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Effectiveness of different insecticides against sucking pests in brinjal

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ABSTRACT

An experiment was conducted to study the bio-efficacy of nine different insecticides (triazophos 0.08 %, imidacloprid 0.002 %, profenophos 0.05 %, diafenthiuron 0.05 %, clothianidin 0.025 %, cartap hydrochloride 0.05 %, thiamethoxam 0.025 %, thiacloprid 0.012 % and spiromesifen 0.024 %) again sucking pests *viz.*, jassid and whitefly in brinjal (GBH 1) at Main Vegetable Research Station, Anand Agricultural University, Anand during *Rabi* season of 2011-12. Among different insecticides evaluated, thiamethoxam, diafenthiuron and thiacloprid emerged as most effective; profenophos, clothianidin and imidacloprid were mediocre; while cartap hydrochloride, spiromesifen and triazophos were found least effective against jassid. So far whitefly is concerned, spiromesifen, diafenthiuron and triazophos emerged as most effective; imidacloprid, profenophos and cartap hydrochloride as mediocre, while clothianidin, thiamethoxam and thiacloprid emerged as least effective. Diafenthiuron exhibited significantly higher brinjal fruit yield (350.57 q/ha), whereas triazophos and cartap hydrochloride hosted significantly lower fruit yield. The minimum and maximum per cent avoidable losses were recorded in diafenthiuron (0.00) and control (55.25), respectively. The highest Net ICBR (71.83) was obtained from the plots treated with profenophos followed by thiacloprid (56.10), cartap hydrochloride (43.93), imidacloprid (39.10) and diafenthiuron (27.69).

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INTRODUCTION

Brinjal (*Solanum melongena* Linnaeus) is known as a “king of vegetables” originated from India, where a wide range of wild types and land races occurs (Thompson and Kelly, 1957). In India, the crop is extensively cultivated in about 5.7 lakh hectares with a production of 96 lakh tonnes. In India, it is cultivated mainly in West Bengal, Orissa, Bihar and Gujarat states. In Gujarat, it is cultivated in 0.65 lakh hectares with an annual production of 11.44 lakh tonnes and a productivity of 17.37 tonnes per hectare (Anonymous, 2013). Brinjal crop suffers severely due to the attack of various insect pests, which reduce its fruit yield and quality. In India, the crop is damaged by more than 30 insect pests right from nursery stage (Regupathy *et al.*, 1997). Of which shoot and fruit borer, *Leucinodes orbonalis* Guenee, Jassid, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* Gennadius, aphid, *Aphis gossypii* Glover, mites, *Tetranychus cinnabarinus* Boisdual and epilachna beetle, *Henosepilachna vigintioctopunctata* (Fab.) are the major and important insect pests. Chemical insecticides are used as the frontline defense sources against insect pest in India. However, their indiscriminate and continuous use creates a number of problems. Hence, new insecticides available in the market are needed to evaluate for their efficacy against sucking pests of brinjal.

MATERIAL AND METHODS

Brinjal crop was transplanted during the second week of September and raised by adopting recommended agronomical practices. Nine different insecticides (triazophos 0.08%, imidacloprid 0.002 %, profenophos 0.05%, diafenthiuron 0.05 %, clothianidin 0.025 %, cartap hydrochloride 0.05 %, thiamethoxam 0.025 %, thiacloprid 0.012 % and spiromesifen 0.024 %) were evaluated along with control. The experiment was laid out in Randomized Block Design replicated 3 times in the plot size of 4.2×3.6 m with the spacing of 90×60 cm. First spray of respective insecticides was given on appearance of sucking pests and subsequent 2 sprays were given at 14 days interval using manually operated Knapsack sprayer with duromist nozzle at a constant pressure of 2.5 kg/cm^2. Each spray application was given to the extent of slight run off stage. For recording observations, five plants were selected randomly in each net plot area and the observations on sucking pests *viz.*, jassid and whitefly were recorded from three (one from top, middle and bottom) leaves of same selected 5 plants. The observations were made prior to 24 hrs of first spray as well as 3, 7, 10 and 14 days after each spray. The fruit yield was recorded picking wise from each net plot. Thus, the data obtained on population were analyzed after transforming them in to square root, while the fruit yield data were analyzed without any transformation. The data were analyzed periodically (spray wise) as well as pooled over periods over sprays to see the consistency of the treatment performance. Per cent reduction in sucking pests population was calculated by comparing the pest population obtained from the unprotected plot with the crop protected by different insecticide treatments using the following formula :

$$\textbf{Per cent reduction in population} = \frac{X_1 - X_2}{X_1} \times 100$$

where,

X_1 = sucking pest population in unprotected plot

X_2 = sucking pest population in protected plot.

Per cent loss in yield was calculated by comparing the highest yield obtained from the treatment with different treatments using the following formula :

$$\textbf{Per cent avoidable loss in yield} = \frac{\text{highest yield in treated plot - yield in treated plot}}{\text{highest yield in treated plot}} \text{x}100$$

Economics and Net Insecticidal Cost Benefit Ratio (NICBR) were also worked out by standard procedure.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads :

Evaluation based on jassid population :

The data pooled over periods on number of jassid per leaf over sprays presented in Table 1 showed that among the different insecticides tested, thiamethoxam recorded significantly lower (4.21 jassid per leaf) jassid population after first spray, and it was at par with diafenthiuron (4.56 jassid per leaf), thiacloprid (5.02 jassid per leaf) and profenophos (5.21 jassid per leaf). Diafenthiuron was significantly superior to Triazophos and spiromesifen, but was at par with rest of the insecticides. Triazophos (7.45 jassid per leaf) and spiromesifen (7.91jassid per leaf) recorded significantly higher jassid population among the insecticides tested and both were at par with each other.

After second spray, thiamethoxam (3.19 jassid per leaf) recorded significantly lower jassid population as compared to cartap hydrochloride, triazophos and spiromesifen, whereas it was at par with diafenthiuron (3.46 jassid per leaf), thiacloprid (3.70 jassid per leaf), profenophos (4.25 jassid per leaf), clothianidin (4.47 jassid per leaf) and imidacloprid (4.88 jassid per leaf). Diafenthiuron (3.46 jassid per leaf) was significantly superior to triazophos (7.34 jassid per leaf) and spiromesifen (7.68 jassid per leaf), but was at par with rest of the insecticides. Later two insecticides recorded significantly higher jassid population among the insecticides tested and both were at par with each other as well as with cartap hydrochloride (5.36 jassid per leaf).

Among the different insecticides evaluated, after third spray thiamethoxam (1.30 jassid per leaf) recorded significantly lower jassid population than rest of the treatments, except diafenthiuron (1.40 jassid per leaf) and thiacloprid (1.93 jassid per leaf) with which it was at par. Diafenthiuron also found significantly effective in reducing the jassid population than rest of the insecticides except thiacloprid with which it was at par. Imidacloprid was at par with profenophos, clothianidin and cartap hydrochloride. Triazophos (7.06 jassid per leaf) recorded significantly higher jassid population among the insecticides tested but was at par with spiromesifen (6.16 jassid per leaf).

The data on pooled over sprays (Table 1) revealed that thiamethoxam (2.78 jassid per leaf) recorded significantly lower jassid population than rest of the treatments, except diafenthiuron (3.00 jassid per leaf) and thiacloprid (3.42 jassid per leaf), with which it was at par. Diafenthiuron also found significantly effective in reducing the jassid population than rest of the insecticides except thiacloprid (3.42 jassid per leaf) and profenophos (3.95 jassid per leaf), with which it was at par. Imidacloprid (4.74 jassid per leaf) was at par with clothianidin (4.47 jassid per leaf) and profenophos (3.95 jassid per leaf) on one hand and with cartap hydrochloride (5.40 jassid per leaf) on another hand of chronological order of effectiveness. Triazophos (7.28 jassid per leaf) and spiromesifen (7.23 jassid per leaf) recorded significantly higher jassid population among the insecticides tested and both were at par with each other.

The per cent reduction in jassid population over control in different treatments ranged from 12.01 (spiromesifen 0.024%) to 53.17 (thiamethoxam 0.025%) after first spray. During second spray, the per cent reduction was in the range of 22.19 (spiromesifen) and 67.68 (thiamethoxam). However, it ranged from 32.05 (triazophos 0.08%) to 87.49 (thiamethoxam) after third spray. The data pooled over periods over sprays indicated that the per cent reduction in different treatments ranged between 25.26 (triazophos) and 71.46 (thiamethoxam). In nut-shell, thiamethoxam 0.025per cent, diafenthiuron 0.05per cent and thiacloprid 0.012per cent recorded significantly lower jassid population and emerged as most effective, profenophos 0.05per cent, clothianidin 0.025per cent and imidacloprid 0.002per cent were mediocre, while cartap hydrochloride 0.05per cent spiromesifen 0.024per cent and triazophos 0.08per cent recorded significantly higher jassid population emerged as least effective insecticides for jassid control.

Many research workers have evaluated and reported the bio-efficacy of insecticides against jassid in brinjal. Spray application of thiamethoxam 25 WG @ 37.5 and 50 g a.i./ ha effectively reduced jassid population in okra. However, diafenthiuron 50 WP @ 50 and 60 g a.i./ha found effective against jassid in brinjal (Anonymous, 2001). Sharma and Lai (2002) reported that thiamethoxam was superior against leaf hoppers infesting brinjal. According to Patel *et al*. (2006), diafenthiuron @ 50 and 60 g a.i. /ha was found highly effective against jassid infesting brinjal. Pareet and Basavanagoud (2009) found that diafenthiuron (1 g/lit.) was

Table 1 : Efficacy of different insecticides against jassid in brinjal (Pooled over periods over sprays)

Treatments (conc.)	Number of jassid per leaf*			
	First Spray	Second spray	Third spray	Pooled over sprays
Triazophos 0.08 (%)	2.82c(7.45) [17.13]	2.80cd (7.34) [25.63]	2.75f (7.06) [32.05]	2.79f (7.28) [25.26]
Imidacloprid 0.002 (%)	2.44b (5.45) [39.38]	2.32ab (4.88) [50.56]	2.10cd (3.91) [62.37]	2.29de (4.74) [51.33]
Profenophos 0.05 (%)	2.39ab (5.21)[42.05]	2.18ab (4.25) [56.94]	1.77bc (2.63) [74.69]	2.11bcd (3.95) [59.45]
Diafenthiuron 0.05 (%)	2.25ab(4.56) [49.28]	1.99ab (3.46) [64.94]	1.38a (1.40) [86.53]	1.87ab (3.00) [69.20]
Clothianidin 0.025 (%)	2.42b (5.36) [40.38]	2.23ab (4.47) [54.71]	2.05cd (3.70) [64.39]	2.23cde (4.47) [54.11]
Cartap hydrochloride 0.05 (%)	2.48b (5.65) [37.15]	2.42bc (5.36) [45.69]	2.39de (5.21) [49.86]	2.43e (5.40) [44.56]
Thiamethoxam 0.025 (%)	2.17a [4.21] [53.17]	1.92a (3.19) [67.68]	1.34a (1.30) [87.49]	1.81a (2.78) [71.46]
Thiacloprid 0.012 (%)	2.35ab (5.02) [44.16]	2.05ab (3.70) [62.51]	1.56ab (1.93) [81.42]	1.98abc (3.42) [64.89]
Spiromesifen 0.024 (%)	2.90cd (7.91) [12.01]	2.86cd (7.68) [22.19]	2.58ef (6.16) [40.71]	2.78f (7.23) [25.77
Control (water spray)	3.08d (8.99)	3.22d (9.87)	3.30g (10.39)	3.20g (9.74)
S.E.± Insecticides (I)	0.08	0.15	0.12	0.09
Periods (P)	0.06	0.05	0.08	0.04
Spray (S)	-	-	-	0.03
I × P	0.14	0.16	0.25	0.10
I × S	-	-	-	0.06
I × P × S	-	-	-	0.19
C.D. (P=0.05)				
I	0.24	0.44	0.34	0.26
P	NS	NS	NS	NS
S	-	-	-	0.08
I × P	NS	NS	NS	NS
I × S	-	-	-	0.17
I × P × S	-	-	-	NS
C.V. (%)	9.83	11.20	18.80	14.15

Notes: Treatment means with letter(s) in common are not significant at 5 (%) level of significance in respective column
Figures in parentheses are retransformed values; those outside are? x+0.05, *transformed values
Figures in [ ] are (%) reduction over control NS = Non-significant

the most effective against jassid in brinjal. Thiacloprid 240 SC @ 750 ml/ha recorded significantly lower jassid population after 3 and 7 days of spray in comparison to spinosad, endosulfan and triazophos (Anonymous, 2011).

Evaluation based on whitefly population :

The data pooled over periods over sprays on number of whitefly per leaf presented in Table 2 was showed that among the different insecticides evaluated, spiromesifen recorded significantly lower whitefly population (3.83 whitefly per leaf) as compared to thiacloprid (5.55 whitefly per leaf), cartap hydrochloride (5.75 whitefly per leaf), clothianidin (6.16 whitefly per leaf) and thiamethoxam (6.63 whitefly per leaf), whereas it was at par with diafenthiuron (4.34 whitefly per leaf), triazophos (4.61 whitefly per leaf), imidacloprid (4.98 whitefly per leaf) and profenophos (5.21 whitefly per leaf) after first spray. Triazophos was found significantly superior to thiamethoxam, but was at par with all the insecticides. Thiamethoxam recorded significantly higher whitefly population and was at par with clothianidin, cartap hydrochloride, thiacloprid, profenophos and imidacloprid.

After second spray, spiromesifen (2.00 whitefly per leaf) recorded significantly lower whitefly population as compared to profenophos (3.70 whitefly per leaf), cartap hydrochloride (4.17 whitefly per leaf), clothianidin (4.47 whitefly per leaf), thiamethoxam (4.70 whitefly per leaf) and thiacloprid (4.84 whitefly per leaf), whereas it was at par with diafenthiuron (2.12 whitefly per leaf), triazophos (2.53 whitefly per leaf) and imidacloprid (2.85 whitefly per leaf). Thiacloprid recorded significantly higher whitefly population than spiromesifen, diafenthiuron, triazophos and imidacloprid but was equally effective as thiamethoxam, clothianidin, cartap hydrochloride and profenophos. Among the different insecticides, spiromesifen (0.80 whitefly per leaf) recorded significantly lower whitefly population than rest of the

Table 2 : Efficacy of different insecticides against whitefly in brinjal (Pooled over periods over sprays)

Treatments (conc.)	Number of whitefly per leaf*			
	First spray	Second spray	Third spray	Pooled over sprays
Triazophos 0.08 (%)	2.26abc (4.61) [51.42]	1.74ab (2.53) [76.98]	1.46ab (1.63) [82.11]	1.82ab (2.81) [71.53]
Imidacloprid 0.002 (%)	2.34abcd (4.98) [47.52]	1.83abc (2.85) [74.07]	1.77bc (2.63) [71.13]	1.98bc (3.42) [65.35]
Profenophos 0.05 (%)	2.39abcd (5.21) [45.10]	2.05bcd (3.70) [66.33]	1.95cd (3.30) [63.78]	2.13cd (4.04) [59.07]
Diafenthiuron 0.05 (%)	2.20ab (4.34) [54.27]	1.62a (2.12) [80.71]	1.24a (1.04) [88.58]	1.69ab (2.35) [76.19]
Clothianidin 0.025 (%)	2.58cd (6.16) [35.09]	2.23cd (4.47) [59.33]	2.23de (4.47) [50.93]	2.35de (5.02) [49.14]
Cartap hydrochloride 0.05 (%)	2.50bcd (5.75) [39.41]	2.16cd (4.17) [62.06]	2.18de (4.25) [53.35]	2.28de (4.70) [52.38]
Thiamethoxam 0.025 (%)	2.67d (6.63) [30.14]	2.28d (4.70) [57.23]	2.42e (5.36) [41.16]	2.46e (5.55) [43.77]
Thiacloprid 0.012 (%)	2.46bcd (5.55) [41.52]	2.31d (4.84) [55.96]	2.11cde (3.95) [56.64]	2.29de (4.74) [51.98]
Spiromesifen 0.024 (%)	2.08a (3.83) [59.64]	1.58a (2.00) [81.80]	1.14a (0.80) [91.22]	1.60a (2.06) [79.13]
Control (water spray)	3.16e (9.49)	3.39e (10.99)	3.10f (9.11)	3.22f (9.87)
S.E. ± Insecticides (I)	0.11	0.13	0.13	0.10
Periods (P)	0.05	0.06	0.07	0.03
Spray (S)	-	-	-	0.03
I × P	0.15	0.18	0.22	0.09
I × S	-	-	-	0.06
I × P × S	-	-	-	0.19
C.D. (P=0.05)				
I	0.33	0.40	0.38	0.29
P	0.13	0.16	NS	0.09
S	-	-	-	0.08
I × P	NS	NS	NS	NS
I × S	-	-	-	0.16
I × P × S	-	-	-	NS
C.V. (%)	10.17	14.58	19.53	14.74

Notes: Treatment means with letter(s) in common are not significant at 5% level of significance in respective column,
Figures in parentheses are retransformed values; those outside are $\sqrt{x+0.5}$, *transformed values, Figures in [ ] are (%) reduction over control
NS= Non-significant

insecticides, except diafenthiuron (1.04 whitefly per leaf) and triazophos (1.63 whitefly per leaf), with which it was at par after third spray. Imidacloprid was at par with profenophos and thiacloprid on one hand and with triazophos on other hand of chronological order. Thiamethoxam (5.36 whitefly per leaf) recorded significantly higher whitefly population but was at par with clothianidin, cartap hydrochloride and thiacloprid.

The data on pooled over sprays (Table 2) revealed that spiromesifen (2.06 whitefly per leaf) recorded significantly lower whitefly population than rest of the insecticides except diafenthiuron (2.35 whitefly per leaf) and triazophos (2.81 whitefly per leaf), with which it was at par. Diafenthiuron and triazophos found significantly superior to profenophos, cartap hydrochloride, thiacloprid, clothianidin and thiamethoxam but was at par with each other and also with spiromesifen and imidacloprid. Profenophos was at par with imidacloprid on one hand and with cartap hydrochloride, thiacloprid and clothianidin on other hand of chronological order. Thiamethoxam (5.55 whitefly per leaf) recorded significantly higher whitefly population but was at par with later three insecticides. The per cent reduction in whitefly population over control in different treatments ranged from 30.14 (thiamethoxam 0.025%) to 59.64 (spiromesifen 0.024%) after first spray. During second spray, the per cent reduction was in the range of 55.96 (thiacloprid 0.012%) and 81.80 (spiromesifen). However, it was ranged from 41.16 (thiamethoxam) to 91.22 (spiromesifen) after third spray. The data pooled over periods over sprays indicated that the per cent reduction in different treatments ranged between 43.77 (thiamethoxam) and 79.13 (spiromesifen).

Overall, spiromesifen 0.024per cent, diafenthiuron 0.05per cent and triazophos 0.08per cent recorded significantly lower whitefly population emerged as most effective, imidacloprid 0.002per cent, profenophos 0.05per cent and cartap hydrochloride 0.05per cent were mediocre, while clothianidin 0.025per cent, thiamethoxam 0.025per cent and thiacloprid 0.012per cent recorded significantly higher whitefly population emerged as least effective insecticides. Many research workers have reported the efficacy of various insecticides against whitefly in brinjal. According to Kumar *et al.* (2001), triazophos (0.05%) exerted superior control (75.22%) of whiteflies. Diafenthiuron 0.025per cent proved effective for controlling whitefly infesting brinjal (Narangalkar, 2003). Thus, these above reports for the effectiveness of diafenthiuron and triazophos are strongly supporting the present findings. Jarande and Dethe (1994), Singh *et al.* (2001); Sudhakar *et al.* (1998) and Mhaske and Mote (2005) reported the effectiveness of imidacloprid against whitefly in brinjal. However, Singh *et al.* (2003) found profenophos as effective for the control of whitefly. These reports also tally with the results of present findings as both above insecticides emerged as mediocre.

Efficacy based on fruit yield :

The data on brinjal fruit yield, per cent avoidable losses and economics are presented in Table 3, which showed that among the various insecticides, diafenthiuron exhibited significantly higher fruit yield (350.57 q/ha) as compared to imidacloprid (284.72 q/ha), spiromesifen (232.33 q/ha), clothianidin (226.85 q/ha), triazophos (225.05 q/ha) and cartap hydrochloride (224.28 q/ha), whereas it was at par with thiamethoxam (342.34 q/ha), thiacloprid (328.19 q/ha) and profenophos (307.10 q/ha). Imidacloprid (284.72 q/ha) was also at par with thiamethoxam, thiacloprid and profenophos on one hand, while with spiromesifen and

Table 3 : Impact of different insecticides on brinjal fruit yield and economics

Treatments(conc.)	Fruit yield (q/ha)	Avoidable losses (%)	Net ICBR
Triazophos 0.08 (%)	225.05d	35.80	23.23
Imidacloprid 0.002 (%)	284.72bc	18.78	39.10
Profenophos 0.05 (%)	307.1ab	12.40	71.83
Difenthiuron 0.05 (%)	350.57a	00.00	27.69
Clothianidin 0.025 (%)	226.85cd	35.29	04.26
Cartap hydrochloride 0.05 (%)	224.28d	36.02	43.93
Thiamethoxam 0.025 (%)	342.34ab	02.35	22.55
Thiacloprid 0.012 (%)	328.19ab	06.38	56.10
Spiromesifen 0.024 (%)	232.33cd	33.73	07.75
Control (water spray)	156.89e	55.25	-
S.E. ±	019.81	-	
C.D. (P=0.05)	058.85	-	
C.V. (%)	012.81	-	

Notes: Treatment means with letter(s) in common are not significant at 5% level of significance in respective column clothianidin on other hand of chronological order for brinjal fruit yield. Triazophos and cartap hydrochloride hosted significantly lower fruit yield and both were at par with each other and also with clothianidin and spiromesifen.

The reports of Patel *et al*. (2006) and Anonymous (2001), noted that diafenthiuron registered higher brinjal fruit yield. Thiacloprid 240 SC @ 750 ml/ha registered significantly higher fruit yield (Anonymous, 2011). In present investigation also diafenthiuron, thiamethoxam and thiacloprid exhibited higher brinjal fruit yield. Thus, above reports tally with the present results of investigation. The minimum (0.00) per cent avoidable losses were recorded in diafenthiuron followed by thiamethoxam (2.35), thiacloprid (6.38) and profenophos (12.40). However, the maximum per cent avoidable losses were recorded in control plot (55.25) followed by cartap hydrochloride (36.02), triazophos (35.80) and clothianidin (35.29). The economics of various insecticides (Table 3) revealed that the highest Net ICBR (71.83) was obtained from the plots treated with profenophos 0.05per cent followed by thiacloprid 0.012per cent (56.10), cartap hydrochloride 0.05per cent (43.93), imidacloprid 0.002per cent (39.10), diafenthiuron 0.05per cent (27.69), triazophos 0.08per cent (23.23) and thiamethoxam 0.025 per cent (22.55). Though, diafenthiuron emerged as most effective against sucking pests as well as also registered higher brinjal fruit yield, the net ICBR was low. It might be due to very high market price of the insecticide. On other hand, cartap hydrochloride emerged as least effective with lower brinjal fruit yield, the Net ICBR was higher, it might be due to very low market price of the insecticide.

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