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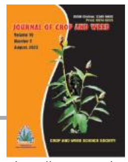

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Effect of Teflubenzuron 75 g l^{-1} + Alphacypermethrin 75 g l^{-1} 150 SC against fall armyworm (*Spodoptera frugiperda* S.) in maize

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ABSTRACT

The present study was conducted to evaluate bio-efficacy of four different concentrations of Teflubenzuron 75 g l^{-1}+Alphacypermethrin 75 g l^{-1}150 SC (200, 300, 400 and 500 ml ha^{-1}) during rabi, 2019-2020 and kharif, 2020 against fall armyworm (FAW) on maize. The premix formulation of this chemical @ 500 ml ha^{-1}gave highest larval population reduction (84.69-81.13 %), lowest leaf damage scoring (1.06-0.83 at 10 days after 2nd spray), highest green cob yield (147.67-133.00 q ha^{-1}) and satisfactory adult coccinellids (1.67-2.00/5 plants at 10 DAS) for both season of trials. The other two next lower doses i.e., @ 400 and 300ml ha^{-1} of the said chemical were also good and they were followed by Thiamethoxam + Lambda cyhalothrin 9.5 % ZC @ 125 ml ha^{-1}. Considering best result from the present experiment, the premix formulation of Teflubenzuron 75 g l^{-1} + Alphacypermethrin 75 g l^{-1}150 SC @ 500 ml ha^{-1} may be recommended to use by the farmers to combat S. frugiperda in maize.

Keywords : Bio-efficacy, FAW, *kharif*, *rabi*, teflubenzuron + alphacypermethrin, treatments

One of the most adaptable developing crops, maize (*Zea mays* L.), has a wide range of adaptation under various agro-climatic situations. Because it has the largest genetic yield potential of all the cereals, maize is referred to as the "queen of cereals" internationally. It is grown on about 150 million hectares in roughly 160 nations with a diverse range of soil types, climates, biodiversity, and management techniques, contributing 36% (782 million t) to the world's grain supply. After rice and wheat, maize is the third-most significant food crop in India. It is grown on 17.49 lakh acres, according to one estimate (Anon., 2019a). Maize serves as a basic raw material as an ingredient in thousands of industrial products, including starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package, and paper industries, in addition to serving as a staple food for humans and high-quality animal feed (Anon., 2019b). In India, maize is grown all year round for use in making industrial goods, green cobs, sweet corn, baby corn, and feed. Due of its special qualities, maize is an excellent crop choice for improving Indian farmers' livelihoods and revenue.

One of the most destructive insect pests on several crops worldwide is the fall armyworm (FAW), *Spodoptera frugiperda* (Smith) (Noctuidae: Lepidoptera). More than 353 plant species from 76 families have reportedly been harmed by this polyphagous insect, which also causes severe losses to numerous agricultural crops (Montezano *et al*., 2018). In January 2016, the first mention of FAW came from Africa (Goergen *et al*., 2016). *S. frugiperda* was discovered for the first time in India in May 2018 in the fields of maize at the University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka (Sharanabasappa *et al*., 2018). The larva of the fall armyworm eats within the whorls of maize, minimizing its interaction with pesticides. Farmers claim that the currently utilized synthetic pesticides at approved levels are ineffective against the fall armyworm due to their usage of 4-5 sprays of various insecticides at high concentrations without understanding of their efficiency (Gutiérrez-Moreno *et al*., 2019). Multiple applications of insecticides may hasten the emergence of resistance in other regions and also contribute to the buildup of pesticides in the environment. Hence, the present trial was conducted to assess the effectiveness of various doses of the new mixed insecticide Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC against fall army worm of maize.

MATERIALS AND METHODS

The experiment was conducted at research farm of College of Agriculture, BCKV, Burdwan, West Bengal, India for two consecutive seasons (*Rabi*, 2019-2020 and *kharif*, 2020). Each replicated trial plot (5 m x 4 m) was laid out in randomized block design (RBD) with four

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replications for each treatment. The number of treatments including untreated control was eight which are mentioned with all details in Table 1. The crop (Variety: Sindhu) was raised maintaining all standard and recommended package of agronomic practices for tillage, spacing, manuring and irrigation. The insecticides were applied as foliar spray with knapsack sprayer (high volume sprayer) using 500 litres of water ha^{-1}. The required dose of the test insecticide was mixed with water.

The data on larval population of *S. frugiperda* were recorded from 10 plants per plot at one day before spray, 3, 5, 7 and 10 days after spray. Accordingly treatment wise larval percent mortality was calculated over untreated control. The yield of maize per plot of 20 m^2 at harvest was considered. The yield data thus obtained were expressed in q ha^{-1} which were analyzed statistically and has been presented. The impact of different concentrations of Teflubenzuron 75 g l^{-1} +Alphacypermethrin 75 g l^{-1}on available important natural enemies (coccinellids) was tested in maize. Their populations were estimated by counting their total numbers from selected 10 plants per plot at 1 day before and 10 days after spray for each treatment. Leaf damage scoring for different treatments was also followed according to Patel and Zaman (2022) (Table 2).

Appropriate statistical tests were followed for the analysis of all data.

RESULTS AND DISCUSSION

During *rabi* season (2019-20), before spray, fall armyworm (larva) population was ranged from 2.00 to 2.17 per plant which was statistically non-significant. All the chemicals were good enough than untreated control to manage fall armyworm population. After two sprays, Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 500 ml ha^{-1} recorded the highest percent reduction over control (84.69%) and is followed by Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 400 ml ha^{-1} (81.83 %) and @ 300 ml ha^{-1} (76.61 %) (Table 3). The next best treatment was Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC @ 125 ml ha^{-1} causing 74.16 % reduction. It was closely followed by 71.27 % reduction in lowest dose (200 ml ha^{-1}) of Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC. Whereas, the lowest reduction (68.24 %) occurred in Alphacypermethrin 10% SC @ 300 ml ha^{-1} and it was followed by 68.64 % reduction in Teflubenzuron 150 SC @ 200 ml ha^{-1}.

Table 5 shows the data on leaf damage score (1-9 scale) at 5 and 10 days after each of 2 round sprays with different insecticides during rabi season (2019-2020). All the treatments awarded significantly lower leaf damage scores than untreated control. The lowest leaf damage score (0.73±0.08 at 5 DAS and 0.43±0.14 at 10 DAS) was observed with the Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 500 ml ha^{-1} followed by same chemical @ 400 ml ha^{-1}(1.46±0.18 at 5 DAS and 0.90±0.11 at 10 DAS) and 300 ml ha^{-1} (1.53±0.14 at 5 DAS and 1.00±0.11 at 10 DAS). The next lowest score was obtained in Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC @ 125 ml ha^{-1} (1.73±0.20 at 5DAS and 1.10±0.11 at 10 DAS) followed by Teflubenzuron 150 SC @ 200 ml ha^{-1} (2.03±0.29 at 5 DAS and 1.20±0.11 at 10 DAS). The highest leaf damage score was obtained in untreated control (3.90±0.23 at 5 DAS and 2.43±0.17 at 10 DAS) and it was followed by Alphacypermethrin 10% SC @ 300 ml ha^{-1} (2.26±0.17 at 5 DAS and 1.73±0.12 at 10 DAS) and Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 200 ml ha^{-1} (2.10±0.40 at 5 DAS and 1.46±0.08 at 10 DAS). More or less similar results have been observed in case of 2nd spray also.

During second season (*Kharif*, 2020), before spray, fall army worm (larva) population was ranged from 0.60 to 0.87 per plant which was statistically non-significant. Different treatment wise, its population reductions over untreated control were more or less similar in tendency just like 1st season trial. All the chemicals were good enough to control fall armyworm population than untreated control. After two sprays, Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 500 ml ha^{-1} recorded the highest percent reduction over control (81.13 %) and was closely followed by same treatment @ 400 ml ha^{-1} (79.89 %) and 300 ml ha^{-1} (78.18 %) (Table 4).The next best treatment was Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC @ 125 ml ha^{-1} (70.8 %) followed by Teflubenzuron 75g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 200 ml ha^{-1} (67.2 %). The lowest population reduction (63.37 %) was recorded in Teflubenzuron 150 SC @ 200 ml ha^{-1} followed by Alphacypermethrin 10% SC @ 300 ml ha^{-1}(66.45 %).

The trend of leaf damage score caused by *S. frugiperda* was found almost similar like 1st season trial at 5 and 10 days after each round of sprays. The lowest leaf damage score (1.56±0.20 at 5 DAS and 1.06±0.27 at 10 DAS) was observed with the Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 500 ml ha^{-1} followed by the same chemical @ 400 ml ha^{-1} (1.86±0.20 at 5 DAS and 1.66±0.43 at 10 DAS) and 300 ml ha^{-1} (2.00±0.17 at 5 DAS and 1.93±0.08). The next best damage score (2.26±0.24 at 5 DAS and 2.03±0.18) was obtained in Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC @ 125 ml ha^{-1} and it was followed by Teflubenzuron 150 SC @ 200 ml ha^{-1} (2.50±0.17 at

Table 1:Treatment details for bio-efficacy trial

Tr. No.	Treatment details	Dose ha^{-1} g *a.i.*	Water volume (L ha^{-1})	Formulation (ml)
T_1	Teflubenzuron 75 g l^{-1}+Alphacypermethrin 75 g l^{-1} 150 SC	30	200	500
T_2	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	45	300	500
T_3	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	60	400	500
T_4	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	75	500	500
T_5	Teflubenzuron 150 SC	30	200	500
T_6	Alphacypermethrin 10% SC	30	300	500
T_7	Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC	27.5	125	500
T_8	Untreated check	-	-	-

Table 2: Visual rating scales for leaf damage assessment

Scale	Description
0	No visible leaf damage
1	Only pinhole damage on leaves
2	Pinhole and shot hole damage to the leaves
3	Small elongated lesions (5-10 mm) on 1-3 leaves
4	Midsized lesions (10-30 mm) on 4-7 leaves
5	Large elongated lesions (> 30 mm) or small portions have eaten on 3-5 leaves
6	Elongated lesions (> 30 mm) and large portions have eaten on 3-5 leaves
7	Elongated lesions (> 30 cm) and 50% of leaf eaten
8	Elongated lesions (30 cm) and large portions have eaten on 70% of leaves
9	Most leaves with long lesions and complete defoliation observed

5 DAS and 2.46±0.18 at 10 DAS). The highest leaf damage score (3.86±0.26 at 5 DAS and 3.46±0.31 at 10 DAS) was received in untreated control followed by Alphacypermethrin 10% SC @ 300 ml ha^{-1} (2.80±0.32 at 5 DAS and 2.63±0.23 at 10 DAS) and Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 200 ml ha^{-1} (2.70±0.30 at 5 DAS and 2.50±0.34 at 10 DAS). Similar results have been observed in case of 2nd spray also (Table 6).

Considering yield of green cob, all insecticidal treatments were statistically better than untreated control. During the first season (rabi) (2019-20) the highest yield was recorded in the treatment of Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 500 ml ha^{-1}*i.e.*, 147.67 q ha^{-1}. It was significantly at par (147.33 q ha^{-1}) in its next dose @ 400 ml ha^{-1}. The lowest yield (125.00 q ha^{-1}) was recorded in untreated control. Apropos the yield performance, the descending status for other treatments were followed as Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 300 ml ha^{-1} (142.33 q ha^{-1}) >Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC @ 125 ml ha^{-1} (140 q ha^{-1}) >Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 200 ml ha^{-1} (135 q ha^{-1}) >Teflubenzuron 150 SC @ 200 ml ha^{-1} (127.67 q ha^{-1}) > Alphacypermethrin 10% SC @ 300 ml ha^{-1} (126.33 q ha^{-1}).

During the Second season (Kharif) (2020-21), the highest green corn cob yield (133.00 q ha^{-1}) was recorded both in the treatments of Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 500 ml ha^{-1} and 400 ml ha^{-1}. The lowest yield was recorded in untreated control which was 113.33 q ha^{-1} (Table 7). The descending trend was almost same like 1st season for all other treatments.

In both seasons of trial (Rabi 2019-20 and Kharif 2020), no significant variations in coccinellid population were noted at different treatments including untreated control at 1 day before spray (DBS) and 10 days after spray (DAS)per five plants, the number of coccinellid adults was ranged from 1.33 to 1.67 at 1 DBS and 1.33 to 2.00 at 10 DAS during 1st season. Same level of population ranged from 1.33 to 2.00 for both at 1 DBS and 10 DAS during 2nd season. (Table 8).

In this experiment, effect of Teflubenzuron + Alphacypermethrin was evaluated for the first time against *S. frugiperda* in maize crop. Scanty literatures have been observed on this chemical control. Tomquelski and Martins (2007), reported that the population of *S. frugiperda* can be minimized by applying Teflubenzuron and Alphacypermethrin separately in Brazil which supports the results of the present investigation. Lamda cayhalothrin +

Table 3: Bio-efficacy of Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC against fall army worm population in Maize for the year 2019-20 (Rabi)

Tr.No.	Treatments	Dose (ml ha^{-1})	Number of larvae/Plant									Per cent reduction over control
			1st spray					2nd spray				
			DBS	3DAS	5DAS	7DAS	10DAS	3DAS	5DAS	7DAS	10DAS	
T_1	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	200	2.07 (1.60)	0.87 (1.17)	0.77 (1.13)	0.70 (1.09)	0.67 (1.08)	0.13 (0.79)	0.10 (0.77)	0.13 (0.79)	0.10 (0.77)	71.27
T_2	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	300	2.03 (1.59)	0.87 (1.17)	0.67 (1.08)	0.60 (1.05)	0.53 (1.02)	0.13 (0.80)	0.10 (0.77)	0.07 (0.75)	0.03 (0.73)	76.61
T_3	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	400	2.07 (1.60)	0.67 (1.08)	0.53 (1.02)	0.43 (0.97)	0.40 (0.95)	0.13 (0.79)	0.07 (0.75)	0.07 (0.75)	0.00 (0.71)	81.83
T_4	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	500	2.10 (1.61)	0.57 (1.03)	0.47 (0.98)	0.40 (0.95)	0.40 (0.95)	0.07 (0.75)	0.03 (0.73)	0.10 (0.77)	0.00 (0.71)	84.69
T_5	Teflubenzuron 150 SC	200	2.17 (1.63)	0.90 (1.18)	0.73 (1.11)	0.67 (1.08)	0.70 (1.10)	0.23 (0.84)	0.10 (0.77)	0.20 (0.84)	0.03 (0.73)	68.64
T_6	Alphacypermethrin 10% SC	300	2.13 (1.62)	0.90 (1.18)	0.77 (1.13)	0.77 (1.12)	0.80 (1.14)	0.17 (0.81)	0.17 (0.81)	0.17 (0.81)	0.03 (0.73)	68.24
T_7	Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC	125	2.00 (1.59)	0.73 (1.11)	0.57 (1.03)	0.67 (1.08)	0.67 (1.07)	0.17 (0.82)	0.13 (0.80)	0.07 (0.75)	0.07 (0.75)	74.16
T8	Untreated check	-	2.10 (1.61)	2.27 (1.66)	2.27 (1.66)	2.30 (1.67)	2.27 (1.65)	0.43 (0.96)	0.63 (1.06)	0.37 (0.93)	0.47 (0.98)	-
	SEm(±)	-	0.03	**0.03**	**0.03**	0.02	0.03	0.06	0.05	0.05	0.02	-
	LSD(0.05)	-	0.09	0.08	0.08	0.07	0.10	0.18	0.14	0.16	0.07	-

*Figures in the parentheses are "X+0.5 transformed value; DBS: Day Before Spray; DAS: Days After Spray

Table 4: Bio-efficacy of Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC against fall army worm population in Maize for the year 2020-21 (Kharif)

Tr. No.	Treatments	Dose (ml ha^{-1})	Number of larvae/Plant									Per cent reduction over control
				1st spray				2nd spray				
			DBS	3DAS	5DAS	7DAS	10DAS	3DAS	5DAS	7DAS	10DAS	
T_1	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	200	0.67 (1.06)	0.33 (0.90)	0.23 (0.84)	0.70 (1.08)	0.43 (0.96)	0.50 (0.98)	0.20 (0.84)	0.37 (0.92)	0.10 (0.77)	67.24
T_2	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	300	0.87 (1.15)	0.10 (0.77)	0.20 (0.83)	0.33 (0.90)	0.47 (0.98)	0.23 (0.86)	0.20 (0.83)	0.27 (0.87)	0.10 (0.77)	78.18
T_3	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	400	0.60 (1.04)	0.30 (0.79)	0.13 (0.79)	0.23 (0.86)	0.40 (0.87)	0.27 (0.87)	0.23 (0.86)	0.13 (0.79)	0.07 (0.75)	79.89
T_4	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	500	0.63 (1.06)	0.00 (0.71)	0.23 (0.84)	0.40 (0.94)	0.40 (0.94)	0.20 (0.83)	0.13 (0.79)	0.27 (0.86)	0.03 (0.73)	81.13
T_5	Teflubenzuron 150 SC	200	0.83 (1.15)	0.27 (0.87)	0.63 (1.06)	0.60 (1.05)	0.50 (1.06)	0.13 (0.79)	0.30 (0.89)	0.40 (0.95)	0.40 (0.95)	63.37
T_6	Alphacypermethrin 10% SC	300	0.87 (1.17)	0.20 (0.84)	0.50 (1.00)	0.73 (1.11)	0.53 (1.01)	0.07 (0.75)	0.23 (0.85)	0.63 (1.05)	0.10 (0.77)	66.45
T_7	Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC	125	0.80 (1.14)	0.23 (0.85)	0.43 (0.97)	0.50 (1.00)	0.40 (0.95)	0.23 (0.85)	0.17 (0.82)	0.40 (0.95)	0.20 (0.84)	70.84
T_8	Untreated check	-	0.87 (1.16)	1.40 (1.33)	1.20 (1.29)	1.60 (1.43)	0.87 (1.17)	1.00 (1.22)	1.10 (1.26)	0.77 (1.12)	0.77 (1.12)	-
	SEm(±)		0.07	0.09	0.08	0.08	0.05	0.06	0.03	0.06	0.03	-
	LSD(0.05)		0.21	0.28	0.23	0.24	0.14	0.18	0.09	0.19	0.09	-

* Figures in the parentheses are"X+0.5 transformed value;DBS: Day Before Spray; DAS: Days After Spray

Table 5: Scoring of leaf damage (1-9 scale) caused by *S. frugiperda* for the year 2019-20 (*Rabi*)

Tr. No.	Treatment details	Dose (ml ha^{-1})	1st spray		2nd spray	
			5 DAS (mean±SD)	10 DAS (mean±SD)	5 DAS (mean±SD)	10 DAS (mean±SD)
T_1	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	200	2.10±0.40	1.46±0.08	2.03±0.35	2.06±0.27
T_2	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	300	1.53±0.14	1.00±0.11	1.56±0.12	1.63±0.14
T_3	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	400	1.46±0.18	0.90±0.11	1.36±0.29	1.56±0.20
T_4	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	500	0.73±0.08	0.43±0.14	0.83±0.14	1.06±0.17
T_5	Teflubenzuron 150 SC	200	2.03±0.29	1.20±0.11	2.36±0.31	2.26±0.29
T_6	Alphacypermethrin 10% SC	300	2.26±0.17	1.73±0.12	2.36±0.17	2.26±0.08
T_7	Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC	125	1.73±0.20	1.10±0.11	1.60±0.26	1.83±0.26
T_8	Untreated check	-	3.90±0.23	2.43±0.17	3.23±0.24	2.86±0.08
	SEm(±)		**0.21**	**0.06**	**0.23**	**0.20**
	LSD(0.05)		**0.64**	**0.18**	**0.70**	**0.62**

Table 6: Scoring of leaf damage (1-9 scale) caused by *S. frugiperda* for the year 2020-21 (Kharif)

Tr. No.	Treatment details	Dose (ml ha^{-1})	1st spray		2nd spray	
			5 DAS (mean±SD)	10 DAS (mean±SD)	5 DAS (mean±SD)	10 DAS (mean±SD)
T_1	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	200	2.70±0.30	2.50±0.34	2.26±0.24	1.96±0.18
T_2	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	300	2.00±0.17	1.93±0.08	1.70±0.11	1.46±0.12
T_3	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	400	1.86±0.20	1.66±0.43	1.53±0.29	1.33±0.26
T_4	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	500	1.56±0.20	1.06±0.27	1.03±0.33	0.83±0.33
T_5	Teflubenzuron 150 SC	200	2.50±0.17	2.46±0.18	2.40±0.15	2.13±0.14
T_6	Alphacypermethrin 10% SC	300	2.80±0.32	2.63±0.23	2.46±0.20	2.20±0.17
T_7	Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC	125	2.26±0.24	2.03±0.18	1.70±0.23	1.63±0.03
T_8	Untreated check	-	3.86±0.26	3.46±0.31	3.13±0.20	2.90±0.10
	SEm(±)		**0.23**	**0.29**	**0.22**	**0.17**
	LSD(0.05)		**0.73**	**0.88**	**0.69**	**0.54**

Table 7: Effect of Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC on cob yield of corn during year 2019-20 (*Rabi*) & 2020 (*Kharif*)

Tr.No.	Treatments	Dosage (ml ha^{-1})	2019-20 Yield (q ha^{-1})	2020-21 Yield (q ha^{-1})
T_1	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	200	135.00	117.33
T_2	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	300	142.33	131.67
T_3	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	400	147.33	133.00
T_4	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	500	147.67	133.00
T_5	Teflubenzuron 150 SC	200	127.67	112.33
T_6	Alphacypermethrin 10% SC	300	126.33	111.00
T_7	Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC	125	140.00	130.00
T_8	Untreated check	-	125.00	113.33
	SEm(±)		**1.61**	**1.51**
	LSD(0.05)		**4.83**	**4.51**

Table 8: Effect of Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC on natural enemies of Corn during year 2019-20 (*Rabi*) and 2020-21 (*Kharif*)

Tr.No.	Treatments	Dosage (ml ha^{-1})	Year 2019-20 Mean count of Coccinellids per 10 plants		Year 2020-2021 Mean count of Coccinellids per 10 plants	
			1 DBS	10 DAS	1DBS	10 DAS
T_1	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	200	1.33 (1.34)	1.67 (1.44)	1.67 (1.46)	1.33 (1.34)
T_2	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	300	1.67 (1.35)	1.67 (1.44)	2.33 (1.68)	2.00 (1.56)
T_3	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	400	1.33 (1.34)	1.67 (1.44)	1.67 (1.46)	2.00 (1.56)
T_4	Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC	500	1.67 (1.35)	1.67 (1.44)	1.67 (1.44)	2.00 (1.56)
T_5	Teflubenzuron 150 SC	200	1.33 (1.34)	1.67 (1.44)	1.33 (1.27)	1.67 (1.35)
T_6	Alphacypermethrin 10% SC	300	1.67 (1.44)	1.00 (1.22)	1.33 (1.27)	1.33 (1.34)
T_7	Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC	125	1.67 (1.35)	1.33 (1.34)	2.00 (1.56)	1.67 (1.44)
T_8	Untreated check	-	1.67 (1.46)	2.00 (1.52)	2.00 (1.56)	1.33 (1.29)
	SEm (±)		**0.22**	**0.18**	**0.21**	**0.21**
	LSD(0.05)		**0.66**	**0.54**	**0.64**	**0.62**

Thiamethoxam reduced the larval population of *S. frugiperda* in maize (70.84 to 74.16 %), which is in line of confirmation with earlier investigator Patidar *et al.* (2022). Teflubenzuron + alpha cypermethrin gave 78.82 % reduction in larval population of *Spodoptera litura* in chilli with satisfactory effect on coccinellids (Rai, 2021).

Leaf damage variation based on hedonic score was not shown earlier with any of the chemicals considered in the present experiment. But, leaf damage variation in maize by *S. frugiperda* has recently been reported for the first time by Patel and Zaman (2022) with the chemicals Broflanilide, Chlorantraniliprole and emamectin benzoate. All these findings are in direct or indirect agreement with the present findings.

This study offers important details on the effectiveness of insecticides with various modes of action to combat fall army worm. Considering field bio-efficacy, yield and comparative safety to natural enemies, we may advise to use premix formulation of Teflubenzuron 75 g l^{-1}+ Alphacypermethrin 75 g l^{-1} 150 SC @ 500 ml ha^{-1} as a foliar spray to manage *S frugiperda* in maize.

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