

Original Research Article

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## Bioefficacy of Biorational Insecticides against Larval Population of *Leucinodes orbonalis* (Guen.) in Brinjal

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### ABSTRACT

#### Keywords

Bio-efficacy,  
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The investigation was conducted at the Horticulture Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan during *Kharif* 2014-15 and 2015-16 for bio-efficacy of bio-rational insecticides against larval population of *Leucinodes orbonalis* (Guen.) in brinjal. The data reveal that maximum reduction in larval population of *L. orbonalis* was recorded in the treatment schedule T<sub>2</sub> (three sprays of Chlorantraniliprole 18.5 SC @ 150 ml/ ha) with cumulative mean reduction of 70.24, 75.24, 64.74 and 70.59, 76.95 and 64.90 per cent; while, minimum larval population reduction of 34.86, 39.44, 32.18 and 34.88, 39.21 and 30.41 per cent was recorded in treatment schedule T<sub>3</sub> (three sprays of NSKE 5% /ha) at 3, 7, and 10 days after sprays, respectively during 2014-15 and 2015-16.

### Introduction

Brinjal, *solanum melongena* L. also known as egg plant, belongs to family solanaceae, is an important vegetable crop grown throughout the world, especially in south Asia and is known to be native of India. In production and productivity, India stands second in the world after China. It is grown in the states of West Bengal, Orissa, Bihar, Gujarat, Maharashtra, Andhra Pradesh, Rajasthan and Karnataka in India. The total area under brinjal cultivation is 0.71 million hectares with an annual production of 13.57 million tons (NHB 2014-15). In the state of Rajasthan it is mainly

grown in Alwar, Jaipur, Ajmer, Bharatpur, Bundi, Baran and Kota districts during summer and rainy seasons in an area of 0.055 lac hectares with an annual production of 0.28 lac tons (anonymous, 2014-15). Brinjal is a rich source of minerals (calcium, magnesium, phosphorus, sodium, potassium, chlorine, iron etc.), vitamins and also has some medicinal importance (Choudhary, 1967).

Brinjal is susceptible to attack of various insects from seedling to senescence. Among these insect pests brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. (Lepidoptera: Pyralidae) is the most destructive pest and is

considered to be the limiting factor in quantitative as well as qualitative harvest of brinjal fruits (Latif *et al.*, 2010; Chakraborty and Sarkar, 2011; Dutta *et al.*, 2011; Saimandir and Gopal, 2012). The pest is very active during the rainy and summer season and may cause 85 to 90 % damage (Misra, 2008; Jagginavar *et al.*, 2009; Thapa, 2010). The infested fruits become unfit for consumption due to loss of quality and hence, lose their market value. It is also reported that there will be reduction in vitamin C content to an extent of 68 per cent in the infested fruits (Hemi, 1955).

Although insecticidal control is one of the common means against the fruit borer, many of the insecticides applied are not effective in the satisfactory control of this pest. Brinjal being a vegetable crop, use of chemical insecticides will leave considerable toxic residues on the fruits. Beside this, sole dependence on insecticides for the control of this pest has led to insecticidal resistance by the pest (Natekar *et al.*, 1987; Harish *et al.*, 2011). Hence, there is an impetus for research and development of cost effective ecofriendly alternative for the management of major pests of brinjal. Strategies employing different entomopathogenic microbial preparations, neem based and biorational insecticides are

the possible alternative measures for the sustainable management of major pests of brinjal, especially in the present era of organic agriculture.

### Materials and Methods

The seeds of brinjal variety- Pusa purple long were sown in well prepared nursery bed during third week of June, 2014-15 and 2015-16 in the shed net house of Horticulture Farm, Rajasthan College of Agriculture, MPUAT, Udaipur. The seedlings were raised by following recommended horticultural operations. The seedlings were finally ready for transplanting in the experimental field after they attained a height of about 15 cm with 3-4 leaves.

The field experiment on the bio-efficacy of bio-rational insecticides was laid out in randomized block design in uniform size plots each measuring 3.0 × 4.5 m and replicated thrice with row to row and plant to plant spacing of 60 × 50 cm, respectively. There were ten treatments including control with three replications. The I spray was done at flowering stage and subsequent II and III sprays were done at 15 days intervals after the first spray.

### Detail of the treatments

| Treatment schedules   | Sprays | Doses / ha              |
|---|--------|-------------------------|
| T <sub>1</sub> - Spinosad 45 SC   | 3      | 200 ml                  |
| T <sub>2</sub> - Chlorantraniliprole 18.5 SC  | 3      | 150 ml                  |
| T <sub>3</sub> - NSKE 5%  | 3      | 5%                      |
| T <sub>4</sub> - Spinosad 45 SC followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC | 1-1-1  | 200 ml – 150 ml – 150ml |
| T <sub>5</sub> - Spinosad 45 SC followed by NSKE 5% - NSKE 5%   | 1-1-1  | 200 ml –5% - 5%         |
| T <sub>6</sub> - Chlorantraniliprole 18.5 SC followed by Spinosad 45 SC – Spinosad 45 SC              | 1-1-1  | 150 ml – 200 ml – 200ml |
| T <sub>7</sub> - Chlorantraniliprole 18.5 SC followed by NSKE 5% – NSKE 5%                            | 1-1-1  | 150 ml – 5% - 5%        |
| T <sub>8</sub> - NSKE 5% followed by Spinosad 45 SC – Spinosad 45 SC                                  | 1-1-1  | 5% - 200 ml – 200 ml    |
| T <sub>9</sub> - NSKE 5% followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC        | 1-1—1  | 5% - 150 ml – 150 ml    |
| T <sub>10</sub> –Control  | -      | -                       |

## Observations

Five plants were selected and tagged randomly and the population of larvae was recorded one day before and 3, 7 and 10 days after each spray and mean reduction were worked out.

## Statistical analysis

Efficacy of different treatments against *L. orbonalis* was analyzed by analysis of variance. The population data was corrected by the correction factor given by Henderson and Tilton (1955) as under:

$$\text{Per cent reduction in population} = 100 \times \left[ 1 - \frac{T_a \times C_b}{T_b \times C_a} \right]$$

Where,

T<sub>a</sub> = Number of insects after treatment

T<sub>b</sub> = Number of insects before treatment

C<sub>a</sub> = Number of insect in untreated check after treatment

C<sub>b</sub> = Number of insects in untreated check before treatment

The reduction percentage figures were transformed into arc sine values and subjected to analysis of variance.

## Results and Discussion

The data presented in Table 1 revealed that all biorational insecticides reduce the population of shoot and fruit borer as compared to control. Maximum reduction in larval population of *L. orbonalis*, 69.94, 76.86 and 65.14 per cent was noted in the treatment schedule T<sub>7</sub> (Chlorantraniliprole 18.5 SC @ 150 ml/ ha – NSKE 5% - NSKE 5%) followed by treatment schedule T<sub>6</sub> (Chlorantraniliprole 18.5 SC @ 150 ml/ ha- Spinosad 45 SC @ 200 ml/ha- Spinosad 45 SC @ 200 ml/ha); whereas, minimum larval population reduction of 28.89, 33.58 and 24.47 per cent was recorded in treatment T<sub>9</sub> (NSKE 5% - Chlorantraniliprole 18.5 SC @ 150 ml/ ha – Chlorantraniliprole 18.5 SC @ 150 ml/ ha)

followed by treatment schedule T<sub>8</sub> (NSKE 5%- Spinosad 45 SC @ 200 ml/ha- Spinosad 45 SC @ 200 ml/ha) at 3, 7 and 10 days after 1<sup>st</sup> spray, respectively during *Kharif* 2014-15. During *kharif* 2015-16, data revealed that the maximum reduction in larval population of shoot and fruit borer, *L. orbonalis* of 70.39, 77.18 and 63.81 per cent was recorded in the treatment schedule T<sub>7</sub> (Chlorantraniliprole 18.5 SC @ 150 ml/ ha – NSKE 5% - NSKE 5%) followed by three spray of treatment schedule T<sub>2</sub> (Chlorantraniliprole 18.5 SC @ 150 ml/ ha) and minimum reduction of 29.88, 34.52 and 26.71 per cent was recorded in treatment T<sub>9</sub> (NSKE 5% - Chlorantraniliprole 18.5 SC @ 150 ml/ ha – Chlorantraniliprole 18.5 SC @ 150 ml/ ha) at 3, 7, and 10 days after 1<sup>st</sup> spray, respectively (Table 2).

All the treatments were found to be superior over control. Maximum reduction in larval population of *L. orbonalis* of 69.44, 74.38 and 65.21 per cent was recorded in the treatment schedule T<sub>2</sub> (Chlorantraniliprole 18.5 SC @ 150 ml/ ha) followed by treatment schedule T<sub>4</sub> (Spinosad 45 SC @ 200 ml/ha- Chlorantraniliprole 18.5 SC @ 150 ml/ ha- Chlorantraniliprole 18.5 SC @ 150 ml/ ha) and minimum larval population reduction of 34.31, 39.54 and 32.78 per cent was recorded in treatment schedule T<sub>3</sub> (NSKE 5% /ha) at 3, 7 and 10 days after 2<sup>nd</sup> spray, respectively during 2014-15 (Table 3). Similarly, during 2015-16 data showed (Table 4) that maximum reduction in larval population of shoot and fruit borer of 70.44, 75.43 and 64.30 per cent was recorded in the treatment schedule T<sub>2</sub> (three spray of Chlorantraniliprole 18.5 SC @ 150 ml/ ha) followed by treatment schedule T<sub>4</sub> (Spinosad 45 SC @ 200 ml/ha- Chlorantraniliprole 18.5 SC @ 150 ml/ha - Chlorantraniliprole 18.5 SC @ 150 ml/ha) and minimum larval population reduction of 33.38, 37.06 and 29.52 per cent was recorded in treatment schedule T<sub>3</sub> (NSKE 5% /ha) at 3, 7, and 10 days after 2<sup>nd</sup> spray respectively.

**Table.1** Bio-efficacy of bio-rational insecticides against larval population of *Leucinodes orbonalis* (Guen.) in brinjal after 1<sup>st</sup> spray during *kharif* 2014-15

| S. No           | Treatment schedules  | Dose ml/ha              | PTP  | Mean reduction (%)               |                  |                  |                  |
|-----------------|--|-------------------------|------|----------------------------------|------------------|------------------|------------------|
|                 |  |                         |      | Days after 1 <sup>st</sup> spray |                  |                  |                  |
|                 |  |                         |      | 3                                | 7                | 10               | Mean             |
| T <sub>1</sub>  | Spinosad 45 SC   | 200 ml                  | 0.60 | 53.59<br>(64.72)                 | 56.64<br>(69.72) | 46.55<br>(52.70) | 52.18<br>(62.38) |
| T <sub>2</sub>  | Chlorantraniliprole 18.5 SC  | 150 ml                  | 0.67 | 54.92<br>(66.94)                 | 58.90<br>(73.28) | 51.87<br>(61.86) | 55.18<br>(67.36) |
| T <sub>3</sub>  | NSKE 5%  | 5%                      | 0.93 | 34.56<br>(32.19)                 | 35.98<br>(34.53) | 31.50<br>(27.34) | 34.05<br>(31.35) |
| T <sub>4</sub>  | Spinosad 45 SC followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC | 200 ml – 150 ml – 150ml | 0.53 | 52.29<br>(62.55)                 | 55.95<br>(68.61) | 47.83<br>(54.92) | 51.98<br>(62.03) |
| T <sub>5</sub>  | Spinosad 45 SC followed by NSKE 5% - NSKE 5%   | 200 ml – 5% - 5%        | 0.87 | 55.32<br>(67.61)                 | 57.68<br>(71.39) | 48.29<br>(55.72) | 53.69<br>(64.91) |
| T <sub>6</sub>  | Chlorantraniliprole 18.5 SC followed by Spinosad 45 SC – Spinosad 45 SC              | 150 ml – 200 ml – 200ml | 0.67 | 56.37<br>(69.28)                 | 60.24<br>(75.31) | 52.73<br>(63.30) | 56.38<br>(69.29) |
| T <sub>7</sub>  | Chlorantraniliprole 18.5 SC followed by NSKE 5% – NSKE 5%                            | 150 ml – 5% - 5%        | 0.60 | 56.76<br>(69.94)                 | 61.29<br>(76.86) | 53.82<br>(65.14) | 57.22<br>(70.65) |
| T <sub>8</sub>  | NSKE 5% followed by Spinosad 45 SC – Spinosad 45 SC                                  | 5% - 200 ml – 200 ml    | 0.80 | 33.13<br>(29.92)                 | 37.34<br>(36.80) | 30.98<br>(26.51) | 33.86<br>(31.07) |
| T <sub>9</sub>  | NSKE 5% followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole +18.5 SC       | 5% - 150 ml – 150 ml    | 0.67 | 32.49<br>(28.89)                 | 35.41<br>(33.58) | 29.64<br>(24.47) | 32.56<br>(28.98) |
| T <sub>10</sub> | Control  | -                       | 0.80 | -                                | -                | -                | -                |
|                 | S.Em.±   |                         | -    | 1.22                             | 1.18             | 1.12             | 1.17             |
|                 | C.D (p = 0.05)   |                         |      | 3.64                             | 3.53             | 3.35             | 3.49             |

Figures in parentheses are retransformed per cent values, \*PTP- Pre treatment population

**Table.2** Bio-efficacy of bio-rational insecticides against larval population of *Leucinodes orbonalis* (Guen.) in brinjal after 1<sup>st</sup> spray during *kharif* 2015-16

| S. No           | Treatment schedules  | Dose ml/ha              | PTP  | Mean reduction (%)               |                  |                  |                  |
|-----------------|--|-------------------------|------|----------------------------------|------------------|------------------|------------------|
|                 |  |                         |      | Days after 1 <sup>st</sup> spray |                  |                  |                  |
|                 |  |                         |      | 3                                | 7                | 10               | Mean             |
| T <sub>1</sub>  | Spinosad 45 SC   | 200 ml                  | 0.67 | 52.74<br>(63.30)                 | 55.26<br>(67.50) | 46.87<br>(53.25) | 51.57<br>(61.35) |
| T <sub>2</sub>  | Chlorantraniliprole 18.5 SC  | 150 ml                  | 0.93 | 55.05<br>(67.15)                 | 59.91<br>(74.82) | 51.97<br>(62.02) | 55.57<br>(68.00) |
| T <sub>3</sub>  | NSKE 5%  | 5%                      | 0.60 | 36.16<br>(34.81)                 | 37.56<br>(37.18) | 31.21<br>(26.88) | 35.03<br>(32.96) |
| T <sub>4</sub>  | Spinosad 45 SC followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC | 200 ml – 150 ml – 150ml | 0.67 | 53.82<br>(65.12)                 | 56.63<br>(69.72) | 45.83<br>(51.44) | 52.01<br>(62.09) |
| T <sub>5</sub>  | Spinosad 45 SC followed by NSKE 5% - NSKE 5%   | 200 ml – 5% - 5%        | 0.80 | 53.09<br>(63.92)                 | 54.90<br>(66.92) | 47.60<br>(54.52) | 51.82<br>(61.78) |
| T <sub>6</sub>  | Chlorantraniliprole 18.5 SC followed by Spinosad 45 SC – Spinosad 45 SC              | 150 ml – 200 ml – 200ml | 0.60 | 54.53<br>(66.26)                 | 59.12<br>(73.61) | 51.33<br>(60.94) | 54.92<br>(66.94) |
| T <sub>7</sub>  | Chlorantraniliprole 18.5 SC followed by NSKE 5% – NSKE 5%                            | 150 ml – 5% - 5%        | 0.73 | 57.06<br>(70.39)                 | 61.51<br>(77.18) | 53.02<br>(63.81) | 57.10<br>(70.46) |
| T <sub>8</sub>  | NSKE 5% followed by Spinosad 45 SC – Spinosad 45 SC                                  | 5% - 200 ml – 200 ml    | 0.87 | 33.96<br>(31.22)                 | 36.42<br>(35.26) | 32.03<br>(28.15) | 34.14<br>(31.54) |
| T <sub>9</sub>  | NSKE 5% followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC        | 5% - 150 ml – 150 ml    | 0.87 | 33.13<br>(29.88)                 | 35.98<br>(34.52) | 31.11<br>(26.71) | 33.44<br>(30.37) |
| T <sub>10</sub> | Control  | -                       | 0.73 | -                                | -                | -                | -                |
|                 | S.Em.±   |                         | -    | 1.20                             | 1.17             | 1.11             | 1.14             |
|                 | C.D (p=0.05)   |                         |      | 3.61                             | 3.51             | 3.32             | 3.42             |

Figures in parentheses are retransformed per cent values, \*PTP- Pre treatment population

**Table.3** Bio-efficacy of bio-rational insecticides against larval population of *Leucinodes orbonalis* (Guen.) in brinjal after 2<sup>nd</sup> spray during *kharif* 2014-15

| S. No           | Treatment schedules  | Dose ml/ha              | PTP  | Mean reduction (%)               |                  |                  |                  |
|-----------------|--|-------------------------|------|----------------------------------|------------------|------------------|------------------|
|                 |  |                         |      | Days after 2 <sup>nd</sup> spray |                  |                  |                  |
|                 |  |                         |      | 3                                | 7                | 10               | Mean             |
| T <sub>1</sub>  | Spinosad 45 SC   | 200 ml                  | 1.13 | 51.24<br>(60.80)                 | 55.69<br>(68.19) | 49.25<br>(57.38) | 52.03<br>(62.12) |
| T <sub>2</sub>  | Chlorantraniliprole 18.5 SC  | 150 ml                  | 1.20 | 56.46<br>(69.44)                 | 59.62<br>(74.38) | 53.87<br>(65.21) | 56.61<br>(69.68) |
| T <sub>3</sub>  | NSKE 5%  | 5%                      | 1.47 | 35.83<br>(34.31)                 | 38.95<br>(39.54) | 34.91<br>(32.78) | 36.59<br>(35.54) |
| T <sub>4</sub>  | Spinosad 45 SC followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC | 200 ml – 150 ml – 150ml | 1.27 | 55.09<br>(67.23)                 | 58.98<br>(73.39) | 52.04<br>(62.15) | 55.32<br>(67.59) |
| T <sub>5</sub>  | Spinosad 45 SC followed by NSKE 5% - NSKE 5%   | 200 ml – 5% - 5%        | 1.40 | 41.92<br>(44.65)                 | 40.07<br>(41.44) | 36.51<br>(35.41) | 39.51<br>(40.50) |
| T <sub>6</sub>  | Chlorantraniliprole 18.5 SC followed by Spinosad 45 SC – Spinosad 45 SC              | 150 ml – 200 ml – 200ml | 1.33 | 53.94<br>(65.33)                 | 57.72<br>(71.45) | 50.49<br>(59.50) | 54.01<br>(65.43) |
| T <sub>7</sub>  | Chlorantraniliprole 18.5 SC followed by NSKE 5% – NSKE 5%                            | 150 ml – 5% - 5%        | 1.47 | 43.94<br>(48.16)                 | 41.97<br>(44.73) | 37.66<br>(37.35) | 41.20<br>(43.41) |
| T <sub>8</sub>  | NSKE 5% followed by Spinosad 45 SC – Spinosad 45 SC                                  | 5% - 200 ml – 200 ml    | 1.60 | 48.21<br>(55.57)                 | 50.92<br>(60.25) | 45.32<br>(50.56) | 48.14<br>(55.46) |
| T <sub>9</sub>  | NSKE 5% followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC        | 5% - 150 ml – 150 ml    | 1.67 | 47.45<br>(54.26)                 | 51.86<br>(61.84) | 46.34<br>(52.33) | 48.53<br>(56.14) |
| T <sub>10</sub> | Control  | -                       | 2.00 | -                                | -                | -                | -                |
|                 | S.Em.±   |                         |      | 1.22                             | 1.19             | 1.17             | 1.18             |
|                 | C.D (p=0.05)   |                         |      | 3.67                             | 3.57             | 3.50             | 3.53             |

Figures in parentheses are retransformed per cent values, \*PTP- Pre treatment population

**Table.4** Bio-efficacy of bio-rational insecticides against larval population of *Leucinodes orbonalis* (Guen.) in brinjal after 2<sup>nd</sup> spray during *kharif* 2015-16

| S. No           | Treatment schedules  | Dose ml/ha              | PTP  | Mean reduction (%)               |                  |                  |                  |
|-----------------|--|-------------------------|------|----------------------------------|------------------|------------------|------------------|
|                 |  |                         |      | Days after 2 <sup>nd</sup> spray |                  |                  |                  |
|                 |  |                         |      | 3                                | 7                | 10               | Mean             |
| T <sub>1</sub>  | Spinosad 45 SC   | 200 ml                  | 1.33 | 52.51<br>(62.92)                 | 56.47<br>(69.45) | 48.01<br>(55.24) | 52.28<br>(62.54) |
| T <sub>2</sub>  | Chlorantraniliprole 18.5 SC  | 150 ml                  | 1.13 | 57.09<br>(70.44)                 | 60.31<br>(75.43) | 53.33<br>(64.30) | 56.85<br>(70.06) |
| T <sub>3</sub>  | NSKE 5%  | 5%                      | 1.67 | 35.29<br>(33.38)                 | 37.49<br>(37.06) | 32.89<br>(29.52) | 35.25<br>(33.32) |
| T <sub>4</sub>  | Spinosad 45 SC followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC | 200 ml – 150 ml – 150ml | 1.60 | 56.09<br>(68.83)                 | 58.16<br>(72.14) | 51.86<br>(61.84) | 55.33<br>(67.60) |
| T <sub>5</sub>  | Spinosad 45 SC followed by NSKE 5% - NSKE 5%   | 200 ml – 5% - 5%        | 1.53 | 41.55<br>(44.00)                 | 40.73<br>(42.58) | 35.52<br>(33.78) | 39.29<br>(40.12) |
| T <sub>6</sub>  | Chlorantraniliprole 18.5 SC followed by Spinosad 45 SC – Spinosad 45 SC              | 150 ml – 200 ml – 200ml | 1.47 | 53.25<br>(64.15)                 | 55.71<br>(68.22) | 47.56<br>(54.45) | 52.11<br>(62.27) |
| T <sub>7</sub>  | Chlorantraniliprole 18.5 SC followed by NSKE 5% – NSKE 5%                            | 150 ml – 5% - 5%        | 1.27 | 44.43<br>(49.00)                 | 43.17<br>(46.81) | 36.37<br>(35.18) | 41.35<br>(43.66) |
| T <sub>8</sub>  | NSKE 5% followed by Spinosad 45 SC – Spinosad 45 SC                                  | 5% - 200 ml – 200 ml    | 1.67 | 47.74<br>(54.78)                 | 50.16<br>(58.94) | 43.44<br>(47.28) | 47.10<br>(53.67) |
| T <sub>9</sub>  | NSKE 5% followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC        | 5% - 150 ml – 150 ml    | 1.73 | 50.58<br>(59.66)                 | 52.16<br>(62.36) | 44.79<br>(49.64) | 49.15<br>(57.22) |
| T <sub>10</sub> | Control  | -                       | 2.20 | -                                | -                | -                | -                |
|                 | S.Em.±   |                         |      | 1.21                             | 1.12             | 1.11             | 1.13             |
|                 | C.D (p=0.05)   |                         |      | 3.64                             | 3.37             | 3.33             | 3.39             |

Figures in parentheses are retransformed per cent values, \*PTP- Pre treatment population



**Table.5** Bio-efficacy of bio-rational insecticides against larval population of *Leucinodes orbonalis* (Guen.) in brinjal after 3<sup>rd</sup> spray during *kharif* 2014-15

| S. No           | Treatment schedules  | Dose ml/ha              | PTP  | Mean reduction (%)               |                  |                  |                  |
|-----------------|--|-------------------------|------|----------------------------------|------------------|------------------|------------------|
|                 |  |                         |      | Days after 3 <sup>rd</sup> spray |                  |                  |                  |
|                 |  |                         |      | 3                                | 7                | 10               | Mean             |
| T <sub>1</sub>  | Spinosad 45 SC   | 200 ml                  | 1.20 | 55.28<br>(67.50)                 | 58.39<br>(72.48) | 51.09<br>(60.54) | 54.86<br>(66.84) |
| T <sub>2</sub>  | Chlorantraniliprole 18.5 SC  | 150 ml                  | 1.27 | 59.61<br>(74.34)                 | 62.11<br>(78.06) | 55.05<br>(67.15) | 58.84<br>(73.19) |
| T <sub>3</sub>  | NSKE 5%  | 5%                      | 1.53 | 38.09<br>(38.06)                 | 41.70<br>(44.27) | 37.10<br>(36.41) | 38.98<br>(39.58) |
| T <sub>4</sub>  | Spinosad 45 SC followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC | 200 ml – 150 ml – 150ml | 1.47 | 56.87<br>(70.11)                 | 60.82<br>(76.16) | 53.33<br>(64.33) | 56.94<br>(70.20) |
| T <sub>5</sub>  | Spinosad 45 SC followed by NSKE 5% - NSKE 5%   | 200 ml – 5% - 5%        | 1.60 | 40.71<br>(42.54)                 | 44.29<br>(48.76) | 39.38<br>(40.26) | 41.46<br>(43.85) |
| T <sub>6</sub>  | Chlorantraniliprole 18.5 SC followed by Spinosad 45 SC – Spinosad 45 SC              | 150 ml – 200 ml – 200ml | 1.40 | 55.99<br>(68.68)                 | 58.87<br>(73.23) | 52.03<br>(62.12) | 55.57<br>(68.01) |
| T <sub>7</sub>  | Chlorantraniliprole 18.5 SC followed by NSKE 5% – NSKE 5%                            | 150 ml – 5% - 5%        | 1.73 | 41.70<br>(44.27)                 | 44.73<br>(49.54) | 40.57<br>(42.31) | 42.34<br>(45.37) |
| T <sub>8</sub>  | NSKE 5% followed by Spinosad 45 SC – Spinosad 45 SC                                  | 5% - 200 ml – 200 ml    | 1.67 | 52.00<br>(62.08)                 | 55.46<br>(67.83) | 49.45<br>(57.72) | 52.26<br>(62.54) |
| T <sub>9</sub>  | NSKE 5% followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC        | 5% - 150 ml – 150 ml    | 1.47 | 54.09<br>(65.58)                 | 59.13<br>(73.66) | 50.40<br>(59.35) | 54.47<br>(66.20) |
| T <sub>10</sub> | Control  | -                       | 2.53 | -                                | -                | -                | -                |
|                 | S.Em.±   |                         |      | 1.20                             | 1.23             | 1.11             | 1.15             |
|                 | C.D (p=0.05)   |                         |      | 3.60                             | 3.68             | 3.33             | 3.45             |

Figures in parentheses are retransformed per cent values, \*PTP- Pre treatment population



**Table.6** Bio-efficacy of bio-rational insecticides against larval population of *Leucinodes orbonalis* (Guen.) in brinjal after 3<sup>rd</sup> spray during *kharif* 2015-16

| S. No           | Treatment schedules  | Dose ml/ha              | PTP  | Mean reduction (%)               |                  |                  |                  |
|-----------------|--|-------------------------|------|----------------------------------|------------------|------------------|------------------|
|                 |  |                         |      | Days after 3 <sup>rd</sup> spray |                  |                  |                  |
|                 |  |                         |      | 3                                | 7                | 10               | Mean             |
| T <sub>1</sub>  | Spinosad 45 SC   | 200 ml                  | 1.33 | 54.09<br>(65.57)                 | 58.80<br>(73.13) | 52.08<br>(62.22) | 54.94<br>(66.97) |
| T <sub>2</sub>  | Chlorantranilprole 18.5 SC   | 150 ml                  | 1.13 | 59.51<br>(74.19)                 | 63.91<br>(80.58) | 55.81<br>(68.38) | 59.62<br>(74.39) |
| T <sub>3</sub>  | NSKE 5%  | 5%                      | 2.20 | 37.13<br>(36.44)                 | 41.20<br>(43.40) | 36.16<br>(34.84) | 38.19<br>(38.23) |
| T <sub>4</sub>  | Spinosad 45 SC followed by Chlorantranilprole 18.5 SC – Chlorantranilprole 18.5 SC | 200 ml – 150 ml – 150ml | 1.33 | 57.68<br>(71.35)                 | 62.66<br>(78.84) | 55.06<br>(67.16) | 58.36<br>(72.45) |
| T <sub>5</sub>  | Spinosad 45 SC followed by NSKE 5% - NSKE 5%                                       | 200 ml – 5% - 5%        | 2.07 | 42.55<br>(45.74)                 | 44.03<br>(48.32) | 39.09<br>(39.78) | 41.90<br>(44.61) |
| T <sub>6</sub>  | Chlorantranilprole 18.5 SC followed by Spinosad 45 SC – Spinosad 45 SC             | 150 ml – 200 ml – 200ml | 1.53 | 55.02<br>(67.09)                 | 57.86<br>(71.64) | 51.54<br>(61.30) | 54.75<br>(66.67) |
| T <sub>7</sub>  | Chlorantranilprole 18.5 SC followed by NSKE 5% – NSKE 5%                           | 150 ml – 5% - 5%        | 2.00 | 43.05<br>(46.61)                 | 45.42<br>(50.73) | 41.28<br>(43.53) | 43.25<br>(46.96) |
| T <sub>8</sub>  | NSKE 5% followed by Spinosad 45 SC – Spinosad 45 SC                                | 5% - 200 ml – 200 ml    | 1.60 | 51.17<br>(60.67)                 | 56.50<br>(69.52) | 47.46<br>(54.28) | 51.65<br>(61.49) |
| T <sub>9</sub>  | NSKE 5% followed by Chlorantranilprole 18.5 SC – Chlorantranilprole 18.5 SC        | 5% - 150 ml – 150 ml    | 1.40 | 54.63<br>(66.48)                 | 59.76<br>(74.61) | 50.00<br>(58.67) | 54.70<br>(66.59) |
| T <sub>10</sub> | Control  | -                       | 2.67 | -                                | -                | -                | -                |
|                 | S.Em.±   |                         |      | 1.22                             | 1.28             | 1.12             | 1.16             |
|                 | C.D (p=0.05)   |                         |      | 3.65                             | 3.85             | 3.36             | 3.48             |

Figures in parentheses are retransformed per cent values, \*PTP- Pre treatment population

**Table.7** Cumulative bioefficacy of biorational insecticide against larval population of *L. orbonalis* in brinjal during *kharif* 2014-15

| Treatment schedules   | Dose ml/ha               | Mean reduction of <i>L. orbonalis</i> population (%) days after sprays |                  |                  |
|---|--------------------------|--|------------------|------------------|
|   |                          | 3  | 7                | 10               |
| T <sub>1</sub> - Spinosad 45 SC   | 200 ml                   | 53.34<br>(64.34)   | 56.89<br>(70.13) | 48.96<br>(56.87) |
| T <sub>2</sub> - Chlorantraniliprole 18.5 SC  | 150 ml                   | 56.96<br>(70.24)   | 60.19<br>(75.24) | 53.59<br>(64.74) |
| T <sub>3</sub> - NSKE 5%  | 5%                       | 36.18<br>(34.86)   | 38.90<br>(39.44) | 34.54<br>(32.18) |
| T <sub>4</sub> - Spinosad 45 SC followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC | 200 ml – 150 ml – 150ml  | 54.73<br>(66.63)   | 58.55<br>(72.72) | 51.05<br>(60.47) |
| T <sub>5</sub> - Spinosad 45 SC followed by NSKE 5% - NSKE 5%   | 200 ml – 5% - 5%         | 45.92<br>(51.60)   | 47.22<br>(53.86) | 41.44<br>(43.80) |
| T <sub>6</sub> - Chlorantraniliprole 18.5 SC followed by Spinosad 45 SC – Spinosad 45 SC              | 150 ml – 200 ml – 200 ml | 55.42<br>(67.76)   | 58.93<br>(73.33) | 51.75<br>(61.64) |
| T <sub>7</sub> - Chlorantraniliprole 18.5 SC followed by NSKE 5% – NSKE 5%                            | 150 ml – 5% - 5%         | 47.37<br>(54.12)   | 49.06<br>(57.04) | 44.00<br>(48.27) |
| T <sub>8</sub> - NSKE 5% followed by Spinosad 45 SC – Spinosad 45 SC                                  | 5% - 200 ml – 200 ml     | 44.54<br>(49.19)   | 47.85<br>(54.96) | 42.09<br>(44.93) |
| T <sub>9</sub> - NSKE 5% followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC        | 5% - 150 ml – 150 ml     | 44.76<br>(49.57)   | 48.66<br>(56.36) | 42.35<br>(45.39) |
| T <sub>10</sub> - Control   | -                        | -  | -                | -                |
| S.Em.±  |                          | 0.83   | 1.15             | 1.10             |
| C.D (p=0.05)  |                          | 2.40   | 3.35             | 3.21             |

Figures in parentheses are retransformed per cent values

**Table.8** Cumulative bioefficacy of biorational insecticidal against larval population, *L. orbonalis* in brinjal during *kharif* 2015-16

| Treatment schedules   | Dose ml/ha               | Mean reduction of <i>L. orbonalis</i> population (%) days after sprays |                  |                  |
|---|--------------------------|--|------------------|------------------|
|   |                          | 3  | 7                | 10               |
| T <sub>1</sub> - Spinosad 45 SC   | 200 ml                   | 53.11<br>(63.93)   | 56.83<br>(70.03) | 48.97<br>(56.90) |
| T <sub>2</sub> - Chlorantraniliprole 18.5 SC  | 150 ml                   | 57.19<br>(70.59)   | 61.34<br>(76.95) | 53.69<br>(64.90) |
| T <sub>3</sub> - NSKE 5%  | 5%                       | 36.20<br>(34.88)   | 38.76<br>(39.21) | 33.45<br>(30.41) |
| T <sub>4</sub> - Spinosad 45 SC followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC | 200 ml – 150 ml – 150ml  | 55.85<br>(68.43)   | 59.08<br>(73.57) | 50.86<br>(60.15) |
| T <sub>5</sub> - Spinosad 45 SC followed by NSKE 5% - NSKE 5%   | 200 ml – 5% - 5%         | 45.70<br>(51.22)   | 46.50<br>(52.61) | 40.79<br>(42.69) |
| T <sub>6</sub> - Chlorantraniliprole 18.5 SC followed by Spinosad 45 SC – Spinosad 45 SC              | 150 ml – 200 ml – 200 ml | 54.26<br>(65.83)   | 57.55<br>(71.15) | 50.13<br>(58.90) |
| T <sub>7</sub> - Chlorantraniliprole 18.5 SC followed by NSKE 5% – NSKE 5%                            | 150 ml – 5% - 5%         | 48.06<br>(55.33)   | 49.75<br>(58.24) | 43.57<br>(47.51) |
| T <sub>8</sub> - NSKE 5% followed by Spinosad 45 SC – Spinosad 45 SC                                  | 5% - 200 ml – 200 ml     | 44.36<br>(48.89)   | 47.63<br>(54.57) | 41.11<br>(43.24) |
| T <sub>9</sub> - NSKE 5% followed by Chlorantraniliprole 18.5 SC – Chlorantraniliprole 18.5 SC        | 5% - 150 ml – 150 ml     | 46.41<br>(52.00)   | 49.12<br>(57.17) | 42.13<br>(45.01) |
| T <sub>10</sub> - Control   | -                        | -  | -                | -                |
| <b>S.Em.±</b>   |                          | 1.15   | 1.17             | 1.09             |
| <b>C.D (p=0.05)</b>   |                          | 3.34   | 3.39             | 3.17             |

Figures in parentheses are retransformed per cent value

The data presented in Table 5 revealed that maximum reduction in larval population of *L. orbonalis* of 74.34, 78.06 and 67.15 per cent was recorded in the treatment schedule T<sub>2</sub> (Chlorantraniliprole 18.5 SC @ 150 ml/ ha) followed by treatment schedule T<sub>4</sub> (Spinosad 45 SC @ 200 ml/ha- Chlorantraniliprole 18.5 SC @ 150 ml/ ha- Chlorantraniliprole 18.5 SC @ 150 ml/ ha) and minimum larval population reduction of 38.06, 44.27 and 36.41 per cent was recorded in treatment T<sub>3</sub> (NSKE 5% /ha) at 3, 7 and 10 day after 3<sup>rd</sup> spray, respectively during 2014-15. Data in Table 6 revealed that maximum reduction in larval population of shoot and fruit borer of 74.19, 80.58 and 68.38 per cent was recorded in the treatment schedule T<sub>2</sub> (Chlorantraniliprole 18.5 SC @ 150 ml/ ha) followed by treatment schedule T<sub>4</sub> (Spinosad 45 SC @ 200 ml/ha- Chlorantraniliprole 18.5 SC @ 150 ml/ha - Chlorantraniliprole 18.5 SC @ 150 ml/ha); whereas, minimum larval population reduction of 36.44, 43.40 and 34.84 per cent was recorded in treatment schedule T<sub>3</sub> (NSKE 5% /ha) at 3, 7, and 10 days after 3<sup>rd</sup> spray, respectively during 2015-16.

### **Cumulative efficacy of bio-rational insecticides**

The data presented in Table 7 revealed that the treatment schedule comprising three spray of Chlorantraniliprole 18.5 SC at 150 ml/ha (T<sub>2</sub>) at 15 days interval was found effective which caused 70.24, 75.24 and 64.74 per cent followed by treatment schedule T<sub>6</sub> (Chlorantraniliprole 18.5 SC at 150 ml/ha- Spinosad 45 SC @ 200 ml/ha- Spinosad 45 SC @ 200 ml/ha) with 67.76, 73.33 and 61.64 per cent reduction in larval population at 3, 7, and 10 days after three spray respectively. The data on cumulative bio-efficacy of biorational insecticides further revealed that minimum reduction in larval population of 34.86, 39.44 and 32.18 per cent was recorded

in treatment schedule (T<sub>3</sub>) NSKE at 5%/ha during *kharif*- 2014-15. The data presented in Table 8 showed that three spray of Chlorantraniliprole 18.5 SC at 150 ml/ha (T<sub>2</sub>) at 15 days interval was found effective, which caused 70.59, 76.95 and 64.90 per cent reduction in larval population at 3, 7, and 10 days after three spray respectively. It was followed by treatment schedule T<sub>4</sub> (Spinosad 45 SC @ 200 ml/ha- Chlorantraniliprole 18.5 SC @ 150 ml/ha - Chlorantraniliprole 18.5 SC @ 150 ml/ha) which caused 68.43, 73.57 and 60.15 per cent reduction at 3, 7, and 10 days after sprays, respectively. Three spray of NSKE at 5% (T<sub>3</sub>) was least effective among all the treatment which caused 34.88, 39.21 and 30.41 per cent larval reduction during *kharif*- 2015-16.

From the available literature, it becomes clear that the newer molecule, chlorantraniliprole was effective in reducing the population of the shoot and fruit borer. The earlier reports by many authors who have evaluated similar biorational insecticides for their efficacy against shoot and fruit borer confirm to our findings like, According to Kalawate and Dethe (2012) spinosad (56.25, 72 and 90 g a.i./ha) was most effective against brinjal shoot and fruit borer and also it afforded moderate control of jassid, whitefly and aphid. Misra (2011) found that chlorantraniliprole @ 40 and 50 gm a.i./ha were significantly superior and statistically on par with each other with regard to its efficacy, resulting in 95-97 per cent reduction in shoot damage; 87-90 per cent reduction in fruit damage on number basis and 88-90 per cent reduction in fruit damage on weight basis. Anil and Sharma (2010) wherein, they found that spinosad and emamectin benzoate were effective in suppressing the fruit infestation by BSFB. Adiroubane and Raghuraman (2008) reported that oxymatrine 1.2 EC (0.2 per cent) and spinosad 45 SC (225 gm/ha), were found to be effective against brinjal

shoot and fruit borer, *L. orbonalis*. Oxymatrine was effective at early vegetative stage. The highest percentage reduction of shoot damage was observed in oxymatrine and it was on par with spinosad. Spinosad was effective at fruiting stage. The maximum per cent reduction of fruit damage was recorded in spinosad which is on par with oxymatrine.

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