded in T_3: spinetoram 6% (5.66% w/w) + methoxyfenozide 30% (28.33%w/w) @ 400ml ha^{-1}, treated plots. The other combination treatments *viz.*, T_2 and T_1 spinetoram 6% (5.66%w/w) + methoxyfenozide 30% (28.33%w/w) @ 375 and 350 ml ha^{-1} treated plots recorded with a mean pod damage of 4.66 and 7.00 per cent and this was followed by T_5: methoxyfenozide 24% @ 517 ml ha^{-1} treated plots (9.00%) and T_4: spinetoram 12% @ 200 ml ha^{-1} treated plots (9.66%) whereas untreated check recorded with a total damage of 17.00 per cent.

The T_3 treated plots with spinetoram 6% (5.66% w/w) + methoxyfenozide 30% (28.33% w/w) at 400 ml ha^{-1} had the lowest mean spotted pod borer damage at 4.0 per cent. The untreated check recorded a total damage of 26.67 per cent, while the other combination treatments, T_2 and T_1

Table 1: Effect of premix insecticides (Spinetoram 6% + Methoxyfenozide 30%) to gram podborer, *H. armigera* in Red gram.

Treatments	Dose(ml /ha)	*H. armigera* (No./Plant)*									
		First application					Second application				
		PTC	1 DAS	3 DAS	7 DAS	10 DAS	PTC	1 DAS	3 DAS	7 DAS	10 DAS
T_1: Spinetoram+Methoxyfenozide	350	3.00	0.78^{b}	0.89^{b}	1.72^{bc}	1.67^{b}	2.56^{c}	0.89^{bc}	1.00^{b}	1.67^{c}	2.05^{b}
T_2: Spinetoram+Methoxyfenozide	375	3.16	0.29^{a}	0.50^{ab}	1.11^{ab}	1.22^{a}	2.67^{c}	0.45^{b}	0.33^{a}	1.22^{b}	1.22^{a}
T_3: Spinetoram+Methoxyfenozide	400	3.27	0.28^{a}	0.28^{a}	1.16^{a}	1.28^{a}	2.22^{a}	0.28^{a}	0.23^{a}	1.05^{a}	1.28^{a}
T_4: Spinetoram	200	3.27	1.39^{bc}	1.33^{b}	2.45^{de}	2.00^{d}	2.39^{bc}	1.50^{d}	1.06^{bc}	2.22^{d}	2.33^{b}
T_5: Methoxyfenozide	517	3.05	1.22^{bc}	1.11^{b}	2.22^{cd}	3.05^{e}	3.61^{d}	1.78^{e}	1.48^{d}	2.39^{de}	3.16^{c}
T_6: Emamectin benzoate 5 SG	220	3.38	1.27^{bc}	1.16^{b}	3.61^{f}	3.83^{g}	4.06^{e}	0.89^{bc}	1.05^{bc}	3.45^{e}	3.83^{d}
T_7: Spinosad	162	3.00	1.67^{c}	1.11^{b}	3.33^{e}	3.44^{f}	4.27^{e}	1.66^{d}	1.50^{d}	3.27^{f}	3.72^{d}
T_8: Untreated check	-	3.50	3.50^{d}	3.39^{c}	4.56^{g}	4.61^{g}	7.00^{f}	7.05^{f}	7.78^{e}	7.34^{g}	6.72^{e}
SEd		0.14	0.19	0.18	0.19	0.10	0.22	0.15	0.12	0.15	
CD<0.5%		0.28	0.38	0.37	0.39	0.23	0.43	0.32	0.25	0.33	

*Mean of two seasons means followed by a same alphabet are not significantly different.

Table 2: Effect of premix insecticides (Spinetoram 6% + Methoxyfenozide 30 %) to spotted podborer, *M. vitrata* in Red gram.

Treatments	Dose(ml /ha)	*M. vitrata* (No./Plant)*									
		First application					Second application				
		PTC	1 DAS	3 DAS	7 DAS	10 DAS	PTC	1 DAS	3 DAS	7 DAS	10 DAS
T_1: Spinetoram+Methoxyfenozide	350	4.55	1.89^{ab}	2.45^{b}	3.00^{ab}	3.33^{ab}	7.06^{ab}	2.17^{ab}	2.83^{ab}	3.67^{a}	5.16^{ab}
T_2: Spinetoram+Methoxyfenozide	375	4.77	1.72^{ab}	2.22^{b}	2.00^{a}	3.00^{ab}	5.89^{ab}	2.00^{ab}	2.44^{ab}	3.56^{a}	5.17^{ab}
T_3: Spinetoram+Methoxyfenozide	400	5.33	1.62^{a}	1.78^{a}	2.05^{a}	2.28^{a}	5.40^{a}	1.78^{a}	2.00^{a}	2.94^{a}	4.66^{a}
T_4: Spinetoram	200	5.61	2.39^{ab}	2.61^{b}	3.39^{bc}	3.16^{ab}	7.22^{c}	2.56^{ab}	2.61^{ab}	5.50^{b}	5.72^{b}
T_5: Methoxyfenozide	517	5.16	2.22^{ab}	3.22^{d}	3.33^{bc}	4.60^{c}	5.56^{bc}	3.38^{bc}	3.56^{bc}	5.83^{b}	6.44^{c}
T_6: Emamectin benzoate 5 SG	220	5.28	2.44^{bc}	3.66^{cd}	4.72^{d}	5.16^{d}	6.72^{ab}	3.27^{bc}	3.77^{bc}	6.78^{c}	6.44^{c}
T_7: Spinosad	162	5.17	2.83^{c}	2.94^{b}	4.66^{d}	4.83^{c}	5.95^{ab}	3.16^{bc}	3.39^{bc}	5.44^{b}	5.44^{b}
T_8: Untreated check	-	5.55	6.55^{d}	7.61^{e}	8.16^{e}	9.15^{e}	9.95^{d}	10.55^{d}	11.06^{d}	11.77^{d}	11.50^{d}
SEd		0.14	0.07	0.10	0.15	0.33	0.14	0.12	0.12	0.17	
CD<0.5 %		0.31	0.17	0.20	0.32	0.69	0.31	0.27	0.25	0.34	

*Mean of two seasons means followed by a same alphabet are not significantly different.

Table 3: Toxicity of (Spinetoram 6% + Methoxyfenozide 30%) on pod borer damage and yield.

Treatments	Formulation (ml/ha)	*H. armigera* damage (%)			*M. vitrata* damage (%)			Total damage (%)	Reduction over control (%)	Grain yield (Kg/ha)	Increase yield (%)
		2019-20	2020-21	Mean	2019-20	2020-21	Mean				
T_1: Spinetoram+Methoxyfenozide	350	8.00^{ab}	6.00^{bc}	7.00	10.67^{bc}	8.00^{b}	9.33	16.33	62.60	624.24^{bc}	22.42
T_2: Spinetoram+Methoxyfenozide	375	5.33^{a}	4.00^{ab}	4.66	8.67^{b}	6.00^{b}	7.33	11.99	72.54	644.26^{b}	24.83
T_3: Spinetoram+Methoxyfenozide	400	4.67^{a}	2.00^{a}	3.33	5.33^{a}	2.67^{a}	4.00	6.00	83.24	745.27^{a}	35.02
T_4: Spinetoram	200	11.33^{bc}	8.00^{bcd}	9.66	12.67^{c}	10.67^{c}	11.67	19.67	51.16	600.84^{cd}	19.40
T_5: Methoxyfenozide	517	10.00^{bc}	8.00^{cd}	9.00	15.33^{d}	12.67^{c}	14.00	23.0	47.33	574.26^{de}	15.67
T_6: Emamectin benzoate 5 SG	220	13.33^{cd}	11.33^{cd}	12.33	21.33^{e}	19.33^{e}	20.33	32.66	25.21	524.36^{f}	7.65
T_7: Spinosad	162	14.00^{cd}	12.67^{de}	13.33	16.67^{d}	16.00^{d}	16.33	29.66	32.08	565.84^{de}	14.42
T_8: Untreated check	-	18.00^{d}	16.00^{e}	17.00	26.67^{f}	26.67^{f}	26.67	43.67	-	484.27^{g}	-
SEd		2.18	2.79		1.57	1.082.33			14.39		
CD<0.5%		4.69	5.99		3.37				30.84		

Means followed by a same alphabet are not significantly different.

spinetoram 6% (5.66%w/w) + methoxyfenozide 30% @ 375 and 350 ml ha^{-1} treated plots recorded a mean pod damage of 7.33 and 9.33 per cent. These were followed by T_4: spinetoram 12% @ 200 ml ha^{-1} treated plots (11.67 %) and T_5: methoxyfenozide 24% @ 517 ml ha^{-1} treated plots (14.00%).

A reduction of 83.24 per cent compared to the untreated control was observed in the T_3 treatment, which involved spinetoram at 6% (5.66% w/w) combined with methoxyfenozide at 30% (28.33% w/w) applied at a rate of 400 ml ha^{-1}. This treatment resulted in the highest recorded grain yield of 745.27 kg ha^{-1}. Following this, the T_2 treatment, which consisted of spinetoram at 6% (5.66% w/w) and methoxyfenozide at 30% (28.33% w/w) at 375 ml ha^{-1}, yielded 644.26 kg ha^{-1}. The T_1 treatment, utilizing the same active ingredients at 350 ml ha^{-1}, produced a yield of 624.24 kg ha^{-1}, both of which were statistically similar. In contrast, the untreated control yielded 484.27 kg ha^{-1}. The most effective treatment, T_3, demonstrated a yield increase of 35.02 per cent over the untreated control.

The treatments were ranked based on their effectiveness in reducing larval populations and enhancing yield potential as follows: T_3: methoxyfenozide 30% (28.33% w/w) at a rate of 400 ml ha^{-1} combined with spinetoram 6% (5.66% w/w) was the most effective, followed by T_2: methoxyfenozide 30% (28.33% w/w) at 375 ml ha^{-1} with spinetoram 6% w/v (5.66% w/w). Next in line was T_1, which consisted of 350 ml ha^{-1} of a mixture of spinetoram 6% (5.66% w/w) and methoxyfenozide 30% (28.33% w/w). T_5 involved methoxyfenozide at 24% concentration applied at 517 ml ha^{-1}, while T_4 utilized 200 ml ha^{-1} of spinetoram at 12%. Lastly, T_6 included Emamectin benzoate at 5% applied at 220 g ha^{-1} and T_7 featured spinosad at 45% concentration at a rate of 162 ml ha^{-1}.

The present results align closely with the findings of Behnam (2010), who indicated that methoxyfenozide effectively targets the citrus leaf miner. Additionally, Ei-Naggar and Tawfeek (2012) found that methoxyfenozide provided substantial protection to plants against pests, leading to increased cotton yields. Smagghe *et al.* (2003) observed that methoxyfenozide is especially potent against lepidopteran insect pests while demonstrating minimal toxicity to other insect groups. Ameta *et al.* (2011) found that the insecticides flubendiamide 480 SC, indoxacarb 14.5 SC and spinosad 48 SC effectively diminished the larval populations of *H. armigera* and *M. testulalais*, resulting in a reduction of flower and pod damage in pigeonpea. The efficacy of spinetoram was investigated by Sanjeevi Kumar and Pavviya (2018), who indicated that spinetoram 12 SC was particularly effective at application rates of 36 and 45 g a.i ha^{-1} when administered three times at 15-day intervals, leading to a significant decrease in the leaf feeder *M. vitrata* on pigeonpea plants. Rao *et al.,* (2007) demonstrated that *M. vitrata* could be effectively managed with the new chemicals spinosad and indoxacarb, achieving reductions of 82% and 72%, respectively, within two days post-application. The efficacy of methoxyfenozide against the groundnut leafminer was investigated by Pavviya and Muthukrishnan (2017). Application of Spinetoram 6% w/v + Methoxyfenozide

30% SC @ 400 ml/ha was found to be excellent insecticide in suppressing the leaf folder and stem borer population during *kharif* 2014-15 paddy crop by registering 0.52% and 0.78 % reduction over control of leaf folder and stem borer, respectively (Raghavendra *et al.,* 2020). Larvae of spiny bollworm, *Earias insulana* (Boisd.) (Lepidoptera: Nolidae) to observe the correlation between the toxicity effect and the potential histopathological changes induced by feeding with LC_{50} of the pesticide Uphold (36% SC), a commercial insecticide mixture formulation of two active ingredients [spinetoram 6% + methoxyfenozide 30% (w/v)] (Ashraf *et al.,* 2023). Spinetoram application in fall armyworm, *Spodoptera frugiperda* caused disruptions in total carbohydrates, proteins, lipids and digestive enzymes. Moreover, significant elevations in acetylcholinesterase, *α*-esterase, *β*-esterase, acid phosphatase, alkaline phosphatase, aspartate aminotransferase, alanine aminotransferase, phenoloxidase and chitinases were monitored. Spinetoram also resulted in severe histological damage of the midgut characterized by necrosis and sloughing of the epithelial lining, in addition to cytoplasmic vacuolization (Salem *et al.,* 2024).

CONCLUSION

A novel type of pesticide produced by fermentation, spinetoram has a wide spectrum of activity against a variety of insect pests. Similar to spinosad, spinetoram poses no hazard to humans or animals and is safe for the environment. Because of this, it is regarded as a very efficient bioinsecticide that is reported to be more active than spinosad over an extended period of time. It has been used extensively to treat a variety of insect pests. Methoxyfenozide is considerably more hazardous to aquatic creatures but has modest oral toxicity to mammals and honeybees. 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. Hence, there is no doubt that this premix combination of spinetoram + methoxyfenozide would find its place in Red gram pod borer management and also safety to natural enemies.

Conflict of interest

All authors declared that there is no conflict of interest.

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