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Field efficacy of insecticide mixtures against the pod borer and leaf eating caterpillar in cowpea

Banka Kanda Kishore Reddy and Ambily Paul

Abstract
Efficacy of insecticide mixtures *viz.,* chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 150 g a.i. ha^{-1}, lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 30 g a.i. ha^{-1}, thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 27.50 g a.i. ha^{-1}, beta cyfluthrin 8.49%+ imidacloprid 19.81% SC @ 15.75+36.70 g a.i. ha^{-1}, flubendiamide 19.92% w/w + thiacloprid 19.92% w/w SC @ 48+48 g a.i. ha^{-1} against the spotted pod borer, *Maruca vitrata* and leaf eating caterpillar, *Spodoptera litura* Fab. infesting cowpea was studied at Vegetable farm, Kalliyoor, Thiruvananthapuram during August - November 2017. Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 30 g a.i ha^{-1}, thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 27.5 g a.i ha^{-1} and chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 150 g a.i ha^{-1} were found superior in the management of *M. vitrata* and *S. litura* over other treatments.

Keywords: Insecticide mixtures, cowpea, *M. vitrata*, *S. litura*

Introduction
Cowpea (*Vigna unguiculata* subsp. sesquipedalis (L.) Verdc.), generally termed as yard long bean is the most widely adapted, versatile and nutritious grain legume crop in tropical and sub-tropical countries. As many as 21 insect pests of different groups are recorded damaging the cowpea crop from germination to maturity (Sardhana and Verma, 1986) [1]. and most of the pests appeared simultaneously in the crop especially at the pod bearing stage. *M. vitrata* and *S. litura* are the most dangerous and potential pests creating considerable damage to the crops. *M.vitrata* infesting flowers and pods causing a loss due to pod damage alone goes 42 to 80 per cent (Halder and Srinivasan, 2011) [2]. The newly hatched larvae of *S.litura* feeds gregariously from lower surface of the leaves and causing heavy damage to the leaves, shoots, stems. Farmer resorts to spray single insecticides against each pest with short interval resulting in insecticide resistance and bio magnification of insecticides and forcing them to use higher dose of insecticides. Invention of pesticide mixture with two or more single insecticides having different mode of action paved the way to solve the above problem. Mixtures of insecticides provide technical advantages for controlling pests in a broad range of settings, typically by increasing the level of target pest control and/or broadening the range of pests controlled (IRAC, 2018) [3]. Recent reports revealed that the pest has developed resistance to the single insecticides which are repeatedly using from long times.

Materials and Methods
Field experiment: The experiment was conducted at Farmers field in Kalliyoor, Thiruvananthapuram, Kerala during August - November, 2017 in RBD with three replications. The new generation insecticide mixtures and single insecticides were sprayed at their recommended doses in cowpea as and when 10 per cent infestation of all pests was noticed. No second spray was given since there is no reoccurrence of pest complex. The details of the treatments were presented in Table.1.

Table 1: Insecticide mixtures selected for the field experiment

	Insecticide mixture	Trade name	Dosage (g a.i. ha^{-1})
T1-	Chlorantraniliprole 8.8% + thiamethoxam 17.5% SC	Voliumflexi	150
T2-	Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC	Ampligo	30
T3-	Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC	Alika 247	27.50
T4-	Beta cyfluthrin 8.49% + imidacloprid 19.81% SC	Solomon	15.75+36.70
T5-	Flubendiamide 19.92% + thiacloprid 19.92% SC	Belt expert	48+48
T6-	Hand mixing of Chlorantraniliprole 18.5% SC +thiamethoxam 25% WG (1:1) - Farmer’s practice	-	--
T7-	Chlorantraniliprole18.5% SC (check)	Coragen	30
T8-	Thiamethoxam 25% WG (check)	Arrow	30
T9-	Control		

Population of larvae of *M. vitrata* in pods was recorded before and 7, 10 and 15 days after treatment. Five plants per replication were selected and number of larvae present in pods of each cowpea plant was counted before and after treatment. Percent infestation was calculated as follows,

$$\text{Per cent infestation (\%)} = \frac{\text{Number of pods damaged plant}^{-1}}{\text{Total number of pods plant}^{-1}} \times 100$$

Leaf damage caused by *S. litura* was calculated by counting total number of leaves and number of infested leaves from five plants/replication before treatment and 1, 3, 5, 7, 10 and 15 days after treatment. Percent leaf damage was calculated by using the following equation [4].

$$\text{Per cent of damage} = \frac{\text{Number of leaves infested plant}^{-1}}{\text{Total number of leaves plant}^{-1}} \times 100$$

Statistical analysis

The data collected were subjected to analysis of variance (ANOVA) after applying appropriate transformations.

Results and Discussion

Effect of insecticide mixtures on larval population of *M. vitrata* in cowpea pods

The effect of new generation insecticide mixtures on the population of *M. vitrata* on cowpea pods is presented in table 2.

Table 2: Effect of various insecticide mixtures on larval population of *M. vitrata* in cowpea pods

Insecticide mixtures	Dosage (g a.i ha^{-1})	Pod damage% (DAS)		
		7	10	15
Chlorantraniliprole 8.8% + thiamethoxam 17.5% SC	150	19.92 (26.25)	14.39 (22.21)	29.92 (33.08)
Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC	30	9.76 (14.99)	14.53 (22.24)	15.82 (23.31)
Thiamethoxam 12.6% + lambda cyhalothrin 9.% ZC	27.5	26.92 (31.24)	23.06 (28.44)	36.67 (37.22)
Beta cyfluthrin 8.49%+ imidacloprid 19.81% SC	15.75+36.70	45.15 (42.20)	34.44 (35.90)	28.18 (32.05)
Flubendiamide19.92% thiacloprid 19.92% SC	48+48	42.67 (40.76)	37.57 (37.70)	48.48 (44.12)
Hand mixing of Chlorantraniliprole 18.5% SC +thiamethoxam 25% WG (1:1)	1:1	24.09 (29.34)	18.09 (24.90)	27.60 (31.62)
Chlorantraniliprole18.5% SC (check)	30	23.16 (28.72)	18.78 (25.68)	28.61 (32.22)
Thiamethoxam 25% WG (check)	30	49.03 (44.44)	61.61 (51.87)	64.64 (53.61)
Control		70.83 (58.06)	76.92 (62.03)	81.14 (65.29)
CD (0.05)		9.367	9.956	9.085

Figures in parentheses are arc sign transformed values, DAS- Days after spraying.

Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 30 g a.i ha^{-1} treated plot recorded the lowest damage (9.76%) on seventh day after spraying which was significantly different from all other treatments followed by chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 150 g a.i ha^{-1} (19.92%), chlorantraniliprole 18.5% SC @ 30 g a.i ha^{-1} (23.16%), hand mixed product of chlorantraniliprole 18.5% SC + thiamethoxam 25% WG @(1:1) (24.09%), thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 27.5 g a.i ha^{-1} (26.92%) and these were on par. Whereas, the percentage damage observed in treatments, flubendiamide 19.92% + thiacloprid 19.92% SC @ 48+48 g a.i ha^{-1}, beta cyfluthrin 8.49% + imidacloprid 19.81% SC @ 15.75+36.7 g a.i ha^{-1}, thiamethoxam 25% WG @ 30g a.i ha^{-1} were 42.67, 45.15, 49.03 per cent respectively and were on par. The unsprayed control plot showed the highest per cent damage (70.83%).

After ten days of spraying the infestation in pods was significantly lower in chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 150 g a.i ha^{-1} (14.39%) followed by lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 30 g a.i ha^{-1} (14.53%), hand mixed product of chlorantraniliprole 18.5% SC + thiamethoxam 25% WG @ (1:1) (18.09%), chlorantraniliprole18.5% SC @ 30 g a.i ha^{-1} (18.78%), thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 27.5 g a.i ha^{-1} (23.06%) and they were significantly on par. Whereas, beta cyfluthrin 8.49% + imidacloprid 19.81% SC @ 15.75+36.7 g a.i ha^{-1}, flubendiamide 19.92% w/w + thiacloprid 19.92% SC @ 48+48 g a.i ha^{-1} recorded 34.44 and 37.57 per cent respectively and found to be on par. While, thiamethoxam 25% WG @ 30 g a.i ha^{-1} recorded 61.61 per cent damage and significantly different from all other treatments. All the treatments were effective in reducing pod damage when compared with untreated control (76.92%).

The lowest pod damage was recorded in lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 30 g a.i ha^{-1} (15.82%) and it was on par with hand mixed product of chlorantraniliprole 18.5% SC + thiamethoxam 25% WG @ (1:1) (27.60), beta cyfluthrin 8.49% + imidacloprid 19.81% SC @ 15.75+36.7 g a.i ha^{-1} (28.18%), chlorantraniliprole 18.5% SC @ 30 g a.i ha^{-1} (28.61%) after fifteen days of spraying. The treatments chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 150 g a.i ha^{-1} and thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 27.5 g a.i ha^{-1} recorded 29.92, 36.67 per cent respectively and have no significant difference. While, flubendiamide19.92% w/w + thiacloprid 19.92% w/w @ 48+48 g a.i ha^{-1} (48.48%), thiamethoxam 25% WG @ 30 g a.i ha^{-1} (64.64%) were recorded higher damage over other chemicals. The control plot showed higher pod damage (81.14%) and it was superior over all other treatments.

In the present study, bio-efficacy of insecticide mixtures against pod borer, *M. vitrata* revealed that lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 30 g a.i ha^{-1} and chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 150 g a.i ha^{-1} found to be effective for the management of *M. vitrata*. Similar results was reported by Roy *et al.*, 2017 in cowpea against managing pod borer, *M. vitrata* by spraying chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 180 ml ha^{-1}.

However, lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 35 g a.i ha^{-1} was found to be the best in reducing the infestation of borer pests in different crops *viz.*, pigeon pea (Patel and Patel, 2013; Swami *et al.*, 2017) [6, 7], soy bean (Birla, 2014) [8], cotton (Bajya *et al.*, 2015) [9], cowpea (Grigolli *et al.*, 2015) [10] and brinjal (Sen *et al.*, 2017) [11].

Effect of insecticide mixtures on leaf damage caused by *S. litura* in cowpea: The lowest leaf damage was found in lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 30 g a.i ha^{-1} (21.04%) and it was on par with thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 27.5 g a.i ha^{-1} (24.00%) which was on par with chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 150 g a.i ha^{-1} (27.63%) after seven days of spraying. The hand mixing of chlorantraniliprole 18.5% SC + thiamethoxam 25% WG @ (1:1) recorded 33.47 percentage damage which was significantly on par with beta cyfluthrin 8.49% + imidacloprid 19.81% SC @ 15.75+36.7 g a.i ha^{-1} (35.53%), chlorantraniliprole18.5% SC @ 30 g a.i ha^{-1} (37.33%). While the treatments flubendiamide19.92% + thiacloprid 19.92% SC @48+48 g a.i ha^{-1} (40.47%) and thiamethoxam 25% WG @ 30 g a.i ha^{-1} (44.45%) showed higher damage over other treatments and on par. The per cent leaf damage was found in untreated control (83.34%) after seven days of spraying (Table 3)

Table 3: Effect of insecticide mixtures on leaf damage caused by *S. litura* in cowpea

Insecticide mixtures	Dosage (g a.i ha^{-1})	Leaf damage% (DAS)*		
		7	10	15
Chlorantraniliprole 8.8% + thiamethoxam 17.5% SC	150	27.63 (31.70)	30.20 (33.31)	34.56 (36.00)
Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC	30	21.04 (27.29)	25.03 (30.04)	27.87 (31.86)
Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC	27.5	24.00 (29.29)	26.46 (30.93)	28.67 (34.34)
Beta cyfluthrin 8.49%+ imidacloprid 19.81% SC	15.75+36.70	35.53 (36.58)	33.73 (35.47)	38.33 (38.24)
Flubendiamide19.92% +thiacloprid 19.92% SC	48+48	40.47 (39.49)	44.76 (41.98)	45.74 (42.54)
Hand mixing of Chlorantraniliprole 18.5% SC +thiamethoxam 25% WG (1:1)	1:1	33.47 (35.31)	36.23 (36.98)	37.30 (37.63)
Chlorantraniliprole18.5%SC (check)	30	37.33 (37.65)	43.30 (41.12)	41.76 (40.26)
Thiamethoxam 25% WG (check)	30	44.45 (41.80)	47.24 (43.41)	49.21 (44.55)
Control		83.34 (66.02)	87.61 (69.45)	85.66 (67.77)
CD (0.05)		3.262	4.443	3.739

Figures in parentheses are arc sign transformed values, DAS- Days after spraying.

More or less similar trend of damage was observed after ten days of spraying. The treatments lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 30 g a.i ha^{-1} (25.03%), thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 27.5 g a.i ha^{-1} (26.46%) recorded lower per cent age of damage and they were on par in their effect with chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 150 g a.i ha^{-1} (30.20%). Similarly, the treatment beta cyfluthrin 8.49% + imidacloprid 19.81% SC @ 15.75+36.7 g a.i ha^{-1} recorded with 33.73 per cent leaf damage which was on par with hand mixed product of chlorantraniliprole 18.5% SC + thiamethoxam 25% WG (1:1) @ 150 g a.i ha^{-1} (36.23%). Whereas, relatively higher leaf damage was found in thiamethoxam 25% WG @ 30 g a.i ha^{-1} (47.24%) followed by flubendiamide19.92% + thiacloprid 19.92% @ 48+48 g a.i ha^{-1} (44.76%), chlorantraniliprole 18.5% SC @ 30 g a.i ha^{-1} (43.30%) and the above treatments were significantly on par. All the treatments shown their efficacy in reducing leaf damage by *S.litura* when compared with untreated control (87.61%).

At fifteen days of spraying, lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 30 g a.i ha^{-1} recorded the lowest per cent damage (27.87%) and it was on par with thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 27.5 g a.i ha^{-1} (28.67%) which was on par with chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 150 g a.i ha^{-1} (34.56%). Similarly, the damage found in plants treated with prepared hand mixed product of chlorantraniliprole 18.5% SC + thiamethoxam 25% WG (1:1) @ 150 g a.i ha^{-1}, beta cyfluthrin 8.49% + imidacloprid 19.81% SC @ 15.75+36.7 g a.i ha^{-1}, chlorantraniliprole18.5% SC @ 30 g a.i ha^{-1} were 37.30, 38.33, 41.76 per cent respectively and the above treatments were significantly on par with each other. Whereas, moderately higher damage per cent was found in thiamethoxam 25% WG @ 30 g a.i ha^{-1} (49.21%) which was on par with flubendiamide19.92% SC + thiacloprid 19.92% SC @ 48+48 g a.i ha^{-1} (45.74%). The results of the present study on the evaluation of insecticide mixtures against leaf eating caterpillar showed that lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 0.50 mL L^{-1}, thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 0.30 mL L^{-1} and chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 0.30 mL L^{-1} were found to be effective in the management of leaf eating caterpillar, *S.litura*. Study conducted by (Kousika *et al.*, 2015) [12]. reported that chlorantraniliprole 4.3% + abamectin 1.7% SC @ 60 g a.i. ha^{-1} was superior and reduce cent per cent reduction in population of *S. litura*. However, many works have been conducted with single insecticides *viz.*, chlorantraniliprole, flubendiamide etc. Chlorantraniliprole @ 0.006% was the effective treatment against *S.litura* in different crops *viz.*, chilli (Hosamani *et al.*, 2008) [13] and groundnut (Kumar *et al.*, 2015) [14]. The results of laboratory studies against *S. litura* with different new generation insecticides revealed that chlorantraniliprole 18.5% SC @ 1-4 ppm was found to be superior (Karuppaiah *et al.*, 2017; Rajasekar and Sridevi, 2017) [15, 16]. Similarly, evaluation of insecticides against *S.litura* under polyhouse condition in capsicum showed that chlorantraniliprole 18.5% SC @ 0.1 mL L^{-1} was highly potent insecticide in controlling larval population and fruit damage (Maruthi *et al.*, 2017) [17]. Study conducted in Kerala revealed that chlorantraniliprole @ 30 g a.i ha^{-1} and flubendiamide @ 48 g a.i ha^{-1} were effective in controlling resistant population of *S. litura* (Sreelakhsmi 2017).

Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 30 g a.i ha^{-1}, thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 27.5 g a.i ha^{-1} and chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 150 g a.i ha^{-1} were found superior in the management of *M. vitrata* and *S. litura* over other treatments. The main cause behind the action of these insecticide mixtures is the compatibility of single insecticides being mixed in formulation and their synergistic effect on the insects at a time and it is important to mix insecticides with different modes of action or those that affect different bio chemical processes in order to overcome the resistance in pest populations. In pest management strategy, insecticide mixtures play a major role by delaying the development of resistance, broad spectrum of activity, synergistic joint action and economic pest control. Additional research efforts are required to develop multi pesticide formulation and to develop safer green labelled mixtures for the future.

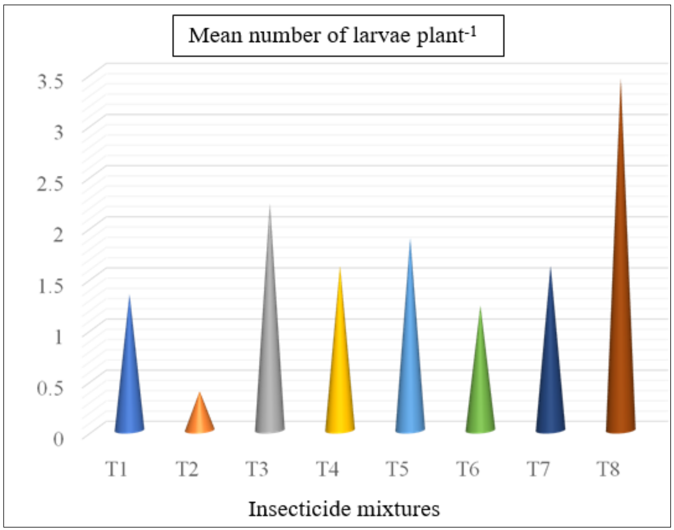

Fig 1: Effect of insecticide mixtures on the population of spotted pod borer, *Maruca vitrata* in cowpea

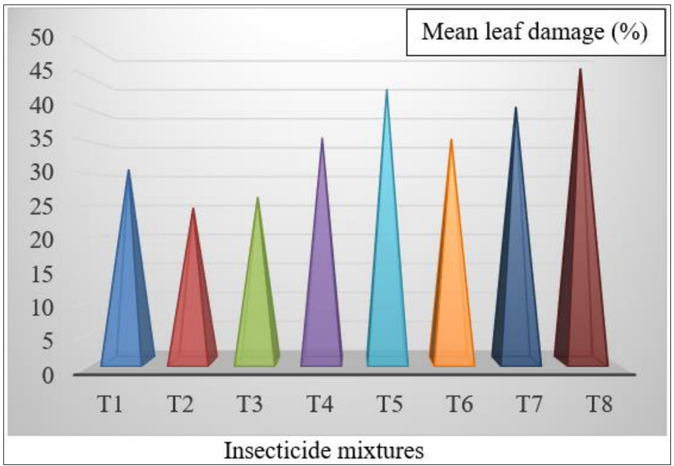

Fig 2: Effect of insecticide mixtures on leaf damage by *Spodoptera litura* in cowpea

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