The Bioscan 11(1): 525-530, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EVALUATION OF SCHEDULE AND THRESHOLD BASED INSECTICIDAL APPLICATION STRATEGIES ON CONCENTRATION AND ACTIVE INGREDIENT AGAINST SUCKING PESTS INFESTING OKRA

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KEYWORDS
Thiamethoxam
Dimethoate
Sucking pests
Concentrations
Application strategies
Okra

Received on :
10.11.2015

Accepted on :
26.02.2016

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ABSTRACT

In order to evaluate insecticidal applications strategies along with different doses of thiamethoxam 25 WG and dimethoate 30 EC for the control of sucking pests *i.e.* jassid, aphid and whitefly infesting okra (*Abelmoschus esculentus* Moench), present investigations were conducted at Anand Agricultural University, Anand during during summer and *kharif,* 2012. In comparison to dimethoate 30 EC, thiamethoxam 25 WG on concentration base (0.0125%) applied on schedule base (first spray on appearance of the pests and subsequently five sprays at ten days interval) found effective by recording lowest sucking pests population. The higher fruit yield of okra, economics and Net Insecticidal Cost Benefit Ratio (NICBR) was also recorded in the said treatment.

INTRODUCTION

Among the vegetables, okra or *Bhendi*, *Abelmoschus esculentus* (L.) Moench belonging to the family Malvaceae is an important seasonal fruit vegetable (Varmudy, 2001). Okra is considered as heat loving plant and grown in *kharif* and summer seasons. Being hardy and short duration crop, it is profitability cultivated in summer when other vegetables are not available in the market. In Gujarat, it is grown almost throughout the year. Besides India, it is grown for its immature green non fibrous edible fruits in many tropical and subtropical parts of the world which contains rich source of vitamins, minerals and fibers (Singh, 1970). As high as 72 species of insects have been recorded on okra (Rao and Rajendran, 2003). Its production is badly affected due to heavy attack of sucking pest's *viz*., *Aphis gossypii* Glover, *Amrasca biguttula biguttula* Ishida and *Bemisia tabaci* Gennadius. The pest's damage was observed up to 37.18 and 69.91 per cent in okra production during monsoon and summer seasons, respectively (Mote, 1977). Normally, the insecticides are recommended on the basis of concentration or active ingredient, both of which can be applied either on schedule base or need base. However, which application strategy out of four *viz.*, application of insecticides on concentration and need base, application of insecticides on concentration and schedule base, application of insecticides on active ingredient and need base and application of insecticides on active ingredient and schedule base is the effective for the management of insect pests required to be investigated. Scanty information is available on evaluation of different application strategies. Therefore, the present study was carried out at B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during summer and *kharif*, 2012.

MATERIALS AND METHODS

In order to identify a suitable spray application strategy, experiments were laid out in a Split Plot Design with four replications having plot size of 3.6 × 4.2 m during the period of two consecutive seasons; summer and *kharif,* 2012 at College Agronomy Farm, B. A. College of Agriculture, AAU, Anand. Okra variety Gujarat Okra-2 (GO-2) was sown at 45 x 30 cm using recommended agronomical practices except plant protection. Details of insecticides and spray schedules are given in Table 1.

Method of application

Methodology for Schedule based application of insecticides

First spray application of respective insecticides with their respective doses was applied on initiation of pests and subsequent five sprays at 10 days interval. The foliar application of respective insecticides was carried out with the help of knapsack sprayer at the pressure of 3.5 kg/cm^2 to the extent of slight runoff at vegetative stage.

Methodology for Threshold based applications of insecticides

In case of need (ETL) based applications, the spray applications of respective insecticides with their respective doses were given as and when any of sucking pests reach or cross the ETL (5 insects/leaf).

For recording the population of sucking pests, five plants were selected randomly in each plot. The observations were recorded at 5 days interval after germination till the maturity of the crop. For recording the population of pests, three leaves (each from top, middle and lower canopy of the plant) were selected randomly on each of selected plants. Periodical pickings were made and yield of okra fruits was summed up for further statistical analysis.

Insecticidal Cost Benefit Ratio (ICBR) of the different insecticidal treatments was worked out on the basis of prevailing market price of insecticidal formulations and labour charges for spray applications. Gross realization of a treatment was worked out by considering the yield and its market price. Net realization was worked out by deducting the gross realization in control from gross realization in insecticidal treatment. Net profit of treatment was worked out by deducting the total cost of plant protection from net realization. Insecticidal Cost Benefit Ratio (ICBR) was calculated by dividing the net realization over control with total cost of plant protection. Finally, net ICBR (NICBR) for each treatment was calculated by deducting one from gross ICBR. The data obtained during experiment were analyzed statistically (Steel and Torrie, 1980) and tabulated parameter-wise.

RESULTS AND DISCUSSION

Efficacy of insecticides on population of jassid, *A. biguttula biguttula*

Thiamethoxam 25 WG (I_1) found significantly superior (1.58 / leaf) than dimethoate 30 EC (I_2) by recording the lower jassid population (Table 3). There was significant impact on jassid population when insecticides applied on concentration (D_1) (1.70 jassids/leaf) than a.i./ha (D_2). Schedule based spray application strategy (S_1) was proved more effective and recorded lower (1.13 /leaf) jassid population than the need (ETLs) based (S_2). Thiamethoxam 25 WG when sprayed either on concentration based (I_1D_1) or on g a.i./ha based (I_1D_1) found equally effective, irrespective of application strategies. The extent of jassid population was up to 1.00 per leaf in plots treated on concentration (%) base (D_1) after following schedule based application strategy (S_1D_1). Schedule based application strategy was performed better (1.00 jassids/leaf) with the application of thiamethoxam 25 WG (S_1I_1). Both the application strategies were equally effective when follow either on concentration (%) or on g a.i./ha, irrespective of insecticides. In general, thiamethoxam 25 WG @ 0.0125% ($S_1I_1D_1$) recorded significantly lower jassid population (0.86 /leaf) when applied on the schedule based spray application strategy. The information available on the higher efficacy of the thiamethoxam 25 WG on concentration (%) based against jassid in okra is meagre. Sinha and Sharma (2008) reported foliar spray of thiamethoxam @ 20 g a.i./ha at 15 days interval effectively reduced the jassid population in okra. Sinha *et al*. (2007) concluded that foliar application of thiamethoxam @ 20 g a.i./ha at fortnightly interval was found effective in managing the leaf hopper population. Sinha and Sharma (2007) pointed out that foliar spray of thiamethoxam @ 25 g a.i./ha at 50 days after sowing found effective in managing leaf hopper population in okra. Bhalala *et al*. (2006) reported that foliar applications of thiamethoxam 25 WG at fortnightly interval at two higher doses (50 and 37.5 g a.i./ha) showed higher effectiveness against sucking pests in okra. Thiamethoxam 25 and 50 g a.i. /ha gave significant control of jassid in okra when sprayed at an interval of 15 days (Mishra and Senapati, 2003). As per the report of Subhadra *et al*. (2002), thiamethoxam @ 25 g a.i./ha proved as most effective insecticide against okra leaf hopper when sprayed at an interval of 15 days. Pathan *et al*. (2010) reported need based (ETL) spray of thiamethoxam 25 WG @ 0.0125% was effective and protected the okra crop against sucking pests.

Efficacy of insecticides on population of aphid, *A. gossypii*

The data presented in Table 4 revealed the superiority of thiamethoxam 25 WG (I_1) with lowest (1.72 /leaf) aphid population over dimethoate 30 EC (I_2). There was no any significant impact on aphid population when insecticides applied on concentration (D_1) or on g a.i./ha (D_2). Schedule based application strategy (S_1) recorded lower (1.22 /leaf) aphid population than the need based (S_2) in okra. The impact was reported negligible on the population of aphid when insecticides were applied either on concentration base (D_1) or on g a.i./ha based (D_2). Thiamethoxam 25 WG on schedule based application strategy (S_1I_1) was found more effective and recorded lower (1.05 /leaf) aphid population. Whereas, dimethoate 30 EC when followed either on any of the one application strategy (S_1I_2 or S_2I_2) was found less effective and fail to provide the adequate protection to okra crop against aphid. The interaction S x D *i.e.* application strategy (S_1 or S_2) with either of the two doses *i.e.* D_1 or D_2 was found equally effective in providing protection to the okra crop against aphid. Insecticide with any one of the two doses with schedule or need based application strategy was equally effective and provided adequate protection to okra crop against aphid. The information generated from this particular investigation could not be discussed in the light of earlier findings due to the lack of appropriate reports. Bhalala *et al*. (2006) reported that foliar applications of thiamethoxam 25 WG at fortnightly interval at two higher doses (50 and 37.5 g a.i./ha) showed higher effectiveness. Mishra (2002) also mentioned that thiamethoxam at @ 25 g a.i. /ha when sprayed on 40 and 60 days after sowing effectively managed the aphid incidence in

Table 1: Details of insecticides and spray schedules

Insecticides (I)	Doses (D) Concentration (%)(D_1)	g a.i./ha (D_2)
Thiamethoxam 25 WG (I_1)	0.0125	50
Dimethoate 30 EC (I_2)	0.03	150
Spray schedules (S)		

Schedule based (S_1): First spray application of insecticides was given at initiation of pests and subsequent five sprays were given at 10 days interval. Need (ETLs) based (S_2): Sprays were carried out as and when any one of sucking pests reach or cross the ETL (5 insects/ leaf).

Table 2: Impact of insecticidal applications on incidence of sucking pests in okra (Pooled: summer and *kharif*, 2012)

Treatments 1	No. of jassids/leaf 2	No. of aphid/leaf 3	No. of whiteflies/leaf 4	Yield(q/ha) 5
$S_1 I_1 D_1$	0.86a	0.93a	0.62a	79.83a
$S_2 I_1 D_1$	2.09d	2.14db	1.62c	64.90bcd
$S_1 I_1 D_2$	1.15b	1.16a	0.93b	71.31b
$S_2 I_1 D_2$	2.21d	2.66bc	1.89cd	62.41cd
$S_1 I_2 D_1$	1.14b	1.29a	0.95b	67.20bc
$S_2 I_2 D_1$	2.69e	2.65bc	1.97d	59.40de
$S_1 I_2 D_2$	1.37c	1.47a	1.02b	66.13bcd
$S_2 I_2 D_2$	2.93f	2.86c	2.09d	53.28e
Control (CS_1)	4.62g	4.58d	3.07e	31.41g
Control (CS_2)	4.59g	4.57d	3.09e	32.56f

ANOVA	S. Em. ±	CD (5%)	S. Em. ±	CD (5%)	S. Em. ±	CD (5%)	S. Em. ±	CD (5%)
Treatment (T)	0.07	0.21	0.20	0.64	0.09	0.29	2.57	7.28
Season (Se)	0.07	NS	0.10	NS	0.04	NS	1.82	NS
T x Se	0.11	NS	0.14	NS	0.06	NS	1.28	NS
I x Se	0.05	NS	0.07	NS	0.03	NS	1.28	NS
D x Se	0.05	NS	0.07	NS	0.03	NS	1.28	NS
S x Se	0.05	NS	0.07	NS	0.03	NS	1.28	NS
I x D x Se	0.07	NS	0.10	NS	0.04	NS	1.82	NS
S x I x Se	0.07	NS	0.10	NS	0.04	NS	1.82	NS
S x D x Se	0.07	NS	0.10	NS	0.04	NS	1.82	NS
S x I x D x Se	0.11	NS	0.14	NS	0.06	NS	2.57	NS
Bet. control	0.07	NS	0.10	NS	0.04	NS	2.57	NS
Se x Bet. control	0.11	NS	0.14	NS	0.06	NS	1.82	NS
Control vs Rest	0.17	0.51	0.38	1.09	0.15	0.44	2.03	6.03
Se x Control vs Rest	0.11	NS	0.14	NS	0.06	NS	1.82	NS
C. V. %	8.94		11.09		8.88		8.73	

Notes: **1.** Treatment mean with letter(s) in common are not significant at 5 % level of significance within column; **2.**I_1: Insecticide Thiamethoxam 25 WG; I_2: Insecticide Dimethoate 30 EC; S_1: Schedule based sprays; S_2: ETL based sprays; D_1: concentration (%); D_2: g a. i./ ha; NS: Not significant at 5% level; CS_1: control for schedule based sprays; CS_2: control for ETLs based sprays; Se: Seasons.

Table 3: Impact of spray applications of insecticides on jassid, *A. biguttula biguttula* in okra (Pooled: summer and *kharif*, 2012)

Treatments 1 Main"	 Sub plot	No. of jassids/ leaf 2 I_1	 3 I_2	 4 Mean (S x D)	 5 Mean (S)	 6 Mean (I)	 7 Mean (D)
S_1	D_1	0.86	1.14	1.00	1.13	I_1 = 1.58	D_1 = 1.70
	D_2	1.15	1.37	1.26			
Mean	S_1 x I	1.00s	1.26t			-	-
S_2	D_1	2.09	2.69	2.39	2.48	I_2 =2.03	D_2 = 1.92
	D_2	2.21	2.93	2.57			
Mean	S_2 x I	2.15u	2.81v	-	-	-	-
Mean (I x D)	D_1	1.48	1.92	-	-	-	-
	D_2	1.68	2.15	-			
ANOVA							
	S x I x D	S x I	I x D	S x D	S	I	D
S. Em. +	0.07	0.05	0.05	0.05	0.04	0.04	0.04
C. D. at 5 %	NS	0.15	NS	NS	0.11	0.11	0.11
C. V. (%)	8.94						

Notes: 1.Treatment means with letter(s) in common are not significant at 5 % level of significance; 2.Sprays (S) S_1: Schedule based spray; S_2: ETLs based spray; Insecticides (I): I_1: Thiamethoxam 25 WG; I_2: Dimethoate 30 EC; Doses (D): D_1: concentration (%); D_2: g a. i./ ha; NS: Not significant at 5% level.

okra. Need (ETL) based spray of thiamethoxam 25 WG @ 0.0125% was found more effective and protected the okra crop against sucking pests (Pathan *et al*., 2010).

Efficacy of insecticides on population of whitefly, *B. tabaci*

Thiamethoxam 25 WG (I_1) was found significantly superior (1.26 whiteflies/leaf) over dimethoate 30 EC (I_2), irrespective of their application strategies and doses (Table 5). Insecticides when sprayed on concentration (%) (D_1) was found better (1.29 whiteflies/leaf) compared to g a.i./ha (D_2). Need (ETLs) based (S_2) application strategy was less effective compared to schedule based (0.89 /leaf) application strategy (S_1). Thiamethoxam 25 WG when follow on concentration based (I_1D_1) was found more effective and recorded 1.26 whiteflies/ leaf. The same insecticide *i.e.* thiamethoxam 25 WG also reduced the whitefly population (1.29 /leaf) significantly when applied on schedule based application strategy (S_1I_1), irrespective of its dose. Schedule based application strategy

Table 4: Impact of spray applications of insecticides on aphid, *A. gossypii* in okra (Pooled: summer and *kharif*, 2012)

Treatments		No. of aphids/ leaf					
1		2	3	4	5	6	7
Main" Sub plot		I1	I2	Mean (S x D)	Mean (S)	Mean (I)	Mean (D)
S1	D1	0.93	1.29	1.11	1.22	I1 = 1.72	D1 = 1.75
	D2	1.16	1.47	1.31			
Mean	S1 x I	1.05s	1.38t			-	-
S2	D1	2.14	2.65	2.40	2.58	I2 = 2.07	D2 = 2.04
	D2	2.66	2.86	2.76			
Mean	S2 x I	2.40u	2.76v	-	-	-	-
Mean (I x D)	D1	1.54	1.97	-	-	-	-
	D2	1.91	2.17	-			
ANOVA							
	S x I x D	S x I	I x D	S x D	S	I	D
S. Em. +	0.10	0.07	0.07	0.07	0.05	0.05	0.05
C. D. at 5 %	NS	0.21	NS	NS	0.14	0.14	NS
C. V. (%)	11.09						

Notes:1. Treatment means with letter(s) in common are not significant at 5 % level of significance; **2.** Sprays (S) S_1: Schedule based spray; S_2: ETLs based spray; Insecticides (I): I_1: Thiamethoxam 25 WG; I_2: Dimethoate 30 EC; Doses (D): D_1: concentration (%); D_2: g a. i./ ha; NS: Not significant at 5% level.

Table 5: Impact of spray applications of insecticides on whitefly, *B. tabaci* in okra (Pooled: summer and *kharif*, 2012)

Treatments		No. of whiteflies/ leaf					
1		2	3	4	5	6	7
Main" Sub plot		I_1	I_2	Mean (S x D)	Mean (S)	Mean (I)	Mean (D)
S_1	D_1	0.62	0.95	0.79o	0.89	I_1 = 1.27	D_1 = 1.29
	D_2	0.93	1.02	0.98p			
Mean	S_1 x I	0.78s	0.99t			-	-
S_2	D_1	1.62	1.97	1.80q	1.95	I_2 = 1.48	D_2 = 1.49
	D_2	1.89	2.09	1.99r			
Mean	S_2 x I	1.76u	2.03v	-	-	-	-
Mean (I x D)	D_1	1.12w	1.46x	-	-	-	-
	D_2	1.41x	1.56x	-			
ANOVA							
	S x I x D	S x I	I x D	S x D	S	I	D
S. Em. +	0.04	0.06	0.06	0.06	0.03	0.03	0.03
C. D. at 5 %	NS	0.16	0.16	0.16	0.09	0.09	0.09
C. V. (%)	8.88						

Notes:1. Treatment means with letter(s) in common are not significant at 5 % level of significance. **2.**Sprays (S) S_1: Schedule based spray; S_2: ETLs based spray; Insecticides (I): I_1: Thiamethoxam 25 WG; I_2: Dimethoate 30 EC; Doses (D): D_1: concentration (%); D_2: g a. i./ ha; NS: Not significant at 5% level.

Table 6: Impact of spray applications of insecticides with their doses on okra fruit yield (Pooled: summer and *kharif*, 2012)

Treatments		Fruit yield (q/ha)					
1		2	3	4	5	6	7
Main" Sub plot		I_1	I_2	Mean (S x D)	Mean (S)	Mean (I)	Mean (D)
S_1	D_1	79.83a	67.20bc	73.52o	71.12	I_1 = 69.61	D_1 = 67.83
	D_2	71.31b	66.13bcd	68.72p			
Mean	S_1 x I	75.57s	66.67t			-	-
S_2	D_1	64.90bcd	59.40de	62.15q	60.00	I_2 = 61.50	D_2 = 63.28
	D_2	62.41cd	53.28e	57.85r			
Mean	S_2 x I	63.66t	56.34u	-	-	-	-
Mean (I x D)	D_1	72.37w	63.30x	-	-	-	-
	D_2	66.86x	59.71y	-			
ANOVA							
	S x I x D	S x I	I x D	S x D	S	I	D
S. Em. +	2.57	1.28	1.28	1.28	0.91	0.91	0.91
C. D. at 5 %	7.28	3.59	3.59	3.59	2.57	2.57	2.57
C. V. (%)	8.73						

Notes:1. Treatment means with letter(s) in common are not significant at 5 % level of significance.**2.**Sprays (S) S_1: Schedule based spray; S_2: ETLs based spray; Insecticides (I): I_1: Thiamethoxam 25 WG; I_2: Dimethoate 30 EC; Doses (D): D_1: concentration (%); D_2: g a. i./ ha.

performed well by recording the lowest *i.e.* 0.79 whitefly/leaf when it follow on the concentration base (S_1D_1), irrespective of the insecticides. Any one of the application strategy (S) *i.e.* schedule based (S_1) or ETLs based (S_1) along with either one of

Table 7: Economics of insecticidal treatments for the control of sucking pests in okra

Treatments	Insecticides	Conc. (%) or g a. i./ha	Qty. of insecticides for sprays (l/ha or kg/ha)	Cost of insecticides (`/liter or kg)	Total cost of plant protection (`/ha)	Yield (q/ha)	Gross realization (`/ha)	Net realization over control (`/ha)	Net profit (`/ha)	ICBR	NICBR
	1	2	3	4	5	6	7	8	9	10	11
S1 I1 D1	Thiamethoxam 25 WG	0.0125%	1.50	3580	7410	79.83	119745	71760	64350	1 : 9.68	1 : 8.68
S2 I1 D1	Thiamethoxam 25 WG	0.0125%	0.75	3580	3705	64.90	97350	49365	45660	1 : 13.32	1 : 12.32
S1 I1 D2	Thiamethoxam 25 WG	50	1.20	3580	6336	71.31	106965	58980	52644	1 : 9.30	1 : 8.30
S2 I1 D2	Thiamethoxam 25 WG	50	0.70	3580	3696	62.41	93615	45630	41934	1 : 12.34	1 : 11.34
S1 I2 D1	Dimethoate 30 EC	0.03%	3.00	330	3030	67.20	100800	52815	49785	1 : 17.43	1 : 16.43
S2 I2 D1	Dimethoate 30 EC	0.03%	1.75	330	1767	59.40	89100	41115	39348	1 : 23.26	1 : 22.26
S1 I2 D2	Dimethoate 30 EC	150	3.00	330	3030	66.13	99195	51210	48180	1 : 16.90	1 : 15.90
S2 I2 D2	Dimethoate 30 EC	150	2.00	330	2020	53.28	79920	31935	29915	1 : 15.80	1 : 14.80
Controls (CS1&CS2)	Controls	-	-	-	-	31.99	47985	-	-	-	-

Skilled labour charges: 170 `/day/spray Number of labours required : 2 per spray   Market price of okra fruits: 15 `/kg

the insecticides *i.e.* thiamethoxam 25 WG (I_1) or dimethoate 30 EC (I_2) with concentration based (%) (D_1) or g a.i./ha based (D_1) were equally effective in reducing the whitefly population in okra (Table 5). However, thiamethoxam 25 WG @ 0.0125% ($S_1I_1D_1$) recorded lower population of whitefly (0.62 /leaf) when sprayed on schedule based application strategy. The information available on the higher efficacy of the thiamethoxam 25 WG on concentration (%) based against whitefly in okra is meagre. While scanning the literatures, Bhalala *et al*. (2006) reported higher effectiveness of foliar applications of thiamethoxam 25 WG at fortnightly interval at two higher doses (50 and 37.5 g a.i./ha) against sucking insect pests in okra.

Fruit Yield

All the insecticidal treatments were found significantly superior over the controls by recording considerably higher fruit yield of the okra. The highest (69.61 q/ha) fruit yield of okra was recorded from thiamethoxam 25 WG (I_1) treated plots (Table 6). Concentration based (D_1) application of insecticides was more effective and recorded higher fruit yield (67.83 q/ha) than of g a.i./ha (D_2). Thiamethoxam 25 WG when applied on concentration (0.0125%) based (I_1D_1) protected the crop significantly with higher (72.37 q/ha) okra fruit yield with any of the strategies. While comparing the two application strategies, schedule based (S_1) showed super performance (71.12 q/ha fruit yield) over need based (S_2). Irrespective of insecticides, schedule based strategy with concentration based dose (S_1D_1) provided higher yield (73.52 q/ha). The schedule based application of thiamethoxam 25 WG (S_1I_1) recorded significantly higher (75.57 q/ha) fruit yield. Among the various combinations (S x I x D), the okra plots with schedule based application of thiamethoxam 25 WG @ 0.0125% ($S_1I_1D_1$) recorded significantly the highest okra fruit yield (79.83 q/ha) followed by the same insecticides and application strategy on g a.i./ha *i.e.* $S_1I_1D_2$ (71.31 q/ha). Misra and Senapati (2003) reported that thiamethoxam 25 WG @ 25-50 g a.i./ha increased the marketable fruit yield of okra compared to conventional insecticides. In the present investigation, thiamethoxam 25 WG @ 0.0125% on schedule based proved as most effective.

Insecticidal cost benefit ratio (ICBR)

The Insecticidal Cost Benefit Ratio (ICBR) for different treatments was also calculated and presented in Table 7. Thiamethoxam 25 WG @ 0.0125% on schedule based application ($S_1I_1D_1$) recorded the highest net realization (71760 '/ha) followed by the need based application of the same insecticide *i.e.* thiamethoxam 25 WG @ 50 g a.i./ha (58980 '/ha). The chronological order of various insecticidal treatments on the basis of Net Insecticidal Cost Benefit Ratio (NICBR) given in brackets after each treatment was: $S_2I_2D_1$ (22.26) > $S_1I_2D_1$ (16.43) > $S_1I_2D_2$ (15.90) > $S_2I_2D_2$ (14.80) > $S_2I_1D_1$ (12.32) > $S_2I_1D_2$ (11.34) > $S_1I_1D_1$ (8.68) > $S_1I_1D_2$ (8.30). Looking to the NICBR, dimethoate 30 EC @ 0.03% on need based application was the most economical as it gave maximum return.

In nutshell, thiamethoxam 25 WG @ 0.0125% on schedule based spray *i.e.* first spray on appearance of sucking pests and subsequently five sprays at ten days interval can be recommended for the effective and economical management of sucking pests in okra.

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