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Bioefficacy of newer insecticide molecules against sucking insect pest complex in okra and their effect on predators

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ABSTRACT: Field experiments were conducted to evaluate the bioefficacy of newer insecticide molecules against okra pest complex and their effect on natural enemies during *kharif* 2019-20. It was found that acetamiprid 20% SP registered significantly lower population of thrips (8.87/3 leaves), leafhopper (6.46/3 leaves), aphid (8.40/3 leaves) and whiteflies (8.46/3 leaves). Further, acetamiprid 20% SP recorded highest reduction in sucking insect pest population compared to untreated control. Imidacloprid 17.8 SL was next best option and registered significantly lower thrips (10.67/3 leaves), leafhoppers (8.53/3 leaves), aphids (10.60/3 leaves) and whiteflies (10.53/3 leaves) population. All the other treatments were significantly superior over untreated control. Acetamiprid 20% SP was also found to be relatively safer and did not have significant deleterious effect on natural enemies. Among all treatments, acetamiprid 20% SP resulted in significantly highest fruit yield (13.45 t/ha).

Keywords: Acetamiprid, okra, thrips, leafhoppers, aphids, whiteflies

INTRODUCTION

Okra (*Abelmoschus esculentus*), popularly known as lady's finger is an important dietary component having very high therapeutic value and health benefits (Anonymous, 2020). Besides, it is also a good source of various vitamins like A, B, C and is also rich in protein, carbohydrates, fats, iron and iodine etc. The okra is one of the important vegetables grown throughout the tropical and sub-tropical regions and also in the warmer parts of the temperate regions. In India okra, is cultivated in 5.46 lakh hectares of area with the production of 54.52 lakh tonnes and productivity of 10 t/ha (Anonymous, 2017). Like other crops, okra also suffers from several biotic and abiotic factors, including insect pests. However, insect pests are major production constraints in okra cultivation and the crop is ravaged by numerous insect pests *viz.,* aphids, leafhoppers, whiteflies and thrips right from sowing till harvesting. These pests cause damage to the crop directly by sucking the sap or indirectly by transmitting a large number of viral diseases. Due to desapping and injection of toxic saliva into plants by sucking pests, leaves turn brownish and may eventually fall down (Rudra and Saikia, 2020). Of late the conventional insecticides are reported to be less effective. There is a need to evaluate new molecules with different mode of action. Hence, present study was conducted to evaluate the bioefficacy of newer insecticide molecules on okra pest complex and their effect on natural enemies.

MATERIALS AND METHODS

A field experiment was conducted at College of Horticulture, Bidar, University of Horticultural Sciences, Bagalkot, during *Kharif* 2019-20 and 2020-21 in Randomized Block Design (RBD), with seven treatments viz., dimethoate 30 EC @ 250 g.a.i/ha, imidacloprid 17.8 SL @ 71.8 g.a.i/ha, acetamiprid 20% SP @ 75 g.a.i/ha, thiamethoxam 25% WG @ 100 g.a.i/ha, profenofos 50 EC @ 250 g.a.i/ha, clothianidin 50 WG @ 25 g.a.i/ha and untreated control replicated thrice. Treatments were imposed on Arka Anamika cultivar of okra which was sown with spacing of 60cm between lines and 30cm from plant to plant. The crop was raised by following package of practices of University of Horticultural Sciences, Bagalkot (Anonymous, 2017a) except plant protection measures. When the pest population crossed the Economic Threshold Level (ETL) treatments were imposed with 1000 litres of spray fluid per hectare using Knapsack Sprayer. The untreated control plot was not sprayed with any chemical.

Observations on thrips, leafhoppers, aphids and whiteflies were recorded on ten randomly selected tagged plants in each plot. Three leaves representing top, middle and bottom portion were selected for recording observations in each plant. The total number of nymphs and adults on each leaf were counted and expressed in terms of numbers per three leaves per plant. The pre-treatment counts were made a day before spray and post treatment counts were made 3, and 7 days after spray. The observations on predators *viz*., Green lace wings and coccinellids were recorded from five randomly selected plants a day before and 3 and 7 days after spray and expressed in terms of numbers per plant. The data recorded on the population of thrips, leafhoppers, aphids and whiteflies were square root transformed. At harvest, total fruit yield per plot was recorded and was computed to hectare basis. The data was subjected single factor Analysis of Variance (ANOVA).

Table 1. Effect of different insecticides on sucking insect pests in okra crop during 2019-20

Treatment	No.thrips / 3 leaves				No.leafhoppers / 3 leaves				No. aphids / 3 leaves			Mean	No.whiteflies / 3 leaves			
	1DBS	3DAS	7DAS	Mean	1DBS	3DAS	7DAS	Mean	1DBS	3DAS	7DAS		1DBS	3DAS	7DAS	Mean
Dimethoate 30 EC @ 250 g a.i./ha	22.8 (4.83)	17.5 (4.24)	14.73 (3.90)	16.12	16.20 (4.09)	15.27 (3.97)	11.73 (3.50)	13.5	18.46 (4.35)	15.51 (4.00)	13.95 (3.80)	14.73	20.20 (4.55)	16.73 (4.15)	14.73 (3.90)	15.73
Imidacloprid 17.8 SL @ 71.8 g a.i./ha	22.73 (4.82)	14.07 (3.82)	10.67 (3.34)	12.37	16.20 (4.09)	12.37 (3.59)	8.53 (3.00)	10.45	18.46 (4.35)	12.06 (3.54)	10.60 (3.33)	11.33	20.20 (4.55)	12.47 (3.60)	10.53 (3.32)	11.15
Acetamiprid 20% SP @ 75 g a.i./ha	22.73 (4.82)	12.27 (3.57)	8.87 (3.06)	10.57	16.00 (4.06)	10.9 (3.38)	6.46 (2.64)	8.68	18.33 (4.34)	10.8 (3.36)	8.40 (2.98)	9.60	20.00 (4.53)	10.40 (3.30)	8.46 (2.99)	9.43
Thiamethoxam 25% WG @ 100 g a.i./ha	22.67 (4.81)	15.85 (4.04)	12.67 (3.63)	14.26	16.27 (4.10)	14.05 (3.81)	10.66 (3.34)	12.36	18.8 (4.39)	14.13 (3.82)	12.6 (3.62)	13.37	20.27 (4.56)	14.67 (3.89)	12.66 (3.63)	13.66
Profenofos 50 EC @ 250 g a.i./ha	22.93 (4.84)	16.33 (4.56)	17.25 (4.21)	16.79	16.27 (4.10)	16.05 (4.07)	12.86 (3.66)	14.46	18.86 (4.40)	17.06 (4.19)	15.86 (4.04)	16.46	20.27 (4.56)	19.67 (4.49)	17.86 (4.28)	18.76
Clothianidin 50 WG @ 25 g a.i./ha	22.67 (4.81)	20.33 (4.39)	16.67 (4.14)	18.50	16.13 (4.08)	16 (4.06)	12.8 (3.65)	14.4	18.26 (4.33)	16.13 (4.08)	14.93 (3.93)	15.53	20.13 (4.54)	18.57 (4.37)	16.8 (4.16)	17.68
Untreated Control	22.87 (4.83)	24.4 (4.99)	26.8 (5.22)	25.6	16.27 (4.10)	19.27 (4.45)	21.4 (4.67)	20.33	18.26 (4.33)	20.06 (4.53)	24.13 (4.96)	22.10	20.27 (4.56)	23.27 (4.88)	25.4 (5.09)	24.34
S Em +	0.3	0.06	0.08		0.18	0.05	0.03		0.02	0.06	0.05		0.18	0.07	0.09	
CD (P=0.05)	NS	0.19	0.26		NS	0.15	0.11		NS	0.18	0.17		NS	0.21	0.27	
CV %	15.23	16.25	13.55		12.1	13.1	19.58		13.2	18.4	19.4		12.1	13.1	16.58	

DBS- Day before spray

DAS-Days after spray

NS- Non-significant

Figures in the parenthesis are √0.5+x transferred values

RESULTS AND DISCUSSION

Thrips population

A day before the imposition of the treatments, population of thrips was uniform and there was no significant difference among the treatments during 2019-20 (Table 1). The observations recorded 3DAS and 7DAS clearly revealed that there was a significant difference among the treatments and all the treatments were superior over the untreated control. Acetamiprid 20 SP registered lowest thrips population (12.27 and 8.87/3leaves at 3DAS and 7DAS, respectively), with mean population of 10.57 thrips/3 leaves (Table-1) which was 76 per cent reduction over the untreated control during 2019-20 (Fig.1). The Imidacloprid 17.8 SL which recorded 14.07 and 10.67 thrips/3 leaves at 3DAS and 7DAS respectively and with mean population of 12.37 thrips/3 leaves was next best treatment. Acetamiprid belongs to new class of insecticide 'neonicotinoids' and precise structure of the acetamiprid is chloronicotinyl compound. It has been shown to be a potent against the nicotinic acetylcholine receptors in insects causing quick knock down of the insects compared to other class of insecticides (Wallace, 2014). Imidacloprid acts on several types of post-synaptic nicotinic acetylcholine receptors in the nervous system (Bunckingham *et al.*, 1997; Matsuda and Sattelle 2005). In insects these receptors are located only within the central nervous system. Following binding to the nicotinic receptors, nerve impulses are spontaneously discharged at this first, followed by, failure of neuron to propagate any signal. Sustained activation of the receptors results from the inability of the acetylcholinisterases to breakdown the pesticide. This binding process is irreversible and brings about the insect death.

Thiamethoxam 25 WG, dimethoate 30EC and clothianidin 50 WG recoded higher mean population of 14.26, 16.12 and 18.50 thrips per 3 leaves, respectively. Untreated control recorded highest population of thrips (25.6/3 leaves). Present findings are in agreement with Udikeri *et al.* (2009; Duraimurugan and Alivelu (2017) who reported the effective control of thrips by newer insecticide acetamiprid 20 SP in cotton and castor crop system, respectively. Similar trend was observed during 2020-21 also wherein acetamiprid was found to be superior over other control by registering highest reduction over untreated control (78%) (Table 2).

Leafhopper population

There was no significant difference among the treatments with respect to leafhopper population a before spray (1DBS) and the population ranged between 16.00 to 16.27 per three leaves during 2019-20 (Table1).

Observations on leafhoppers 3DAS and 7DAS during 2019-20 clearly revealed that acetamiprid 20% SP was significantly superior over other treatments by recording lowest leafhopper population (10.90/3 leaves and 6.46/3 leaves, respectively) with mean population of 8.68 leafhoppers/3 leaves (Table-1) and 85 per cent reduction over control (Fig.1) during 2019-20. Imidacloprid 17.8 SL with 12.37 and 8.53 leafhoppers per plant and thiamethoxam 25% WG with 14.05 and 10.66 leafhoppers per plant 3 DAS and 7 DAS respectively, were next best treatments in row (Table 1). Untreated control recorded significantly highest leafhopper (19.27 and 21.40 leafhoppers/3 leaves, 3 DAS and 7DAS respectively and with highest mean leafhopper population (20.33/3 leaves). Present findings are in accordance with results of Udikeri *et al.* (2009); Duraimurugan and Alivelu (2017) who reported the effective control of leafhoppers in cotton and castor crop, respectively by acetamiprid and imidacloprid. Further, they inferred that neonicotinoid group of insecticides are more effective in controlling the herbivores compared to conventional insecticides mainly because there was no pesticide resistance due to their recent development. Simon Delso (2015) through series of experiments found out that when these neonicotinoid insecticides are translocated through the plant system their physicochemical properties such as high persistence they cause higher mortality in insects compared to previous generation insecticides. The observations made during 2020-21 again revealed that acetamiprid was best among the different treatments with 89 per cent reduction of leafhopper population over control. Similar trend for the performance of other treatments (Table 2).

Aphid population

Aphid population pre count made a before the spray depicted the uniform distribution among the different treatments and there was no significant difference (Table 1). The observations made on aphid population at 3DAS and 7DAS revealed that there was a significant difference among the treatments and all the treatments were superior over untreated control. However, among different treatments, acetamiprid 20% SP was the best by recording lowest aphid population (10.80 and 8.40 per 3 leaves at 3DAS and 7 DAS, respectively with mean population of 9.60 aphids per 3 leaves during 2019-20 (Table 1). Further, the superiority of the acetamiprid was also evidenced by the highest reduction over untreated control (99%) (Fig.1). As observed in the management of other sucking pests imidacloprid 17.8 SL and thiamethoxam 25% WG showed consistent performance against aphids also with 11.33 and 13.37 mean population of aphids. Among all the treatments untreated control was significantly inferior and recorded highest aphid

Table 2: Effect of different insecticides on sucking insect pests in okra crop during 2020-21

Treatment	No. thrips / 3 leaves			Mean	No.leafhoppers / 3 leaves			Mean	No.aphids / 3 leaves			Mean	No. whiteflies / 3 leaves			Mean
	1DBS	3DAS	7DAS		1DBS	3DAS	7DAS		1DBS	3DAS	7DAS		1DBS	3DAS	7DAS	
Dimethoate 30 EC @ 250 g a.i./ha	21.8 (4.72)	16.5 (4.12)	13.73 (3.77)	15.12	15.20 (3.96)	14.27 (3.84)	10.73 (3.35)	12.50	17.46 (4.24)	14.51 (3.87)	12.95 (3.67)	13.73	19.2 (4.44)	15.73 (4.03)	13.73 (3.77)	14.73
Imidacloprid 17.8 SL @ 71.8 g a.i./ha	21.73 (4.71)	13.07 (3.68)	9.67 (3.19)	11.37	15.20 (3.96)	11.37 (3.45)	7.53 (2.83)	9.45	17.46 (4.24)	11.06 (3.40)	9.60 (3.18)	10.33	19.2 (4.44)	11.47 3.46)	9.53 (3.17)	10.5
Acetamiprid 20% SP @ 75 g a.i./ha	21.73 (4.71)	11.27 (3.43)	7.87 (2.89)	9.57	15.00 (3.94)	9.90 (3.22)	5.46 (2.44)	7.68	17.33 (4.22)	9.80 (3.21)	7.40 (2.81)	8.60	19 (4.42)	9.4 (3.15)	7.46 (2.82)	8.43
Thiamethoxam 25% WG @ 100 g a.i./ha	21.67 (4.71)	14.85 (3.92)	11.67 (3.49)	13.26	15.27 (3.97)	13.05 (3.68)	9.66 (3.19)	11.36	17.8 (4.28)	13.13 (3.69)	11.6 (3.48)	12.37	19.27 (4.45)	13.67 (3.76)	11.66 (3.49)	12.67
Profenofos 50 EC @ 250 g a.i./ha	21.93 (4.74)	19.33 (4.45)	16.25 (4.09)	17.79	15.27 (3.97)	15.05 (3.94)	11.86 (3.52)	13.46	17.86 (4.28)	16.06 (4.07)	14.86 (3.92)	15.46	19.27 (4.45)	18.67 (4.38)	16.86 (4.17)	17.77
Clothianidin 50 WG @ 25 g a.i./ha	21.67 (4.71)	17.77 (4.27)	15.67 (4.02)	16.72	15.13 (3.95)	15.00 (3.94)	11.80 (3.51)	13.40	17.26 (4.21)	15.13 (3.95)	13.93 (3.80)	14.53	19.13 (4.43)	17.57 (4.25)	15.8 (4.04)	16.69
Untreated Control	21.87 (4.73)	23.4 (4.89)	25.8 (5.13)	24.6	15.27 (3.97)	18.27 (4.33)	19.93 (4.51)	19.10	17.26 (4.21)	19.06 (4.42)	17.13 (4.20)	18.10	19.27 (4.45)	22.27 (4.77)	24.4 (4.99)	23.34
S Em +	0.3	0.05	0.07		0.18	0.04	0.04		0.02	0.05	0.04		0.18	0.06	0.08	
CD (P=0.05)	NS	0.18	0.24		NS	0.13	0.12		NS	0.16	0.15		NS	0.19	0.26	
CV %	14.2	16.5	18.3		15.1	14.15	14.58		16.28	20.4	20.4		14.5	16.1	16.58	

DBS- Day before spray; DAS-Days after spray; NS- Non-significant

Figures in the parenthesis are √0.5+x transferred values

Table 3: Impact of different insecticides on natural enemies and yield of okra

Treatment	2019-20							2020-21						
	Chrysoperla (No./plant)			Coccinellids (No./plant)			Yield (t/ha)	*Chrysoperla* (No./plant)			Coccinellids (No./plant)			Yield (t/ha)
	1DBS	3DAS	7 DAS	1DBS	3DAS	7 DAS		1DBS	3DAS	7 DAS	1DBS	3DAS	7 DAS	
Dimethoate 30 EC @ 250 g a.i./ha	3.63 (2.14)	2.20 (1.78)	1.25 (1.50)	1.20 (1.30)	1.02 (1.23)	0.98 (1.21)	9.45	3.13 (2.03)	1.70 (1.64)	0.75 (1.32)	0.70 (1.30)	0.52 (1.23)	0.42 (1.19)	9.25
Imidacloprid 17.8 SL @ 71.8 g a.i./ha	3.40 (2.09)	2.10 (1.76)	1.22 (1.49)	1.14 (1.28)	0.90 (1.18)	0.93 (1.19)	12.20	2.90 (2.21)	1.60 (1.61)	0.72 (1.31)	0.64 (1.28)	0.40 (1.18)	0.43 (1.20)	11.70
Acetamiprid 20% SP @ 75 g a.i./ha	2.89 (1.97)	1.90 (1.70)	1.55 (1.59)	1.15 (1.28)	1.03 (1.23)	0.87 (1.17)	13.45	2.39 (1.84)	1.40 (1.55)	1.05 (1.43)	0.65 (1.28)	0.53 (1.24)	0.37 (1.17)	12.95
Thiamethoxam 25% WG @ 100 g a.i./ha	3.41 (2.10)	2.01 (1.73)	1.96 (1.71)	1.17 (1.29)	1.04 (1.24)	0.84 (1.15)	10.65	2.91 (1.98)	1.51 (1.58)	1.46 (1.57)	0.67 (1.29)	0.54 (1.24)	0.34 (1.16)	10.40
Profenofos 50 EC @ 250 g a.i./ha	2.78 (1.94)	2.20 (1.78)	1.88 (1.69)	1.16 (1.28)	1.00 (1.22)	0.62 (1.05)	6.90	2.28 (1.81)	1.70 (1.64)	1.38 (1.54)	0.66 (1.28)	0.50 (1.22)	0.12 (1.06)	6.80
Clothianidin 50 WG @ 25 g a.i./ha	3.12 (2.02)	2.33 (1.82)	1.25 (1.50)	1.15 (1.28)	1.03 (1.23)	0.93 (1.19)	8.20	2.62 (1.90)	1.83 (1.68)	0.75 (1.32)	0.65 (1.28)	0.53 (1.24)	0.43 (1.20)	8.05
Untreated Control	3.40 (2.09)	2.20 (1.78)	2.01 (1.73)	1.20 (1.30)	1.02 (1.23)	1.04 (1.21)	4.30	2.90 (2.21)	1.70 (1.64)	1.51 (1.58)	0.70 (1.30)	0.52 (1.23)	0.54 (1.24)	3.65
S Em ±	0.07	0.05	0.06	0.08	0.07	0.06	0.36	0.05	0.02	0.04	0.06	0.05	0.04	0.31
CD (P=0.05)	NS	NS	NS	NS	0.21	0.18	1.15	NS	NS	NS	NS	0.20	0.14	1.10
CV %	6.26	5.79	6.69	7.25	8.54	8.35	12.43	5.61	6.28	5.55	6.15	7.35	7.30	8.32

DBS- Day before spray; DAS-Days after spray;

Figures in the parenthesis are $\sqrt{0.5+x}$ transferred values; NS- Non-significant population of 20.06 and 24.13 per 3 leaves after 3DAS and 7DAS respectively with mean population of 22.10 aphids per 3 leaves. Similar trend was noticed during 2020-21 also (Table 2 and Fig.1) as acetamiprid was the best among the different treatments with 98 per cent reduction of aphid population over control. The present findings are in accordance with Udikeri *et al.* (2009) who observed effective control of aphids in cotton ecosystem system.

Whitefly population

The whitefly population was distributed uniformly among the different treatments with no significant difference among the treatments and the pest load ranged from 20.00 to 20.27 (Table 1). Observations made on whitefly population 3DAS and 7DAS showed significant difference among the different treatments. Acetamiprid 20% SP recorded lowest whitefly population (10.40/3 leaves and 8.46/3 leaves at 3DAS and 7DAS, respectively) with the mean whitefly of 9.43 per 3 leaves (Table 1) and 62 per cent reduction over control (Fig.1), followed by, imidacloprid 17.8 SL recorded 12.47 and 10.53 whiteflies per three leaves on 3DAS and 7DAS respectively, with mean population of 11.15 whiteflies per three leaves, during 2019-20 (Table 1). thiamethoxam 25% WG, dimethoate 30 EC and profenosfos 50 EC recorded higher mean whitefly population (13.66, 15.73 and 18.76, respectively). Among all the other treatments, Untreated control registered significantly highest whitefly population (an average of 24.34/3 leaves). Present findings are in line with the results of Aina *et al.* (2017) who found acetamiprid 20 SP as a very good option in controlling whiteflies. Similar trend was observed during 2020-12 (Table 2). Acetamiprid resulted in highest reduction of whiteflies over control (62%).

Natural enemy population

The observations on natural enemies *viz*., Green lace wings and coccinellids during 2019-20 and 2020-21 revealed that acetamiprid 20% SP is safe and had lesser deleterious effect on the predatory population compared to other treatments (Table 3). Present findings are in line with Sonali and Yadu (2018) who reported that acetamiprid 20 SP as one among the safer chemicals in chilli ecosystem with lesser deleterious effect on natural enemies. Acetamiprid 20% SP has recorded highest fruit yield (13.45 t/ ha) which was followed by, imidacloprid 17.8 SL (12.20 t/ha). Untreated control recorded a minimum fruit yield of 4.30 t/ha (Table 3) during 2019-20. Similar trend was noticed during 2020-21 (Table 3).

CONCLUSION

Acetamiprid 20% SP was found to be best among different treatments in controlling sucking insect pest complex *viz*., thrips, leafhoppers, aphids and whiteflies with higher yield and was found to be relatively safe to predators.

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