EVALUATION OF VARIOUS SYNTHETIC INSECTICIDES AGAINST *Earias vittella* FABRICIUS INFESTING OKRA

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ABSTRACT

A field experiment was conducted at Main Vegetable Research Station, Anand Agricultural University, Anand, Gujarat during summer 2010 to evaluate the efficacy of different nine insecticides (emamectin benzoate 0.0025%, indoxacarb 0.00725%, spinosad 0.0225%, thiodicarb 0.075%, flubendiamide 0.0144%, novaluron 0.01%, chlorfenapyr 0.01%, cypermethrin + chlorpyriphos 0.055%, endosulfan 0.07%) along with control against shoot and fruit borer, *Earias vittella* Fabricius infesting okra. Of these, flubendiamide 0.0144% recorded lower larval population of *E. vittella* followed by indoxacarb and emamectin benzoate. On the basis of per cent shoot and fruit damage, flubendiamide, indoxacarb, emamectin benzoate and cypermethrin + chlorpyriphos recorded lower per cent shoot damage and found most effective. Flubendiamide (76.73 q/ha) registered significantly higher fruit yield followed by cypermethrin + chlorpyriphos (64.84 q/ha). The highest (25.27) Net NICBR was recorded from the plots treated with cypermethrin + chlorpyriphos followed by endosulfan (16.99), indoxacarb (09.44), thiodicarb (7.26), chlorfenapyr (06.87) and flubendiamide (5.46).

Key words: Okra, *Abelmoschus esculentus,* synthetic insecticides, *Earias vittella,* yield

INTRODUCTION

Okra [*Abelmoschus esculentus* (Linnaeus) Moench] is an important vegetable crop belonging to family Malvaceae. There are many factors affecting the low productivity of okra. One of them is the losses caused by insect pests. The crop is affected by number of insect pest, mites and nematodes during different growth stages. According to Khan and Mukhopadhyay (2004), the major insect pests infesting okra crop are: shoot and fruit borer [*Earias vittella* (Fabricius)], fruit borer [*Helicoverpa armigera* (Hubner) Hardwick], jassid [*Amrasca biguttula biguttula* (Ishida)], whitefly [*Bemisia tabaci* (Gennadius)], aphid [*Aphis gossypii* (Glover)] and mites [*Tetranychus cinnabarinus* (Boisduval)]. Of these pests, shoot and fruit borer, *E. vittella* is the most destructive pests causing economic damage to the crop at all the growth stages. The freshly hatched larvae bore into tender shoots and tunnel downwards. As a results, shoots withered, dropped down and ultimately the growing point is killed. With the formation of buds, flowers and fruits, the larvae bore inside and feed on inner tissues. The damaged buds and flowers withered and fell down without bearing any fruit whereas, the affected fruits showed deformity in shape and remain stunted in growth. Such fruits had hardly any marketable value (Butani, 1984).

The chemical insecticides are used as the front line defense sources against insect pest. Many research workers evaluated different insecticides against *E. vittella* in okra. However, various new molecules with different mode of action are available in the market which required to be tested for the control of *E. vittella* in okra. Hence, the experiment was planned to evaluate the efficacy of various synthetic insecticides against *E. vittella* in okra during summer season.

MATERIALS AND METHODS

Different nine insecticides (emamectin benzoate 0.0025%, indoxacarb 0.00725%, spinosad 0.0225%, thiodicarb 0.075%, flubendiamide 0.0144%, novaluron 0.01%, chlorfenapyr 0.01%, cypermethrin + chlorpyriphos 0.055% and endosulfan 0.07%) were tested along with control in a Randomized Block Design replicated thrice in a plot size of 3.0 x 4.5 m with a spacing of 60 x 30 cm. The first spray of respective insecticides was made on appearance of the *E. vittella* while, subsequent two sprays were given at 10 days interval. The insecticides were evaluated on the basis of number of larvae per plant, per cent shoot damage, per cent fruit damage as well as okra fruit yield. For recording observations on larval population and shoot damage, five plants were selected randomly in each plot and observations on larval population were recorded from the same selected plants. Shoot damage was recorded by counting total and damaged shoots from the each plot. The observations on fruit damage were made by counting total and damaged fruits from each plot at each picking. The observations on larval population and shoot damage were made before 24 hours of first spray as well as 3, 7, and 10 days after each spray. Fruit yield was recorded picking wise. The first spray of respective insecticides was made on appearance of the *E. vittella* while, subsequent two sprays were given at 10 days interval. Third spray was given for preventing fruit damage.

RESULTS AND DISCUSSION

Evaluation based on larval population

The data on efficacy of insecticides on larval population of *E. vittella* are presented in Table 1. The data indicated that there was uniform larval population in the field before the first spray as the treatment differences were non significant. The data pooled over sprays on larval population also revealed that all the insecticidal treatments were significantly effective when compared with control after 3, 7 and 10 days of spray.

Among the different insecticides, flubendiamide 0.0144% recorded significantly lower larval population than rest of the treatments except emamectin benzoate and indoxacarb with which it was at par after 3 days of spray. Emamectin benzoate and indoxacarb were also at par with cypermethrin + chlorpyriphos. The remaining insecticides; spinosad, novaluron, endosulfan, thiodicarb and chlorfenapyr were at par with each other.

After 7 days of spray, flubendiamide 0.0144% recorded significantly lower larval population than rest of the treatments except indoxacarb with which it was at par. Indoxacarb found significantly superior over cypermethrin + chlorpyriphos, spinosad, novaluron, thiodicarb, endosulfan and chlorfenapyr while, it was at par with emamectin benzoate. Novaluron was at par with spinosad, cypermethrin + chlorpyriphos on one hand while, with thiodicarb, endosulfan and chlorfenapyr on other hand of chronological order of effectiveness.

After 10 days, flubendiamide 0.0144% recorded significantly lowest larval population than rest of the treatments. Indoxacarb, emamectin benzoate and cypermethrin + chlorpyriphos were at par with each other but, significantly superior as compared to thiodicarb, novaluron, chlorfenapyr and endosulfan in preventing larval population after 10 days of spray. Spinosad, thiodicarb, novaluron, chlorfenapyr and endosulfan were did not significantly differ from each other and found equally effective against *E. vittella* larval population.

The per cent reduction in larval population over control in different treatments ranged from 35.57 (thiodicarb) and 77.85 (flubendiamide), 25.98 (chlorfenapyr) to 86.61 (flubendiamide) and 37.86 (chlorfenapyr and endosulfan) to 92.14 (flubendiamide) after 3, 7 and 10 days of spray, respectively.

Evaluation based on per cent shoot damage

The data on efficacy of insecticides on per cent shoot damage caused by *E. vittella* are presented in Table 2. The data indicated that there was uniform shoot damage in the field before the first spray as the treatment differences were non significant. The data also revealed that all the insecticidal treatments were significantly effective when compared with control after 3, 7 and 10 days of spray except chlorfenapyr 0.01% which was at par with control after 7 days of spray.

Among the different insecticides, emamectin benzoate recorded significantly lower shoot damage than rest of the treatments except flubendiamide with which it was at par after 3 days of spray. Indoxacarb was at par with flubendiamide on one hand and with cypermethrin + chlorpyriphos on other hand of effectiveness. Novaluron, spinosad and endosulfan were at par with each other and found equally effective. Similarly, thiodicarb and chlorfenapyr were at par with each other.

After 7 days of spray, flubendiamide and indoxacarb were at par with each other which recorded significantly lower per cent shoot damage than rest of the treatments. Cypermethrin + chlorpyriphos was at par with emamectin benzoate on one hand and with spinosad on other hand of effectiveness. Endosulfan was at par with novaluron and spinosad on one hand and with thiodicarb on other hand of effectiveness. Chlorfenapyr was at par with thiodicarb on one hand and with control on other hand of effectiveness.

Flubendiamide recorded significantly lowest per cent shoot damage than rest of the treatments after 10 days of spray. Indoxacarb, cypermethrin + chlorpyriphos and emamectin benzoate were at par with each other but found significantly effective than rest of the insecticides in preventing shoot damage. Endosulfan was at par with spinosad on one hand and with novaluron, thiodicarb and chlorfenapyr on other hand of effectiveness.

The per cent reduction in shoot damage over control in different treatments ranged between 18.90 (chlorfenapyr) to 71.23 (emamectin benzoate), 16.89 (chlorfenapyr) to 88.31 (flubendiamide) and 32.86 (chlorfenapyr) to 97.75 (flubendiamide) after 3, 7 and 10 days of spray, respectively.

Evaluation based on per cent fruit damage

The data (Column 2 in Table 3) on per cent fruit damage caused by *E. vittella* revealed that all the insecticidal treatments were significantly superior by recording lower per cent fruit damage when compared with control. Flubendiamide recorded significantly lower per cent fruit damage as compared to thiodicarb, chlorfenapyr, endosulfan and novaluron while, it was at par with emamectin benzoate, cypermethrin + chlorpyriphos, indoxacarb and spinosad. Novaluron was at par with thiodicarb, chlorfenapyr and endosulfan for fruit damage.

The per cent reduction in fruit damage over control in different treatments ranged between 51.72 and 84.81. The highest (84.81) per cent reduction was obtained in the treatment of flubendiamide while, it was lowest (51.72) under treatment of novaluron.

Evaluation based on fruit yield

The data on okra fruit yield (Column 3 in Table 3) indicated that flubendiamide registered significantly higher fruit yield (76.73 q/ha) than rest of the treatments except cypermethrin + chlorpyriphos with which it was at par. Cypermethrin + chlorpyriphos (64.84 q/ha) was at par with emamectin benzoate, indoxacarb, spinosad and thiodicarb but, recorded significantly higher okra fruit yield as compared to endosulfan, chlorfenapyr and novaluron. Endosulfan, chlorfenapyr and novaluron were at par with emamectin benzoate, indoxacarb, spinosad and thiodicarb for okra fruit yield.

The per cent avoidable losses (Column 4 in Table 3) were recorded minimum (00.00) in flubendiamide followed by cypermethrin + chlorpyriphos (15.50) and emamectin benzoate (21.10). However, the maximum per cent avoidable losses were recorded in control (71.99) plot followed by novaluron (37.55) and chlorfenapyr (34.28).

The highest (25.27) Net NICBR (Column 5 in Table 3) was obtained from the plots treated with cypermethrin + chlorpyriphos followed by endosulfan (16.99), indoxacarb (09.44), thiodicarb (7.26), chlorfenapyr (06.87) and flubendiamide (5.46). Though the flubendiamide was the most effective against *E. vittella* as well as also registered higher okra fruit yield with the highest realization over control, the net ICBR was low. It might be due to very high market price of the insecticide.

Thus, based on *E. vittella* larval population, per cent shoot as well as fruit damage and okra fruit yield, it can be concluded that flubendiamide 0.0144%, emamectin benzoate 0.0025% and indoxacarb 0.00725% can be considered as most effective insecticides. Cypermethrin + chlorpyriphos 0.055%, spinosad 0.0225% and thiodicarb 0.075% found moderately effective while, endosulfan 0.07%, novaluron 0.01% and chlorfenapyr 0.01% were least effective against infestation of *E. vittella* on okra.

The bio-efficacy of insecticides was evaluated by many researchers against *E. vittella* in okra. Priya and Misra (2007) registered lower fruit borer infestation to fruits in the treatment of spinosad. Kuttalam *et al.* (2008) found emamectin benzoate @ 13 and 15 g a.i./ha as effective insecticide in suppressing the larval population. As per the report of Anonymous (2008), emamectin benzoate 5% SG @ 11 g a.i./ha recorded the lower eggs and larval population of *E. vittella*, lower per cent shoot as well as fruit damage and gave higher yield.

Among the various insecticides evaluated by Chatterjee and Samanta (2009), emamectin benzoate had the lowest shoot and fruit infestation followed by indoxacarb. Shinde and Shetgar (2009) found spinosad 0.005% and indoxacarb 0.01% as most effective insecticides in managing okra shoot and fruit borer. As per the results of the experiment conducted for evaluation of different insecticides against *E. vittella* in okra by Patra *et al.* (2009), the shoot damage ranged between 4.7 to 21.2%. The lowest (4.7%) shoot infestation due to *E. vittella* was recorded in the treatment of emamectin benzoate 5 SG @ 15 g a.i./ha followed by spinosad 2.5 SC @ 50 g a.i./ha (4.9%) and indoxacarb 14.5 SC @ 50 g a.i./ha (5.2%). The highest shoot infestation was recorded in untreated check (21.2%).

Gupta *et al.* (2009) reported that indoxacarb (70 and 140 g a.i./ha) was found most effective against shoot and fruit borer infesting okra. According to Sinha and Nath (2009), indoxacarb and chlorpyriphos + cypermethrin found effective against *E. vittella*. Chowdary *et al.* (2010) reported lower larval population of *E. vitella* as well as lower fruit damage due to application of spinosad, emamectin benzoate and flubendiamide. Pardeshi *et al.* (2010) registered lower infestation of *E. vittella* to okra fruits in the treatment of chlorpyriphos + cypermethrin.

In present investigation, flubendiamide, emamectin benzoate and indoxacarb emerged out as highly effective insecticides while, chlorpyriphos + cypermethrin and spinosad found moderately effective. Thus, the above reports are close agreement with the present results.

CONCLUSION

Based on *E. vittella* larval population, per cent shoot as well as fruit damage and okra fruit yield, flubendiamide, emamectin benzoate and indoxacarb recorded lower larval population, per cent shoot as well as fruit damage and registered higher okra fruit yield can be considered as most effective insecticides. Cypermethrin + chlorpyriphos, spinosad and thiodicarb found medicore while, endosulfan, novaluron and chlorfenapyr were least effective against *E. vittella* infesting okra.

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Table 1: Efficacy of different insecticides on larval population of *E. vittella* in okra (Pooled of period over sprays)

Treatments (Conc.)	Number of larva(e)/plant*			
	Before spray	Days after spray		
		3	7	10
1	2	3	4	5
Emamectin benzoate 5 WG 0.0025%	1.05 ^{a} (0.60)	0.96 ^{ab} (0.42) [71.81]	0.96 ^{bc} (0.42) [66.93]	0.98 ^{b} (0.46) [67.14]
Indoxacarb 14.5 SC 0.00725%	1.05 ^{a} (0.60)	0.98 ^{ab} (0.46) [69.13]	0.91^{ab} (0.33) [74.02]	0.95 ^{b} (0.40) [71.43]
Spinosad 45 SC 0.0225%	1.07 ^{a} (0.64)	1.14 ^{c} (0.80) [46.31]	1.09 ^{de} (0.69) [45.67]	1.08 ^{cd} (0.67) [52.14]
Thiodicarb 75 WP 0.075%	1.20 ^{a} (0.94)	1.21 ^{c} (0.96) [35.57]	1.15 ^{ef} (0.82) [35.43]	1.12 ^{d} (0.75) [46.43]
Flubendiamide 480 SC 0.0144%	1.17 ^{a} (0.87)	0.91 ^{a} (0.33) [77.85]	0.82 ^{a} (0.17) [86.61]	0.78 ^{a} (0.11) [92.14]
Novaluron 10 EC 0.01%	1.17 ^{a} (0.87)	1.18 ^{c} (0.89) [60.00]	1.14 ^{def} (0.80) [37.01]	1.14 ^{d} (0.80) [42.86]
Chlorfenapyr 10 EC 0.01%	1.11 ^{a} (0.73)	1.22 ^{c} (0.99) [50.00]	1.20 ^{f} (0.94) [25.98]	1.17 ^{d} (0.87) [37.86]
Cypermethrin+Chlorpyriphos 55 EC 0.055%	1.05 ^{a} (0.60)	1.02 ^{b} (0.54) [63.76]	1.05 ^{cd} (0.60) [52.76]	1.02 ^{bc} (0.54) [61.43]
Endosulfan 35 EC 0.07%	1.08 ^{a} (0.67)	1.20 ^{c} (0.94) [36.91]	1.17^{ef} (0.87) [31.50]	1.17 ^{d} (0.87) [37.86]
Control (water spray)	1.20 ^{a} (0.94)	1.41^{d} (1.49)	1.33 ^{g} (1.27)	1.38 ^{e}(1.40)
ANOVA				
S. Em. $\pm$ Insecticides (I)	0.05	0.03	0.03	0.03
Spray (S)	-	0.01	0.01	0.01
I x S	-	0.04	0.03	0.03
C.D. (5%) I	NS	0.10	0.09	0.09
S	-	NS	0.03	0.03
I x S	-	0.11	0.10	NS
C.V. (%)	7. 91	7.36	6.84	6.96

Notes: ***1. Treatment means with letter(s) in common are not significant at 5 % level of significance in respective column***

2. Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$ **** transformed values***

3. Figures in [ ] are per cent reduction over control

Table 2: Effectiveness of different insecticides against shoot damage caused by *E. vittella* in okra (Pooled of period over sprays)

Treatments (Conc.)	Shoot damage (%)*			
	Before spray	Days after spray		
		3	7	10
1	2	3	4	5
Emamectin benzoate 5 WG 0.0025%	20.92 ^{a} (12.75)	12.71 ^{a} (04.87) [71.23]	13.98 ^{b} (05.84) [69.38]	12.79 ^{b} (04.90) [71.04]
Indoxacarb 14.5 SC 0.00725%	17.41 ^{a} (8.95)	14.50 ^{bc} (06.27) [62.97]	11.13 ^{a} (03.73) [80.44]	11.00 ^{b} (03.64) [78.49]
Spinosad 45 SC 0.0225%	19.34 ^{a} (10.97)	18.75 ^{d} (10.33) [38.98]	18.84 ^{cd} (10.43) [45.31]	16.56 ^{c} (08.12) [52.01]
Thiodicarb 75 WP 0.075%	22.06 ^{a} (14.11)	21.20 ^{e} (13.08) [22.74]	22.05 ^{ef} (14.09) [26.11]	19.57 ^{d} (11.22) [33.69]
Flubendiamide 480 SC 0.0144%	20.75 ^{a} (12.55)	13.58 ^{ab} (05.51) [67.45]	08.58 ^{a} (02.23) [88.31]	03.55 ^{a} (00.38) [97.75]
Novaluron 10 EC 0.01%	21.91 ^{a} (13.92)	18.47 ^{d} (10.04) [40.70]	19.47 ^{d} (11.11) [41.74]	17.77 ^{cd} (09.31) [44.98]
Chlorfenapyr 10 EC 0.01%	20.31 ^{a} (12.05)	21.75 ^{e} (13.73) [18.90]	23.46 ^{fg} (15.85) [16.89]	19.70 ^{d} (11.36) [32.86]
Cypermethrin+Chlorpyriphos 55 EC 0.055%	20.85 ^{a} (12.67)	15.64 ^{c} (07.27) [57.06]	16.40 ^{bc} (07.97) [58.21]	12.56 ^{b} (04.73) [72.04]
Endosulfan 35 EC 0.07%	21.24 ^{a} (13.12)	19.23 ^{d} (10.85) [35.91]	20.24 ^{de} (11.97) [37.23]	17.43 ^{cd} (08.97) [46.99]
Control (water spray)	21.23 ^{a} (13.11)	24.30 ^{f} (16.93)	25.89 ^{g} (19.07)	24.29 ^{e} (16.92)
ANOVA				
S. Em. ± Insecticides (I)	1.09	0.43	0.86	0.78
Spray (S)	-	0.28	0.29	0.48
I x S	-	0.89	0.91	1.51
C.D. (5%) I	NS	1.27	2.56	2.31
S	-	0.83	0.85	1.41
I x S	-	2.61	2.70	NS
C.V. (%)	9.18	5.79	11.70	12.29

Notes:* *1. Treatment means with letter(s) in common are not significant at 5 % level of significance in respective column

2. Figures in parentheses are retransformed values; those outside are arc sin* transformed values

3. Figures in [ ] are per cent reduction over control

Table 3: Efficacy of different insecticides on fruit damage and its impact on okra fruit yield

Treatments (conc.)	Fruit damage (%)*	Fruit yield (q/ha)	Avoidable losses (%)	Net ICBR
1	2	3	4	5
Emamectin benzoate 5 WG 0.0025%	12.43 [ab] (4.63) [83.42]	60.54 [bc]	21.10	03.61
Indoxacarb 14.5 SC 0.00725%	16.09 [abc] (7.68) [72.49]	59.85 [bc]	22.00	09.44
Spinosad 45 SC 0.0225%	16.59 [abc] (8.15) [70.81]	58.07 [bc]	24.32	02.69
Thiodicarb 75 WP 0.075%	16.82 [bcd] (8.37) [70.02]	52.45 [bc]	31.64	07.26
Flubendiamide 480 SC 0.0144%	11.88 [a] (4.24) [84.81]	76.73 [a]	00.00	05.46
Novaluron 10 EC 0.01%	21.54 [d] (13.48) [51.72]	47.92 [c]	37.55	03.33
Chlorfenapyr 10 EC 0.01%	18.57 [cd] (10.14) [63.68]	50.43 [c]	34.28	06.87
Cypermethrin+Chlorpyriphos 55 EC 0.055%	15.68 [abc] (7.30) [73.85]	64.84 [ab]	15.50	25.27
Endosulfan 35 EC, 0.07%	21.47 [d] (13.40) [52.01]	51.07 [c]	33.44	16.99
Control (water spray)	31.90 [e] (27.92)	21.49 [d]	71.99	-
S. Em. ±	1.63	04.54	-	-
C.D. (5%)	4.84	13.49	-	-
C.V. (%)	15.41	14.47	-	-

***Notes:** 1. Treatment means with letter(s) in common are not significant at 5 % level of significance in respective column*

*2. Figures in parentheses are retransformed values; those outside are arc sin * transformed values*

3. Figures in [ ] are per cent reduction over control

[MS received: September 1, 2012] *[MS accepted: September 21, 2012]*