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RESEARCH PAPER

# Efficacy of newer insecticides against the brinjal, *Solanum melongena* (L.) shoot and fruit borer, *Leucinodes orbonalis* (Guen.) in Karaikal district, U.T. of Puducherry

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To evaluate the efficacy of newer insecticides against brinjal shoot and fruit borer, *L. orbonalis*, two supervised field experiments were conducted during *Kharif* 2010 (Field experiment I) and *Rabi* 2011 (Field experiment II) at Eastern farm of PAJANCOA and RI, Department of Horticulture, Karaikal with the variety PLR2, as an irrigated crop. Four rounds of foliar applications were given. Among the treatments the lowest mean per cent shoot damage was recorded in the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha followed by emamectin benzoate 25 WG @ 11 g a.i./ha, carbaryl 50 WP + wettable sulphur 50 WP @ 500 g a.i./ha and were superior than the untreated check. From the field experiment I and II, the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha recorded lesser infestation of shoot and fruit borer *L. orbonalis* followed by emamectin benzoate 25 WG @ 11 g a.i./ha and were superior than the other treatments on number and weight basis. The highest yield was observed in the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha (27.08 $t.ha^{-1}$ and 36.10 $t.ha^{-1}$) followed by emamectin benzoate 25 WG @ 11 g a.i./ha (23.61 $t.ha^{-1}$ and 32.66 $t.ha^{-1}$) compared to the untreated check (14.20 $t.ha^{-1}$ and 18.46 $t.ha^{-1}$) and recorded maximum benefit cost ratio in the field experiment I and II, respectively.

**Key words :** Brinjal, *Leucinodes orbonalis*, Newer insecticides

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## INTRODUCTION

Brinjal or eggplant (*Solanum melongena* L.) is one of the common vegetable crop cultivated extensively by virtue of its wide adaptability to grow from plains to an altitude upto 1500 MSL. It is an important solanaceous crop of sub-tropics and tropics (Anonymous, 2008).It is a good source of minerals and vitamins and is rich in total water soluble sugars, free reducing sugars, amide proteins among other nutrients. This economically important commercial crop is infested by more than 142 species of insects, 4 species of mites and 3 species of nematodes from planting to harvest (Sohi, 1966). Among the various insect pests attacking the eggplant, shoot and fruit borer, *Leucinodes orbonalis* (Guen.); stem borer, *Euzophera perticella* (Rag.); hadda beetle, *Henosepilachna vigintioctopunctata* (Fab.); *H. dodecastigma* (Wied.); leaf hopper, *Amrasca devastans* (Dist.); lacewing bug, *Urentius echinus* (Dist.); aphid, *Aphis gossypii* (Glov.) and whitefly, *Bemisia tabaci* (Genn.) were designated as major pests (Singh, 1970). Among the various methods of pest management, the use of insecticides form the first line of defence against the insect pests. Newer insecticide molecules are better alternative to conventional synthetic insecticides in the context of environmentally benign management tactics so also in order to mitigate the adverse effect on the total environment. In many cases, alternate or eco-friendly method of insect management offer adequate level of pest control with less hazards and safe to non-target organisms. With this background, the present study was undertaken to evaluate the bioefficacy of newer insecticides against the brinjal shoot and fruit borer, *L. orbonalis*.

## RESEARCH METHODOLOGY

**Efficacy of newer insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* :**

To evaluate the efficacy of newer insecticides against brinjal shoot and fruit borer, *L. orbonalis*, two supervised field experiments were conducted during *Kharif* 2010 (Field experiment I) and *Rabi* 2011(Field experiment II) at Eastern farm of PAJANCOA and RI, Department of Horticulture, Karaikal as an irrigated crop. The experiment was laid out in a Randomized Block Design (RBD) with three replications and eleven treatments in a 6.5 x 2.5 square meter plot with a spacing of 60 x 60 cm and the variety used was PLR 2. The foliar treatments were given using high volume sprayer (Hand operated knapsack sprayer). Four foliar applications were given at $58^{th}$, $73^{rd}$, $86^{th}$ and $101^{st}$ days after sowing (DAS). Observations on pest damage was recorded on ten randomly selected plants prior to the treatment and after imposing the treatment. Post treatment observations were recorded on 1, 3, 5, 7, and 14 days after spraying. The fruit yield was recorded plot wise as and when the harvesting was done in the field experiment I and II.

**Assessment of shoot and fruit borer, *Leucinodes orbonalis* (Guen.) damage :**

The shoot damage by *L. orbonalis*, was assessed based on the total number of shoots and affected shoots in a plot on 10 randomly selected plants and the per cent shoot damage was worked out.

The fruit damage by *L. orbonalis*, was assessed based on the total number of fruits and the number of damaged fruits in 10 randomly selected plants, and the per cent fruit damage was worked out (Bebitha, 2009).

The yield of brinjal fruits was recorded from each plot on weight basis and computed to per hectare.The per cent data recorded for shoot and fruit damage was converted into corresponding angular transformation (Arcsin) if the values ranged from 0 to 100 for statistical analysis (Snedecor and Cochran, 1967). The data obtained from the field were analyzed in a simple Randomized Block Design by “F” test for significance as described by Panse and Sukhatme (1967). Critical difference values were calculated at 5 per cent probability level and the treatment mean values of the experiments were compared using Duncans Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

## RESEARCH FINDINGS AND ANALYSIS

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

**Efficacy of newer insecticides against brinjal shoot and fruit borer, *L. orbonalis* (Guen.) :**

***Field experiment I (Kharif) :***

Based on shoot damage basis:

Before the first foliar application, the per cent shoot damage ranged from 3.75 to 5.36 per cent/plant. At 7 DAT, the per cent shoot damage ranged from 1.73 to 8.67 per cent/plant. In the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha, the per cent shoot damage was low (1.73%) followed by triazophos 45 EC @ 500 g a.i./ha (2.13%) and emamectin benzoate 25 WG @ 11 g a.i./ha (2.14%) compared to the untreated check (8.67%).At 14 DAT, the per cent shoot damage ranged from 2.02 to 10.53 per cent/plant. In the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha the per cent shoot damage was low (2.02%) followed by emamectin benzoate 25 WG @ 11 g a.i./ha (2.14%) and all the treatments were superior than the untreated check (10.53%).

Before the second foliar application, the per cent shoot damage ranged from 2.02 to 10.53 per cent/plant. At 7 DAT, the shoot damage ranged from 1.69 to 9.05 per cent/plant. In the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha the per cent shoot damage was low (1.69%) followed by indoxacarb 14. 5 SC @ 75 g a.i./ha (2.04%) and were comparable with other treatments. All the treatments were found to be superior than the untreated check (9.05%).The per cent shoot damage was in an increasing trend and continued upto 14 DAT.

Before the third foliar application, the per cent shoot

**Table 1 : Effect of newer insecticides against brinjal shoot and fruit borer, *L. orbonalis* (Guen.) on variety PLR 2 (Field experiment I)**

| Sr. No. | Treatments | Mean of 3 replications (% shoot damage #) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I Foliar application | | | II Foliar application | | III Foliar application | | IV Foliar application | | Per cent reduction over control |
| | | Pre count | 7 DAT | 14 DAT | 7 DAT | 14 DAT | 7 DAT | 14 DAT | 7 DAT | 14 DAT | |
| 1. | Spinosad 45 SC@75 g a.i/ha | 4.06 | 2.86 (9.65)$^{ab}$ | 4.52 (11.04)$^{ab}$ | 4.00 (11.09)$^{ab}$ | 8.52 (16.90)$^{bc}$ | 3.56 (10.80)$^{bc}$ | 7.48 (15.79)$^{ab}$ | 5.70 (13.27)$^{ab}$ | 9.81 (17.81)$^{ab}$ | 59.20 |
| 2. | Indoxacarb 14.5 SC@75 g a.i/ha | 5.06 | 3.84 (11.29)$^{bc}$ | 3.09 (9.88)$^{ab}$ | 2.04 (8.11)$^{a}$ | 5.43 (13.44)$^{ab}$ | 3.20 (10.20)$^{bc}$ | 8.72 (16.62)$^{abc}$ | 6.81 (15.12)$^{bc}$ | 10.21 (18.52)$^{abc}$ | 58.90 |
| 3. | Emamectin benzoate 25 WG@11g a.i./ha | 3.75 | 2.14 (8.40)$^{ab}$ | 2.14 (8.40)$^{ab}$ | 5.54 (12.83)$^{ab}$ | 8.94 (17.32)$^{bc}$ | 2.90 (9.16)$^{abc}$ | 4.83 (12.40)$^{ab}$ | 5.88 (14.02)$^{bc}$ | 8.83 (17.28)$^{ab}$ | 64.27 |
| 4. | Triazophos 40 EC@500 g a.i/ha | 4.65 | 2.13 (8.38)$^{ab}$ | 4.85 (12.56)$^{ab}$ | 2.10 (8.22)$^{a}$ | 5.67 (13.45)$^{ab}$ | 4.23 (11.44)$^{bc}$ | 8.90 (17.35)$^{bc}$ | 7.36 (15.74)$^{bc}$ | 10.50 (18.50)$^{abc}$ | 54.82 |
| 5. | Profenofos 50 EC@750 g a.i/ha | 4.96 | 3.39 (10.36)$^{ab}$ | 6.64 (13.97)$^{ab}$ | 5.92 (12.91)$^{ab}$ | 9.31 (17.76)$^{bc}$ | 3.40 (10.30)$^{bc}$ | 9.83 (18.19)$^{bc}$ | 8.75 (17.20)$^{c}$ | 11.28 (19.57)$^{abc}$ | 49.65 |
| 6. | Novaluron 10 EC @75 g a.i/ha | 4.36 | 5.68 (13.52)$^{cd}$ | 7.54 (15.25)$^{ab}$ | 3.42 (10.56)$^{ab}$ | 7.54 (15.25)$^{bc}$ | 3.60 (10.86)$^{bc}$ | 7.80 (15.78)$^{ab}$ | 6.46 (14.70)$^{bc}$ | 9.36 (17.81)$^{ab}$ | 56.12 |
| 7. | Carbaryl 50WP + Wettable Sulphur 50 WP (1:1)@500 g a.i./ha | 4.10 | 3.17 (10.11)$^{ab}$ | 5.49 (13.35)$^{ab}$ | 2.43 (8.85)$^{a}$ | 5.49 (13.35)$^{ab}$ | 1.83 (7.65)$^{ab}$ | 6.49 (14.73)$^{ab}$ | 5.23 (13.13)$^{ab}$ | 7.95 (16.33)$^{ab}$ | 62.29 |
| 8. | Chlorantraniliprole 20 SC@40 g a.i/ha | 5.16 | 1.73 (7.49)$^{a}$ | 2.02 (8.09)$^{a}$ | 1.69 (7.33)$^{a}$ | 2.00 (8.05)$^{a}$ | 0.96 (5.62)$^{a}$ | 3.52 (10.79)$^{a}$ | 3.40 (10.57)$^{a}$ | 6.11 (14.30)$^{a}$ | 78.01 |
| 9. | Neem oil@2% | 5.26 | 3.38 (10.55)$^{b}$ | 6.96 (14.42)$^{ab}$ | 5.40 (12.65)$^{ab}$ | 6.96 (14.42)$^{abc}$ | 3.56 (10.81)$^{bc}$ | 6.53 (14.78)$^{ab}$ | 7.50 (15.73)$^{bc}$ | 9.72 (18.05)$^{abc}$ | 51.34 |
| 10. | *B. thuringiensis* var. kurstaki@50 g a.i./ha | 4.90 | 6.60 (14.87)$^{de}$ | 9.50 (17.94)$^{b}$ | 7.92 (16.23)$^{b}$ | 11.83 (20.04)$^{bc}$ | 4.33 (11.96)$^{c}$ | 6.33 (14.27)$^{ab}$ | 7.93 (16.26)$^{bc}$ | 13.06 (20.98)$^{bc}$ | 35.12 |
| 11. | Untreated check | 5.36 | 8.67 (17.12)$^{e}$ | 10.53 (18.03)$^{b}$ | 9.05 (17.45)$^{b}$ | 12.76 (20.75)$^{c}$ | 13.63 (21.63)$^{d}$ | 13.68 (21.70)$^{c}$ | 12.60 (20.76)$^{d}$ | 16.12 (23.59)$^{c}$ | - |
| | C.D. (P=0.05) | NS | 1.50* | 4.74* | 3.72* | 3.50* | 1.99* | 2.95* | 1.66* | 2.90* | |

NS – Not significant
* - Significant at P=0.05
\# - Mean of 10 plants

Values in parentheses are arcsin transformed values
DAS- Days after sowing
DAT- Days after treatment

damage ranged from 2.00 to 12.76 per cent/plant. At 7 DAT, the per cent shoot damage ranged from 0.96 to 13.63 per cent/plant. In the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha, the per cent shoot damage was low (0.96%) followed by carbaryl 50 WP + wettable sulphur 50 WP @ 500 g a.i./ha (1.83%) and were comparable with other treatments. All the treatments were superior than the untreated check (13.63%). At 14 DAT, the per cent shoot damage was in an increasing trend and ranged from 3.52 to 13.68 per cent/plant. In the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha, the per cent shoot damage was low (3.52%) followed by emamectin benzoate 25 WG @ 11 g a.i./ha (4.83%) compared to the untreated check (13.68%).

Before the fourth foliar application, the per cent shoot damage ranged from 3.52 to 13.68 per cent/plant. At 7 DAT, there was a reduction in per cent shoot damage and ranged from 3.40 to 12.60 per cent/plant. In the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha, the per cent shoot damage was low (3.40%) followed by carbaryl 50 WP + wettable sulphur 50 WP @ 500 g a.i./ha (5.23%) while the untreated check recorded a maximum per cent shoot damage of 12.60 per cent/plant. Similar trend was observed upto 14 DAT. It was found that the treatment with chlorantraniliprole 20 SC @ 40 g a.i/ha was superior among the treatments with a per cent reduction of 78.01 per cent compared to the other treatments (Table1).

Based on number basis :

The per cent fruit infestation on number basis was observed in five pickings. The per cent fruit infestation ranged from 6.29 to 38.25 per cent. The per cent fruit infestation was low in the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha which ranged from 6.29 to 10.46 per cent in all the five pickings followed by emamectin benzoate 25 WG @ 11 g a.i./ha (10.71 to 16.66%) and superior than untreated check (31.63 to 38.25%) (Table 3).

Based on weight basis :

In the field experiment I, it was found that the per cent fruit borer infestation ranged from 7.29 to 39.25 per cent from five pickings. The fruit infestation on weight basis was low in the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha which ranged from 7.29 to 11.46 per cent followed by emamectin benzoate 25 WG @ 11 g a.i./ha (11.71 to 15.66%) compared to the untreated check (31.56 to 39.25%) (Table 4).

***Field experiment II (Rabi) :***

Based on shoot damage basis:

Before the first foliar application, the per cent shoot damage ranged from 2.60 to 5.10 per cent/plant. At 7 DAT, the per cent shoot damage was in an increasing trend and ranged from 0.83 to 9.54 per cent/plant. In the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha the per cent shoot damage was low (0.83%) followed by emamectin benzoate 25 WG @ 11 g a.i./ha (1.36%). Similar trend was observed in the treatment with novaluron 10 EC @ 75 g a.i./ha (1.92%) compared to the untreated check (9.54%).At 14 DAT the per cent shoot damage was in an increasing trend and ranged from 1.02 to 10.53 per cent/plant. A low per cent shoot damage was observed in the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha (1.02%) followed by emamectin benzoate 25 WG @ 11 g a.i./ha (1.64%) and indoxacarb 14.5 SC @ 75 g a.i./ha (3.09%) while the untreated check recorded a maximum per cent shoot damage of 10.53 per cent/plant.

Before the second foliar application, the per cent shoot damage ranged from 1.02 to 10.53 per cent/plant. At 7 DAT, the per cent shoot damage ranged from 0.78 to 9.10 per cent/plant. In the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha the per cent shoot damage was low (0.78%) followed by triazophos 40 EC @ 500 g a.i./ha (1.13%) and was comparable with the treatment emamectin benzoate 25 WG @ 11 g a.i./ha (1.64%) compared to the untreated check and similar trend was also observed at 14 DAT.

Before the third and fourth foliar application, the per cent shoot damage ranged from 3.63 to 13.93 and 3.85 to 15.34 per cent/plant, respectively. It was found that after the third and fourth foliar application, the per cent shoot damage was lower in the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha as in the previous applications (Table 2).

Based on number basis :

The per cent fruit infestation ranged from 5.83 to 39.54 per cent. The per cent fruit infestation was low in the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha which ranged from 5.83 to 10.43 per cent in all the five pickings followed by emamectin benzoate 25 WG @ 11 g a.i./ha (11.71 to 17.28%) compared to the

**Table 2 : Effect of newer insecticides against brinjal shoot and fruit borer, *L. orbonalis* (Guen.) on variety PLR 2 (Field experiment II) (% shoot damage #) Mean of 3 replications**

| Sr. No | Treatments | I Foliar application | | | II Foliar application | | III Foliar application | | IV Foliar application | | Per cent reduction over control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre count | 7 DAT | 14 DAT | 7 DAT | 14 DAT | 7 DAT | 14 DAT | 7 DAT | 14 DAT | |
| 1. | Spinosad 45 SC@75 g a.i/ha | 3.56 (10.86)$^{ab}$ | 2.44 (7.35)$^{a}$ | 4.52 (11.04)$^{ab}$ | 2.08 (8.06)$^{ab}$ | 5.70 (13.80)$^{a}$ | 3.10 (10.15)$^{abc}$ | 7.20 (15.56)$^{abc}$ | 5.70 (13.27)$^{ab}$ | 8.19 (16.58)$^{bc}$ | 60.14 |
| 2. | Indoxacarb 14.5 SC@75 g a.i/ha | 4.23 (11.66)$^{ab}$ | 2.00 (8.04)$^{a}$ | 3.09 (9.88)$^{ab}$ | 1.48 (6.85)$^{ab}$ | 6.29 (14.47)$^{a}$ | 4.16 (11.70)$^{abc}$ | 8.55 (16.49)$^{abc}$ | 6.81 (15.12)$^{bc}$ | 8.80 (17.22)$^{bc}$ | 52.99 |
| 3. | Emamectin benzoate 25 WG@11g a.i./ha | 3.06 (10.03)$^{ab}$ | 1.36 (5.42)$^{a}$ | 1.64 (6.02)$^{a}$ | 1.64 (7.23)$^{ab}$ | 5.00 (12.77)$^{a}$ | 3.05 (9.50)$^{ab}$ | 4.94 (12.56)$^{ab}$ | 5.23 (13.13)$^{ab}$ | 6.75 (15.04)$^{b}$ | 67.39 |
| 4. | Triazophos 40 EC@500 g a.i/ha | 4.16 (11.73)$^{ab}$ | 2.76 (9.53)$^{a}$ | 4.85 (12.56)$^{ab}$ | 1.13 (4.83)$^{a}$ | 6.56 (14.16)$^{a}$ | 5.26 (12.70)$^{bc}$ | 9.46 (17.91)$^{bcd}$ | 7.36 (15.74)$^{bc}$ | 8.50 (16.94)$^{bc}$ | 49.61 |
| 5. | Profenofos 50 EC@750 g a.i/ha | 4.26 (11.83)$^{ab}$ | 3.26 (6.08)$^{a}$ | 6.64 (13.97)$^{ab}$ | 2.12 (6.26)$^{a}$ | 4.77 (11.74)$^{a}$ | 3.66 (10.67)$^{abc}$ | 10.16 (18.52)$^{cd}$ | 8.75 (17.20)$^{c}$ | 9.15 (17.60)$^{c}$ | 46.45 |
| 6. | Novaluron 10 EC @75 g a.i/ha | 4.30 (11.90)$^{ab}$ | 1.92 (7.87)$^{a}$ | 7.54 (15.25)$^{ab}$ | 1.49 (6.95)$^{ab}$ | 5.01 (12.91)$^{a}$ | 4.03 (11.48)$^{abc}$ | 8.14 (16.28)$^{abc}$ | 6.46 (14.70)$^{bc}$ | 8.21 (16.63)$^{bc}$ | 48.96 |
| 7. | Carbaryl 50WP + Wettable Sulphur 50 WP (1:1)@500 g a.i./ha | 3.70 (11.05)$^{ab}$ | 2.42 (8.94)$^{ab}$ | 5.49 (13.35)$^{ab}$ | 1.87 (7.84)$^{ab}$ | 6.34 (13.69)$^{a}$ | 3.43 (10.02)$^{abc}$ | 6.72 (14.98)$^{abc}$ | 5.88 (14.02)$^{bc}$ | 7.36 (15.74)$^{bc}$ | 57.14 |
| 8. | Chlorantraniliprole 20 SC@40 g a.i/ha | 2.60 (9.09)$^{a}$ | 0.83 (5.22)$^{a}$ | 1.02 (7.09)$^{a}$ | 0.78 (4.14)$^{a}$ | 3.63 (10.99)$^{a}$ | 1.93 (7.93)$^{a}$ | 3.85 (11.32)$^{a}$ | 3.4 (10.57)$^{a}$ | 4.39 (12.04)$^{a}$ | 78.40 |
| 9. | Neem oil@2% | 4.36 (11.93)$^{b}$ | 3.90 (9.33)$^{ab}$ | 6.96 (14.42)$^{ab}$ | 4.67 (12.35)$^{bc}$ | 7.10 (15.33)$^{a}$ | 3.76 (11.14)$^{abc}$ | 7.80 (16.15)$^{abc}$ | 7.5 (15.73)$^{bc}$ | 9.02 (17.46)$^{c}$ | 44.71 |
| 10. | *B. thuringiensis* var. kurstaki@50 g a.i./ha | 4.40 (12.06)$^{b}$ | 6.45 (14.49)$^{ab}$ | 9.50 (17.94)$^{b}$ | 6.06 (13.99)$^{c}$ | 12.76 (20.92)$^{b}$ | 6.06 (14.20)$^{c}$ | 6.66 (14.76)$^{abc}$ | 7.93 (16.26)$^{bc}$ | 8.54 (16.95)$^{bc}$ | 33.36 |
| 11. | Untreated check | 5.10 (12.86)$^{b}$ | 9.54 (17.98)$^{b}$ | 10.53 (18.03)$^{b}$ | 9.10 (17.54)$^{c}$ | 13.93 (21.91)$^{b}$ | 13.76 (21.77)$^{d}$ | 15.34 (23.24)$^{d}$ | 12.6 (20.76)$^{d}$ | 14.02 (21.97)$^{d}$ | -- |
| | CD(P=0.05) | 1.419** | 4.77* | 4.74* | 3.04** | 2.84* | 2.24** | 2.73* | 1.66* | 1.16** | |

* and ** indicate significance of values at P=0.05 and 0.01, respectively   Values in parentheses are arcsin transformed values   DAS- Days after sowing
\# - Mean of 10 plants   DAT- Days after treatment

**Table 3 : Effect of newer insecticides against brinjal fruit infestation by *L. orbonalis* (Guen.) on number basis**

| | | Mean of 3 replications | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sr. No. | Treatments | Fruit infestation on number basis Field experiment I | | | | | Fruit infestation on number basis Field experiment II | | | | |
| | | I Picking | II Picking | III Picking | IV Picking | V Picking | I Picking | II Picking | III Picking | IV Picking | V Picking |
| 1. | Spinosad 45 SC @75 g a.i/ha | 17.97 | 12.08 | 20.36 | 21.29 | 15.47 | 15.66 | 13.74 | 22.36 | 23.19 | 16.59 |
| | | (25.07)$^{bc}$ | (20.32)$^{abc}$ | (26.69)$^{bc}$ | 26.98)$^{abc}$ | (23.13)$^{ab}$ | (23.26)$^{bc}$ | (21.71)$^{abc}$ | 28.15)$^{bc}$ | (28.42)$^{bcd}$ | (23.95)$^{bc}$ |
| 2. | Indoxacarb 14.5 SC @75 g a.i/ha | 22.97 | 19.13 | 26.67 | 26.16 | 18.40 | 20.73 | 22.41 | 28.68 | 28.35 | 21.22 |
| | | (28.61)$^{cd}$ | (25.91)$^{bcd}$ | (31.09)$^{cde}$ | (30.69)$^{cd}$ | (25.31)$^{ab}$ | (26.97)$^{cd}$ | (28.19)$^{b-e}$ | 32.38)$^{cde}$ | (32.05)$^{cde}$ | (27.41)$^{cde}$ |
| 3. | Emamectin benzoate 25 WG@11g a.i./ha | 14.86 | 10.71 | 15.31 | 16.66 | 12.97 | 12.87 | 11.71 | 17.28 | 16.50 | 13.41 |
| | | (22.67)$^{b}$ | (19.08)$^{ab}$ | (22.99)$^{ab}$ | (23.3720$^{ab}$ | (21.10)$^{a}$ | (20.95)$^{b}$ | (19.95)$^{ab}$ | 24.44)$^{b}$ | (23.73)$^{ab}$ | (21.47)$^{b}$ |
| 4. | Triazophos 40 EC@500 g a.i/ha | 24.13 | 24.55 | 27.38 | 28.10 | 20.18 | 21.53 | 26.55 | 29.07 | 29.20 | 23.00 |
| | | (29.41)$^{cde}$ | (29.07)$^{bcd}$ | (31.54)$^{cde}$ | (31.96)$^{cd}$ | (24.59)$^{ab}$ | (27.61)$^{cd}$ | (30.64)$^{de}$ | 32.60)$^{cde}$ | (32.69)$^{cde}$ | (28.58)$^{def}$ |
| 5. | Profenofos 50 EC@750 g a.i/ha | 27.10 | 17.53 | 30.75 | 22.82 | 25.64 | 24.93 | 19.92 | 32.55 | 23.04 | 25.12 |
| | | (31.37)$^{de}$ | (24.53)$^{bcd}$ | (33.65)$^{de}$ | (28.52)$^{bc}$ | (30.33)$^{bc}$ | (29.92)$^{de}$ | (26.26)$^{bcd}$ | 34.73)$^{de}$ | (28.64)$^{bcd}$ | (30.00)$^{ef}$ |
| 6. | Novaluron 10 EC@75 g a.i/ha | 26.28 | 22.36 | 29.86 | 26.46 | 26.88 | 25.85 | 24.40 | 31.61 | 27.65 | 27.65 |
| | | (30.83)$^{de}$ | (28.18)$^{bcd}$ | (32.97)$^{de}$ | (30.95)$^{cd}$ | (31.22)$^{bc}$ | (30.47)$^{de}$ | (29.57)$^{cde}$ | 34.15)$^{de}$ | (31.70)$^{cde}$ | (31.72)$^{ef}$ |
| 7. | Carbaryl 50 WP + Wettable Sulphur 50 WP (1:1)@500 g a.i./ha | 28.05 | 15.96 | 23.23 | 20.76 | 16.37 | 20.35 | 17.83 | 25.10 | 21.95 | 17.54 |
| | | (31.97)$^{de}$ | (23.37)$^{abc}$ | (28.81)$^{cd}$ | (27.05)$^{abc}$ | (23.84)$^{ab}$ | (26.79)$^{cd}$ | (24.86)$^{bcd}$ | 30.03)$^{cd}$ | (27.90)$^{bc}$ | (24.70)$^{bcd}$ |
| 8. | Chlorantraniliprole 20 SC | 8.13 | 6.29 | 9.75 | 12.10 | 10.46 | 5.83 | 7.40 | 10.37 | 10.43 | 7.43 |
| | @40 g a.i/ha | (16.19)$^{a}$ | (14.50)$^{a}$ | (18.09)$^{a}$ | (20.35)$^{a}$ | (18.78)$^{a}$ | (13.90)$^{a}$ | (15.77)$^{a}$ | 18.68)$^{a}$ | (18.76)$^{a}$ | (15.42)$^{a}$ |
| 9. | Neem oil@2% | 26.49 | 20.05 | 31.49 | 27.62 | 25.76 | 24.20 | 22.05 | 33.45 | 28.80 | 26.26 |
| | | (30.71)$^{de}$ | (26.12)$^{bcd}$ | (34.12)$^{de}$ | (31.69)$^{cd}$ | (30.47)$^{bc}$ | (29.40)$^{de}$ | (27.67)$^{b-e}$ | 35.32)$^{de}$ | (32.44)$^{cde}$ | (30.81)$^{ef}$ |
| 10. | *B. thuringiensis* var. kurstaki | 29.41 | 25.84 | 27.62 | 30.60 | 28.43 | 27.63 | 27.51 | 29.66 | 31.17 | 29.40 |
| | @50 g a.i./ha | (32.81)$^{de}$ | (29.62)$^{cd}$ | (31.58)$^{cde}$ | (33.53)$^{cd}$ | (32.19)$^{bc}$ | (31.68)$^{de}$ | (30.98)$^{de}$ | 32.86)$^{cde}$ | (33.93)$^{de}$ | (32.82)$^{f}$ |
| 11. | Untreated check | 31.95 | 31.63 | 32.56 | 35.18 | 38.25 | 29.67 | 34.29 | 34.31 | 36.25 | 39.54 |
| | | (34.40)$^{e}$ | (34.16)$^{d}$ | (34.79)$^{e}$ | (36.38)$^{d}$ | (38.18)$^{c}$ | (32.98)$^{e}$ | (35.81)$^{e}$ | 35.85)$^{e}$ | (37.01)$^{e}$ | (38.95)$^{g}$ |
| | C.D. (P=0.05) | 2.590* | 5.229* | 2.842* | 3.645* | 2.239** | 2.53* | 4.48* | 2.89* | 2.98* | 2.44* |

* and ** indicate significance of values at P=0.05 and 0.01, respectively     Values in parentheses are arcsin transformed values

**Table 4 : Effect of newer insecticides against brinjal fruit infestation by L. orbonalis (Guen.) on weight basis**

| Sr. No. | Treatments | Mean of 3 replications: Fruit infestation on weight basis, Field experiment I | | | | | Fruit infestation on weight basis, Field experiment II | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I Picking | II Picking | III Picking | IV Picking | V Picking | I Picking | II Picking | III Picking | IV Picking | V Picking |
| 1. | Spinosad 45 SC | 18.97 | 13.08 | 19.36 | 20.29 | 16.47 | 14.66 | 12.74 | 24.36 | 24.19 | 15.59 |
| | @75 g a.i/ha | (25.82)$^{bc}$ | (21.32)$^{abc}$ | (25.69)$^{bc}$ | (25.98)$^{abc}$ | (24.13)$^{ab}$ | (22.26)$^{bc}$ | (20.71)$^{abc}$ | (29.15)$^{bc}$ | (29.42)$^{bcd}$ | (22.95)$^{bc}$ |
| 2. | Indoxacarb 14.5 SC | 23.63 | 20.13 | 25.67 | 25.16 | 19.40 | 19.73 | 21.41 | 29.68 | 31.35 | 20.22 |
| | @75 g a.i/ha | (29.06)$^{cd}$ | (26.91)$^{bcd}$ | (30.09)$^{cde}$ | (29.69)$^{cd}$ | (26.31)$^{ab}$ | (25.97)$^{cd}$ | (27.19)$^{b-e}$ | (33.38)$^{cde}$ | (34.05)$^{cde}$ | (26.41)$^{cde}$ |
| 3. | Emamectin benzoate 25 WG@11g a.i./ha | 15.53 | 11.71 | 14.31 | 15.66 | 13.97 | 11.87 | 10.71 | 18.28 | 18.50 | 12.41 |
| | | (23.20)$^{b}$ | (20.08)$^{ab}$ | (23.99)$^{ab}$ | (22.37)$^{ab}$ | (22.10)$^{a}$ | (19.95)$^{b}$ | (18.95)$^{ab}$ | (25.44)$^{b}$ | (25.73)$^{ab}$ | (20.47)$^{b}$ |
| 4. | Triazophos 40 EC | 24.79 | 25.55 | 26.38 | 27.10 | 21.18 | 20.53 | 25.55 | 30.07 | 31.20 | 22.00 |
| | @500 g a.i/ha | (29.85)$^{de}$ | (30.07)$^{bcd}$ | (30.54)$^{cde}$ | (30.96)$^{cd}$ | (25.59)$^{ab}$ | (26.61)$^{cd}$ | (29.64)$^{de}$ | (33.60)$^{cde}$ | (34.69)$^{cde}$ | (29.58)$^{def}$ |
| 5. | Profenofos 50 EC | 27.76 | 18.53 | 29.75 | 21.82 | 26.64 | 23.93 | 18.92 | 33.55 | 25.04 | 24.12 |
| | @750 g a.i/ha | (31.79)$^{def}$ | (25.53)$^{bcd}$ | (32.65)$^{de}$ | (27.52)$^{bc}$ | (31.33)$^{bc}$ | (28.92)$^{de}$ | (25.26)$^{bcd}$ | (35.73)$^{de}$ | (30.64)$^{bcd}$ | (29.00)$^{ef}$ |
| 6. | Novaluron 10 EC | 26.28 | 23.36 | 28.86 | 25.46 | 27.76 | 24.85 | 23.40 | 32.61 | 29.65 | 26.65 |
| | @75 g a.i/ha | (30.83)$^{de}$f | (29.18)$^{bcd}$ | (31.97)$^{de}$ | (29.95)$^{cd}$ | (31.47)$^{bc}$ | (29.47)$^{de}$ | (28.57)$^{cde}$ | (35.15)$^{de}$ | (33.70)$^{cde}$ | (30.72)$^{ef}$ |
| 7. | Carbaryl 50 WP + Wettable Sulphur 50 WP (1:1)@500 g a.i./ha | 28.71 | 16.96 | 22.23 | 19.76 | 17.37 | 19.35 | 16.83 | 26.10 | 23.95 | 16.54 |
| | | (32.40)$^{def}$ | (24.37)$^{abc}$ | (27.81)$^{cd}$ | (26.05)$^{abc}$ | (24.84)$^{ab}$ | (25.79)$^{cd}$ | (23.86)$^{bcd}$ | (31.03)$^{cd}$ | (29.90)$^{bc}$ | (23.70)$^{bcd}$ |
| 8. | Chlorantraniliprole 20 SC | 8.79 | 7.29 | 8.75 | 11.10 | 11.46 | 4.83 | 6.40 | 11.37 | 12.43 | 6.43 |
| | @40 g a.i/ha | (17.09)$^{a}$ | (15.50)$^{a}$ | (17.09)$^{a}$ | (19.35)$^{a}$ | (19.78)$^{a}$ | (12.90)$^{a}$ | (14.77)$^{a}$ | (19.68)$^{a}$ | (20.76)$^{a}$ | (14.42)$^{a}$ |
| 9. | Neem oil@2% | 27.16 | 21.05 | 30.49 | 26.62 | 27.88 | 23.20 | 21.05 | 34.45 | 30.80 | 25.26 |
| | | (31.22)$^{def}$ | (27.12)$^{bcd}$ | (33.12)$^{de}$ | (30.69)$^{cd}$ | (32.22)$^{bc}$ | (28.40)$^{de}$ | (26.67)$^{b-e}$ | (36.32)$^{de}$ | (34.44)$^{cde}$ | (29.81)$^{ef}$ |
| 10. | B. thuringiensis var. kurstaki | 30.41 | 26.84 | 26.62 | 29.60 | 29.43 | 26.63 | 26.51 | 30.66 | 33.17 | 31.40 |
| | @50 g a.i./ha | (33.45)$^{ef}$ | (30.62)$^{cd}$ | (30.58)$^{cde}$ | (32.53)$^{cd}$ | (33.19)$^{bc}$ | (30.68)$^{de}$ | (29.98)$^{de}$ | (33.86)$^{cde}$ | (35.93)$^{de}$ | (31.82)$^{f}$ |
| 11. | Untreated check | 32.62 | 32.63 | 31.56 | 34.18 | 39.25 | 28.67 | 33.29 | 35.31 | 38.25 | 37.54 |
| | | (34.82)$^{f}$ | (35.16)$^{d}$ | (33.79)$^{e}$ | (35.38)$^{d}$ | (39.18)$^{c}$ | (31.98)$^{e}$ | (34.81)$^{e}$ | (36.85)$^{e}$ | (39.01)$^{e}$ | (37.95)$^{g}$ |
| | C.D.(P=0.05) | 2.080* | 5.229* | 2.842* | 3.645* | 2.239** | 2.53* | 4.48* | 2.89* | 2.98* | 2.44* |

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Values in parentheses are arcsin transformed values untreated check (29.67 to 39.54%) (Table 3).

Based on weight basis :

It was found the per cent fruit borer infestation ranged from 4.83 to 38.25 per cent from five pickings irrespective of the treatments. The fruit infestation on weight basis was low in the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha which ranged from 4.83 to 12.43 per cent and all the treatments were superior than the untreated check (28.67 to 38.25%) (Table 4).

Misra (2008) evaluated the chemicals namely rynazypyr 20 SC @ 40 g a.i./ha and flubendiamide 480 SC @ 100 g a.i./ha against brinjal shoot and fruit borer, *L. orbonalis*. The results revealed that rynazypyr 20 SC @ 40 g a.i./ha showed 90 to 97 per cent reduction of shoot damage and 87 to 90 per cent reduction in the fruit damage on number basis and 88 to 90 per cent on weight basis compared to the untreated check. It was concluded that rynaxypyr 20 SC @ 40 and 50 g a.i./ha was effective against shoot and fruit borer of brinjal. Hosamani *et al*. (2008) reported that in the treatment with rynaxypyr at 30 g a.i./ha recorded a minimum per cent larval population of *Spodoptera litura* (Fab.), *Spodoptera exigua* (Hub.) and *Helicoverpa armigera* (Hub.) in chillies. Bhosale *et al*. (2009) stated that rynaxypyr 30 g a.i./ha was found to be most effective in controlling the pod borer, *Helicoverpa armigera*, plume moth, *Exelastis atomosa* (Wals.). Similarly, results were also in aggregation with the work of Jarrod *et al*. (2008) and Bheemanna *et al*. (2008). Rajesh Chowdary *et al*. (2010) indicated that rynaxypyr 20 SC @ 30 and 20 g a.i./ha was superior and recorded less larval population as well as low fruit damage in okra against shoot and fruit borer, *Earias vitella* (Fab.) and *Helicoverpa armigera* (Hub.). The present findings are in conformity with the above observations.

***Yield :***

The yield of brinjal fruits (PLR 2) from the field experiment I was recorded and are given in the Table 5. The yield ranged from 14.20 to 27.08 t.ha$^{-1}$. The highest yield was observed in the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ha (27.08 t.ha$^{-1}$) followed by emamectin benzoate 25 WG @ 11 g a.i./ha (23.61 t.ha$^{-1}$) and spinosad 45 SC @ 75 g a.i./ha (20.83 tha$^{-1}$). It was found that the chlorantraniliprole 20 SC @ 40 g a.i./ha (27.08 t.ha$^{-1}$) was found to be superior among the treatments than the untreated check (14.20 t.ha$^{-1}$).In the field experiment II,the highest yield was recorded in the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ ha (36.10 t.ha$^{-1}$) followed by emamectin benzoate 25 WG @ 11 g a.i./ha (32.66 t.ha$^{-1}$) compared to the untreated check (18.46 t.ha$^{-1}$).

The data from the field experiment I showed that the treatment with chlorantraniliprole 20 SC @ 40 g a.i./ ha recorded maximum benefit cost ratio (1:21.58) followed by emamectin benzoate 25 WG @ 11 g a.i./ha (1:18.52). The lowest benefit cost ratio was recorded in the treatment with *B. thuringiensis* var. *kurstaki* @ 50

**Table 5 : Yield of brinjal fruits in variety PLR 2**

**Mean of 3 replications**

| Sr. No. | Treatments | Yield | | Benefit cost ratio (BCR) | |
|---|---|---|---|---|---|
| | | Field experiment I t ha$^{-1}$ | Field experiment II t ha$^{-1}$ | Field experiment I | Field experiment II |
| 1. | Spinosad 45 SC@75 g a.i/ha | 20.83$^{bc}$ | 29.10$^{bc}$ | 1:14.43 | 1:17.31 |
| 2. | Indoxacarb 14.5 SC@75 g a.i/ha | 17.80$^{cd}$ | 25.66$^{cde}$ | 1:9.86 | 1:8.78 |
| 3. | Emamectin benzoate 25 WG@11g a.i./ha | 23.61$^{ab}$ | 32.66$^{ab}$ | 1:18.52 | 1:19.89 |
| 4. | Triazophos 40 EC@500 g a.i/ha | 17.53$^{cd}$ | 24.20$^{cde}$ | 1:5.53 | 1:9.99 |
| 5. | Profenofos 50 EC@750 g a.i/ha | 17.21$^{cd}$ | 22.33$^{def}$ | 1:4.98 | 1:8.16 |
| 6. | Novaluron 10 EC @75 g a.i/ha | 17.82$^{cd}$ | 27.30$^{bcd}$ | 1:10.42 | 1:12.80 |
| 7. | Carbaryl 50 WP + Wettable Sulphur 50 WP (1:1)@500 g a.i./ha | 18.70$^{cd}$ | 28.33$^{bc}$ | 1:12.87 | 1:15.22 |
| 8. | Chlorantraniliprole 20 SC@40 g a.i/ha | 27.08$^{a}$ | 36.10$^{a}$ | 1:21.58 | 1:26.53 |
| 9. | Neem oil@2% | 16.85$^{cd}$ | 21.66$^{def}$ | 1:3.70 | 1:5.09 |
| 10. | B. thuringiensis var. kurstaki@50 g a.i./ha | 16.25$^{cd}$ | 20.13$^{ef}$ | 1:1.99 | 1:3.05 |
| 11. | Untreated check | 14.20$^{d}$ | 18.46$^{f}$ | --- | --- |
| | C.D. (P=0.05) | 1.88** | 2.05** | - | - |

** indicates significance of value at P =0.01

g a.i./ha (1:1.99). However, all the treatments recorded a higher cost benefit ratio compared to the untreated check. Similar trend was observed in the field experiment II.

The declining order of benefit cost ratio was arranged as chlorantraniliprole 20 EC @ 40 g a.i./ha > emamectin benzoate 25 WG @ 11 g a.i./ha > spinosad 45 SC @75 g a.i./ha > carbaryl 50 WP + wettable sulphur 50 WP @ 500 g a.i./ha > novaluron 10 EC @ 75 g a.i./ha > indoxacarb 14.5 SC @ 75 g a.i./ha > triazophos 40 EC @ 500 g a.i/ha > profenofos 50 EC @ 750 g a.i./ha > neem oil @ 2 per cent > *B. thuringiensis* var. *kurstaki* @ 50 g a.i./ha. (Table 5). It was concluded that in Karaikal District, U.T. of Puducherry, India, the variety PLR 2 can be recommended to the farmer with need based application of chlorantraniliprole 20 SC @ 40 g a.i./ha against shoot and fruit borer, *L. orbonalis* Pal and Singh (2003) stated that dichlorvos + fenvalerate combination gave the highest yield while the carbaryl was least effective and recorded lesser yield. It was also indicated that the cost benefit ratio was maximum in the treatment with fenvalerate and minimum in the treatment with carbaryl. Thillaikarasi (2005) reported that carbaryl sprays are superior against the sucking pests and leaf beetle population in brinjal and also recorded the highest yield. Misra (2008) reported that the treatment with rynaxypyr 20 SC @ 40 and 50 g a.i./ha in brinjal recorded a higher yield during winter and summer field experiments. Rajesh Chowdary *et al*. (2010) stated that among the newer insecticides molecules evaluated rynaxypyr 20 SC @ 20 and 30 g a.i./ha were superior and recorded a higher fruit yield followed by spinosad @ 56 g a.i./ha (Wargantiwar *et al.*, 2010; Mane and Kulkarni, 2011 and Singh *et al.*, 2008).

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