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Efficacy of insecticide mixtures against sucking pests of Cowpea

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Abstract
Evaluation of efficacy of insecticide mixtures against sucking pests in cowpea *viz.*, pod bug, *Riptortes pedestris* (Fabricius) and cowpea aphid, *Aphis cracciovora* (Koch) was conducted at College of Agriculture, Vellayani, Thiruvananthapuram during 2017. The results revealed that chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC @ 150 g a.i. ha^{-1} was found effective in managing the population of pod bug, *R. pedestris,* followed by thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC @ 150 g a.i. ha^{-1} and beta cyfluthrin 8.49 % + imidacloprid 19.81 % SC @ 150 g a.i. ha^{-1}. Less number of the bug was found in effective treatments against 5.67 bugs/ plant in control after 7 days of spraying. More or less similar result was obtained in the management of cowpea aphid, *A. craccivora*. Less incidence of aphid was observed in the plants treated with chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC @ 150 g a.i ha^{-1}, thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC @ 150 g a.i. ha^{-1}, chlorantraniliprole 18.5 % SC + thiamethoxam 25 % WG (tank mixed) @ 1:1 and thiamethoxam 25 % WG @ 150 g a.i. ha^{-1} against 211.67 aphids $plant^{-1}$ in control after 15 days of spraying.

Keywords: Efficacy, insecticide mixtures, *Aphis craccivora*, Riportes pedestris

Introduction
Cowpea (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdc.) commonly termed as yard long bean is a nutritionally important legume crop grown in semi-arid and sub-humid tropics of Asia for both vegetables and pulses. In India, cowpea is grown as sole, inter-crop, mix-crop and in agro-forestry combinations. Inspite of all improvement brought in the cultivation of cowpea, its productivity is still very low due to insect-pests attack [1].An array of pests attacks this crop includes pod borers, leaf feeders, sap sucking insects etc which infest the crop simultaneously especially at the pod bearing stage. Due to the spraying of various insecticides having similar mode of action with short intervals resulted in resistance, secondary pest outbreaks and pest resurgence along with destruction of natural enemies and environmental pollution. Resistance typically develops due to the continuous use of single insecticide with similar mode of action or chemistries in the presence of common detoxification pathways [2]. Insecticide mixtures are the best alternative to address the above problems and to mitigate insecticide resistance. Combining insecticides with different properties such as contact or systemic action can be advantageous for containing both chewing and sucking pests simultaneously. Mixtures may enhance the overall target spectra allowing the control of a wide range of pests when they are present on the crop at the same time [3]. Keeping in this view in backdrop, this study has been undertaken to evaluate the efficacy of insecticide mixtures against sucking pests of cowpea.

Materials and Methods
Experiment was conducted in the vegetable farm, Kalliyoor, Thiruvananthapuram during 2017 to evaluate the efficacy of insecticide mixtures against pod bug, Riportus pedestris Fabricius and cowpea aphid, *Aphis craccivora* Koch infesting cowpea. Experiment was laid out in RBD with three replications. The following insecticide mixtures were tested for their efficacy against sucking pests and the insecticides were applied at 5-10 % infestation level.

Pod Bug, *R. pedestris*
The pods, flowers, leaves and stem were closely inspected for pod bug nymphs and adults and the mean number present in each plant was observed (5 plants/replication) before treatment and 1, 3, 5, 7, 10 and 15 days after treatment.

Insecticide mixtures selected for study

Insecticide mixture	Trade name	Dosage (g a.i ha^{-1})
T_1- Chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC	Voliumflexi	150
T_2- Lambda cyhalothrin 4.6 % + chlorantraniliprole 9.3 % ZC	Ampligo	30
T_3- Thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC	Alika 247	27.50
T_4- Beta cyfluthrin 8.49 % + imidacloprid 19.81 % SC	Solomon	15.75+36.70
T_5- Flubendiamide 19.92 % + thiacloprid 19.92 % SC	Belt expert	48+48
T_6- Chlorantraniliprole 18.5 % SC +thiamethoxam 25 % WG (1:1) (Tank mixed)	-	--
T_7- Chlorantraniliprole18.5% SC (check)	Coragen	30
T_8- Thiamethoxam 25 % WG (check)	Arrow	30
T_9- Control		

Cowpea Aphid, *A. craccivora*

The number of aphids from each plant was assessed from 15 cm of the terminal twig with unopened leaves and two opened leaves (5 plants/replication) before treatment and 1, 3, 5, 7, 10 and 15 days after treatment [11].

In control plot, the plain water was sprayed. The pre-count population was taken from all treatment plots.

Results and Discussion

Pod bug

The effectiveness of insecticide mixtures against population of pod bug, *R. pedestris* in cowpea was shown in Table. 1

Significantly lower population was recorded in thiamethoxam 25 % WG @ 30 g a.i ha^{-1} (0.33) and it was on par with tank mixed product of chlorantraniliprole 18.5 % SC + thiamethoxam 25 % WG @ (1:1) (0.67), chlorantraniliprole18.5 % SC @ 30 g a.i ha^{-1} (0.67), beta cyfluthrin 8.49 %+ imidacloprid 19.81 % SC @ 15.75+36.7 g a.i ha^{-1} (1.00), thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC @ 27.5 g a.i ha^{-1} (1.00) flubendiamide19.92 % + thiacloprid 19.92 % SC @ 48+48 g a.i ha^{-1} (1.00) after first day of spraying. The highest population was found in chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC @ 150 g a.i ha^{-1} (1.67), lambda cyhalothrin 4.6 % + chlorantraniliprole 9.3 % ZC @ 30 g a.i ha^{-1} (1.33) which were on par with each other. More or less similar result was obtained on third day after spraying and no bug was seen in plants treated with mixtures prepared by hand mixed of chlorantraniliprole 18.5 % SC + thiamethoxam 25 % WG @ (1:1) (0.00) and it was significantly different from thiamethoxam 25 % WG @ 30 g a.i ha^{-1} (0.33). Whereas, population of bug in chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC @ 30 g a.i ha^{-1}, beta cyfluthrin 8.49 % + imidacloprid 19.81 % SC @ 15.75+36.7 g a.i ha^{-1}, flubendiamide19.92 % + thiacloprid 19.92 % SC @ 48+48 g a.i ha^{-1}, lambda cyhalothrin 4.6 % + chlorantraniliprole 9.3 % ZC @ 30 g a.i ha^{-1} treated plants were one. The population in thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC @ 27.5 g a.i ha^{-1} (0.67) and chlorantraniliprole18.5 %SC @ 30 g a.i ha^{-1} (0.67) were significantly on par.

No pod bug was found in chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC @ 150 g a.i ha^{-1} (0.00), beta cyfluthrin 8.49 % + imidacloprid 19.81 % @ 15.75+36.7 g a.i ha^{-1} (0.00), hand mixed product of chlorantraniliprole 18.5 % SC + thiamethoxam 25 % WG @ (1:1) (0.00), thiamethoxam 25 % WG @ 30 g a.i ha^{-1} (0.00) which were on par with thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC @ 27.5 g a.i ha^{-1} (0.33) after five days of spraying. Significantly the highest population was seen in uncontrolled treatment (5.67) followed by flubendiamide19.92 % + thiacloprid 19.92 % SC @ 48+48 g a.i ha^{-1} (1.33).

After seven days of spraying, more or less similar trend was observed. No insects were recorded in chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC 150 g a.i ha^{-1} (0.00), thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC @ 27.5 g a.i ha^{-1} (0.00) beta cyfluthrin 8.49 % + imidacloprid 19.81 % SC@ 15.75+36.7 g a.i ha^{-1} treated plants. Whereas, more number of insects were recorded in flubendiamide 19.92 % + thiacloprid 19.92 % SC @ 48+48 g a.i ha^{-1} (2.00) followed by chlorantraniliprole18.5 % SC @ 30 g a.i ha^{-1} (1.67), lambda cyhalothrin 4.6 % + chlorantraniliprole 9.3 % ZC @ 30 g a.i ha^{-1} (1.33), hand mixed product of chlorantraniliprole 18.5 % SC + thiamethoxam 25 % WG @ (1:1) (1.00) and thiamethoxam 25 % WG @ 30 g a.i ha^{-1} (1.00) and they were significantly different.

Thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC @ 27.5 g a.i ha^{-1} (0.00) recorded no population of pod bugs followed by chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC @ 150 g a.i ha^{-1} (0.67), hand mixed product of chlorantraniliprole 18.5 % SC +thiamethoxam 25 % WG @ (1:1) (1.00) after tenth day of spraying. Whereas, higher population was found in flubendiamide19.92 % + thiacloprid 19.92 % SC @ 48+48 g a.i ha^{-1} (2.00), chlorantraniliprole18.5 % SC @ 30 g a.i ha^{-1} (2.00) followed by lambda cyhalothrin 4.6 % + chlorantraniliprole 9.3 % ZC @ 30 g a.i ha^{-1} (1.67), beta cyfluthrin 8.49 %+ imidacloprid 19.81 % SC @ 15.75+36.7 g a.i ha^{-1} (1.33), thiamethoxam 25 % WG @ 30 g a.i ha^{-1} (1.33) and they were on par with each other.

More or less similar result was obtained on fifteen days of treatment and lower population was observed in the treatments plants of chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC @ 150 g a.i ha^{-1} (0.67) and thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC @ 30 g a.i ha^{-1} (1.33) which were significantly on par. While, higher population was observed in chlorantraniliprole18.5 %SC @ 30 g a.i ha^{-1} (2.67) followed by flubendiamide19.92 % + thiacloprid 19.92 % SC @ 48+48 g a.i ha^{-1} (2.33), lambda cyhalothrin 4.6 % + chlorantraniliprole 9.3 % ZC @ 30 g a.i ha^{-1} (2.33), beta cyfluthrin 8.49 %+ imidacloprid 19.81 % w/w @ 15.75+36.7 g a.i ha^{-1} (2.00), thiamethoxam 25 % WG @ 30 g a.i ha^{-1} (2.00) and they were significantly on par. The untreated control plot infested with (6.00) number of bugs.

Table 1: Population of pod bug, Riptortes pedestris treated with insecticides

Insecticide mixtures	Field dose ($mL\ L^{-1}$)	*Number of bugs per plant (DAS)					
		1	3	5	7	10	15
T_1: Chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC	0.30	1.67 (1.46)	1.00 (1.22)	0.00 (0.70)	0.00 (0.70)	0.67 (1.05)	0.67 (1.05)
T_2: Lambda cyhalothrin 4.6 % + chlorantraniliprole 9.3 % ZC	0.50	1.33 (1.34)	1.00 (1.22)	1.00 (1.22)	1.33 (1.34)	1.67 (1.46)	2.33 (1.68)
T_3: Thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC	0.30	1.00 (1.22)	0.67 (1.05)	0.33 (0.88)	0.00 (0.70)	0.00 (0.70)	1.33 (1.34)
T_4: Beta cyfluthrin 8.49 %+ imidacloprid 19.81 % SC	0.40	1.00 (1.22)	1.00 (1.22)	0.00 (0.70)	0.00 (0.70)	1.33 (1.34)	2.00 (1.56)
T_5: Flubendiamide19.92% +thiacloprid 19.92 % SC	0.50	1.00 (1.22)	1.00 (1.22)	1.33 (1.34)	2.00 (1.55)	2.00 (1.55)	2.33 (1.68)
T_6: Chlorantraniliprole 18.5 % SC +thiamethoxam 25 % WG (1:1) (Tank mixed)	0.30	0.67 (1.05)	0.00 (0.70)	0.00 (0.70)	1.00 (1.22)	1.00 (1.18)	1.67 (1.46)
T_7: Chlorantraniliprole18.5% SC (check)	0.30	0.67 (1.05)	0.67 (1.05)	1.00 (1.22)	1.67 (1.44)	2.00 (1.56)	2.67 (1.77)
T_8: Thiamethoxam 25 % WG (check)	0.40	0.33 (0.89)	0.33 (0.88)	0.00 (0.70)	1.00 (1.22)	1.33 (1.29)	2.00 (1.56)
T_9: Control		4.67 (2.28)	5.00 (2.34)	5.67 (2.48)	5.67 (2.48)	6.33 (2.60)	6.00 (2.54)
CD (0.05)		0.352	0.276	0.336	0.449	0.494	0.405

Figures in parentheses are √x+1 transformed values, DAS- Days after spraying, *Mean of fifteen plants

Aphid

The results on the efficacy of new generation insecticide mixtures against the population of cowpea aphid, *A. craccivora* are given in Table. 2

No aphid was observed in 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 @ 27.5 g a.i ha-1, beta cyfluthrin 8.49 % + imidacloprid 19.81 % w/w @ 15.75+36.7 g a.i ha-1, flubendiamide19.92 % + thiacloprid 19.92 % SC @ 48+48 g a.i ha-1, hand mixed product of chlorantraniliprole 18.5 % SC + thiamethoxam 25 % WG @ (1:1) and thiamethoxam 25 % WG @ 30 g a.i ha-1 after first day of spraying. However significant population of aphid was present in control plot (121.67) which was on par with chlorantraniliprole (30.00).

More or less similar result was found on third day after spraying. No population of aphid was observed in the plants treated with 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 @ 27.5 g a.i ha^{-1}, beta cyfluthrin 8.49 %+ imidacloprid 19.81 % SC @ 15.75+36.7 g a.i ha^{-1}, flubendiamide19.92 % + thiacloprid 19.92 % SC @ 48+48 g a.i ha^{-1}, hand mixing of chlorantraniliprole 18.5 % SC + thiamethoxam 25 % WG @ (1:1) and thiamethoxam 25 % WG @ 30 g a.i ha^{-1}. While, plants sprayed with chlorantraniliprole18.5 % SC @ 30 g a.i ha^{-1} alone showed presence of aphid (24.00) and it was significantly different from control (169.33).

Similar trend was observed five days after spraying. Number of aphids present in chlorantraniliprole18.5 % SC @ 30 g a. i ha^{-1} was 33.33 which was significantly different from control plot (178.33). However, aphid population appeared in flubendiamide19.92 % + thiacloprid 19.92 % SC @ 48+48 g a.i ha^{-1} treated plants (26.67) which was significantly different from chlorantraniliprole18.5 % SC @ 30 g a.i ha^{-1} (41.67) treated plants and control (178.33) after seven days of spraying. No aphids were seen in 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 @ 27.5 g a.i ha^{-1}, beta cyfluthrin 8.49 % + imidacloprid 19.81 % SC @ 15.75+36.7 g a.i ha^{-1}, hand mixed product of chlorantraniliprole 18.5 % SC + thiamethoxam 25 % WG @ (1:1) and thiamethoxam 25 % WG @ 30 g a.i ha^{-1} treated plants.

After ten days of spraying, the highest population was noticed in chlorantraniliprole 18.5 % SC @ 30 g a.i ha^{-1} (63.33) followed by flubendiamide 19.92 % + thiacloprid 19.92 % SC @ 48+48 g a.i ha^{-1} (36.67) and lambda cyhalothrin 4.6 % + chlorantraniliprole 9.3 % ZC @ 30 g a.i ha^{-1} (30.00). Whereas, no population was detected in chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC @ 150 g a.i ha^{-1}, thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC @ 27.5 g a.i ha^{-1}, beta cyfluthrin 8.49 % + imidacloprid 19.81 % SC @ 15.75+36.7 g a.i ha^{-1}, hand mixed product of chlorantraniliprole 18.5 % SC +thiamethoxam 25 % WG @ (1:1) and thiamethoxam 25 % WG @ 30 g a.i ha^{-1}

On fifteen days after spraying, the highest population was found in chlorantraniliprole18.5 % SC @ 30 g a.i ha^{-1} (121.00) which is significantly different from other treatments. flubendiamide19.92 % + thiacloprid 19.92 % SC @ 48+48 g a.i ha^{-1} was recorded a population of 51.67 is on par with lambda cyhalothrin 4.6 % + chlorantraniliprole 9.3 % ZC @ 30 g a.i ha^{-1} (50.00). While, the lowest population was recorded in beta cyfluthrin 8.49 % + imidacloprid 19.81 % SC @ 15.75+36.7 g a.i ha^{-1} (21.00).

The studies on the bio efficacy of combi products against cowpea pests are so meagre. However, several research works on efficacy of pesticide mixture against pests of cotton, tea, rice etc., are available. Studies conducted by insecticide mixture, thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC @ 27.5 g a.i ha^{-1} against sucking pests was found to be effective against jassids and whiteflies in soy bean[4] and sucking pests of tea [5].

Another granular formulation chlorantraniliprole 5% + thiamethoxam 10 % WG was effective in managing sucking pests of rice [6]. These findings are in agreement with the present study [7]. reported that chlorantraniliprole 10 % + thiamethoxam 20 % SC was highly effective against aphid infesting cowpea. Various research works have been conducted by using single insecticide thiamethoxam against aphid. Thiamethoxam 25 WG @ 25 g a.i ha^{-1} was found to be effective in decreasing aphids in green gram [8], brinjal [9], blackgram [10], cowpea and salad cucumber [11], cowpea [12], and in urd bean [13].

The rate of resistance development in an arthropod pest population is approximately proportional to the frequency of pesticide applications, especially when using those with similar modes of action [14, 15]. Major resistance mechanisms associated with arthropod pests are metabolic detoxification and target site insensitivity [15, 16].

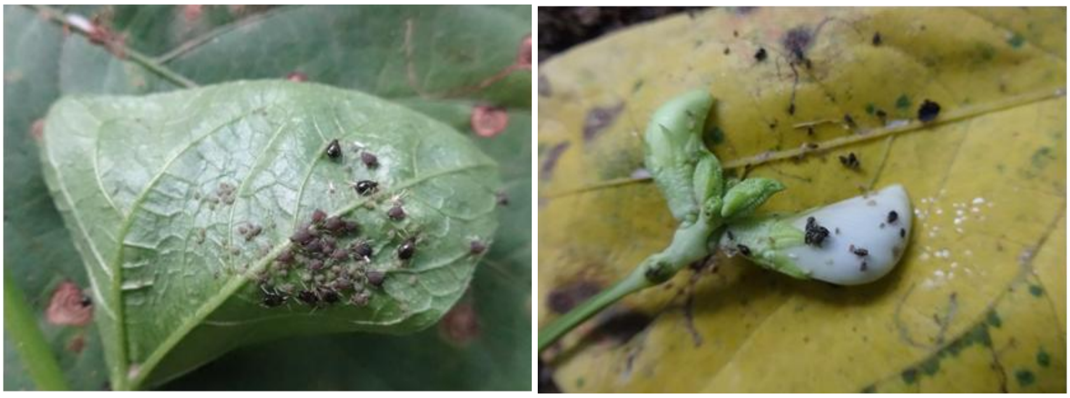
Table 2: Population of cowpea aphid, *Aphis craccivora* treated with insecticide mixtures

Insecticide mixtures	Field dose (mL L^{-1})	*Number of aphids per 15 cm shoot (DAS)					
		1	3	5	7	10	15
T_1: Chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC	0.30	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)
T_2: Lambda cyhalothrin 4.6 % + chlorantraniliprole 9.3 % ZC	0.50	0 (0.70)	0 (0.70)	0 (0.70)	13.67 (3.77)	30.00 (5.51)	50.00 (7.06)
T_3: Thiamethoxam 12.6 % + lambda cyhalothrin 9.5 % ZC	0.30	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)
T_4: Beta cyfluthrin 8.49 %+ imidacloprid 19.81 % SC	0.40	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)	21.00 (0.70)
T_5: Flubendiamide19.92% +thiacloprid 19.92 % SC	0.50	0 (0.70)	0 (0.70)	0 (0.70)	26.67 (5.21)	36.67 (6.09)	51.67 (7.23)
T_6: Chlorantraniliprole 18.5 % SC +thiamethoxam 25 % WG (1:1) (Tank mixed)	0.30	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)
T_7: Chlorantraniliprole18.5% SC (check)	0.30	30.00 (5.51)	24.00 (4.92)	33.33 (5.80)	41.67 (6.49)	63.33 (7.98)	121.00 (10.49)
T_8: Thiamethoxam 25 % WG (check)	0.40	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)	0 (0.70)
T_9: Control		121.67 (11.04)	169.33 (13.01)	178.33 (13.34)	178.33 (13.34)	196.67 (14.01)	211.67 (14.54)
CD (0.05)		0.399	0.613	0.602	0.682	0.689	1.041

Figures in parentheses are $\sqrt{x+1}$ transformed values, DAS- Days after spraying, *Mean of fifteen plants

a. Riptortes pedestris **b.** Damage symptom on pods

Plate 1: Pod bug and its infestation in cowpea pods



Leaf infestation Flower infestation

Plate 2: Infestation of cowpea aphid, *A. craccivora* in cowpea

Conclusion

The present study on the evaluation of insecticide mixtures against pests of cowpea revealed that the combination insecticides *viz.*, 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} were proved better in managing the sucking pests cowpea aphid, *A. craccivora* and pod bug, *R. pedestris* along with tank mixed insecticide mixture. However, the tank mixing may not be used under field conditions due to variation in dosage during mixing by the famers.

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