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Field efficacy of selected insecticides against fall armyworm on maize crop

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Abstract
The bio-efficacy of some selected insecticides against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) in maize ecosystem was evaluated at College of Agriculture, Raipur (C.G.). The results of investigation on bio-efficacy of insecticides showed in terms of effect of 1st, 2nd and 3rd spray on the percent reduction of insect population over control and it was resulted that, thiamethoxam 12.6% + lambdacyhalothrin 9.5% ZC@ 125 ml a.i.ha^{-1} was found superior, which was followed by indoxacarb 14.5% SC@ 750 ml a.i.ha^{-1}.

Keywords: Bio-efficacy, maize, natural enemies, *Spodoptera frugiperda*

Introduction
Maize (*Zea mays* L.) belongs to the family of poaceae and also known as corn, is a cereal that was first time grown by people in Central America. Now days it is world's third largest cereal crop and due to its greater genetic yield ability, is called as "Queen of Cereals". In world the whole area, production and productivity under maize crop during 2017-18 were 180 million ha, 103 million tonnes and 5.72 tonnes per ha, respectively while in India the area, production and productivity were recorded, 9.5 million ha, 25.00 million tonnes and 2.63 tonnes per ha, respectively (Anonymous, 2017). In Chhattisgarh, maize crop occupies an area of 71.48 lac per ha with production of 149.2 lac per tonnes and an average productivity of 2089 kg per ha (Anonymous, 2018).
The insect pests of maize field include cut worms, stem borer, white grub, chaffer beetle, armyworm, gram pod borer, wireworm, hairy caterpillar etc. (Arifie *et. al.* 2019) [2]. There are many pests of maize crop that can cause damage to yield of maize. Insect infestation is one of them. Mathur (1987) [7] observed that over 250 species of insect are associated with maize yield losses in the field as well as in storage conditions. These insects cause massive losses in maize crops. According to Khan (1983) [6] the annual losses due to stem-borer in maize crop of 149 million of rupees. In past few years, an invasive pest fall armyworm (belonging to the Order –Lepidoptera and Family-Noctuidae) is reported which is responsible for huge losses in maize crop (Goergen *et al*., 2016) [4]. In Chhattisgarh the fall armyworm, *Spodoptera frugiperda* was first reported at Raipur in the month of August 2018 (Deole and Paul 2018) [3].

Material and Method
The present investigation was conducted at Research Cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The trials were laid out during year 2019 in a randomized block design having plot size of 4.5×5.0 m^2 at experiment from of the department. The sowing was done on 14 July 2019 and maize crop variety was NMH-731. The pre-treatment observation on fall armyworm (number of larvae per plant) were taken 24 hours before spraying, while post-treatment observation made after 3, 5, 7 and 10 days after spraying. For the observation, five plants were randomly selected from each plot and per cent reduction of *S. frugiperda* was also worked out. Eight insecticides *viz*. Chlorpyrifos 50 + Cypermethrin 5% EC@ 750 ml a.i.ha^{-1}, Chlorpyrifos 50% + Cypermethrin 5% EC@ 1000 ml a.i.ha^{-1}, Chlorpyrifos 50% EC@ 1000 ml a.i.ha^{-1}, Cypermethrin 10% EC@ 750 ml a.i.ha^{-1}, Thiamethoxam 12.6% + Lambda-Cyhalothrin 9.5% ZC@ 125 ml a.i.ha^{-1}, Cypermethrin 10% + Indoxacarb 10% SC@ 750 ml a.i.ha^{-1}, Cypermethrin 10% + Indoxacarb 10% SC@ 1000 ml a.i.ha^{-1}, Indoxacarb 14.5% SC@ 750 ml a.i.ha^{-1} were evaluated against fall armyworm.

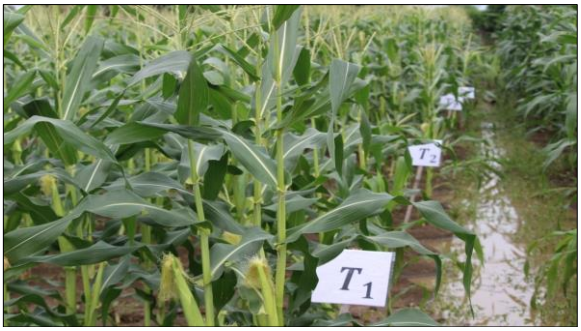

Fig 1: View of the pest management trial

Result and Discussion

The observations were recorded after first spray revealed that, percent reduction of *S. frugiperda* population was ranged from 40.74 to 65.92 percent in various treatments. The overall maximum larval population reduction was recorded in T_5 (65.92), which was treated by Thaimethoxam 12.6% EC + Lambda-cyhalothrin 9.5% ZC@125 ml a.i. ha^{-1} followed by T_8- Indoxacarb 14.5 SC@ 750 ml a.i.ha^{-1}(57.77%), while lowest in T_7 - Cypermethrin 10% EC + Indoxacarb 10% SC@ 1000 ml a.i. ha^{-1} treated plot and was recorded only 40.74 percent reduction in insect population (Table1).

During second spray, percent reduction of *S. frugiperda* population was variate from 49.36 to 83.54 percent in different treatments. The overall maximum larval population reduction was recorded in T_5 plot *i.e.* 83.54, which was treated by Thaimethoxam 12.6% EC + Lambda-cyhalothrin 9.5% ZC@125 ml a.i. ha^{-1}, followed by T_4 - Cypermethrin 10% EC@750 ml a.i. ha^{-1} (78.48), while lowest in T_2 – chlorpyrifos 50% + Cypermethrin 5% EC@1000 ml a.i. ha^{-1} treated plot and was recorded only 49.36 percent reduction in insect population (Table2).

The observations were recorded after third spray revealed that, percent reduction of *S. frugiperda* population was ranged from 54.65 to 84.88 percent in various treatments. The overall maximum larval population reduction was recorded in T_5- Thaimethoxam 12.6% EC + Lambda-cyhalothrin 9.5% ZC@125 ml a.i. ha^{-1} (84.88), followed by T_8 - Indoxacarb 14.5% SC@750 ml a.i. ha^{-1} (75.58), while lowest in T_7 - Cypermethrin 10% + Indoxacarb 10% SC@1000 ml a.i. ha^{-1} treated plot and was recorded only 54.65 percent reduction in insect population (Table3).

According to the results of analysis, the larval percent reduction of fall armyworm was recorded maximum in Thaimethoxam 12.6% EC + Lambda-cyhalothrin 9.5% ZC@125 ml a.i. ha^{-1} with 65.92 percent after first spray, 83.54 percent after second spray and 84.88 percent after third spray.

The present findings were confirmed with the results of Satyanarayana *et al.* (2010) [8] who found that Emamectin benzoate 0.00725% was the most effective insecticides followed by Indoxacarb 0.0145% and Indoxacarb 0.00725% + Novaluron 0.005% in reducing the larval population of *S. litura.*

Table 1: Bio-efficacy of various combination of insecticides against fall armyworm after first spray on maize crop

Treatments	Insecticides	Pre-treatment observation	Post-treatment observation				Mean	Percent reduction of insect population over control
			3 DAS	5 DAS	7 DAS	10 DAS		
T1	Chlorpyrifos 50 +Cypermethrin 5% EC	1.93	1.53	0.33	0.46	0.66	0.77	42.96
		(1.46)	(1.59)	(1.15)	(1.21)	(1.29)		
T2	Chlorpyrifos 50% + Cypermethrin 5% EC	1.86	1.46	0.20	0.60	0.80	0.75	44.44
		(1.50)	(1.57)	(1.09)	(1.26)	(1.34)		
T3	Chlorpyrifos 50% EC	2.26	1.40	0.26	0.53	0.73	0.73	45.92
		(1.56)	(1.54)	(1.12)	(1.23)	(1.31)		
T4	Cypermethrin 10% EC	1.73	1.06	0.33	0.60	0.80	0.66	51.11
		(1.65)	(1.43)	(1.15)	(1.25)	(1.34)		
T5	Thiamethoxam 12.6% + Lambda-Cyhalothrin 9.5% ZC	1.33	0.93	0.13	0.33	0.53	0.46	65.92
		(1.61)	(1.38)	(1.06)	(1.15)	(1.23)		
T6	Cypermethrin 10% + Indoxacarb 10% SC	2.2	1.06	0.40	0.53	0.60	0.66	51.11
		(1.41)	(1.43)	(1.18)	(1.23)	(1.26)		
T7	Cypermethrin 10% + Indoxacarb 10% SC	2.13	1.40	0.40	0.60	0.80	0.80	40.74
		(1.52)	(1.54)	(1.18)	(1.26)	(1.34)		
T8	Indoxacarb 14.5% SC	2.0	1.20	0.20	0.33	0.53	0.57	57.77
		(1.56)	(1.48)	(1.09)	(1.15)	(1.23)		
T9	Untreated	2.60	1.60	1.13	1.33	1.40	1.35	
		(1.61)	(1.61)	(1.26)	(1.52)	(1.54)		
	SE (m) ±	0.064	0.042	0.043	0.064	0.057		
	CD at 5%	N/S	0.126	0.13	0.192	0.172		

Table 2: Bio-efficacy of various combination of insecticides against fall armyworm after second spray on maize crop

Treatments	Insecticides	Pre-treatment observation	Post-treatment observation				Mean	Percent reduction of insect population over control
			3 DAS	5 DAS	7 DAS	10 DAS		
T1	Chlorpyrifos 50 + Cypermethrin 5% EC	1.93	0.40	0.20	0.40	0.53	0.33	58.22
		(1.46)	(1.17)	(1.09)	(1.18)	(1.23)		
T2	Chlorpyrifos 50% + Cypermethrin 5% EC	1.86	0.60	0.20	0.40	0.53	0.40	49.36
		(1.50)	(1.26)	(1.09)	(1.18)	(1.23)		
T3	Chlorpyrifos 50% EC	2.26	0.53	0.13	0.20	0.33	0.28	64.55
		(1.56)	(1.23)	(1.06)	(1.09)	(1.15)		
T4	Cypermethrin 10% EC	1.73	0.26	0.20	0.06	0.33	0.17	78.48
		(1.65)	(1.12)	(1.09)	(1.03)	(1.15)		

T5	Thiamethoxam 12.6% + Lambda-Cyhalothrin 9.5% ZC	1.33	0.20	0.06	0.13	0.26	0.13	83.54
		(1.61)	(1.09)	(1.03)	(1.06)	(1.12)		
T6	Cypermethrin 10% + Indoxacarb 10% SC	2.20	0.33	0.20	0.40	0.46	0.31	60.75
		(1.41)	(1.15)	(1.09)	(1.18)	(1.21)		
T7	Cypermethrin 10% + Indoxacarb 10% SC	2.13	0.40	0.26	0.33	0.40	0.33	58.22
		(1.52)	(1.18)	(1.12)	(1.15)	(1.18)		
T8	Indoxacarb 14.5% SC	2.0	0.26	0.13	0.26	0.33	0.21	73.41
		(1.56)	(1.12)	(1.06)	(1.12)	(1.15)		
T9	Untreated	2.60	0.80	0.93	0.66	1.26	0.79	
		(1.61)	(1.34)	(1.38)	(1.28)	(1.50)		
	SE (m) ±	0.064	0.04	0.033	0.039	0.04		
	CD at 5%	N/S	0.122	0.1	0.118	0.121		

Table 3: Bio-efficacy of various combination of insecticides against fall armyworm after third spray on maize crop

Treatments	Insecticides	Pre-treatment observation	Post-treatment observation				Mean	Percent reduction of insect population over control
			3 DAS	5 DAS	7 DAS	10 DAS		
T1	Chlorpyrifos 50 +Cypermethrin 5% EC	1.93	0.33	0.20	0.4	0.46	0.31	63.95
		(1.46)	(1.15)	(1.09)	(1.18)	(1.21)		
T2	Chlorpyrifos 50% + Cypermethrin 5% EC	1.86	0.04	0.26	0.33	0.40	0.33	61.62
		(1.50)	(1.18)	(1.12)	(1.15)	(1.18)		
T3	Chlorpyrifos 50% EC	2.26	0.53	0.20	0.26	0.33	0.33	61.62
		(1.56)	(1.23)	(1.09)	(1.12)	(1.15)		
T4	Cypermethrin 10% EC	1.73	0.40	0.20	0.46	0.53	0.35	59.30
		(1.65)	(1.18)	(1.09)	(1.20)	(1.23)		
T5	Thiamethoxam 12.6% + Lambda-Cyhalothrin 9.5% ZC	1.33	0.20	0.06	0.13	0.20	0.13	84.88
		(1.61)	(1.09)	(1.03)	(1.06)	(1.09)		
T6	Cypermethrin 10% + Indoxacarb 10% SC	2.20	0.26	0.33	0.46	0.60	0.35	59.30
		(1.41)	(1.12)	(1.15)	(1.20)	(1.23)		
T7	Cypermethrin 10% + Indoxacarb 10% SC	2.13	0.46	0.40	0.33	0.4	0.39	54.65
		(1.52)	(1.21)	(1.18)	(1.14)	(1.17)		
T8	Indoxacarb 14.5% SC	2.00	0.26	0.13	0.26	0.33	0.21	75.58
		(1.56)	(1.12)	(1.06)	(1.12)	(1.15)		
T9	Untreated	2.6	0.80	0.86	0.93	1.00	0.86	
		(1.61)	(1.34)	(1.36)	(1.38)	(1.41)		
	SE (m) ±	0.064	0.037	0.043	0.054	0.055		
	CD at 5%	N/S	0.112	0.131	0.163	0.165		

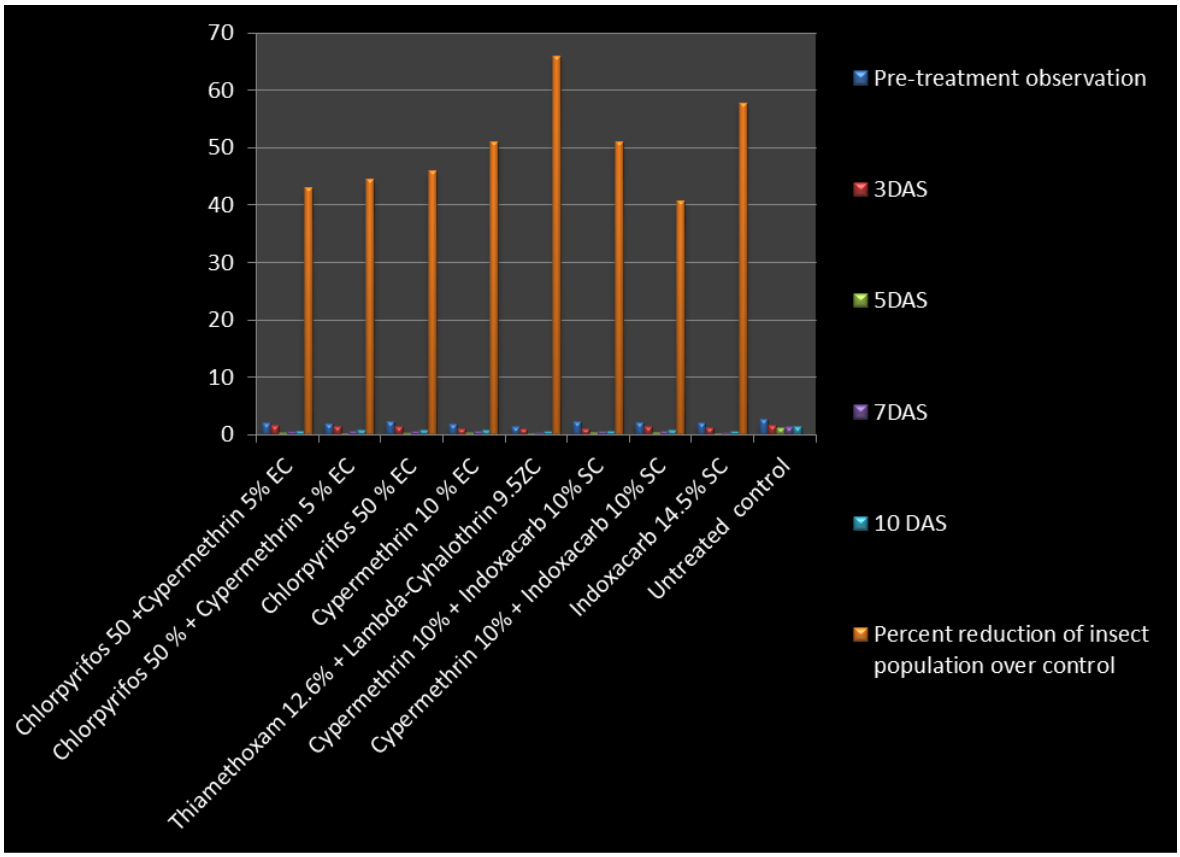

Fig 2: Percent reduction of population of *Spodoptera frugiperda* after first spray

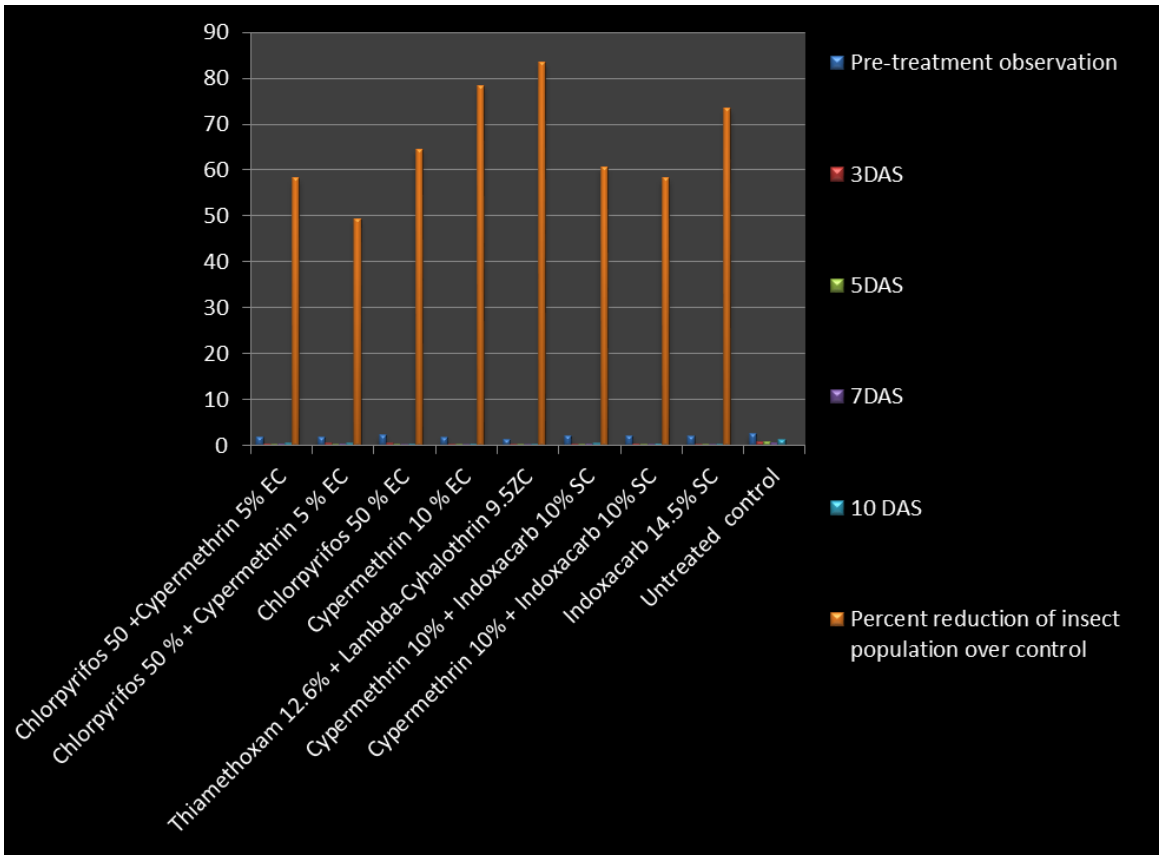

Fig 3: Percent reduction of population of *Spodoptera frugiperda* after second spray

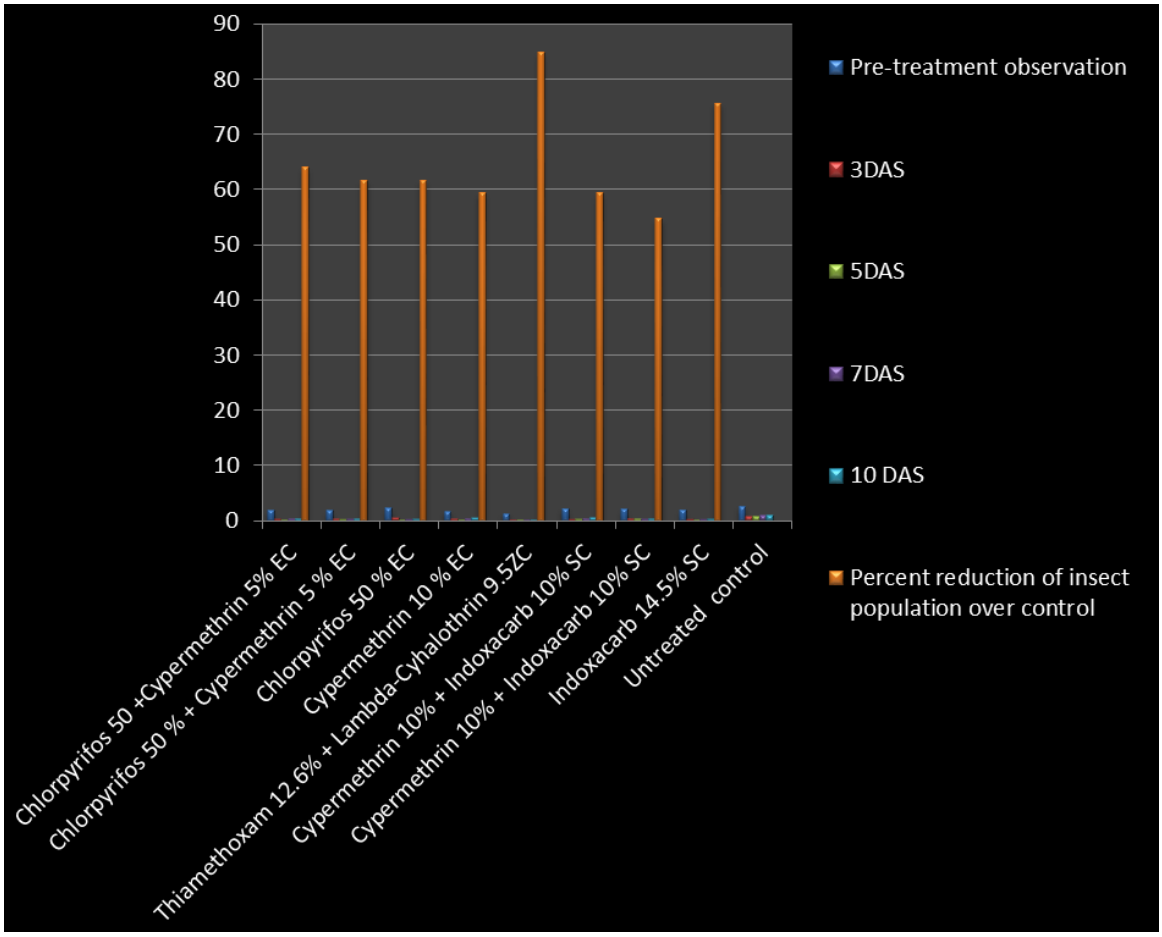

Fig 4: Percent reduction of population of *Spodoptera frugiperda* after third spray

Conclusion

Among the various insecticide formulations used during the thesis research problem, Thiamethoxam 12.6% + lambdacyhalothrin 9.5% ZC@ 125 ml a.i./ha was found to be most effective against fall armyworm as compared to other insecticides.

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