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Evaluation of different bio Pesticides against Mango Hoppers in Eastern Uttar Pradesh

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ABSTRACT: The management of mango hopper was investigated using chemical pesticides, entomopathogens, and botanicals under field circumstances over the period of 2022-2023 at Vindhyavasini Park (Mango Orchard) located in Gorakhpur University, Gorakhpur. The experimental findings revealed that the pesticide treatment involving imidacloprid 17.8 SL at a concentration of 0.007% exhibited superior efficacy compared to all other pesticide treatments. This was evident from the highest observed mortality rates of the hopper on days 1, 3, 7, and 15 after spraying during the first, second, and third applications. The mean mortality percentages for these applications were 89.42%, 93.92%, and 95.92%, respectively. The next most effective treatment, NSKE 5%, demonstrated a mean mortality of 77.58%, 73.67%, and 78.50% for the corresponding applications. The mortality percentage in the botanical treatment using NSKE (Neem Seed Kernel Extract) was seen to be high, with values of 77.58%, 73.67%, and 78.50% recorded during the first, second, and third spray applications, respectively. The efficacy of the entomopathogenic fungus *Lecanicillium lecanii* 1.15%WP in managing the mango hopper was seen to be superior. The mean mortality rates 71.00%, 68.25%, and 70.75% were recorded during the first, second, and third rounds of spray treatment, respectively, under field condition.

Keywords: Entomopathogens, Mango hopper, Bio-pesticides, NSKE and *Lecanicillium lecanii.*

INTRODUCTION

The mango (*Mangifera indica* L., family, Anacardiaceae) holds significant commercial value as a widely consumed fruit, and it is also recognized as the national fruit of India. The fruit in concern is commonly known as the "king of fruits" owing to its extensive adaptability, notable sweetness, exceptional flavor, and delectable taste, alongside its abundant nutritional content, mineral fiber, and high levels of vitamins A, C, and pro-vitamins (Kumar, 2016). India is widely recognized as a significant global producer of mangoes. In the Indian subcontinent, mango cultivation holds a significant share of fifty percent in the global production, hence positioning India as the third-largest exporter of mangoes. According to Galan (2013), India possesses the largest land area compared to the other nations. India, renowned for its significant land size of 2,339 million hectares and impressive crop yield of 2,036,600 metric tons, holds the esteemed position of being the top global agricultural producer. The cultivation of this crop is observed in various regions of India, including Uttar Pradesh, Karnataka, Bihar, Gujarat, Tamil Nadu, and Maharashtra. Uttar Pradesh stands as the foremost state in terms of production, boasting a total output of 4,807,83 metric tons. The source cited is from an anonymous author in the year 2022. The low mango yields in India can be attributed to ineffective orchard management practices, such as the presence of dense canopies with broader spacing and limited sunshine absorption. The drop in mango quality and production has been seen in recent years, which can be attributed to several causes such as alterations in climatic conditions, susceptibility of cultivars, and the presence of pests and diseases (Kumar *et al*., 2017).

A total of 26 nematode species and 462 insect species that are considered a threat to mango cultivation have been noticed at a global level. Kannon and Rao (2006) have identified several insect predators that have been observed to affect the growth of mango trees. These predators include hoppers such as *Idioscopus clypealis* (Lethierry) and *Amritodus atkinsoni* (L.), mealybugs like *Drosicha mangiferae* (Green), fruit flies such as *Bactrocera dorsalis* (Hendel), a fruit sucking moth known as *Eudocima aurantia* (Moore), thrips specifically *Aeolothrips itermedius* Bagnall, ants of the species *Oecophylla smaragdina* (Fabricius), termites belonging to the *Odontotermes* spp., and the grey weevil named *Myllocerus discolour* (Boheman). The increased prevalence of mango hoppers, specifically *A. atkinsoni*, *I. clypealis*, and *Idioscopus nitidulus* (Walker), during the flowering season of mangoes can be attributed to climate change and improved environmental circumstances. *I. Clypealis* is the most prevalent and diminutive species of hopper. The specimen exhibits two distinct markings on its cranial region and lacks any discernible patterns on its wings, however it does possess two markings on its scutellum. According to Verghese and Thangam (2011), *I. nitidulus* exhibits reproductive capability on both shoots and flowers, but *I. clypeal* is limited to reproduction solely on flowers. The majority of the blooms abscised before to fruit set due to excessive proliferation and persistent sap depletion. The occurrence resulted in the failure of crops at the stages of flowering and fruiting, leading to potential losses of up to 100%. The feeding behavior of nymph and adult mango hoppers involves the extraction of cell sap from the phloem tissue found in delicate sections of twigs, inflorescence, leaves, and developing fruits (Rahman and Kuldeep 2007; Prabhakara *et al*., 2011). These detrimental effects include a reduction in the strength of the inflorescence, resulting in its curling and desiccation due to extensive puncturing and continuous sap drainage. Additionally, it impedes the opening of flowers and induces premature fruit drop, leading to potential losses of up to 50% and a subsequent decrease in overall yield. Additionally, grasshoppers have a detrimental impact on crops as they excrete a sticky substance like honey during periods of moisture. The growth of fungi such as *Capnodium mangiferae* (Cooke) and *Meliola mangiferae* (Earle) is facilitated by this phenomenon, resulting in the proliferation of black sooty mold on the foliage, branches, and fruits. The presence of a black coating on the surfaces of the leaves has an impact on the plant's typical photosynthetic process. This phenomenon renders the plant incapable of initiating floral development, leading to premature fruit abscission. The phenomenon referred to as "honey dew sickness" was identified by Butani in 1993. The phenomenon of mango hoppers dispersing was seen throughout both their growth stage and their egg-laying stage. According to Babu *et al*. (2002), the eggs of these organisms are deposited within the trunk, resulting in tissue injury and the subsequent inhibition of fruit production in the panicle. In instances where there is a high prevalence of pests, the potential for crop losses to reach 100% is significant. According to the findings of Kaushik *et al*. (2014), many insect pests of mango persist as a challenge throughout the tree's growth stages, reproducing at varied intervals.

In 2018, Rakshitha and colleagues conducted an experiment in which they evaluated the efficacy of four herbal formulations against the mango hopper *I. nitidulus*. The experiment involved testing these formulations at various concentrations, alongside a positive control (imidacloprid) and a negative control (water). The population of hoppers was reduced by varying quantities of neem soap and pongamia soap at a concentration of 5 ml per liter. In their study, Valvi *et al*. (2018) examined the efficacy of three formulations derived from entomopathogenic fungus, namely *Metarhizium anisopliae*, *Leccaniicillium leccanii*, *B. bassiana*, and a combination of *L. leccanii* and *M. anisopliae*, in controlling hoppers of the species *A. atkinsoni* within a subtropical climatic region. In the experimental condition when *L. leccanii* and *M. anisopliae* were employed simultaneously, the number of hoppers observed per five panicles was 0.59. Conversely, when *M. anisopliae* was administered in isolation, the number of hoppers recorded per five panicles was 1.11/5 panicles. These findings indicate that the presence of both *L. leccanii* and *M. anisopliae* resulted in the lowest hopper population on the trees. In order to effectively manage the hopper population, it has been proposed that the use of these fungicides either in combination or individually be employed.

In their study, Manivannan *et al*. (2018) conducted an experiment to evaluate the efficacy of four biological control agents, namely *M. anisopliae*, *B. bassiana*, *L. lecanii*, and *Chrysoperla zastrowii*, in managing the population of *Amrasca biguttula biguttula* inside an insectary setting. In their study, Sarode and Mohite (2016) examined four distinct categories of bio-pesticides, namely *M. anisopliae, V. lecanii, B. bassiana*, and NSKE. The study revealed that all four treatments had comparable efficacy in lowering the population of mango hoppers, with no significant differences observed among them. According to Ray *et al*. (2011), the therapy using the module with imidacloprid demonstrated superior performance compared to the other treatments. Subsequently, the NSKE treatment exhibited the maximum fruit output, measuring 219.10 kg per tree, at a rate of 1.55 hoppers per panicle. Conversely, the module treated with thiamethoxam, azadirachtin, and ethofenprox demonstrated the lowest fruit yield, amounting to 175.20 kg per tree, with a hoppers-to-panicle ratio of 3.55. All treatment modules shown superior efficacy in reducing the population of mango hoppers compared to the control group.

Therefore, the current study was conducted to evaluate the efficacy of several insecticides, including imidacloprid, botanicals such as Neem oil, NSKE, and Neem leaf extract, as well as entomopathogens including *Lecanicillium lecanii*, *Beauveria bassiana*, and *Metarhizium anisopliae*, against mango hoppers.

MATERIALS AND METHODS

The current study, named "Assessment of various bio-pesticides for the control of mango hoppers," was conducted to explore the effectiveness of conventional biopesticides in managing mango hopper infestations. A field experiment was conducted in the year 2022-2023 at DDU, Gorakhpur University, Gorakhpur. The experiment took place during the flowering season and involved the Dasheri, Amarpali, Langra, and Sindhu varieties of trees. These trees were approximately 15-20 years old and were spaced at intervals of 10×10 meters. The experimental design comprised of a total of eight treatments, which included a standard treatment and an untreated control. Each treatment was reproduced three times. Each individual tree was designated as a single replication.

A. Spray fluid

The required volume of spray solution was created during the time of application. The amount of spray fluid needed per tree was around seven liters.

B. Spray schedule

The initial application of spray was carried out at the flower initiation stage, followed by a second application 21 days after the first spray, and a third application 21 days after the second spray. A pre-treatment count of mango hoppers was conducted one day prior to the application on the inflorescence. The post-treatment counts were recorded at four time points: 1, 3, 7, and 15 days following the application of the spray.

The percentage reduction of insect population was computed by using Henderson Tilton's formula

Mortality(%) =

Where,

Ta – No. of insects in the treatment after spraying

Tb – No. of insects in the treatment before spraying

Ca – No of insects in the untreated check after spraying.

Cb – No. of insects in the untreated check before spraying.

RESULTS AND DISCUSSION

In the study shown in (Table 1, Fig. 1), the effectiveness of NSKE (T1), Neem oil (T2), Neem leaf extract (T3), *Beauveria bassiana* (T4), *Lecanicillium lecanii* (T5), *Metarhizium anisopliae* (T6), Imidacloprid (T7), and water (T8) as a control was tested against the mango hopper in 2022- 2023. In Table 1, you can observed the details of the average population of mango hoppers. All of the treatments were done twice in a year. After one day of the first spray, the lowest mortality rate was 52% for T3 (Neem leaf extract), followed by 55.33% for Neem oil and 62.67% for *Beauveria bassiana* and 64.67% for *Metarhizium anisopliae*. Statistically, these treatments were all about the same. The highest mortality rate was seen with imidacloprid (87.33%), followed by Neem seed kernel extract (73.00%) and *Lecanicillium lecanii* (71.00%). However, neither of these treatments was statistically different from the control (water), which had an 11.66 percent mortality rate.

Also, three days after the first spray, the treatment T3 (Neem leaf extract) had the lowest percentage of mortality of mango hopper (59.00%). It was followed by Neem oil (60.33%), and *Beauveria bassiana* (68.67 %). Treatments T3 and T2 were statistically same. Imidacloprid had the highest mortality rate (91.33%), followed by Neem seed kernel extract (82.67%) and *Lecanicillium lecanii* (76.33%). Statistically, these treatments were different from the control (water) group (10.67%) (Table 1, Fig. 1).

After 7 days of the first spray, the data showed that treatment T7 was very highest, mortality rate 76.33 % of the mango hoppers. It was followed by treatment T1 (Neem seed kernel extract) and treatment T5 (*Lecanicillium lecanii*). Both of these treatments were very different from each other. The treatments that killed the fewest mango hoppers were T7 and T1, with 88.67% and 76.33% mortality rates, respectively. This was a much higher death rate than the untreated control (7.67%) (Table 1, Fig. 1).

After 15 days of 1st application, minimum per-cent mortality was observed T3 (Neem leaf extract) 48.00%, followed by Neem oil (51.33%) and *Metarhizium anisopliae* (55.33%) both the treatment was statistically different. However, maximum percent mortality was observed in imidacloprid (90.33%) followed by Neem seed kernel extract (78.33%) and *Lecanicillium lecanii* (70.33%). Overall mean mortality during 1st spray of different treatments revealed that T7 was highest mortality than other treatments with 89.42%, followed by treatment T1(NSKE) with 77.58 %, whereas, mango hopper mortality in other treatments varied from 89.42 % to 54.75 %. However untreated check recorded lowest mortality with 9.67%. In this first spray of treatment superior was T7 (Imidacloprid) with 88.90 per cent reduction over control followed by T1 (NSKE) 87.25 per cent reduction over control and lowest mortality percentage was found Neem leaf extract (T3) 81.01 % followed by neem oil with 81.88 per cent reduction over control (Table 1, Fig. 1).

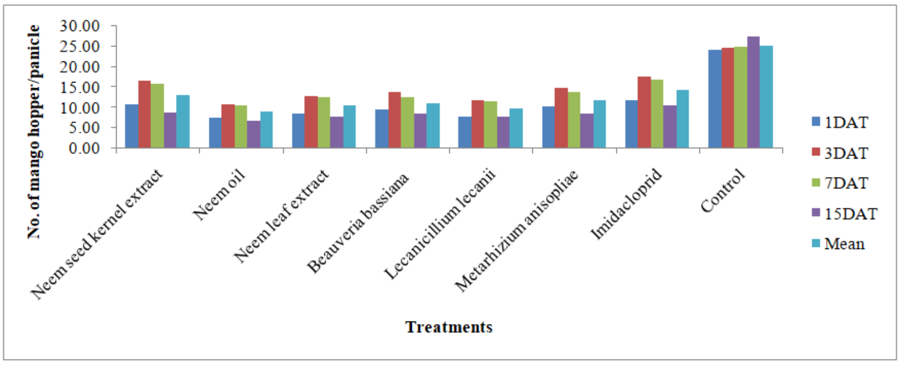

Fig. 1. Bio-efficacy of biopesticides against hopper, *A. atkinsoni* infesting mango after first spray.

Table 1: Bio-efficacy of biopesticides against hopper, *A. atkinsoni* infesting mango after first spray.

Treatments(T)	Dose @_ gm/lt of water	DBS	Mortality of hoppers (%) Days After Spraying (DAS)				MEAN Mortality (%)	% Reduction over control
			1DAT	3DAT	7DAT	15DAT		
Neem seed kernel extract (T1)	5.0%	27.00 (5.20)	73.00 (8.54)	82.67 (9.09)	76.33 (8.74)	78.33 (8.85)	77.58 (8.81)	87.25
Neem oil (T2)	0.5%	24.33 (4.93)	55.33 (7.44)	60.33 (7.77)	52.00 (7.21)	51.33 (7.17)	54.75 (7.40)	81.88
Neem leaf extract (T3)	10.0%	20.67 (4.55)	52.00 (7.21)	59.00 (7.68)	50.00 (7.07)	48.00 (6.93)	52.25 (7.23)	81.01
Beauveria bassiana (T4)	5% WP (1 ×109cfu/g)	23.00 (4.80)	62.67 (7.92)	68.67 (8.29)	58.33 (7.64)	62.33 (7.90)	63.00 (7.94)	84.29
Lecanicillium lecanii (T5)	1.15% WP (1 × 109cfu/g)	22.00 (4.69)	71.00 (8.43)	76.33 (8.74)	66.33 (8.14)	70.33 (8.39)	71.00 (8.43)	86.02
Metarhizium anisopliae (T6)	1.15% WP (1 × 109cfu/g)	17.00 (4.12)	64.67 (8.04)	73.33 (8.56)	56.67 (7.53)	55.33 (7.44)	62.50 (7.91)	84.16
Imidacloprid (T7)	1 ml/liter	30.00 (5.48)	87.33 (9.35)	91.33 (9.56)	88.67 (9.42)	90.33 (9.50)	89.42 (9.46)	88.90
Control (T8)	-	15.00 (3.87)	11.66 (3.42)	10.67 (3.27)	7.67 (2.77)	9.67 (3.11)	9.92 (3.15)	-
Overall Mean		22.38 (4.73)	59.71 (7.73)	65.29 (8.08)	57.00 (7.55)	58.21 (7.63)	-	-
CD (5%)		3.62	2.61	3.33	2.23	2.28	-	-
CV (%)		7.30	2.92	3.47	2.57	2.59	-	-
SEM±		1.18	0.85	1.09	0.72	0.74	-	-

According to the findings of Adnan *et al*. (2014), the Imidacloprid treatment reduced the hopper population by a greater percentage (88.59 ± 8.64) than any other treatment. Among the tested botanicals, neem oil 1% exhibited the highest mean hopper mortality (79.71%), followed by pungam oil 1%, which was superior to neem seed extract (NSE) 5%, which exhibited the lowest mean mortality (40.31%). Adnan *et al*. (2014) also found neem oil to be effective against mango hopper, with mortality rates of 48.35, 60.15, and 56.54 percent following application for 24, 72, and 168 hours, respectively. *Lecanicillium lecanii*, compared to *Beaveria bassiana* and *Metarhizium anisopliae*, had a higher mean percent mortality of 71.0 compared to *Beaveria bassiana* and *Metarhizium anisopliae*. Singh *et al*. (2008) reported that the solitary application of *Lecanicillium lecanii* at a concentration of 5g/l resulted in a lower hopper population of 1.7 per panicle.

Bio-efficacy of biopesticides against hopper, *A. atkinsoni* infesting mango after second spray of mango plant (Table 2, Fig. 2) shows that after the second spraying, the greatest mortality rate was seen in treatment T7 (90.33%), followed by treatment T1 (71.67%). The treatment T3 was the least effective at lowering the death rate in the mango hopper population, with only 51.00%. Treatments T2 and T4 were next, with 52.33% and 64.33%, respectively. Both of these treatments were statistically equal.

On the third day after treatment, T7 (Table 2, Fig. 2) was found to be very effective, with a 94.33% death rate. It was followed by T1 with an 80.67% death rate and T5 with a 72.00% death rate. Both treatments were statistically different from each other. The lowest death rate was found in T3 (49.67%), then in T2 (53.67%), and finally in T4 (67.33%). However, these rates were still much lower than the control (Water) rate of 11.67%. The results of the different treatments after 7 days of the second application showed that treatment T7 had the highest death rate (95.33%), followed by treatment T1 (87.25%) and treatment T5 (68.00%). However, T3 (45.00%) was the least effective treatment, and T2 (48.00%) was the next least effective (Table 2). Thirteen days after treatment, T7 was found to be very successful, with a 96.00% death rate. It was followed by T1 with a 69.00% death rate, and then T5 with a 63.00% death rate. These results were not statistically similar to each other. While T2 had the lowest death rate (39.33%), it was followed by T3 (40.33%) and T4 (55.00%). However, all of these rates were much lower than the control group (Water, 13.00%).

The overall mean of the second spray in 2022–23 showed that treatments T7 and T1 were extremely effective at controlling the mango hopper population (93.92% and 73.67%, respectively). Other treatments, like T3 (46.50%), were not as good, followed by T2 (48.33%), but the control (water) had a significantly lower mean mortality rate of 10.75% (Table 2, Fig. 2).

Checking at the data in (Table 2, Fig. 2) shows that the treatment T7 had the greatest decline in size compared to the control group (88.55%). It was followed by T1 with an 85.40% decline, then T5 with an 84.24% decline, and finally T4 with an 82.68% drop. There was the least amount of decrease over control in T3 (76.88%), then in T2 (77.75%), and finally in T4 (82.68%). So, these results were similar to those of

Verghese *et al*. (2000); Ray *et al*. (2011); Nigthojam and Kumar (2012); Borad and Rathod (2013); Adnan *et al*. (2014); Sarode and Mohite (2016); Chaudhari *et al*. (2017). On the other hand, Kumar and Giraddi (2001) said that imidacloprid and lambda-cyhalothrin were the best at controlling mango hoppers.

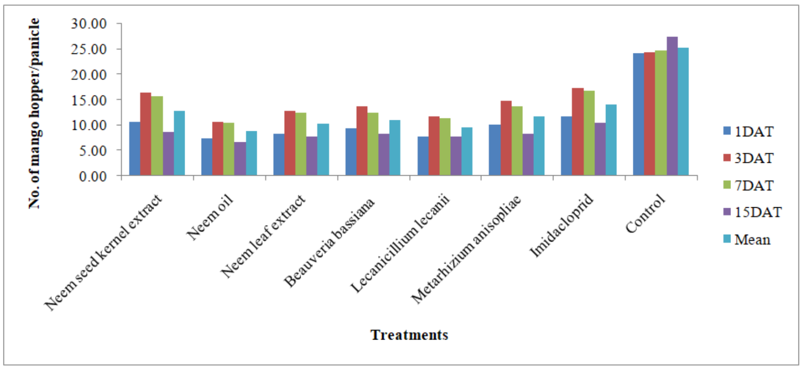

Fig. 2. Bio-efficacy of biopesticides against hopper, *A. atkinsoni* infesting mango after second spray.

Table 2 : Bio-efficacy of biopesticides against hopper, *A. atkinsoni* infesting mango after second spray.

Treatments(T)	Dose @_ gm/lt of water	DBS	Mortality of hoppers (%) Days After Spraying (DAS)				MEAN Mortality(%)	% Reduction over control
			1DAT	3DAT		15DAT		
Neem seed kernel extract (T1)	5.0%	19.33 (4.40)	71.67 (8.47)	80.67 (8.98)	87.25	69.00 (8.31)	73.67 (8.58)	85.40
Neem oil (T2)	0.5%	19.33 (4.40)	52.33 (7.23)	53.67 (7.33)	48.00 (6.93)	39.33 (6.27)	48.33 (6.95)	77.75
Neem leaf extract (T3)	10.0%	23.67 (4.87)	51.00 (7.14)	49.67 (7.05)	45.00 (6.71)	40.33 (6.35)	46.50 (6.82)	76.88
Beauveria bassiana (T4)	5% WP (1 × 109cfu/g)	13.67 (3.70)	64.33 (8.02)	67.33 (8.21)	61.67 (7.85)	55.00 (7.42)	62.08 (7.88)	82.68
Lecanicillium lecanii (T5)	1.15% WP (1 x 109cfu/g)	16.67 (4.08)	70.00 (8.37)	72.00 (8.49)	68.00 (8.25)	63.00 (7.94)	68.25 (8.26)	84.24
Metarhizium anisopliae (T6)	1.15% WP (1 × 109cfu/g)	25.00 (5.00)	66.67 (8.17)	68.00 (8.25)	66.00 (8.12)	61.33 (7.83)	65.50 (8.09)	83.58
Imidacloprid (T7)	1 ml/litre	28.00 (5.29)	90.33 (9.50)	94.00 (9.70)	95.33 (9.76)	96.00 (9.80)	93.92 (9.63)	88.55
Control (T8)	-	17.33 (4.16)	9.00 (3.00)	11.67 (3.42)	9.33 (3.06)	13.00 (3.61)	10.75 (3.28)	-
Overall Mean		20.38 (4.51)	59.42 (7.71)	62.13 (7.88)	58.33 (7.64)	54.63 (7.39)	-	-
CD (5%)		4.72	2.33	3.48	2.55	2.55	-	-
CV (%)		10.05	2.61	3.75	2.88	2.99	-	-
SEM±		1.54	0.76	1.13	0.83	0.83	-	-

Bio-efficacy of biopesticides against hopper, *A. atkinsoni* infesting mango after third spray of mango plant Table 3 shows that the highest death rate happened after the third spray application, on the first day after treatment. It was 94.67% in T7, followed by 76.03% in T1, 70.33 % in T5, and 68.00 % in T4. The treatment T3 had the lowest success rate in lowering the death rate of mango hoppers (50.00%), followed by T2 (55.00%) and T6 (67.67%). Treatments T6 and T4 were statistically the same.

After three days of the third application, treatment T7 was the most effective, with a 96.00% mortality rate. It was followed by treatment T1 with an 84.33% mortality rate and treatment T5 with a 74.67% mortality rate. Treatments T4 (70.67%) and T6 (68.33%) were statistically same. While T3 had the lowest death rate (57.67%), it was followed by T2 (60.00%) and T6 (68.33%). These rates were still much lower than the control (Water) rate of 11.33% (Table 3, Fig. 3).

After 7 days of the third application, the effects of the different treatments were studied. Treatment T7 had the highest mortality rate (96.33%), followed by T1 (79.67%) and T5 (70.00%). On the other hand, T2 (52.00%) was the least successful treatment, followed by T3 (53.33%) and T4 (64.33%). The statistical significance of T4 (64.33%) and T6 (62.33%) was the same (Table 3, Fig 3).

Following the third application, after 15 days, treatment T7 was the most successful of all, with a mortality rate of 96.67%. T1 and T5 came in second and third, respectively, with 74.00% and 68.0%). Treatments T4 (60.00%) and T6 (62.33%) showed statistical similarity with one another. T3 was the least successful treatment, at 35.33 percent; it was followed by T2 at 41.33 percent and T4 at 60.03 percent. The overall mean mortality of the third spray in 2022–2023 showed that treatments T7 and T1 were very effective at controlling the population of mango hoppers, with 95.92% and 78.50%, respectively. Other treatments, T3 (49.08%), followed T2 (52.08%), but had a significantly lower mean mortality with water (control) at 12.18% (Table 3, Fig. 3).

Looking at the data in (Table 3, Fig. 3) showed that the treatment T7 had the highest drop in population compared to the control group (87.30%), followed by T1 (84.61%), and then T5 (82.92%). There was the least change from control in T3 (75.38%), then in T2 (76.80%), and finally in T4 (81.62%). After 14 days of the third spray, Poornima *et al*. (2018) discovered that thiamethoxam 25 WG @ 0.3 g/l cut the number of hoppers by the most (1.15/inflorescence). On the next level, imidacloprid 17.8 SL @ 0.25 m/l and lambda cyhalothrin 5 EC @ 0.5 ml/l worked best (4.75 and 5.58/inflorescence). Manjunath *et al*. (2017) discovered that buprofezin 25 SC at 1.25 ml/l was the best way to lower the amount of mango hoppers. The 2017 study by Chaudhari *et al*. found that imidacloprid 17.8 SL @ 0.007% and thiamethoxam 25 WG @ 0.0025% were the most effective, with a mean death rate of 95.35% and 93.998%, respectively. It was found by Sarode and Mohite (2016) that imidacloprid was the best way to get rid of mango hoppers. Thiamethoxam and lambda cyhalothrin also worked. It was also found by Rathod and Borad (2013) that imidacloprid (0.0053%), thiamethoxam (0.0075%), and acetamiprid (0.005%) were good at lowering the number of hoppers (*A. atkinsoni*) that ate mango. There were 4.53 hoppers per panicle on average with thiamethoxam 0.016%, according to Samanta *et al*. (2009). This chemical also had the best yield (180 fruits per tree and 72 kg per tree) and the highest cost-benefit ratio (1:2.89). The second place went to imidacloprid 0.01%.

Table 3 : Bio-efficacy of biopesticides against hopper, *A. atkinsoni* infesting mango after third spray.

Treatments(T)	Dose @_ gm/lt of water	DBS	Mortality of hoppers (%) Days After Spraying (DAS)				MEAN Mortality (%)	% Reduction over control
			1DAT	3DAT	7DAT	15DAT		
Neem seed kernel extract (T1)	5.0%	12.33 (3.51)	76.00 (8.72)	84.33 (9.18)	79.67 (8.93)	74.00 (8.60)	78.50 (8.86)	84.61
Neem oil (T2)	0.5%	18.33 (4.28)	55.00 (7.42)	60.00 (7.75)	52.00 (7.21)	41.33 (6.43)	52.08 (7.22)	76.80
Neem leaf extract (T3)	10.0%	20.33 (4.51)	50.00 (7.07)	57.67 (7.59)	53.33 (7.30)	35.33 (5.94)	49.08 (7.01)	75.38
Beauveria bassiana (T4)	5% WP (1 × 109cfu/g)	17.33 (4.16)	68.00 (8.25)	70.67 (8.41)	64.33 (8.02)	60.00 (7.75)	65.75 (8.11)	81.62
Lecanicillium lecanii (T5)	1.15% WP (1 × 109cfu/g)	18.00 (4.24)	70.33 (8.39)	74.67 (8.64)	70.00 (8.37)	68.00 (8.25)	70.75 (8.41)	82.92
Metarhizium anisopliae (T6)	1.15% WP (1 × 109cfu/g)	21.00 (4.58)	67.67 (8.23)	68.33 (8.27)	65.33 (8.08)	62.33 (7.90)	65.92 (8.12)	81.67
Imidacloprid (T7)	1 ml/litre	12.67 (3.56)	94.67 (9.73)	96.00 (9.80)	96.33 (9.82)	96.67 (9.83)	95.92 (9.79)	87.40
Control (T8)	-	24.33 (4.93)	12.00 (3.46)	11.33 (3.37)	11.00 (3.32)	14.00 (3.74)	12.08 (3.48)	-
Overall Mean		18.04 (4.25)	61.71 (7.86)	65.38 (8.09)	61.50 (7.84)	56.46 (7.51)	-	-
CD (5%)		5.02	2.86	2.45	3.09	2.42	-	-
CV (%)		11.40	3.10	2.53	3.34	2.77	-	-
SEM±		1.64	093	0.80	1.00	0.79	-	-

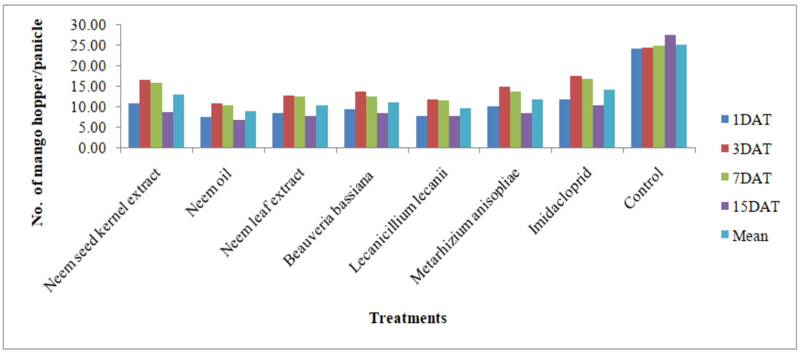

Fig. 3. Bio-efficacy of biopesticides against hopper, *A. atkinsoni* infesting mango after third spray.

CONCLUSIONS

The insecticide efficacy study in 2022-23 displayed that the first spray, second spray and third spray overall per cent reduction of the mango hopper was more in imidacloprid (88.90%), (88.55%) and (87.40%) and followed by NSKE (87.25%), (85.40%) and (84.61%), *Lecanicillium lecanii* (86.02%), (84.24%) and (82.92%). The least was recorded in neem leaf extract (81.01%), (76.88%) and (75.38%) followed by neem oil (81.88%), (77.75%) and (76.80%). Mortality of hopper per cent high in first spray, followed by second spray. Over all treatments in superior treatment was imidacloprid followed by NSKE and *Lecanicillium lecanii*.

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Conflict of Interest. None.

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