Comparative efficacy of biopesticides & insecticides against flea beetle (*Phyllotreta cruciferae* Goeze & *Monolepta signata* Olivier), infesting *Brassica rapa* L. in Odisha

ABSTRACT

A field study was carried out at the instructional farm of College of Horticulture, OUAT, Chiplima, Odisha to evaluate the field efficacy of different botanical, microbial, and novel insecticides *viz*., T_1: *Azadirachta indica* 300 ppm @2500ml/ha, T_2: *Bacillus thuringiensis* @2500ml/ha, T_3: *Lecanicillium lecanii* @2500ml/ha, T_4: Spinetoram 11.7 % SC @500 ml/ha, T_5: Diafenthiuron 50 % WP @600g/ha, T_6: Chlorantraniliprole @150ml/ha variety "Sushree" in randomized block design (RBD), seven treatments replicated thrice during two consecutive *Rabi* seasons in 2021-22 and 2022-23. The pooled mean results revealed that the treatment (T4) spinetoram 11.7 % SC @500ml/ha applied at 15 days interval (Three times) was comparatively effective among the tested treatments in suppressing flea beetle (2.61 grubs+adults plant^{-1} with 70.06% ROC). In contrast, the treatment (T5) diafenthuron 50% WP @600g/ha was found to be relatively safer towards natural enemies population, *i.e.,* predatory coccinellid beetle (4.41 grubs+beetle plant^{-1} with 11.82% ROC), syrphid fly (1.68 maggots plant^{-1} with 15.57% ROC) and spider (0.84 spiders plant^{-1} with 20.75% ROC), under field conditions in west-central table land of Odisha.

The field trial carried out against the flea beetle (*Phyllotreta cruciferae* Goeze and *Monolepta signata* Olivier) infesting rapeseed-toria (*Brassica rapa* L.) revealed that spinetoram 11.7 % SC @ 500ml/ha applied at 15 days interval (Three times) was comparatively effective among the tested treatments in suppressing flea beetle. This was followed by *Lecanicillium lecanii* @2500ml/ha, Diafenthiuron 50 % WP @600g/ha, Chlorantraniliprole @150ml/ha, *Azadirachta indica* 300 ppm @2500ml/ha, T_2: *Bacillus thuringiensis* @2500ml/ha. The treatment, diafenthuron 50% WP @600g/ha was found to be relatively safe towards natural enemies viz., coccinellids, syrphids and spiders.

Keywords: Efficacy; insecticides;; Biopesticides; flea beetle; coccinellids; syrphids; natural enemies; rapeseed-toria

(As far as possible the key words should not be rewritten from the title)

Attention to authors: The title is slightly modified. All the red colour words are to be deleted and green ink for incorporating with the text. Tables and reference section require attention

1. INTRODUCTION

The cruciferous oilseed species of *Brassica*, commonly referred to as rapeseed-mustard, represents a crucial agricultural commodity globally. This group encompasses eight species, including Indian mustard, toria, yellow sarson, brown sarson, gobhi sarson, karan rai, black mustard, and taramira. These crops are extensively cultivated across 53 countries worldwide, emphasizing their significant economic importance in agriculture [1]. Toria (*Brassica rapa* Linnaeus, 2n = 20) is a major oilseed crop in the Indian subcontinent, primarily cultivated during the *Rabi* season. It belongs to the *Brassicaceae* family and is commonly referred to as

sarson or lahi, whose origins trace back to South-East Asia, where it emerged from the hybridization of *B. nigra* and *B. campestris* [2,3,4]. Delete this paragraph. Write what you need for the title of your paper. Change the reference number accordingly.

Rapeseed-mustard is an important crop, plays a crucial role in India's edible oil sector, accounting for nearly 80% of the total *Rabi* oilseed production [5]. The However, the yield of this plant is significantly plagued and hindered by various insect pests [6]. Among them, mustard flea beetle (*Phyllotreta cruciferae* Goeze) is a major pest impacting rapeseed and toria in India, especially during the seedling stage [7]. This beetle is known to inflict considerable damage, particularly on early-sown crops. Research indicates that flea beetle activity peaks between October and December, which results in stunted plant growth and diminished crop yields in some regions [8]. Apart from this, the white spotted flea beetle, *Monolepta signata* Olivier significantly affects the yield of rapeseed-toria crop yield causing severe defoliation at the young seedling stage [9,10]. Nonetheless, pest density in the crop ecosystem has often been attenuated by several natural enemies and predators like coccinellid beetles, syrphid flies, and spiders [11].

Common mitigation strategies against insect pests may include extensive and unregulated application of conventional chemical pesticides, nevertheless, it has been shown to not only accelerate the development of insecticide resistance but also result in pest resurgence, environmental pollution, harm to non-target organisms, and accumulation of harmful residues in the food chain [12]. To address these challenges, integrated pest management (IPM) practices, such as adjusting sowing times and employing novel insecticides with improved efficacy are increasingly recommended to protect mustard crops in India. Consequently, there is an urgent need for both safer and more effective insecticides, featuring diverse modes of action to delay resistance. Researchers have increasingly emphasized the adoption of next-generation insecticides with biopesticides as sustainable solutions for pest control [13] in rapeseed-toria cultivation and so is the present field experiment.

2. MATERIALS AND METHODS

The field experiment was conducted for two consecutive *Rabi* seasons of 2021/22 and 2022/23 at the Experimental Farm, College of Horticulture, Odisha University of Agriculture and Technology, Chiplima, (Give the coordinates) Odisha. In this field trial 21 plots were marked in a randomized block design and each plot had the size of 20 m^2 (4 x 5 m), and with 30 X 10 cm plant to row spacing. “Sushree” variety was sown @ 5kg/ha during mid-October of 2021 as well as in 2022. There were seven treatments, each replicated thrice. The details of all the treatments are provided below. In each plot, ten plants were selected randomly, and from each plant, an average number of insects per plant *i.e.,* Flea beetle (No. of grubs+adults $plant^{-1}$), Coccinellid beetles (No. of grubs+adults $plant^{-1}$), Syrphid fly (No. of maggots $plant^{-1}$) and Spider (No. of adults $plant^{-1}$) was calculated. A pre- and post-count of insect pest population (No. of grubs $plant^{-1}$) was recorded. All recommended agronomical practices were followed to raise the crop (Add Reference). on plots of size and at seed rate.

2.1 Treatment schedule:

T1: *Azadirachta indica* 300 ppm @2500ml/ha,
T2: *Bacillus thuringiensis* @2500ml/ha,
T3: *Lecanicillium lecanii* @2500ml/ha,
T4: Spinetoram 11.7 %SC @500 ml/ha,
T5: Diafenthiuron 50 % WP @600g/ha,
T6: Chlorantraniliprole @150ml/ha applied in each treatment

Date of chemical application:

I spray: 30 days after sowing (DAS)
II spray:15 days after first scheduled application *i.e.,* 45 DAS
III spray:15 days after the 2nd scheduled application *i.e.,* 60 DAS

for the management of flea beetle on rapeseed-toria, then

2.1 Observations on insect-pest and natural enemies' population and treatment details

A random sample of flea beetle and natural enemies' population on ten plants was taken from both the treated and untreated plots to evaluate the field efficacy of six different botanical, microbial, and novel insecticides *viz*.,

plot of each replication once, at 85% plant emergence *i.e.,* repeated at compared with untreated control.

2.1.1 Average population count of insect-pest and natural enemies

To assess the effectiveness of various treatments, observations were made one day in advance *i.e.,* 1 day before application (1 DBA), five days following application *i.e.,* 5 days after application (5 DAA), ten days following application (10 DAA), and fourteen days following application (14 DAA). Following each treatment,

2.2 Per cent reduction in insect-pest and natural enemies' population in the treated plot over untreated control

The per cent reduction in pest and natural enemies' population count was calculated using the following formula: What is the source? Whose formula? Write the authors name, Give reference

$$\text{Per cent reduction in pest or natural enemies over untreated control (\%)} = \frac{\text{Pest or natural enemy population (untreated plot – treated plot)}}{\text{Pest or natural enemy population in the untreated plot}} \times 100$$

.

2.2 Statistical analysis

The data obtained for various insect counts were subjected to square root transformation. The data was analyzed using the procedures given by Gomez and Gomez [14]. The statement variations were tested for significance by the "F" test. The standard error of means SE(m)± and critical difference (CD) at a 5% significance level was calculated following the standard procedure. Treatment means were compared with a critical difference (CD). Based on the statistically analyzed data, the results of the observations were interpreted.

3. RESULTS AND DISCUSSION

3.1 Flea beetle

Incidence of two different species of flea beetles, *i.e., Phyllotreta cruciferae* and *Monolepta signata*, were observed in the crop ecosystem 4 weeks after sowing (46th Standard Mean Week). This corroborates with the findings of Das [15] and Keot *et al*. [16], who confirmed the pest incidence of flea beetles of both species as well. Figure 1 represents the distribution of the mustard flea beetle and white spotted flea beetle in the rapeseed-toria crop ecosystem, throughout the cropping seasons.

Table 1 presents the pooled analysis data of two years, *i.e.,* two consecutive *Rab*i seasons of 2021/22 and 2022/23, on the comparative efficacy of various insecticides against the flea beetle population on rapeseed-toria. Before initiating the first application, the population recorded in the treatment plots varied from 7.07 to 10.00 grubs+adults plant^{-1}.
The results revealed that the "spinetoram (T_4)" was found to be effective among all treatments with 2.61 grubs+adults plant^{-1} and 70.06% reduction in population over untreated control (ROC), followed by "*Lecanicillium lecanii* (T_3)" recording 3.07 grubs+adults plant^{-1} with 64.79% ROC. The percent reduction in the rest of the treatments varied within the 44.10 to 60.47 % range. Similar results were reported by Srinivasan a *et al.* [17] which concluded that three applications of foliar spray of spinetoram 10% w/w + sulfoxaflor 30% w/w WG @350 ml/ha and spinetoram 10% + sulfoxaflor 30% WG @300 ml/ha were superior and effective in reducing the flea beetle damage.

The order of efficacy (in descending order) of different treatments tested against the flea beetle population concerning reduction percentage over control is as follows the below mentioned sequence. (T_4): Spinetoram 11.7 % SC @500 ml/ha (70.06% ROC) > (T_3): *Lecanicillium lecanii* @2500ml/ha (64.79% ROC) > (T_6): Chlorantraniliprole 18.50 % SC @150 ml/ha (60.55% ROC) > (T_5): Diafenthiuron 50% WP @600 g/ha (58.37% ROC) > (T_1):*Azadirachta indica* 300ppm @2500ml/ha (48.39% ROC) > (T_2): *Bacillus thuringiensis* @2500 ml/ha (44.15% ROC).

3.2 Natural enemies (predators)

Apart from flea beetles, three natural enemies (predators) *viz.* Coccinellid beetles, Syrphid flies, and Spiders associated with the major rapeseed-toria/mustard crop pests were observed in the crop field (Figure 2).

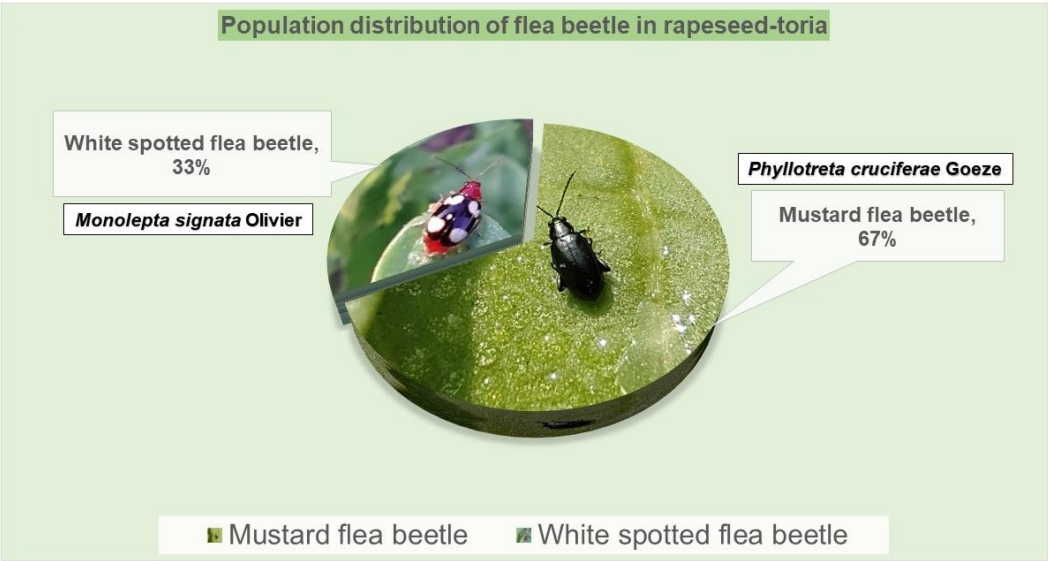

Figure 1. The population distribution of flea beetle species in the rapeseed-toria experimental field-crop ecosystem (Rabi of 2021/22 and 2022/23)

Label just Figure -1 & Figure – 2 inside the picture

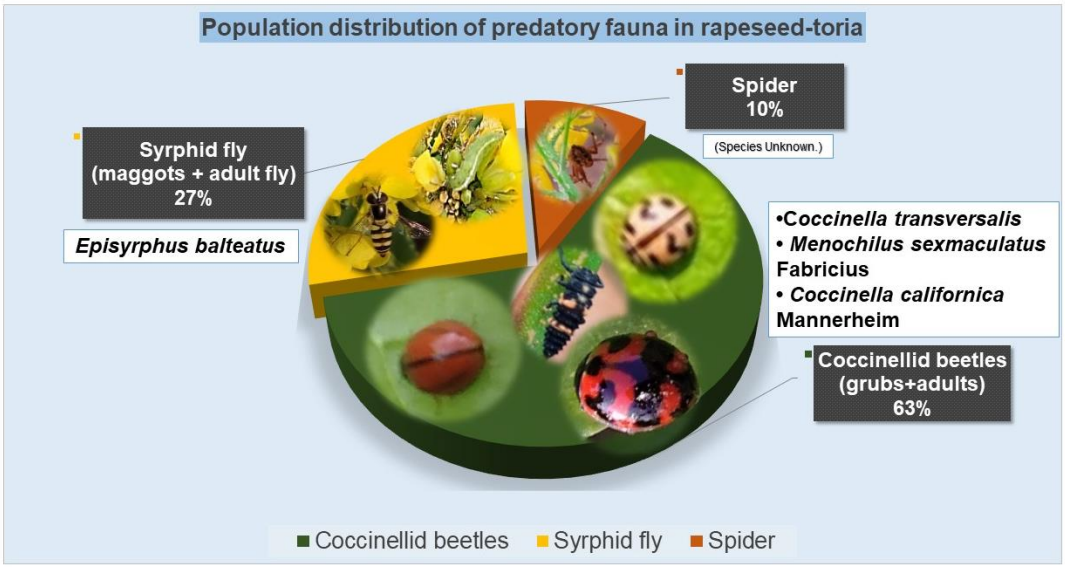

Figure 2. The population distribution of predatory fauna in the rapeseed-toria experimental field-crop ecosystem (Rabi of 2021/22 and 2022/23)

The pooled analysis data of two years, *i.e.,* two consecutive *Rabi* seasons of 2021/22 and 2022/23, for comparative efficacy of various novel insecticides on coccinellid beetles (Table 2), revealed that "diafenthiuron 50% WP @600g/ha (T_5)" was relatively safer with least reduction of the population over untreated control (4.40 grubs+adults plant^{-1} with 11.82% ROC), followed by "spinetoram 11.7 % SC @500 ml/ha (T_4)" which had 4.29 grubs+adults plant^{-1} with 14.02% ROC. Likewise for syrphid fly, "diafenthiuron 50% WP @600g/ha (T_5)" was comparatively safer with 1.68 maggots plant^{-1} (Table 3) and 15.57% ROC followed by

"chlorantraniliprole 18.50 % SC @150ml/ha (T_6)" which had 1.48 maggots plant^{-1} with 25.62% ROC. In addition, for the spider population, "diafenthiuron 50% WP @600g/ha (T_5)" was relatively safer with least reduction of the population over untreated control (0.84 adults/plant and 20.75% ROC) followed by "chlorantraniliprole 18.50 % SC @150ml/ha (T_6)" which had 0.78 adults plant^{-1} with 26.41% ROC (Table 4). The findings resembled the outcomes by Bajya *et al.* [18], it was concluded that diafenthiuron 47.8 SC @ 286.8 g a.i./ha was highly effective in suppressing the sucking pests, and it had no adverse effects on the natural enemies.

4. CONCLUSION

From the present study, it can be concluded that the novel insecticide, "spinetoram 11.7% SC @500ml/ha (T_4) at 15 days intervals (Three times)" was comparatively effective against both the species of flea beetle infesting rapeseed-toria under field conditions. However, "diafenthiuron 50% WP @600gm/ha (T_5) at 15 days intervals (Three times)" was found to be relatively safer towards coccinellid beetles, syrphid fly, and spiders, in both the trials carried out during 2021/22 and 2022/23 for both the experimental years (*Rabi* of) in the west-central tableland region of Odisha, India.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during the writing or editing of this manuscript.

Table 1: Comparative efficacy of botanical, microbial, and novel insecticides against flea beetle in rapeseed-toria under field conditions (Pooled data of *Rabi*, 2021/22 and 2022/23)

Treatments	Pooled Mean population of flea beetle (No. of grubs+adults/plant)												Overall pest count	Reduction over untreated control (%)
	1st Application (Mean of two years)					2nd Application (Mean of two years)				3rd Application (Mean of two years)				
	1 DBA	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean	
T1: Azadirachtin 300 ppm	10.00 (3.17)	4.44 (2.12)	4.22 (2.07)	4.05 (2.02)	5.68	3.85 (1.97)	3.80 (1.96)	3.84 (1.97)	3.83	3.62 (1.91)	3.43 (1.87)	3.37 (1.85)	3.47	4.50	48.39
T2: *Bacillus thuringiensis*	8.69 (2.96)	5.43 (2.34)	5.26 (2.30)	4.92 (2.23)	6.08	4.67 (2.17)	4.49 (2.13)	4.45 (2.12)	4.54	4.25 (2.07)	4.39 (2.11)	4.43 (2.12)	4.35	4.87	44.15
T3: *Lecanicillium lecanii*	8.33 (2.90)	2.54 (1.61)	2.18 (1.49)	1.99 (1.43)	3.76	1.73 (1.33)	1.35 (1.18)	1.24 (1.14)	1.44	0.75 (0.89)	0.72 (0.88)	0.57 (0.79)	0.68	3.07	64.79
T4: Spinetoram 11.7% SC	7.07 (2.67)	1.70 (1.32)	1.34 (1.18)	1.25 (1.14)	2.84	1.13 (1.09)	1.05 (1.05)	0.80 (0.92)	0.99	0.43 (0.70)	0.27 (0.57)	0.14 (0.44)	0.28	**2.61**	**70.06**
T5: Diafenthiuron 50% WP	8.33 (2.89)	3.21 (1.81)	2.86 (1.71)	2.95 (1.73)	4.34	2.65 (1.64)	2.51 (1.60)	2.50 (1.60)	2.56	2.42 (1.57)	2.60 (1.63)	2.46 (1.59)	2.50	3.63	58.37
T6: Chlorantraniliprole 18.50% SC	8.10 (2.85)	3.11 (1.78)	3.12 (1.78)	2.51 (1.60)	4.21	2.17 (1.49)	2.13 (1.48)	2.07 (1.46)	2.12	1.98 (1.43)	1.89 (1.39)	1.51 (1.25)	1.79	3.44	60.55
T7: Untreated control	9.08 (3.02)	9.53 (3.10)	10.53 (3.25)	11.77 (3.44)	10.23	12.33 (3.52)	11.54 (3.40)	11.89 (3.45)	11.92	12.26 (3.51)	11.53 (3.40)	12.45 (3.54)	12.08	8.72	-
SE(m) ±	0.122	0.073	0.077	0.207	-	0.084	0.103	0.055	-	0.158	0.121	0.146	-	-	-
CD (*P*= *.05*)	NS	0.22	0.23	0.63	-	0.25	0.31	0.17	-	0.48	0.37	0.44	-	-	-

**Figures in parentheses are square root transformed values.* Each value is mean of two years observation *DBA: Days before application; DAA: Days after application*

Table 2: Comparative efficacy of botanical, microbial, and novel insecticides on Coccinellid beetle in rapeseed-toria under field conditions (Pooled data of *Rabi*, 2021/22 and 2022/23)

Treatments	Pooled Mean population of Coccinellid beetle (No. of grubs+adults/plant)													
	1st Application (Mean of two years)					2nd Application (Mean of two years)				3rd Application (Mean of two years)				Overall insect count	Reduction over untreated control (%)
	1 DBA	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean		
T1: Azadirachtin 300 ppm	4.94 (2.23)	3.51 (1.89)	3.53 (1.89)	3.57 (1.90)	3.89	3.57 (1.90)	3.68 (1.93)	3.67 (1.93)	3.64	3.63 (1.92)	3.68 (1.93)	3.68 (1.93)	3.66	3.73	25.25
T2: *Bacillus thuringiensis*	4.81 (2.21)	3.71 (1.94)	3.31 (1.83)	3.12 (1.78)	3.74	3.10 (1.77)	2.98 (1.74)	2.85 (1.70)	2.98	2.33 (1.54)	2.25 (1.52)	2.22 (1.51)	2.27	2.99	40.08
T3: *Lecanicillium lecanii*	4.97 (2.24)	3.91 (1.99)	3.12 (1.78)	3.08 (1.77)	3.77	3.07 (1.77)	3.01 (1.75)	2.86 (1.70)	2.98	2.45 (1.58)	2.34 (1.55)	2.34 (1.55)	2.38	3.04	39.07
T4: Spinetoram 11.7% SC	4.34 (2.10)	4.22 (2.07)	4.35 (2.10)	4.48 (2.13)	4.35	4.21 (2.06)	4.44 (2.12)	4.37 (2.10)	4.34	4.21 (2.06)	4.15 (2.05)	4.15 (2.05)	4.17	4.29	14.02
T5: Diafenthiuron 50% WP	4.66 (2.17)	4.08 (2.03)	4.13 (2.04)	4.35 (2.10)	4.31	4.12 (2.04)	4.49 (2.13)	4.49 (2.13)	4.36	4.56 (2.15)	4.52 (2.14)	4.52 (2.14)	4.54	**4.40**	**11.82**
T6: Chlorantraniliprole 18.50% SC	4.77 (2.20)	4.05 (2.02)	4.03 (2.02)	3.99 (2.01)	4.21	3.69 (1.93)	3.84 (1.97)	3.64 (1.92)	3.72	3.63 (1.92)	3.63 (1.92)	3.64 (1.92)	3.64	3.86	22.64
T7: Untreated control	4.77 (2.20)	4.47 (2.13)	4.95 (2.24)	4.60 (2.16)	4.70	4.78 (2.20)	4.68 (2.17)	5.12 (2.27)	4.86	4.96 (2.24)	5.67 (2.39)	5.66 (2.39)	5.43	4.99	-
SE(m) ±	0.043	0.050	0.036	0.087	-	0.051	0.042	0.104	-	0.038	0.053	0.051	-	-	-
CD (*P=.05*)	NS	0.15	0.11	0.26	-	0.15	0.13	0.31	-	0.12	0.16	0.15	-	-	-

**Figures in parentheses are square root transformed values.* Each value is mean of two years observation *DBA: Days before application*
DAA: Days after application

Table 3: Comparative efficacy of botanical, microbial, and novel insecticides on Syrphid fly in rapeseed-toria under field conditions (Pooled data of *Rabi*, 2021/22 and 2022/23)

Treatments	Pooled Mean population of Syrphid fly (No. of maggots/plant)													
	1st Application (Mean of two years)					2nd Application (Mean of two years)				3rd Application (Mean of two years)				
	1 DBA	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean	Overall insect count	Reduction over untreated control (%)
T1: Azadirachtin 300 ppm	1.59 (1.28)	1.37 (1.19)	1.30 (1.16)	1.29 (1.16)	1.39	1.28 (1.15)	1.27 (1.15)	1.27 (1.15)	1.28	1.24 (1.14)	1.22 (1.13)	1.21 (1.12)	1.22	1.30	34.67
T2: *Bacillus thuringiensis*	1.68 (1.32)	1.49 (1.24)	1.46 (1.23)	1.46 (1.23)	1.52	1.42 (1.21)	1.42 (1.21)	1.40 (1.20)	1.42	1.37 (1.19)	1.34 (1.18)	1.34 (1.18)	1.35	1.43	28.14
T3: *Lecanicillium lecanii*	1.56 (1.27)	1.43 (1.22)	1.43 (1.22)	1.40 (1.20)	1.46	1.36 (1.19)	1.35 (1.18)	1.35 (1.18)	1.36	1.31 (1.17)	1.29 (1.16)	1.29 (1.16)	1.30	1.37	31.15
T4: Spinetoram 11.7% SC	1.78 (1.35)	1.25 (1.14)	1.14 (1.09)	1.11 (1.08)	1.32	1.11 (1.08)	1.04 (1.04)	1.03 (1.04)	1.06	0.97 (1.01)	0.91 (0.98)	0.87 (0.96)	0.92	1.10	44.72
T5: Diafenthiuron 50% WP	1.73 (1.33)	1.69 (1.32)	1.68 (1.32)	1.67 (1.31)	1.69	1.67 (1.31)	1.68 (1.31)	1.68 (1.31)	1.67	1.67 (1.31)	1.66 (1.31)	1.67 (1.31)	1.67	**1.68**	**15.57**
T6: Chlorantraniliprole 18.50% SC	1.49 (1.24)	1.52 (1.25)	1.51 (1.25)	1.48 (1.24)	1.50	1.47 (1.23)	1.46 (1.23)	1.46 (1.23)	1.47	1.46 (1.23)	1.45 (1.22)	1.47 (1.23)	1.46	1.48	25.62
T7: Untreated control	1.56 (1.27)	1.63 (1.29)	1.71 (1.33)	1.87 (1.38)	1.69	1.89 (1.39)	1.89 (1.39)	1.93 (1.39)	1.90	2.12 (1.47)	2.33 (1.54)	2.63 (1.64)	2.36	1.99	-
SE(m) ±	0.133	0.115	0.083	0.054	-	0.056	0.058	0.056	-	0.088	0.069	0.045	-	-	-
CD (*P*= *.05*)	NS	0.35	0.25	0.16	-	0.17	0.18	0.17	-	0.27	0.21	0.14	-	-	-

**Figures in parentheses are square root transformed values.* Each value is mean of two years observation

DBA: Days before application *DAA: Days after application*

Table 4: Comparative efficacy of botanical, microbial, and novel insecticides on Spider in rapeseed-toria under field conditions (Pooled data of *Rabi*, 2021/22 and 2022/23)

Treatments	Pooled Mean population of Spider (No. of adults/plant)												Overall count	Reduction over untreated control (%)
	1st Application (Mean of two years)					2nd Application (Mean of two years)				3rd Application (Mean of two years)				
	1 DBA	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean	
T1: Azadirachtin 300 ppm	0.83 (0.94)	0.80 (0.92)	0.78 (0.91)	0.73 (0.88)	0.79	0.70 (0.87)	0.68 (0.85)	0.68 (0.85)	0.69	0.68 (0.85)	0.64 (0.83)	0.64 (0.83)	0.65	0.71	33.01
T2: *Bacillus thuringiensis*	0.87 (0.96)	0.85 (0.95)	0.81 (0.93)	0.67 (0.85)	0.80	0.64 (0.83)	0.56 (0.78)	0.55 (0.77)	0.58	0.40 (0.67)	0.40 (0.67)	0.40 (0.67)	0.40	0.59	44.33
T3: *Lecanicillium lecanii*	0.85 (0.95)	0.76 (0.90)	0.68 (0.86)	0.59 (0.80)	0.72	0.55 (0.78)	0.45 (0.70)	0.41 (0.68)	0.47	0.34 (0.68)	0.41 (0.68)	0.54 (0.77)	0.43	0.54	49.05
T4: Spinetoram 11.7% SC	0.89 (0.97)	0.82 (0.93)	0.78 (0.91)	0.74 (0.89)	0.81	0.70 (0.87)	0.66 (0.84)	0.64 (0.83)	0.66	0.63 (0.82)	0.60 (0.81)	0.60 (0.81)	0.61	0.69	34.90
T5: Diafenthiuron 50% WP	0.89 (0.97)	0.86 (0.95)	0.88 (0.96)	0.88 (0.96)	0.88	0.84 (0.94)	0.82 (0.93)	0.82 (0.93)	0.83	0.82 (0.93)	0.83 (0.94)	0.84 (0.94)	0.83	0.84	**20.75**
T6: Chlorantraniliprole 18.50% SC	0.85 (0.95)	0.81 (0.93)	0.80 (0.92)	0.80 (0.92)	0.82	0.79 (0.91)	0.76 (0.90)	0.76 (0.90)	0.77	0.76 (0.90)	0.77 (0.91)	0.77 (0.91)	0.77	0.78	26.41
T7: Untreated control	0.92 (0.99)	0.94 (1.00)	1.03 (1.04)	1.07 (1.06)	0.99	1.11 (1.08)	1.10 (1.07)	1.07 (1.06)	1.09	1.04 (1.04)	1.11 (1.08)	1.11 (1.08)	1.09	1.06	-
SE(m) ±	0.015	0.033	0.068	0.063	-	0.047	0.059	0.057	-	0.059	0.096	0.131	-	-	-
CD (*P*= *.05*)	NS	0.10	0.21	0.19	-	0.14	0.18	0.17	-	0.18	0.29	0.40	-	-	-

**Figures in parentheses are square root transformed values.* Each value is mean of two years observation

DBA: Days before application *DAA: Days after application*

Good that you have taken the observation @ interval five days. Since there is not much difference between 5 DAA, 10 DAA and 14 DAA, better to take 14 DAA alone for the table construction. Always try to simplify the presentation of data so that it becomes easy for the readers.

REFERENCES (NEED TO DELETE SOME REFERENCES- LOOK AT THE TEXT & THEN ARRANGE)

1. Directorate of Rapeseed-Mustard Research. (n.d.). *Brief about rapeseed-mustard crop*. ICAR-Directorate of Rapeseed-Mustard Research. Retrieved October 23, 2024, from https://www.drmr.res.in

2. Olson, G. (1960) Species crosses within the genus *Brassica*. II. Artificial *Brassica napus* L. Hereditas, 46:351-386.

3. Mizushima, U., and Tsunoda S. (1967). A plant exploration in *Brassica* and Allied Genera. Tohoku Journal of Agricultural Research, 17:249–276.

4. Mahendra, J., Salam, J. L., Kar, S., Saxena, R. R., Bhanwar, R. R., Chandrakar, T., Singh, R., & Rohit. (n.d.). (2020). Genetic diversity estimation in toria [*Brassica rapa* (L)] genotypes collected from Bastar Plateau. International Journal of Current Microbiology and Applied Sciences, 9(3)**:**2577-2584.

5. "Brief about Rapeseed-Mustard Crop." *ICAR-Directorate of Rapeseed-Mustard Research*, www.drmr.res.in. Accessed 23 Oct. 2024.

6. Bakhetia, R.C., Sekhon, B.S. (1989). Insect pests and their management in rapeseed mustard. Journal of Oilseed Research, 6(2): 269-299.

7. Verma, P.K., Varma, A., & Aggarwal, G. (2023). Studies on Insect-pests Complex of Rapeseed Mustard and their Natural Species in Roorkee Region, Uttarakhand, India. Biological Forum – An International Journal, 15(5): 529-533.

8. Patel, S., Singh, C.P., & Yadav S.K. (2017). Seasonal Incidence of mustard flea beetle, *Phyllotreta cruciferae* on Brassica species in relation to weather parameters at different dates of sowing. Journal of Entomology and Zoology Studies, 5(4): 673-677.

9. Firake, D.M., Lytan, D., & Behere, G.T. (2013). Bio-diversity and Seasonal Activity of Arthropod Fauna in Brassicaceous Crop Ecosystems of Meghalaya, North East India. Molecular Entomology, 3(4).

10. Parija, S., & Biswal, L. (2023). Seasonal Incidence of Insect Pests and Predatory Fauna on Toria (*Brassica rapa*) in West Central Tableland of Odisha, India. International Journal of Environment and Climate Change, 13(11):231-240.

11. Singh, K. (2013) Preying Propensity of Larvae/ Grubs of Syrphid and Coccinellid Predators on Mustard aphid, *Lipaphis erysimi* (Kalt.) International Journal of Agriculture and Food Science Technology, 4(7):687-694.

12. Zhang, Y., Gu, Y., Luo, Y., Li, Y., Zhang, T., & Zhou, Y. (2020). “Effects of Pesticides on Ecosystems and Human Health: A Review.” *European Environment*, 30(4):123–135.

13. Phoreus Biotech. (2024). “How Biopesticides are Harnessing the Power of Nature.” *Phoreus Biotech*, https://phoreusbiotech.com/blog/category/general/.

14. Gomez, K.A., & Gomez, A.A. (1976). Statistical procedures for agricultural research with emphasis on rice. IRRI, Los Baños, Philippines. 264 P.

15. Das, R. (2020). A field study on insect pest complex of Brassicaceous crops in some areas of Cachar, Assam. Journal of Entomology and Zoology Studies, 8(4): 2043-2045.

16. Keot, S., Saikia, D.K. and Nath, R.K. (2002). Insect pest complex of Brassica vegetables. J. Agril. Sci. Soc. North East India. 15(1): 28-33.

17. Srinivasan, G., Chinniah, C.,Kalyanasundaram, M., & Shanthi, M. (2019). Evaluation of spinetoram and sulfoxaflor against Flea beetle, Scelodonta strigicollis Motschulsky on Grapevine. Madras Agricultural Journal, doi:10.29321/MAJ 2019.000308

18. Bajya, D.R., Ranjith, M., Lakharan, M.C., & Raza, S.K. (2016). Efficacy Of Diafenthiuron 47.8 Sc Against Sucking Pests Of Cotton And Its Safety To Natural Enemies. Indian Journal of Entomology, 78(1): 15-23.