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Biorational management of mango hoppers

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Abstract
A field experiment was conducted on farmer's field (Vadodara) during 2019 and 2020 to evaluate various biopesticides against hopper *Amritodus atkinsoni* Lethierry infesting mango. Of the eight evaluated biopesticides, neem seed kernel extract 5.0 % (NSKE), neem oil 0.5 %and neem leaf extract 10.0 % (NLE) were found the most effective in reducing the incidence of mango hopeprs. However, *Beauveria bassiana* 5% WP (1 x 10^9 cfu/g), *Lecanicillium lecanii* 1.15% WP (1 x 10^9 cfu/g) and *Metarhizium anisopliae* 1.15% WP (1 x 10^9 cfu/g) were found mediocre in their effectiveness.

Keywords: *Amritodus atkinsoni*, biopesticides, Langra, Mango, Mango hoppers

Introduction
Mango (*Mangifera indica* Linnaeus) is the national fruit of India and very popular among the people and known as "King of fruits", because of their wide range of adaptability, high nutritive value, richness in variety, attractive colour, delicious taste and excellence flavour. It is rich source of vitamin A and C. Andhra Pradesh, Uttar Pradesh, Bihar, Karnataka, Telangana, Tamil nadu, Maharashtra and Gujarat are major mango producing states of the country. Gujarat ranks 8th in area occupying 1,53,180 ha, and 5th in production (Anon., 2018). The crop is attacked by about 492 species of insects, 17 species of mites and 26 species of nematodes at the world level. Of these, 188 species of insects have been reported from India (Tandon and Verghese, 1985) [7]. Among all, *Idioscopus clypealis*, *I. niveosparsus*, *I. nagpurensis* and *Amritodus atkinsoni* are important species of hoppers infesting mango (Pena *et al.*, 1998) [5]. According to Rahman and Kuldeep (2007) [6] mango hoppers cause 20-100 per cent yield loss by giving rise to growth of sooty mould that reduces photosynthetic efficiency of leaves and market quality of fruits. Physical injury is also caused to leaves, panicles and shoots due to egg laying in the tissues.

Materials and Methods
For testing the bio efficacy of various biopesticides against hopper, *A. atkinsoni* infesting mango an experiment was conducted atfarmer's field at Kajapura village of Vadodara district of Gujarat during 2019 and 2020. The experiment was laid out in Completely Randomized Design with nine treatments *viz*.,NSKE 5%, neem oil 0.5%, NLE 10%, garlic bulb extract 5% (GBE), ginger rhizome extract 5% (GRE), *B. bassiana* (1 x 10^9 cfu/g), *L. lecanii* (1 x 10^9 cfu/g), *M. anisopliae* (1 x 10^9 cfu/g) and control (water spray) along with three repetitions with a view to evaluate bio-efficacy of various biopesticides against *A. atkinsoni.* For the purpose, existing trees of mango cv. *Langra* grown at a spacing of 10 × 10 m having equal age, canopy and growth were selected. Treatment wise application of biopesticides were given at ETL (5 hoppers/panicle) by using foot sprayer with required concentration and spray was given at 10 days interval. The observations were recorded before spraying as well as 5, 7 and 10 days after each spray from 5 randomly selected panicles or inflorescences from each direction (i.e. North, South, East and West) from each tree. The data obtained were analyzed by following standard statistical technique (Steel and Torrie, 1980) [9].

Results and Discussion
The population of hoppers was homogeneous before spray in all the treatments as treatments did not differed significantly. All the evaluated biopesticides were significantly superior to control up to 10 days of spray.

First spray

First year, 2019 (Table 1)

The population of mango hoppers was homogeneous in all the biopesticidal treatments before spray as difference among the treatments were non-significant. All the evaluated biopesticides were found significantly superior over control up to 10 days of spray during the first year, 2019. There was a reduction of hoppers population upto 7 days of application of biopesticides after first and second spray, whereas population was slightly increased after 10 days of observations in both the sprays.

First spray

The data on pooled over periods of first spray indicated the lowest hopper population (4.70 hoppers/panicle) was recorded from the treatment of NSKE 5% which was at par with neem oil 0.5% (5.02 hoppers/panicle) and NLE 10% (5.12 hoppers/panicle). These treatments were significantly superior to the rest of the evaluated treatments. The trees treated with *B. bassiana* 5 % WP (7.97 hoppers/panicle), *L. lecanii* 1.15 % WP (8.14 hoppers/panicle), *M. anisopliae* 1.15 % WP (8.32 hoppers/panicle), GBE 5% (9.15 hoppers/panicle) and GRE 5% (9.30 hoppers/panicle) recorded significantly lower population of hoppers than control.

Second spray

The data on pooled over periods of second spray clearly asserted that NSKE 5% (2.06 hoppers/panicle), neem oil 0.5% (2.16 hoppers/panicle) and NLE 10% (2.32 hoppers/panicle) were found significantly superior among the evaluated biopesticides. It was found that the treatments of *B. bassiana* 5 % WP (4.04hoppers/panicle), *L. lecanii* 1.15 % WP (4.12 hoppers/panicle) and *M. anisopliae* 1.15 % WP (4.21hoppers/panicle) provided significant reduction of hoppers infesting mango. The trees treated with GRE 5% recorded the highest (6.42hoppers/panicle) hoppers population and it was at par with GBE 5% (6.26hoppers/panicle).

Pooled over sprays

Results of pooled over first and second sprays revealed that NSKE 5% (3.26 hoppers/panicle) was found significantly superior than all the evaluated biopesticides except neem oil 0.5% (3.46 hoppers/panicle) and NLE 10% (3.62 hoppers/panicle). The trees treated with *B. bassiana* 5 % WP (5.85 hoppers/panicle), *L. lecanii* 1.15 % WP (6.00 hoppers/panicle) and *M. anisopliae* 1.15 % WP (6.10 hoppers/panicle) had significantly lower incidence of hoppers compared to the remaining treatments. Among the tested biopesticides, the trees treated with GRE 5% recorded the maximum (7.79 hoppers/panicle) *A. atkinsoni* population and it was at par with GBE 5% (7.62 hoppers/panicle).

Second year, 2020 (Table 2)

During second year (i.e. 2020) also the population of hoppers was homogeneous in all the biopesticidal treatments before spray as difference between the treatments was non-significant. All the evaluated biopesticides were found significantly superior over control up to 10 days of spray.

First spray

The data of pooled over periods of the first spray asserted that NSKE 5% (5.95 hoppers/panicle), neem oil 0.5% (6.21 hoppers/panicle) and NLE 10% (6.31 hoppers/panicle) were found significantly superior to the evaluated biopesticides. It was also concluded that the treatments of *B. bassiana* 5 % WP (9.11 hoppers/panicle), *L. lecanii* 1.15 % WP (9.23 hoppers/panicle), *M. anisopliae* 1.15 % WP (9.42 hoppers/panicle), GBE 5% (10.00 hoppers/panicle) and GRE 5% (10.13 hoppers/panicle) provided significant reduction in population of hopper, *A. atkinsoni*.

Second spray

Looking to the data on pooled over periods of the second spray, the lowest hopper population was recorded from the treatment of NSKE 5% (2.09hoppers/panicle) which was at par with neem oil 0.5% (2.39hoppers/panicle) and NLE 10% (2.46 hoppers/panicle). These treatments were significantly superior to rest of the treatments. The trees treated with *B. bassiana* 5 % WP (4.17hoppers/panicle), *L. lecanii* 1.15 % WP (4.34 hoppers/panicle) and *M. anisopliae* 1.15 % WP (4.52 hoppers/panicle) were found mediocre in their efficacy. However, GRE 5% (6.36 hoppers/panicle) recorded significantly lower population of hoppers and was at par with the treatment of GBE 5% (6.10 hoppers/panicle).

Pooled over sprays

The data on the pooled over sprays indicated that NSKE 5% (3.78 hoppers/panicle) was found significantly superior over all the evaluated biopesticides except neem oil 0.5% (4.08 hoppers/panicle) and NLE 10% (4.21 hoppers/panicle). The trees treated with *B. bassiana* 5 % WP (6.42 hoppers/panicle), *L. lecanii* 1.15 % WP (6.58 hoppers/panicle) and *M. anisopliae* 1.15 % WP (6.74 hoppers/panicle) had significantly lower incidence of hoppers compared to the treatments under evaluation. The trees treated with GRE 5% recorded the maximum (8.14 hoppers /panicle) *A. atkinsoni* population and it was at par with GBE 5% (7.97 hoppers/panicle).

Pooled over periods, sprays and years [(2019 and 2020) (Table 3)]

Population of mango hoppers was homogeneous in all the biopesticidal treatments before spray as difference among the treatments were non-significant as shown in pooled over years (2019 and 2020). All the evaluated biopesticides were found significantly superior over control up to 10 days of spray.

First spray

As indicated by the data of pooled over periods and years of the first spray, NSKE 5% (5.31 hoppers/panicle) was found significantly superior among all the evaluated biopesticides except neem oil 0.5% (5.60 hoppers/panicle) and NLE 10% (5.70 hoppers/panicle). However, the trees with the application of *B. bassiana* 5 % WP (8.50 hoppers/panicle), *L. lecanii* 1.15 % WP (8.68 hoppers/panicle), *M. anisopliae* 1.15 % WP 8.86 hoppers/panicle), GBE 5% (9.55 hoppers/panicle) and GRE 5% (9.68 hoppers/panicle) exhibited significant effect on population of hoppers.

Second spray

The data on pooled over periods of the second spray of both the years asserted that NSKE 5% (2.09 hoppers/panicle), neem oil 0.5% (2.26 hoppers/panicle) and NLE 10% (2.39 hoppers/panicle) were found significantly superior to the evaluated biopesticides. It was certain that the treatments of *B. bassiana* 5 % WP (4.08hoppers/panicle), *L. lecanii* 1.15 % WP (4.25 hoppers/panicle) and *M. anisopliae* 1.15 % WP

(4.34hoppers/panicle) provided significant reduction in population of hopper, *A. atkinsoni*. The trees treated with GRE 5% recorded the highest (6.36 hoppers/panicle) hopper population and it was at par with GBE 5% (6.21 hoppers/panicle).

Overall, NSKE 5% (3.54/panicle) was significantly superior and stood first among all the evaluated insecticides except neem oil 0.5% (3.74/panicle) and NLE 10% (3.91/panicle). *B. bassiana* 5 % WP (6.10/panicle), *L. lecanii* 1.15 % WP (6.31/panicle) and *M. anisopliae* 1.15 % WP (6.42/panicle) were the next effective treatments. Whereas, the trees treated with GRE 5% recorded the maximum (7.97/panicle) incidence of hoppers and remained at par with the treatment of GBE 5% (7.79/panicle).

According to Mohapatra *et al.* (2019) [4] NSKE 5 % was found the most effective followed by *L. lecanii* 1.15 % WP, neem oil 1 % and neem leaf extract (NLE) 10 per cent in reducing the incidence of *A. Atkinsoni*. Also, Chaudhari *et al.* (2017) [3] found neem oil 1 % with a mean mortality of mango hoppers ranging 79.71 – 66.40 %.*L. lecanii* 1.15% WP was found superior in controlling the mango hoppers with a mean mortality of 86.04 and 71.99 per cent during I and II spray, respectively under field conditions. Sarode and Mohite (2016) [8] reported that *M. anisopliae*, *V. lecanii*, *B. bassiana* and NSKE were equally effective in reducing population of mango hoppers. Neem seed kernel extract at 5 % or neem oil at 0.5 % were found effective for the management of mango hoppers, *A. atkinsoni* (Anon., 2006). Thus, these reports are in agreement with the present findings.

Table 1: Efficacy of different biopesticides against hoppers in mango (2019)

Tr. No.	Treatments	Conc. (%)	No. of hopper(s)/panicleat indicated days and spray									
			Before spray	First spray				Second spray				Pooled over periods and sprays
				5	7	10	Pooled over periods	5	7	10	Pooled over periods	
1	Neem seed kernel extract 5.0 %	5.0	3.06 (8.86)	2.36^{a} (5.07)	2.21^{a} (4.38)	2.27^{a} (4.65)	2.28^{a} (4.70)	1.88^{a} (3.03)	1.64^{a} (2.19)	1.28^{a} (1.14)	1.60^{a} (2.06)	1.94a (3.26)
2	Neem oil 0.5 %	0.5	3.09 (9.05)	2.41^{a} (5.31)	2.26^{a} (4.61)	2.35^{ab} (5.02)	2.35^{a} (5.02)	1.91^{a} (3.15)	1.66^{a} (2.26)	1.31^{a} (1.22)	1.63^{a} (2.16)	1.99a (3.46)
3	Neem leaf extract 10.0 %	10.0	3.03 (8.68)	2.43^{ab} (5.40)	2.30^{ab} (4.79)	2.38^{abc} (5.16)	2.37^{a} (5.12)	1.96^{ab} (3.34)	1.69^{a} (2.36)	1.37^{a} (1.38)	1.68^{a} (2.32)	2.03a (3.62)
4	Garlic bulb extract 5.0 %	5.0	3.16 (9.49)	3.08^{cd} (8.99)	3.02^{cd} (8.62)	3.19^{d} (9.68)	3.10^{b} (9.11)	2.98^{c} (8.38)	2.64^{c} (6.47)	2.19^{c} (4.30)	2.60^{c} (6.26)	2.85c (7.62)
5	Ginger rhizome extract 5.0 %	5.0	3.10 (9.11)	3.11^{cd} (9.17)	3.05^{cd} (8.80)	3.22^{d} (9.87)	3.13^{b} (9.30)	3.01^{cd} (8.56)	2.66^{c} (6.58)	2.23^{c} (4.47)	2.63^{c} (6.42)	2.88c (7.79)
6	*Beauveria bassiana* 5% WP (1 x 10^{9} cfu/g)	-	3.13 (9.30)	2.99^{bc} (8.44)	2.77^{bc} (7.17)	2.96^{bcd} (8.26)	2.91^{b} (7.97)	2.47^{bc} (5.60)	2.15^{b} (4.12)	1.75^{b} (2.56)	2.13^{b} (4.04)	2.52b (5.85)
7	*Lecanicillium lecanii* 1.15% WP (1 x 10^{9} cfu/g)	-	3.05 (8.80)	3.02^{c} (8.62)	2.81^{c} (7.40)	3.00^{cd} (8.50)	2.94^{b} (8.14)	2.48^{bc} (5.65)	2.18^{b} (4.25)	1.79^{b} (2.70)	2.15^{b} (4.12)	2.55b (6.00)
8	*Metarhizium anisopliae* 1.15% WP (1 x 10^{9} cfu/g)	-	3.34 (10.66)	3.05^{c} (8.80)	2.84^{c} (7.57)	3.02^{d} (8.62)	2.97^{b} (8.32)	2.51^{bc} (5.80)	2.19^{b} (4.30)	1.80^{b} (2.74)	2.17^{b} (4.21)	2.57b (6.10)
9	Control	-	3.25 (10.06)	3.66^{d} (12.90)	3.54^{d} (12.03)	3.59^{d} (12.39)	3.60^{c} (12.46)	3.57^{d} (12.24)	3.54^{d} (12.03)	3.52^{d} (11.89)	3.55^{d} (12.10)	3.57d (12.24)
S. Em. ± T			0.15	0.18	0.15	0.19	0.10	0.16	0.13	0.11	0.08	0.06
P			-	-	-	-	0.06	-	-	-	0.05	0.04
S			-	-	-	-	-	-	-	-	-	0.03
T x P			-	-	-	-	0.17	-	-	-	0.14	0.11
T x S			-	-	-	-	-	-	-	-	-	0.09
S x P			-	-	-	-	-	-	-	-	-	0.05
T x P x S			-	-	-	-	-	-	-	-	-	0.16
C. D. at 5%			NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C.V. (%)			8.13	10.55	9.73	11.49	10.64	11.40	9.83	10.19	10.67	10.73

Notes: 1. Figures in parentheses are retransformed values, those outside are √(x+0.5) transformed values.
2. Treatment means with letter(s) in common are non-significant by DNMRT at 5% level of significance
3. Significant parameters and its interactions: T, S, P, T x S and S x P, where T=Treatment, P=Period and S=Spray

Table 2: Efficacy of different biopesticides against hoppers in mango (2020)

Tr. No.	Treatments	Conc. (%)	No. of hopper(s)/panicle at indicated days and spray									
			Before spray	First spray				Second spray				Pooled over periods and sprays
				5	7	10	Pooled over periods	5	7	10	Pooled over periods	
1	Neem seed kernel extract 5.0 %	5.0	3.26 (10.13)	2.55^{a} (6.00)	2.46^{a} (5.55)	2.60^{a} (6.26)	2.54^{a} (5.95)	2.03^{a} (3.62)	1.61^{a} (2.09)	1.19^{a} (0.92)	1.61^{a} (2.09)	2.07^{a} (3.78)
2	Neem oil 0.5 %	0.5	3.20 (9.74)	2.62^{ab} (6.36)	2.54^{a} (5.95)	2.62^{a} (6.36)	2.59^{a} (6.21)	2.16^{a} (4.17)	1.68^{a} (2.32)	1.25^{a} (1.06)	1.70^{a} (2.39)	2.14^{a} (4.08)
3	Neem leaf extract 10.0 %	10.0	3.11 (9.17)	2.63^{ab} (6.42)	2.57^{ab} (6.10)	2.64^{a} (6.47)	2.61^{a} (6.31)	2.20^{ab} (4.34)	1.70^{a} (2.39)	1.28^{ab} (1.14)	1.72^{a} (2.46)	2.17^{a} (4.21)
4	Garlic bulb extract 5.0 %	5.0	3.26 (10.13)	3.25^{c} (10.06)	3.18^{cd} (9.61)	3.29^{b} (10.32)	3.24^{b} (10.00)	2.98^{c} (8.38)	2.56^{cd} (6.05)	2.18^{de} (4.25)	2.57^{c} (6.10)	2.91^{c} (7.97)
5	Ginger rhizome extract	5.0	3.29	3.28^{c}	3.19^{cd}	3.31^{bc}	3.26^{b}	3.01^{c}	2.61^{d}	2.22^{e}	2.62^{c}	2.94^{c}

	5.0 %		(10.32)	(10.26)	(9.68)	(10.46)	(10.13)	(8.56)	(6.31)	(4.43)	(6.36)	(8.14)
6	*Beauveria bassiana* 5% WP (1 x 10^9 cfu/g)	-	3.13 (9.30)	3.12^{bc} (9.23)	3.05^{bc} (8.80)	3.13^{b} (9.30)	3.10^{b} (9.11)	2.67^{bc} (6.63)	2.11^{b} (3.95)	1.69^{bc} (2.36)	2.16^{b} (4.17)	2.63^{b} (6.42)
7	*Lecanicillium lecanii* 1.15% WP (1 x 10^9 cfu/g)	-	3.20 (9.74)	3.17^{c} (9.55)	3.07^{c} (8.92)	3.14^{b} (9.36)	3.12^{b} (9.23)	2.71^{c} (6.84)	2.17^{b} (4.21)	1.74^{c} (2.53)	2.20^{b} (4.34)	2.66^{b} (6.58)
8	*Metarhizium anisopliae* 1.15% WP (1 x 10^9 cfu/g)	-	3.32 (10.52)	3.19^{c} (9.68)	3.09^{c} (9.05)	3.17^{b} (9.55)	3.15^{b} (9.42)	2.73^{c} (6.95)	2.21^{bc} (4.38)	1.77^{cd} (2.63)	2.24^{b} (4.52)	2.69^{b} (6.74)
9	Control	-	3.27 (10.19)	3.59^{c} (12.39)	3.67^{d} (12.97)	3.80^{c} (13.94)	3.68^{c} (13.04)	3.62^{d} (12.60)	3.65^{e} (12.82)	3.60^{f} (12.46)	3.62^{d} (12.60)	3.65^{d} (12.82)
S. Em. ± T			0.17	0.16	0.15	0.15	0.09	0.15	0.11	0.13	0.08	0.06
P			-	-	-	-	0.05	-	-	-	0.05	0.03
S			-	-	-	-	-	-	-	-	-	0.03
T x P			-	-	-	-	0.16	-	-	-	0.13	0.10
T x S			-	-	-	-	-	-	-	-	-	0.08
S x P			-	-	-	-	-	-	-	-	-	0.05
T x P x S			-	-	-	-	-	-	-	-	-	0.15
C. D. at 5%			NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C.V. (%)			9.37	9.07	8.98	8.69	8.91	9.81	8.75	12.30	10.21	9.50

Notes: 1. Figures in parentheses are retransformed values, those outside are √(x+0.5) transformed values.
2. Treatment means with letter(s) in common are non-significant by DNMRT at 5% level of significance
3. Significant parameters and its interactions: T, S, P, T x S and S x P, where T=Treatment, P=Period and S=Spray

Table 3: Efficacy of different biopesticides against hoppers in mango (Pooled: 2019 and 2020)

Tr. No.	Treatments	No. of hopper(s)/panicle at indicated days and spray									
		Before spray	First spray				Second spray				Pooled over periods and sprays
			5	7	10	Pooled over periods	5	7	10	Pooled over periods	
1	Neem seed kernel extract 5.0 %	3.16 (9.49)	2.46^{a} (5.55)	2.33^{a} (4.93)	2.44^{a} (5.45)	2.41^{a} (5.31)	1.96^{a} (3.34)	1.63^{a} (2.16)	1.24^{a} (1.04)	1.61^{a} (2.09)	2.01^{a} (3.54)
2	Neem oil 0.5 %	3.15 (9.42)	2.51^{a} (5.80)	2.40^{a} (5.26)	2.49^{a} (5.70)	2.47^{a} (5.60)	2.03^{a} (3.62)	1.67^{a} (2.29)	1.28^{a} (1.14)	1.66^{a} (2.26)	2.06^{a} (3.74)
3	Neem leaf extract 10.0 %	3.07 (8.92)	2.53^{a} (5.90)	2.44^{a} (5.45)	2.51^{a} (5.80)	2.49^{a} (5.70)	2.08^{a} (3.83)	1.69^{a} (2.36)	1.32^{a} (1.24)	1.70^{a} (2.39)	2.10^{a} (3.91)
4	Garlic bulb extract 5.0 %	3.21 (9.80)	3.16^{b} (9.49)	3.10^{b} (9.11)	3.25^{b} (10.06)	3.17^{b} (9.55)	2.98^{cd} (8.38)	2.60^{c} (6.26)	2.18^{c} (4.25)	2.59^{c} (6.21)	2.88^{c} (7.79)
5	Ginger rhizome extract 5.0 %	3.20 (9.74)	3.19^{b} (9.68)	3.12^{b} (9.23)	3.26^{b} (10.13)	3.19^{b} (9.68)	3.01^{d} (8.56)	2.64^{c} (6.47)	2.22^{c} (4.43)	2.62^{c} (6.36)	2.91^{c} (7.97)
6	*Beauveria bassiana* 5% WP (1 x 10^9 cfu/g)	3.13 (9.30)	3.06^{b} (8.86)	2.91^{b} (7.97)	3.04^{b} (8.74)	3.00^{b} (8.50)	2.58^{b} (6.16)	2.13^{b} (4.04)	1.72^{b} (2.46)	2.14^{b} (4.08)	2.57^{b} (6.10)
7	*Lecanicillium lecanii* 1.15% WP (1 x 10^9 cfu/g)	3.13 (9.30)	3.09^{b} (9.05)	2.94^{b} (8.14)	3.07^{b} (8.92)	3.03^{b} (8.68)	2.59^{b} (6.21)	2.18^{b} (4.25)	1.76^{b} (2.60)	2.18^{b} (4.25)	2.61^{b} (6.31)
8	*Metarhizium anisopliae* 1.15% WP (1 x 10^9 cfu/g)	3.33 (10.59)	3.12^{b} (9.23)	2.97^{b} (8.32)	3.09^{b} (9.05)	3.06^{b} (8.86)	2.62^{bc} (6.36)	2.20^{b} (4.34)	1.79^{b} (2.70)	2.20^{b} (4.34)	2.63^{b} (6.42)
9	Control	3.26 (10.13)	3.62^{c} (12.60)	3.60^{c} (12.46)	3.70^{c} (13.19)	3.64^{c} (12.75)	3.60^{e} (12.46)	3.60^{d} (12.46)	3.56^{d} (12.17)	3.58^{d} (12.32)	3.61^{d} (12.53)
S. Em. ± T		0.11	0.11	0.10	0.12	0.07	0.11	0.08	0.08	0.06	0.04
P		-	-	-	-	0.04	-	-	-	0.03	0.02
S		-	-	-	-	-	-	-	-	-	0.05
Y		0.05	0.06	0.05	0.06	0.03	0.05	0.04	0.04	0.03	0.04
T x P		-	-	-	-	0.12	-	-	-	0.10	0.07
T x S		-	-	-	-	-	-	-	-	-	0.06
S x P		-	-	-	-	-	-	-	-	-	0.03
T x Y		0.16	0.17	0.15	0.17	0.10	0.16	0.12	0.12	0.08	0.06
Y x S		-	-	-	-	-	-	-	-	-	0.03
Y x P		-	-	-	-	0.06				0.05	0.03
T x P x S		-	-	-	-	-	-	-	-		0.10
T x P x Y		-	-	-	-	0.17	-	-	-	0.14	0.11
T x S x Y		-	-	-	-	-	-	-	-	-	0.08
S x P x Y		-	-	-	-	-	-	-	-	-	0.05
T x P x S x Y		-	-	-	-	-	-	-	-	-	0.15
C. D. at 5%		NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C.V. (%)		8.79	9.81	9.34	10.11	9.77	10.59	9.31	11.27	10.44	10.11

Notes: 1. Figures in parentheses are retransformed values, those outside are √(x+0.5) transformed values.
2. Treatment means with letter(s) in common are non-significant by DNMRT at 5% level of significance
3. Significant parameters and its interactions: T, P, Y x S, S x P and S x T, where T=Treatment, P=Period, S=Spray and Y=Year

Conclusion

From the above results it can be concluded that among the eight biopesticides evaluated, it can be deduced that the NSKE 5 %, neem oil 0.5 % and NLE 10 % were found the most effective in reducing the incidence of *A. atkinsoni* infesting mango.

References

1. Evaluation of effective dose and source of Azadirachtin against mango hoppers. [Weblink: http://www.aau.in/college-menu/department/753~796] 2021.
2. India Statistics. Ministry of Agriculture & Farmers Welfare, Govt. of India. [Weblink: indiastat.com] 2018.
3. Chaudhari AU, Sridharan S, Sundar SSD. Management of mango hopper with newer molecules and biopesticides under ultra-high density planting system. Journal of Entomology and Zoology Studies 2017;5(6):454-458.
4. Mohapatra AR, Thumar RK, Gohe lNM, Aniyaliya MD. Bio-efficacy of different biopesticides against hopper, *Amritodus atkinsoni* Lethierry infesting mango. International Journal of Chemical Studies 2019;7(6):1654-1659.
5. Pena JE, Mohyuddin AI, Wysoki M. A review of the pest management situation in mango agroecosystem. Phytoparasitica 1998;26:1-20.
6. Rahman AS, Kuldeep. Mango hopper: bioecology and management- A review. Agricultural Review 2007;28(1):49-55.
7. Tandon PL, Verghese A. World list of insect, mite and other pests of mango. Technical Document, No. 5, IIHR, Bangalore 1985;6(3):122-131.
8. Sarode BR, Mohite PB. Seasonal incidence and bio-rational management of mango hoppers, *Amritodus atkinsoni* Leth. International Organization for Scientific Research- Journal of Agriculture and Veterinary Science 2016;9(1):29-31.
9. Steel RGD, Torrie JH. Principles and procedures of statistics. McGraw Hill Book Company, New York 1980, 137.