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**Patel NB**
Tribal Reserch-cum-Training Centre, Anand Agricultural University, Devgadhbaria, Gujarat, India

**Dodia JF**
Assistant Research Scientist (Ento), Main Rice Research Station, Anand Agricultural University, Nawagam, Gujarat, India

**Dr. DP Gohil**
Associate Research Scientist Main Vegetable Research Station Anand Agricultural University, Anand, Gujarat, India

**Dr. DM Korat**
Associate Director of Research Anand Agricultural University Anand, Gujarat, India

**Correspondence**
**Patel NB**
Tribal Reserch-cum-Training Centre, Anand Agricultural University, Devgadhbaria, Gujarat, India

# Evaluation of microbial insecticides against leaf folder, *Cnaphalocrocis medinalis* Guen. infesting paddy

**Patel NB, Dodia JF, Dr. DP Gohil and Dr. DM Korat**

**Abstract**
A field experiment was conducted at Main Rice Research Station, Anand Agricultural University, Anand (Gujarat) during *kharif*-2009, 2010 and 2011 to assess the effect of eight microbial insecticides *viz.*, *Bacillus thuringiensis* (*Bt*) @ 1.0 kg/ha, *B.t.* @ 1.5 kg/ha, *Beauveria bassiana* @ 1.0 kg/ha (cfu 2 x $10^6$), *B. bassiana* @ 1.5 kg/ha, *Verticillium lecanii* @ 1.0 kg/ha(cfu 2 x $10^6$), *V. lecanii* @ 1.5 kg/ha, *Nomuraea rileyi* @ 1.0 kg/ha, *N. rileyi* @ 1.5 kg/ha and recommended insecticide (Cartap hydrochloride 0.05 %) against leaf folder, *Cnaphalocrocis medinalis* Guen. infesting paddy. Results revealed that both the treatments of *B. bassiana* (higher and lower dose) exhibited leaf damage at par with chemical insecticide. Spider population in untreated plots registered maximum as compared to treated plots. Highest grain yield was harvested from the plots treated with chemical insecticide followed by *N. rileyi* @ 1.5 kg/ha. All the treatments of microbial insecticides were found at par with respect to fodder yield. Economics of different treatments showed that maximum Incremental Cost Benefit Ratio (ICBR) (1:48) was registered in the treatment of *V. lecanii* @ 1.0 kg/ha followed by *B. bassiana* @ 1 and 1.5 kg/ha. Though the treatments of *N. rileyi* exhibited relatively higher ICBR but it failed to suppress the pest effectively.

**Keywords:** Microbial insecticides, *Cnaphalocrocis medinalis*, infesting paddy

## Introduction
Paddy (*Oryza sativa* L.) is an important and staple food crop for more than two thirds of the population of India and more than 65 per cent of the world population (Mathur *et al.*, 1999) [8]. In India, the crop is grown over an area of 39.16 m ha with production of 85.59 M tonnes (Anonymous, 2012) [3]. Among the various constraints of paddy production, damage due to insect pests is substantial and needs regular attention. Kalode and Pasalu (1986) [6] reported that over 100 species of insect pests attack rice crop at various stages of its growth. However, about 20 insect pests have major significance in different rice growing regions of India. According to Pathak and Dhaliwal (1981) [10], the losses caused by insect pests in paddy is to be 24 per cent. Among the different insect pests damaging paddy, a group of leaf defoliators play an important role in reducing the yield of the crop. Paddy growers mostly depend on toxic chemical pesticides to manage these pests. Frequent use of insecticides not only pollute the surrounding environment but also responsible for resurgence as well as development of resistance in insects to a particular insecticide. To minimize the dependence on toxic chemicals, it was imperative to determine the efficacy of microbial insecticides commercially available in market so that the same can be included while formulating the IPM strategy. No work has been done in this direction in middle Gujarat region and therefore, the present study was proposed to carry out with a view to determine the relative bio-efficacy of microbial insecticides against leaf folder, *Cnaphalocrocis medinalis* Guen.

## Materials and methos
A field experiment was laid out at Main Rice Research Station, Anand Agricultural University, Nawagam (Gujarat) during *Kharif*- 2009, 2010 and 2011 in a Randomized Block Design to assess the bio-efficacy of microbial insecticides against leaf folder infesting in paddy. Seedlings of paddy variety GR-11 weretransplanted at 20 x 15 cm spacing in second week of August. There were ten treatments viz., *Bacillus thuringiensis* (*Bt*) @ 1.0 kg/ha, *B.t.* @ 1.5 kg/ha, *Beauveria bassiana* (cfu 2 x $10^6$)@ 1.0 kg/ha, *B. bassiana* @ 1.5 kg/ha, *Verticillium lecanii* @ 1.0 kg/ha, *V. lecanii* @ 1.5 kg/ha, *Nomuraea rileyi* @ 1.0 kg/ha, *N. rileyi* @ 1.5 kg/ha and recommended insecticide (Cartap hydrochloride 0.05 %) were evaluated along with untreated check. Incidence of leaf folder was recorded at 3, 7 and 10 days after each spray. For the purpose, 10 hills were randomly selected from net plot area. Leaf folder (LF) incidence was assessed by counting total and LF damaged /rolled leaves.

Population of predatory spiders in each net plot area was also recorded during each observation. Treatment–wise grain and fodder yield was recorded at harvest. Considering the pest load single spray was applied during all the three years of experimentation.

## Results and discussion

### Leaf folder

Data (Table 1) on leaf folder damage recorded during individual year as well as pooled indicated that the incidence of the pest was reduced significantly in all the treated plots over untreated check. During first year (2009-10), minimum (0.91%) number of damaged leaves due to leaf folder were registered in plots treated with cartap hydrochloride followed by *B. bassiana* @ 1.0 kg/ha (0.95%) and *B. thuringiensis* @ 1.5 kg/ha (1.10%). Both the dose of *N. rileyi* and *B. thuringiensis* at lower doses (1.0 kg/ha) proved inferior in controlling the leaf folder. With respect to leaf folder damage, all the insecticidal treatments found at par, however relatively low incidence (0.63 to 0.74%) was found in plots treated with *B. bassiana*(1 and 1.5 kg/ha) and cartap hydrochloride (0.05%) as it is evident from the data recorded for second and third year of experimentation. Pooled data revealed that both the treatments of *B. bassiana* (higher and lower doses) exhibited 0.77 to 0.95% leaf damage which were at par with chemical insecticide (0.77%). Both the treatments of *N. rileyi* and *B. thuringiensis* proved inferior whereas both the treatments of *V. lecanii* found mediocre in suppressing the leaf folder damage. The effectiveness of *B. bassiana* against leaf folder noticed in present study is in accordance with the reports of Alice *et al.* (2003) [1] and Ambethgar (2007) [2] who showed that the *B. bassiana* was the most effective biological pesticide against *C. medinalis.* Similarly, the reports of Panda *et al.* (1999) [9] and Kaur *et al.* (2008) [7] stating effectiveness of *B. thuringiensis* against paddy leaf folder corroborate with the present finding.

### Spiders

Spider population (Table 2) recorded in different treatments during first year of study revealed that all the treatments exhibited more or less same numbers (0.96 to 1.24 spiders/hill) of spiders, however untreated plots registered maximum spiders as compared to treated plots. Data recorded for second and third year as well as pooled revealed that significantly more numbers of spiders were found in untreated plots. The microbial insecticides found to be slightly hazardous to the predatory spiders similar to that of chemical insecticide. Reduction in spider population due to the application of biopesticides in paddy crop has also been reported by few earlier workers. Ghosh *et al.* (2006) [5] observed low mortality of spiders in plots treated with *B. bassiana* and *B. thuringiensis* in brinjal. Similarly, Chatterjee and Senapati (2010) [4] reported that the application of *Bt.k.* at 1000 ppm reduced 29.74 to 33.04% spider population after 3 days of spray and *B. bassiana* reduced 21.04% population after 14 days of spray in cabbage crop. These reports are in agreement with the present finding.

### Grain Yield

Data on grain yield (Table 3) recorded for the first year showed that all the treated plots, except lower dose of *B. bassiana* registered significantly higher yields over the treatment of untreated check (control). Yield data recorded for subsequent years *i.e.* 2010-11 and 2011-12 also revealed similar results wherein all the treated plots produced significantly higher yields in comparison to check. Data recorded for individual year indicated that the plots sprayed with chemical insecticide produced maximum yield followed by higher (1.5 kg/ha) dose of*N. rileyi* and both (higher and lower) the doses of *V. lecanii*. Pooled results revealed that highest (3859 kg/ha) grain yield was harvested from the plots treated with chemical insecticide followed by *N. rileyi* @ 1.5 kg/ha (3634 kg/ha). Among the microbial insecticides, lower doses of *B. bassiana* and *B. thuringiensis* proved inferior in producing the grain yield.From available source of literature, it revealed that none of the earlier worker has evaluated *N. rileyi* against lepidopteran pests of paddy. However, reduction in the population of army worm, *Mythimna separata* infesting sorghum and increasing the yield due to application of *N. rileyi* has been reported by Shekharappa and Patil (2008) [11].

### Fodder Yield

Fodder yield data (Table 3) recorded for the first year did not show any treatment effect as the results are non-significant, however maximum (5119 kg/ha) yield was harvested from the plots treated with chemical insecticide followed by *N. rileyi* @ 1.5 kg/ha (4611 kg/ha). Results of second and third year of experimentation as well as pooled registered significantly higher fodder yield over untreated check. With respect to fodder yield, all the treatments of microbial insecticides found at par, however the plots treated with higher dose (1.5 kg/ha) of *N. rileyi* and *V. lecanii* produced relatively more yields in comparison to rest of the microbial insecticides.

### Economics

Economics (Table 4) of different treatments worked out based on the grain as well as fodder yields, its prevailing market price and cost involved in each treatment it revealed that maximum ICBR (1:48) was registered in the treatment of *V. lecanii* @ 1.0 kg/ha followed by *B. bassiana*@ 1 and 1.5 kg/ha. Though the treatments of *N. rileyi* exhibited relatively higher ICBR but it failed to suppress the insect pest effectively.

## Conclusion

Considering the effectiveness and economics, it can be concluded that among the various microbial insecticides, *Bacillus thuringiensis* @ 1.0 kg/ha or *Beauveria bassiana* @ 1.0 and 1.5 kg/ha and *Verticillium* lecanii @ 1 kg/ha found effective in suppressing the leaf folder, *Cnaphalocrocis medinalis* Guen. incidence in paddy.

**Table 1:** Incidence of leaf folder in different treatments of microbial insecticides evaluated in paddy

| Sr. No. | Treatments | Leaf damage (%) | | | |
|---|---|---|---|---|---|
| | | 2009-10 | 2010-11 | 2011-12 | Pooled |
| 1 | *Bacillus thuringiensis*@ 1.0 kg/ha | 6.26* (1.19) | 5.69 (0.98) | 5.29 (0.85) | 5.75 (1.00) |
| 2 | *Bacillus thuringiensis*@ 1.5 kg/ha | 6.02 (1.10) | 5.58 (0.95) | 5.51 (0.92) | 5.70 (0.99) |
| 3 | *Beauveria bassiana*@ 1.0 kg/ha | 5.59 (0.95) | 4.93 (0.74) | 4.57 (0.63) | 5.03 (0.77) |
| 4 | *Beauveria bassiana*@ 1.5 kg/ha | 6.25 (1.19) | 5.60 (0.95) | 4.90 (0.73) | 5.58 (0.95) |
| 5 | *Verticillium lecanii*@ 1.0 kg/ha | 6.11 (1.13) | 5.61 (0.96) | 5.15 (0.81) | 5.62 (0.96) |
| 6 | *Verticillium lecanii*@ 1.5 kg/ha | 6.03 (1.10) | 5.55 (0.94) | 5.28 (0.85) | 5.62 (0.96) |
| 7 | *Nomuraea rileyi*@ 1.0 kg/ha | 6.16 (1.15) | 5.57 (0.94) | 5.21 (0.82) | 5.65 (0.97) |
| 8 | *Nomuraea rileyi*@ 1.5 kg/ha | 6.25 (1.19) | 5.80 (1.02) | 5.29 (0.85) | 5.78 (1.01) |
| 9 | Cartap hydrochloride 0.05 % | 5.48 (0.91) | 4.95 (0.74) | 4.66 (0.66) | 5.03 (0.77) |
| 10 | Untreated control (Check) | 13.24 (5.25) | 12.88 (4.97) | 12.25 (4.50) | 12.79 (4.90) |
| | S.Em. ± T | 0.32 | 0.34 | 0.33 | 0.19 |
| | T x Y | 0.58 | 0.61 | 0.63 | 0.34 |
| | C.D. at 5 % T | 0.95 | 0.99 | 0.98 | 0.55 |
| | T x Y | NS | NS | NS | NS |
| | C.V. (%) | 17.45 | 19.75 | 21.73 | 19.55 |

*Arc sin transformed values, Figures in parentheses are retransformed values
NS= Not Significant

**Table 2:** Population of spiders in different treatments of microbial insecticides evaluated in paddy

| Sr. No. | Treatments | Mean population of spiders/hill | | | |
|---|---|---|---|---|---|
| | | 2009-10 | 2010-11 | 2011-12 | Pooled |
| 1 | *Bacillus thuringiensis*@ 1.0 kg/ha | 1.30* (1.19) | 1.20 (0.94) | 1.16 (0.85) | 1.22 (0.99) |
| 2 | *Bacillus thuringiensis*@ 1.5 kg/ha | 1.23 (1.01) | 1.16 (0.85) | 1.12 (0.75) | 1.17 (0.87) |
| 3 | *Beauveria bassiana*@ 1.0 kg/ha | 1.30 (1.19) | 1.20 (0.94) | 1.15 (0.82) | 1.22 (0.99) |
| 4 | *Beauveria bassiana*@ 1.5 kg/ha | 1.31 (1.22) | 1.23 (1.01) | 1.17 (0.87) | 1.24 (1.04) |
| 5 | *Verticillium lecanii*@ 1.0 kg/ha | 1.29 (1.16) | 1.18 (0.89) | 1.16 (0.85) | 1.21 (0.96) |
| 6 | *Verticillium lecanii*@ 1.5 kg/ha | 1.32 (1.24) | 1.22 (0.99) | 1.21 (0.96) | 1.25 (1.06) |
| 7 | *Nomuraea rileyi*@ 1.0 kg/ha | 1.30 (1.19) | 1.23 (1.01) | 1.21 (0.96) | 1.25 (1.06) |
| 8 | *Nomuraea rileyi*@ 1.5 kg/ha | 1.30 (1.19) | 1.21 (0.96) | 1.15 (0.82) | 1.22 (0.99) |
| 9 | Cartap hydrochloride 0.05 % | 1.29 (1.16) | 1.23 (1.01) | 1.26 (1.09) | 1.26 (1.09) |
| 10 | Untreated control (Check) | 1.21 (0.96) | 1.54 (1.87) | 1.55 (1.90) | 1.53 (1.84) |
| | S.Em. ± T | 0.03 | 0.04 | 0.03 | 0.02 |
| | T x Y | 0.05 | 0.06 | 0.06 | 0.03 |
| | C.D. at 5 % T | 0.09 | 0.10 | 0.10 | 0.06 |
| | T x Y | NS | NS | NS | NS |
| | C.V. (%) | 7.28 | 9.71 | 10.47 | 9.17 |
| | | | | | |

* $\sqrt{X+0.5}$ transformed values, Figures in parentheses are retransformed values

**Table 3:** Grain and fodder yield in different treatments of microbial insecticides evaluated in paddy

| Sr. No. | Treatments | Grain yield (kg/ha) | | | | Fodder yield (kg/ha) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2009-10 | 2010-11 | 2011-12 | Pooled | 2009-10 | 2010-11 | 2011-12 | Pooled |
| 1 | *Bacillus thuringiensis*@ 1.0 kg/ha | 2994 | 3429 | 3613 | 3345 | 4166 | 4483 | 4535 | 4395 |
| 2 | *Bacillus thuringiensis*@ 1.5 kg/ha | 3146 | 3451 | 3504 | 3367 | 4372 | 4590 | 4683 | 4548 |
| 3 | *Beauveria bassiana*@ 1.0 kg/ha | 2875 | 3179 | 3320 | 3125 | 3997 | 4444 | 4579 | 4340 |
| 4 | *Beauveria bassiana*@ 1.5 kg/ha | 3168 | 3473 | 3624 | 3421 | 4403 | 4657 | 4822 | 4627 |
| 5 | *Verticillium lecanii*@ 1.0 kg/ha | 3201 | 3592 | 3786 | 3526 | 4448 | 4770 | 4887 | 4701 |
| 6 | *Verticillium lecanii*@ 1.5 kg/ha | 3239 | 3564 | 3732 | 3512 | 4535 | 4903 | 4978 | 4805 |
| 7 | *Nomuraea rileyi*@ 1.0 kg/ha | 3114 | 3548 | 3721 | 3461 | 4340 | 4857 | 4659 | 4518 |
| 8 | *Nomuraea rileyi*@ 1.5 kg/ha | 3320 | 3667 | 3917 | 3634 | 4611 | 5045 | 5171 | 4942 |
| 9 | Cartap hydrochloride 0.05 % | 3657 | 3875 | 4047 | 3859 | 5119 | 5422 | 5512 | 5351 |
| 10 | Untreated control (Check) | 2235 | 2062 | 2191 | 2162 | 3927 | 3312 | 3103 | 3447 |
| | S.Em. ± T | 237.15 | 257.05 | 259.72 | 134.10 | 327.95 | 358.09 | 381.21 | 193.30 |
| | T x Y | - | - | - | 251.51 | - | - | - | 356.42 |
| | C.D. at 5 % T | 688.19 | 745.94 | 753.70 | 376.83 | NS | 1039.16 | 1106.25 | 543.20 |
| | T x Y | - | - | - | NS | - | - | - | NS |
| | C.V. (%) | 15.32 | 15.19 | 14.64 | 15.03 | 14.93 | 15.50 | 16.24 | 15.60 |

**Table 4:** Economics of different insecticidal treatments evaluated under study

| Sr. No. | Treatments | Yield (kg/ha) | | Gross income (Rs./ha) | Cost of treatment (Rs./ha) | Gross realization (Rs./ha) | Net realization over control (Rs./ha) | ICBR |
|---|---|---|---|---|---|---|---|---|
| | | Grain | Fodder | | | | | |
| 1 | *Bacillus thuringiensis*@ 1.0 kg/ha | 3345 | 4395 | 50603 | 1352 | 49251 | 15332 | 1:11.34 |
| 2 | *Bacillus thuringiensis*@ 1.5 kg/ha | 3367 | 4548 | 51184 | 1928 | 49256 | 15337 | 1:7.95 |
| 3 | *Beauveria bassiana*@ 1.0 kg/ha | 3125 | 4340 | 47743 | 400 | 47343 | 13424 | 1:33.56 |
| 4 | *Beauveria bassiana*@ 1.5 kg/ha | 3421 | 4627 | 52017 | 500 | 51517 | 17598 | 1:35.20 |
| 5 | *Verticillium lecanii*@ 1.0 kg/ha | 3526 | 4701 | 53477 | 400 | 53077 | 19158 | 1:47.90 |
| 6 | *Verticillium lecanii*@ 1.5 kg/ha | 3512 | 4805 | 48705 | 500 | 48205 | 14286 | 1:28.57 |
| 7 | *Nomuraea rileyi*@ 1.0 kg/ha | 3461 | 4518 | 47781 | 400 | 47381 | 13462 | 1:33.66 |
| 8 | *Nomuraea rileyi*@ 1.5 kg/ha | 3634 | 4942 | 50367 | 500 | 49867 | 15948 | 1:31.90 |
| 9 | Cartap hydrochloride 0.05 % | 3859 | 5351 | 58940 | 740 | 58200 | 24281 | 1:32.81 |
| 10 | Untreated control (Check) | 2162 | 3447 | 33919 | - | 33919 | - | 1:11.34 |

Price : Grain - Rs. 250/20kg, Labour Charge : Rs. 100/day, Fodder - Rs. 40/20 kg

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