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# Eco-friendly management of spotted pod borer, *Maruca vitrata* on black gram

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**Abstract**
The present research investigation entitled carried out in kharif season of 2024-25 at Seed Technology and Research Unit field, Dr. PDKV Akola. Experimental plot treated with seed treatment thiamethoxam 25 WG @ 3 g/kg seed and one cover spray of thiamethoxam after initiation of sucking pests. The biorationals treatments namely *Bacillus thuringiensis* 1 kg ha$^{-1}$, Neem oil 2%, Dashparni ark 10% (125 ml/10 lit.), *Beauveria bassiana* 1×10$^{8}$ @ 40 ml/10 lit., *Metarhizium anisopliae* 1×10$^{8}$ @ 40 ml/10 lit., NSE 5%, Quinalphos 25EC 20 ml/10 lit used for two spray, 1$^{st}$ spray at 35$^{th}$ DAE and 2$^{nd}$ one at 50$^{th}$ DAE. The mean effect of different treatments on *Maruca vitrata* found a lowest larval population in treatment plot $T_7$ (Quinalphos 25EC 20 ml/10 lit.) which recoded 0.89 larvae/plant. Then effective treatments shown were $T_6$ (NSE 5%) and $T_1$ (*Bacillus thuringiensis* 1 kg ha$^{-1}$) recorded a larval population 3.16 and 3.49 larvae/plant. The effect of these biorationals on population of natural enemies like Ladybird beetle and Spider found was beneficial.
The effect of various biorationals on per cent pod damage of *Maruca vitrata*, effective treatment found was $T_7$ (Quinalphos 25EC 20 ml/10 lit.) which recorded a pod damage 8.02 per cent followed by treatments $T_6$ (NSE 5%) and $T_1$ (*Bacillus thuringiensis* 1 Kgha$^{-1}$) recorded a damage of 8.10 and 8.60 per cent. Yield and incremental cost benefit ratio of various biorationals treatments tested against the pod borers of black gram indicated that highest yield of black gram was recorded in treatment$T_7$ (Quinalphos 25EC 20 ml/10 lit.) was 8.80q/ha followed by treatments $T_6$ (NSE 5%), $T_2$ (Neem oil 2%) and $T_1$ (*Bacillus thuringiensis* 1 Kgha$^{-1}$) recorded yield 8.60 q/ha, 7.20q/ha and 7.00 q/ha. The highest ICBR was obtained in treatment $T_7$ (Quinalphos 25EC 20 ml/10 lit.) (1:9.61), followed by treatment $T_6$ (NSE 5%) was (1:3.05), $T_1$ (*Bacillus thuringiensis* 1 Kgha$^{-1}$) ranked third with (1:2.41) ICBR.

**Keywords:** Biorationals, *Maruca vitrata*, NSE 5%, *Bacillus thuringiensis*, Neem oil

## Introduction
Black gram (*Vigna mungo* (L.) Hepper) is a leguminous crop that belongs to the Fabaceae family and the genus Vigna (Verdcourt, 1970) [22]. In India, about 18 to 20 species of insect pests damage the black gram (Nayar *et al.*, 1976 and Singh and Singh, 1977) [11, 17]. As many as 30 insect pests of different groups appear in succession at different stages of crop growth of black gram (Dhuri and Singh, 1983) [5]. In India, quantitative avoidable losses (7 to 35%) caused by insect pest complex both in black gram and green gram varied with different agro-climatic condition. The annual yield loss due to insect pests has been estimated to 30 per cent in urd bean and mung bean (Hamad and Dubey, 1983) [7]. In black gram, the avoidable loss in yield due to insect pest was recorded to be 34.7 per cent (Saxena, 1983) [14]. On an average, 2.5 to 3.0 million tonnes of pulses are lost annually due to pest problems (Rabindra *et al.*, 2004) [12]. Black gram is affected by a variety of insect pests throughout its growth cycle, from sowing to harvest, as well as during storage of the harvested produce (Lal and Sachan, 1987) [10]. Notable among these pests, which cause significant economic damage to farmers, are the spotted pod borer (*Maruca vitrata* Geyer), gram pod borer (*Helicoverpa armigera Hübner*), blue butterfly (*Lampidesboeticus* L.), plume moth (*Exelastisatomosa Walsingham*), and pod bug (*Clavigralla gibbosa* Spinola), (Reddy *et al.*, 1998) [13]. *Maruca vitrata* is particularly damaging as it bores into pods internally, leading to severe losses in legume crops. Climatic elements such as temperature, humidity, and rainfall, each of which varies significantly by region and season play a major role in influencing the growth and population increase of these insect species.

These factors affect both the extent of pest outbreaks and the severity of crop damage. In addition, pest populations are regulated by ecological factors like the presence of natural predators and parasitoids (Becker, 1974) [1]. As such, research on pest population dynamics is essential to understand their life cycle and ecological interactions. This understanding is vital for developing timely and effective pest control strategies that correspond with the pest life stages and the crop's growth period.

In brief, eco-friendly management of pod borers in black gram offers promising benefits for sustainable agriculture, it's success depends on a combination of farmer education, availability of inputs, environmental support, and effective integration with other pest control methods. With proper support and awareness programs, these methods can play a crucial role in reducing chemical load and ensuring healthier agro-ecosystems.

## Materials and Methods

The field experiment was undertaken in field of Seed Technology and Research Unit, Dr. PDKV Akola during kharif season 2024. Experimental plot treated with seed treatment thiamethoxam 25WG@ 3 g/kg seed and one cover spray of thiamethoxam after initiation of sucking pests. The biorationals treatments namely *Bacillus thuringiensis* 1 kg $ha^{-1}$, Neem oil 2%, Dashparni ark 10% (125 ml/10 lit.), *Beauveria bassiana* $1\times10^8$ @ 40 ml/10 lit., *Metarhizium anisopliae* $1\times10^8$ @ 40 ml/10 lit., NSE 5%, Quinalphos 25EC 20 ml/10 lit used for two spray, 1st spray at 35th DAE and 2nd one at 50th DAE. Observation was recorded 24 hr. before treatment and 3rd, 7th and 14th day after treatment at both spraying. Percent reduction over control and percent pod damage of harvest worked out during the research work. Percentage of pod damage was calculated from each plot on 5 plants at the time of harvest according to formula.

$$\text{Percentage of pod damage} = \frac{\text{Total no of damaged pods}}{\text{Total no of examined pods}} \times 100$$

The population of natural enemies counted per plant on each treatment 3rd, 7th and 14th DAT and B:C ratio calculated of different biorationals treatments.

## Results and Discussion

### Mean effect of biorationals on larval population of *Maruca vitrata* at first spray

The summarized data given in Table 1 illustrated that the most effective treatment in terms of larval population reduction for *Maruca vitrata* after application of 1st spray, the mean effect indicate that the best treatment was $T_7$ (Quinalphos 25EC 20 ml/10 lit.), which recorded 0.91 larvae/plant. Which statistically significant over rest of treatments. The next effective treatment proved better for larval reduction was $T_6$ (NSE 5%) which recorded a larval population 3.16 larvae/plant, which found at par with treatments $T_1$ (*Bacillus thuringiensis* 1 kg $ha^{-1}$) and $T_2$ (Neem oil 2%) which recorded larval population 3.32, 3.35 larvae/plant. Then next better treatment was $T_4$ (*Beauveria bassiana*1×108 @ 40 ml/10 lit.) which recorded larval population 4.14 larvae/plant. While another effective treatment was $T_5$ (*Metarhizium anisopliae* $1\times10^8$ @ 40 ml/10 lit.) which was statistically similar with treatments $T_3$ (Dashparni ark 10% (125 ml/lit.) recorded larval population 5.85 and 6.49 larvae/plant. The highest larval population was found in treatment $T_8$ (Untreated control), which recorded larval population 6.71 larvae/plant. Kaleshwari *et al.* (2024) who observed the lowest larval population (0.89 larvae/plant) of spotted pod borer was noticed in the plot treated with Indoxacarb 14.5 SC percent and it was at par with *Beauveria bassiana* 1.15% (1.53 larvae/plant), NSKE 5% (1.76 larvae/plant) and *Metarhizium anisopilae* 2% (1.83 larvae/plant). The present study revealed that all treatments were significantly superior over untreated control. The most effective treatment, in terms of larval reduction found was NSE 5%, Neem oil and *Bacillus thuringiensis* 1 kg $ha^{-1}$ found effective by Ganapathy (2010) [6]. The similar finding obtained by Byrappa *et al.* (2012) [3] and Sreekanth and Seshamahalakshmi (2012) [19].

**Table 1:** Effect of biorationals on larval population of *Maruca vitrata* on black gram

| Tr. No. | Treatments | *Maruca vitrata* larval population larvae/ plant | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st spray | | | | | 2nd spray | | | | |
| | | Pre count | 3 DAS | 7 DAS | 14 DAS | Mean | Pre-count | 3 DAS | 7 DAS | 14 DAS | Mean |
| $T_1$ | *Bacillus thuringiensis* 1 $Kgha^{-1}$ | 6.77 (2.60) | 3.45 (1.86) | 3.30 (1.82) | 3.21 (1.79) | 3.32 (1.82) | 6.79 (2.61) | 3.85 (2.00) | 3.43 (1.85) | 3.20 (1.79) | 3.49 (1.89) |
| $T_2$ | Neem oil 2% | 6.36 (2.52) | 3.46 (1.86) | 3.33 (1.83) | 3.25 (1.81) | 3.35 (1.83) | 6.33 (2.52) | 4.07 (2.04) | 3.81 (1.96) | 3.46 (1.86) | 3.78 (1.95) |
| $T_3$ | Dashparni ark 10% (125 ml/10 lit.) | 7.00 (2.63) | 6.04 (2.46) | 6.54 (2.56) | 6.89 (2.62) | 6.49 (2.55) | 7.10 (2.67) | 6.99 (2.64) | 6.53 (2.55) | 6.88 (2.62) | 6.80 (2.60) |
| $T_4$ | *Beauveria bassiana* $1\times10^8$ @ 40 ml/10 lit. | 6.20 (2.49) | 4.21 (2.06) | 3.85 (1.96) | 4.36 (2.07) | 4.14 (2.03) | 6.20 (2.49) | 4.20 (2.05) | 3.84 (1.96) | 4.34 (2.06) | 4.13 (2.02) |
| $T_5$ | *Metarhizium anisopliae* $1\times10^8$ @ 40 ml/10 lit. | 7.01 (2.59) | 5.56 (2.35) | 5.82 (2.41) | 6.16 (2.46) | 5.85 (2.39) | 7.00 (2.63) | 5.54 (2.35) | 5.80 (2.40) | 6.14 (2.45) | 5.83 (2.39) |
| $T_6$ | NSE 5% | 6.10 (2.47) | 3.25 (1.81) | 3.15 (1.77) | 3.09 (1.76) | 3.16 (1.78) | 6.22 (2.49) | 3.94 (1.98) | 3.04 (1.74) | 2.61 (1.61) | 3.19 (1.78) |
| $T_7$ | Quinalphos 25EC 20 ml/10 lit. | 6.00 (2.45) | 1.34 (1.15) | 0.76 (0.87) | 0.63 (0.80) | 0.91 (0.94) | 6.00 (2.45) | 1.32 (1.15) | 0.74 (0.86) | 0.61 (0.79) | 0.89 (0.93) |
| $T_8$ | Untreated Control | 6.17 (2.48) | 6.08 (2.46) | 7.00 (2.65) | 7.03 (2.65) | 6.71 (2.59) | 6.37 (2.52) | 7.07 (2.66) | 6.99 (2.65) | 7.22 (2.69) | 7.09 (2.67) |
| | 'F' Test | N.S. | Sig | Sig | Sig | Sig | N.S. | Sig | Sig | Sig | Sig |
| | SE(m)± | - | 013 | 0.14 | 0.12 | 0.06 | - | 0.15 | 0.13 | 0.14 | 0.06 |
| | $CDaT_5\%$ | - | 0.38 | 0.42 | 0.37 | 0.18 | - | 0.46 | 0.40 | 0.42 | 0.19 |
| | CV% | - | 10.96 | 12.04 | 10.53 | 5.20 | - | 12.43 | 11.54 | 12.16 | 5.49 |

Figures in parentheses are square root transformation. DAS-Day after spray

**Mean effect of biorationals on larval population of *Maruca vitrata* at second spray**

The data summarized at third, seven and fourteen days after second spray given in Table 1 indicated that all the treatments of biorationals are statistically superior. The most superior treatment found was $T_7$ (Quinalphos 25EC 20 ml/10 lit.) recorded 0.89 larvae/plant. The next effective treatment was $T_6$ (NSE 5%) which found at par with treatments $T_1$ (*Bacillus thuringiensis* 1 kg $ha^{-1}$) and $T_2$ (Neem oil 2%) which recorded larval population 3.16, 3.49 and 3.78 larvae/plant and both these found at par with treatment $T_4$ (*Beauveria bassiana* $1\times10^8$ @ 40 ml/10 lit.), which recorded larval population 4.13 larvae/plant. The next better treatment is $T_5$ (*Metarhizium anisopliae* $1\times10^8$ @ 40 ml/10 lit.) recorded larval population 5.83 larvae/plant. While next effective treatment found was treatment $T_3$ (Dashparni ark 10% (125 ml/lit.) recorded larval population 6.80 and found at par with treatment $T_8$ (Untreated control), which recorded larval population 7.09 larvae/plant. The present study revealed that all treatments were significantly superior over untreated control. The most effective treatments in terms of larval reduction of *Maruca vitrata* found were NSE 5%, *Bacillus thuringiensis* 1 kg $ha^{-1}$ and Neem oil 2% by Bhumika K. (2018). The similar finding obtained by Byrappa *et al.* (2012) [3] and Ganapathy (2010) [6].

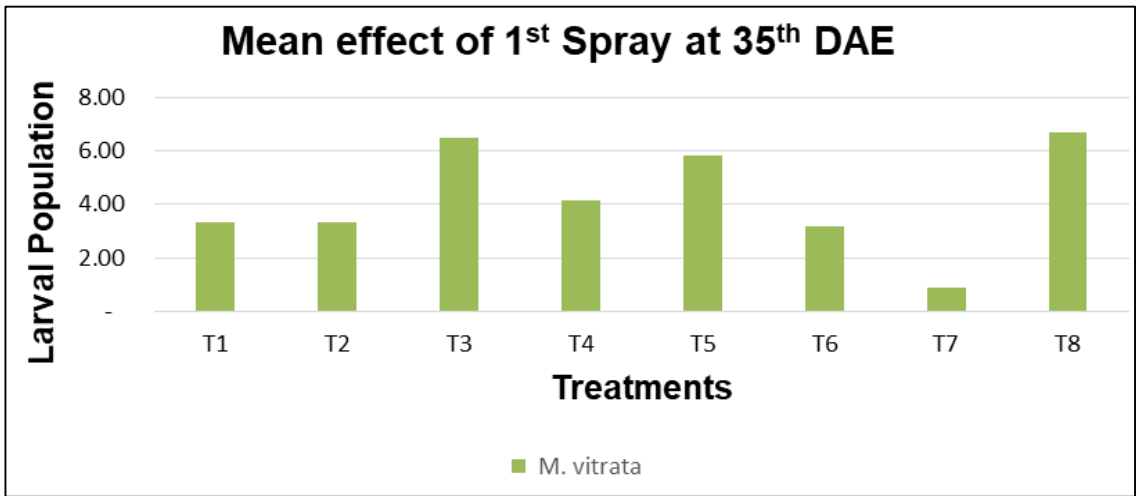


**Fig 1:** Mean effect of 1st Spray on spotted pod borer, *Maruca vitrata* on larval population

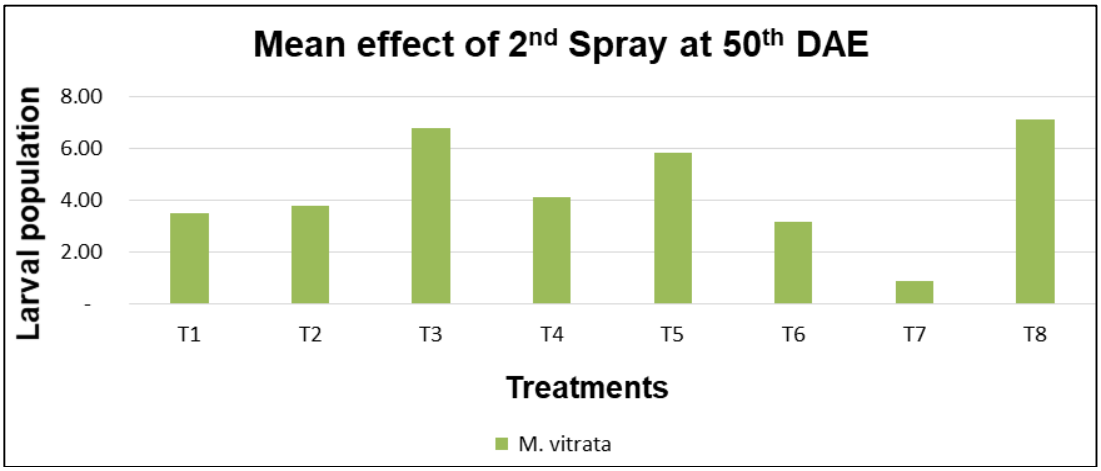


**Fig 2:** Mean effect of 2nd Spray on spotted pod borer, *Maruca vitrata* on larval population.

**Table 2:** Effect of biorational on per cent pod damage inflicted by *Maruca vitrata*, yield and ICBR of black gram

| Tr. No. | Treatments | Pod damage *Maruca vitrata (%)* | Yield (q/ha) | ICBR (C/A) |
|---|---|---|---|---|
| $T_1$ | *Bacillus thuringiensis* 1 $Kgha^{-1}$ | 8.60 | 7.00 | 2.41 |
| $T_2$ | Neem oil 2% | 9.00 | 7.29 | 0.56 |
| $T_3$ | Dashparni ark 10% (125ml/10 lit.) | 18.80 | 5.20 | -0.24 |
| $T_4$ | *Beauveria bassiana* $1\times10^8$ @ 40 ml/10 lit. | 16.00 | 5.47 | 0.39 |
| $T_5$ | *Metarhizium anisopliae* $1\times10^8$ @ 40 ml/10 lit. | 16.80 | 5.20 | -0.40 |
| $T_6$ | NSE 5% | 8.10 | 8.60 | 3.05 |
| $T_7$ | Quinalphos 25EC 20 ml/10 lit. | 8.02 | 8.80 | 9.61 |
| $T_8$ | Untreated Control | 22.00 | 5.00 | - |
| | SE(m)± | 0.16 | 0.48 | |
| | CD at 5% | 0.50 | 1.46 | |
| | CV% | 7.94 | 12.68 | |

**Per cent pod damage inflicted by *Maruca vitrata* on black gram**

The data indicated in Table 2 showed that the per cent pod damage caused by *Maruca vitrata* in black gram was in range of 8.02 to 22.00 per cent. All the treatments found superior over untreated control. The most effective observed treatment was $T_7$ (Quinalphos 25EC 20 ml/10 lit.) which recorded a pod damage 8.02 per cent and found at par with the treatment $T_6$ (NSE 5%) which recorded pod damage 8.10 per cent also this treatment was found at par with treatment $T_1$ (*Bacillus thuringiensis* 1 $Kgha^{-1}$) recorded a damage of 8.60 per cent. The next treatment found better to record lesser per cent pod damage was $T_2$ (Neem oil 2%) recorded 9.00 per cent damage at the time of harvest. The next treatments followed by were $T_4$ (*Beauveria bassiana* $1\times10^8$ @ 40 ml/ 10 lit.) and $T_5$ (*Metarhizium anisopliae* $1\times10^8$ @ 40 ml/10 lit.) recorded a pod damage 16.00 and 16.80 per cent inflicted by *M. vitrata.* The next treatment in terms of reduction of pod damage found was $T_3$ (Dashparni ark 10% (125 ml/10 lit.) recorded 18.80 per cent pod damage. While the treatment $T_8$ (Untreated control) recorded highest pod damage i.e. 22.00 per cent.

Singh and Singh (2019) reported that the biopesticides, NSKE 5% was found effective followed by *Metarhizium anisopliae* ($1 \times 10^8$ Spores $g^{-1}$). These findings are in agreement with Yadav and Singh, (2014) [23] and Sonune *et al.* (2010) who found that minimum pod damage was recorded in the Spinosad treatment. Selvam K (2018) found that the percent reduction of pod damage was maximum (74.72%) after chlorpyrifos 20% EC applied at 2.5 mL/L at pod maturing stage. This was followed by neem oil (65.99%) and azadirachtin 0.03% (65.84%). Which is in conformity with present finding of *M. vitrata*.

**Effect of biorationals on yield of black gram**

The data analyzed on treatment basis to assess the effect of various biorationals against lepidopteran pod borers depicted in Table 2 indicated that the highest yield obtained in treatment $T_7$ (Quinalphos 25EC 20 ml/10 lit.) i.e. 8.80q/ha, which significantly superior over rest of treatments. The next most effective treatments obtained in terms of yield were $T_6$ (NSE 5%) which recorded a yield 8.60q/ha and found at par with the treatment $T_2$ (Neem oil 2%) with a yield 7.29q/hq. This treatment also found at par with the treatment $T_1$ (*Bacillus thuringiensis* 1 $Kgha^{-1}$) recorded a yield 7.00q/ha. Whereas next all other treatments *viz*, $T_4$ (*Beauveria bassiana* $1\times10^8$ @ 40 ml/10 lit.), $T_5$ (*Metarhizium anisopliae* 1×108 @ 40 ml/10 lit.), $T_3$ (Dashparni ark 10% (125 ml/10 lit.) and $T_8$ (Untreated control) recorded a yield of 5.47, 5.20, 5.20 and 5.00q/ha, respectively and found at par with each other. Singh and Singh (2019) reported that in biopesticides NSKE 5%produced maximum yield. The present findings are agreement with Umbarkar and Parsana (2014) [21], Yadav and Singh (2014) and Kaushik *et al.* (2016)

**Incremental cost benefit ratio of various biorationals treatments on black gram**

It could be seen from Table 2 that incremental cost benefit ratio (ICBR) of treatment $T_7$ (Quinalphos 25EC 20 ml/10 lit.) was maximum (1:9.61). It was followed by treatment $T_6$ (NSE 5%) was (1:3.05) and treatment $T_1$ (*Bacillus thuringiensis* 1 $Kgha^{-1}$) was (1:2.41) ICBR.

**Effect of biorationals on Natural enemies of black gram**

The profound of biorationals on Ladybird beetle and Spider population expressed in table 3 and 4 showed that the data obtained from observations recorded after application of 1st and 2nd spray on black gram showed non-significant effect in respect of Ladybird beetle and Spider population. All treatments of biorationals recorded uniform population of natural enemies and there was no influence profound due to application of biorationals on population of Ladybird beetle and Spider on black gram. Yadav *et al.* (2022) reported that adult population of *C. septempunctata* ranged from 1.67 to 5.67 per 10 plants during Kharif, 2018. Among all the bio-rational and botanical insecticides treatments the maximum population of C. septempunctata was recorded in NSKE (5%) with 4.67 adults per 10 plants, similarly the present findings are supported by Tiwari *et al.* (2011) [20] who reported that neem-based pesticides were found relatively less harmful to the coccinellid beetle. The present findings are supported by Dash *et al* (1996), who reported that neem oil spray (3%) and NSKE (5%) were observed with greater populations of spiders. The present findings are also in confirmation with Tiwari *et al* (2011) [20], who reported that neem-based pesticides were found relatively less harmful to the spiders.

**Table 3:** Effect of biorationals on Ladybird beetle on black gram

| Tr. No. | Treatments | Ladybird beetle population/ Plant | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st Spray | | | | | 2nd Spray | | | | |
| | | Pre-count | 3 DAS | 7 DAS | 14 DAS | Mean | Pre-count | 3 DAS | 7 DAS | 14 DAS | Mean |
| $T_1$ | *Bacillus thuringiensis* 1 Kg $ha^{-1}$ | 2.03 (1.43) | 2.41 (1.56) | 2.29 (1.52) | 2.28 (1.51) | 2.33 (1.52) | 2.01 (1.42) | 2.37 (1.54) | 2.26 (1.51) | 2.25 (1.50) | 2.29 (1.51) |
| $T_2$ | Neem oil 2% | 2.10 (1.45) | 2.38 (1.54) | 2.28 (1.51) | 2.27 (1.51) | 2.31 (1.52) | 2.07 (1.44) | 2.34 (1.52) | 2.25 (1.50) | 2.24 (1.50) | 2.28 (1.51) |
| $T_3$ | Dashparni ark 10% (125ml/10 lit.) | 2.68 (1.64) | 2.09 (1.45) | 1.96 (1.40) | 1.94 (1.40) | 2.00 (1.42) | 2.66 (1.63) | 2.07 (1.44) | 1.93 (1.39) | 2.17 (1.48) | 2.06 (1.44) |
| $T_4$ | *Beauveria bassiana* $1\times10^8$ @ 40 ml/10 lit. | 2.82 (1.68) | 2.36 (1.54) | 2.22 (1.49) | 2.21 (1.49) | 2.26 (1.51) | 2.82 (1.68) | 2.33 (1.53) | 2.19 (1.48) | 2.16 (1.47) | 2.23 (1.49) |
| $T_5$ | *Metarhizium anisopliae* $1\times10^8$ @ 40 ml/10 lit. | 2.23 (1.49) | 2.29 (1.52) | 2.22 (1.49) | 2.20 (1.48) | 2.24 (1.49) | 2.21 (1.48) | 2.26 (1.51) | 2.17 (1.47) | 2.28 (1.51) | 2.24 (1.50) |
| $T_6$ | NSE 5% | 2.70 (1.64) | 3.11 (1.77) | 2.42 (1.56) | 2.41 (1.56) | 2.65 (1.63) | 2.68 (1.64) | 3.08 (1.75) | 2.39 (1.55) | 2.38 (1.54) | 2.62 (1.62) |
| $T_7$ | Quinalphos 25EC 20 ml/10 lit. | 2.64 (1.61) | 1.55 (1.23) | 1.42 (1.18) | 1.41 (1.17) | 1.46 (1.20) | 2.61 (1.60) | 1.53 (1.23) | 1.38 (1.16) | 1.38 (1.16) | 1.43 (1.18) |
| $T_8$ | Control | 3.11 (1.76) | 3.78 (1.92) | 3.30 (1.79) | 3.28 (1.79) | 3.46 (1.83) | 2.81 (1.68) | 3.69 (1.90) | 3.24 (1.78) | 3.20 (1.77) | 3.38 (1.81) |
| | 'F' Test | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |

Figures in parentheses are square root transformation, DAS-Day after spray

**Table 4:** Effect of biorationals on Spider of black gram

| Spider population/ plant | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tr. No | Treatments | 1st Spray | | | | | 2nd Spray | | | | |
| | | Precount | 3 DAS | 7 DAS | 14 DAS | Mean | Pre-count | 3 DAS | 7 DAS | 14 DAS | Mean |
| $T_1$ | *Bacillus thuringiensis* 1 Kgha$^{-1}$ | 2.02 (1.42) | 2.48 (1.57) | 2.36 (1.53) | 2.34 (1.52) | 2.39 (1.54) | 1.99 (1.41) | 2.46 (1.57) | 2.34 (1.52) | 2.30 (1.51) | 2.36 (1.54) |
| $T_2$ | Neem oil 2% | 2.09 (1.45) | 2.42 (1.56) | 2.29 (1.51) | 2.28 (1.51) | 2.33 (1.52) | 2.07 (1.44) | 2.40 (1.55) | 2.27 (1.50) | 2.24 (1.50) | 2.30 (1.51) |
| $T_3$ | Dashparni ark 10% (125ml/10 lit.) | 2.69 (1.64) | 2.10 (1.45) | 2.21 (1.49) | 2.19 (1.48) | 2.17 (1.47) | 2.67 (1.63) | 2.07 (1.44) | 2.20 (1.49) | 2.16 (1.47) | 2.14 (1.47) |
| $T_4$ | *Beauveria bassiana* $1\times10^8$ @ 40 ml/10 lit. | 2.08 (1.44) | 2.42 (1.56) | 2.23 (1.50) | 2.21 (1.49) | 2.29 (1.51) | 2.06 (1.43) | 2.40 (1.55) | 2.22 (1.49) | 2.20 (1.48) | 2.27 (1.51) |
| $T_5$ | *Metarhizium anisopliae* $1\times10^8$ @ 40 ml/10 lit. | 2.23 (1.49) | 2.34 (1.53) | 2.22 (1.49) | 2.20 (1.48) | 2.25 (1.50) | 2.20 (1.48) | 2.31 (1.52) | 2.21 (1.48) | 2.18 (1.47) | 2.23 (1.49) |
| $T_6$ | NSE 5% | 2.69 (1.64) | 3.09 (1.76) | 2.43 (1.56) | 2.41 (1.55) | 2.64 (1.62) | 2.67 (1.63) | 3.06 (1.75) | 2.40 (1.55) | 2.35 (1.53) | 2.60 (1.61) |
| $T_7$ | Quinalphos 25EC 20 ml/10 lit. | 2.64 (1.61) | 1.55 (1.23) | 1.41 (1.18) | 1.40 (1.17) | 1.45 (1.20) | 2.63 (1.60) | 1.53 (1.23) | 1.39 (1.17) | 1.35 (1.15) | 1.42 (1.18) |
| $T_8$ | Control | 2.47 (1.57) | 3.75 (1.93) | 3.29 (1.81) | 3.26 (1.80) | 3.43 (1.84) | 3.05 (1.74) | 3.73 (1.91) | 3.29 (1.81) | 3.23 (1.79) | 3.42 (1.83) |
| | 'F' Test | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |

Figures in parentheses are square root transformation. DAS-Day after spray

## Conclusion

Amongst tested biorationals against *Maruca vitrata* the most effective biorational treatment found was $T_6$ (NSE 5%), $T_1$ (*Bacillus thuringiensis* 1 kg ha$^{-1}$) and $T_2$ (Neem oil 2%) in terms of larval reduction and per cent pod damage at harvest. This similar trend obtained in terms of yield, as effective control offered by these three treatments ($T_6$, $T_1$ and $T_2$) translate in higher yield and achieved higher ICBR in comparison to other biorationals. The influence of these biorationals on population of natural enemies like Ladybird beetle and Spider found was most effective. Harbouring population found in plots which treated with treatments $T_6$ (NSE 5%), $T_1$ (*Bacillus thuringiensis* 1 kg ha$^{-1}$) and $T_2$ (Neem oil 2%).

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