



## Non chemical management of mango hopper, *Amritodus Ankinsonii*

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### Abstract

A field experiment was conducted at Horticulture Polytechnic, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat) during 2021-22 to 2023-24. The result indicated that, apply three sprays of *Beauveria bassiana* 1.15 WP (1 x 10<sup>8</sup>cfu/g) or *Metarhizium anisopliae* 1.15 WP (1 x 10<sup>8</sup>cfu/g) 60g/10 litre of water for management of mango hopper. First spray should be done at panicle initiation and apply subsequent two sprays at an interval of 10 days.

**Keywords:** Non-chemical, mango, hopper, *Amritodus ankinsonii*

### Introduction

Mango (*Mangifera indica* Linn.) is a very important and popular fruit in the world. It is the choicest fruit of the subcontinent and is known as king of all fruits. Its popularity is mainly due to its excellent flavour, delicious taste, and high nutritive value being rich in carbohydrates, vitamins (A and C) and minerals. (Ojokoh 2007 [8]; Adnan *et al.* 2014 [1] and Masoodi *et al.* 2020) [6]. The origin lies somewhere in the Himalayas, around India and Burma (FAO, 2007) [3], but it is cultivated today in almost all countries of the world. In Pakistan, India, Malaysia, and South China, it is economically very important fruit crop (Joshi and Kumar 2012 [5]; Tharanathan *et al.* 2006) [12] and is regarded as the national tree of Bangladesh (Anonymous 2011) [2]. India has been the highest mango-producing country with 18.43 million tons mango production as per the data published in 2014 (NHB 2014). Its origin is believed to be south Asia where it has been cultivated for the last four thousand years. Now it is a commercially cultivated important fruit of this subtropical region particularly Bangladesh, India, and Pakistan. Among the mango pests, Mango hopper *Idioscopus clypealis* (Lethierry) is one of the most serious and widespread pests throughout the country, which causes heavy damage to mango crop. Both the nymphs and adults of the hoppers puncture and suck the sap from tender shoots, inflorescences, and leaves of mango crop, which cause non setting of flowers and dropping of immature fruits, thereby reducing the yield. Hoppers also excrete a secretion, called honey dew. In moist weather, it encourages the development of fungi like *Meliola mangiferae* (Earle), resulting in growth of sooty mould on dorsal surface of leaves, branches, and fruits. This black coating interferes with the normal photosynthetic activity of

the plant, ultimately resulting in non setting of flowers and dropping of immature fruits. This damage is called honey dew disease. On heavily infested trees, crop losses of 50% or more have been recorded (Patel, *et al.*, 2004) [9]. Many inorganic insecticides have been recommended so far, for management of mango hopper throughout India. However, harmful chemical insecticides used for the management of mango hopper created many problems like resistance, resurgence, residue among others (Munj, *et al.*, 2015) [7]. Therefore, there is a need for eco-friendly practices for the management of mango hopper. Now a day there is a demand for farmers for the nonchemical management of mango hopper. Therefore, the experiment was proposed to determine the effectiveness of various entomopathogenic fungus and botanicals against mango hopper.

### Materials and Methods

An experiment was conducted at Horticulture Polytechnic, Navsari Agricultural University, Navsari, Gujarat during 2021-22 to 2023-24. The experiment was conducted in a large plot technique design with nine treatment and three repetitions. Single mango tree was considered as one replication (same age of trees). Ten terminal twigs/panicles from all four directions from lower canopy of tree were selected randomly for counting mango hopper populations (nymphs and adults). First spray was done before flowering whereas second and third spray was done after ten days of first and second spray, respectively. The observation of mango hopper was recorded from each mango tree at 24 hours before spraying and after 3, 7 and 9 days of each spraying.

### Treatment Details

Tr. No.	Treatment	Conc. (%)	Dose (ml/g) per 10 L of water
T <sub>1</sub>	<i>Metarhizium anisopliae</i> 1.15 WP (1 x 10 <sup>8</sup> cfu/g)	0.007	60
T <sub>2</sub>	<i>Beauveria bassiana</i> 1.15 WP (1 x 10 <sup>8</sup> cfu/g)	0.007	60
T <sub>3</sub>	<i>Lecanicillium lecanii</i> 1.15 WP (1 x 10 <sup>8</sup> cfu/g)	0.007	60
T <sub>4</sub>	Azadirachtin 0.15 EC (1500 ppm)	0.0006	40
T <sub>5</sub>	Neem oil	0.5	50

T <sub>6</sub>	<i>Metarhizium anisopliae</i> 1.15 WP (1 x 10 <sup>8</sup> cfu/g) + <i>Beauveria bassiana</i> 1.15 WP (1 x 10 <sup>8</sup> cfu/g)	0.007 + 0.007	120
T <sub>7</sub>	<i>Metarhizium anisopliae</i> 1.15 WP (1 x 10 <sup>8</sup> cfu/g) + <i>Lecanicillium lecanii</i> 1.15 WP (1 x 10 <sup>8</sup> cfu/g)	0.007 + 0.007	120
T <sub>8</sub>	<i>Beauveria bassiana</i> 1.15 WP (1 x 10 <sup>8</sup> cfu/g) + <i>Lecanicillium lecanii</i> 1.15 WP (1 x 10 <sup>8</sup> cfu/g)	0.007 + 0.007	120
T <sub>9</sub>	Control (Untreated)	--	--

**Table 1:** Effectiveness of various entomopathogens and botanicals against mango hopper during 2021-22.

Treatment	No. of hoppers per panicle													Overall Pooled (3 Sprays)
	I Spray				II Spray			III Spray			Pooled			
	BS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS	9 DAS	
T <sub>1</sub>	5.40 (2.43)*	4.33 (2.17)	2.97 (1.86)	3.80 (2.06)	4.07 (2.10)	3.73 (2.04)	4.93 (2.28)	5.33 (2.39)	4.37 (2.20)	4.73 (2.24)	4.58 (2.25)	3.69 (2.05)	4.49 (2.21)	4.25 (2.17) <sup>ab</sup>
T <sub>2</sub>	5.10 (2.36)	3.93 (2.09)	2.93 (1.83)	3.63 (2.01)	3.50 (1.98)	3.20 (1.91)	3.90 (2.09)	4.67 (2.22)	3.63 (2.01)	3.90 (2.08)	4.03 (2.12)	3.26 (1.93)	3.81 (2.07)	3.70 (2.04) <sup>a</sup>
T <sub>3</sub>	5.53 (2.45)	5.37 (2.41)	4.33 (2.18)	5.07 (2.35)	5.50 (2.43)	4.50 (2.23)	5.67 (2.48)	6.23 (2.56)	5.17 (2.36)	5.60 (2.44)	5.70 (2.49)	4.67 (2.27)	5.44 (2.44)	5.27 (2.40) <sup>bc</sup>
T <sub>4</sub>	6.22 (2.59)	6.20 (2.58)	5.20 (2.38)	5.57 (2.46)	6.00 (2.54)	5.87 (2.52)	5.87 (2.52)	6.77 (2.68)	6.73 (2.69)	7.10 (2.75)	6.32 (2.61)	5.93 (2.53)	6.18 (2.58)	6.14 (2.58) <sup>cd</sup>
T <sub>5</sub>	6.33 (2.61)	6.47 (2.63)	5.43 (2.41)	5.63 (2.46)	6.10 (2.56)	5.93 (2.53)	6.00 (2.54)	6.90 (2.72)	7.60 (2.84)	7.17 (2.76)	6.49 (2.64)	6.32 (2.61)	6.27 (2.60)	6.36 (2.62) <sup>cd</sup>
T <sub>6</sub>	6.37 (2.62)	5.73 (2.49)	4.70 (2.28)	5.40 (2.42)	5.90 (2.53)	4.87 (2.31)	6.17 (2.58)	6.23 (2.59)	5.23 (2.39)	5.63 (2.46)	5.96 (2.54)	4.93 (2.33)	5.73 (2.62)	5.54 (2.46) <sup>c</sup>
T <sub>7</sub>	5.63 (2.47)	6.87 (2.71)	6.20 (2.57)	6.83 (2.70)	6.93 (2.72)	6.50 (2.62)	6.43 (2.63)	7.67 (2.86)	7.50 (2.81)	8.33 (2.97)	7.16 (2.76)	6.73 (2.68)	7.20 (2.74)	7.03 (2.74) <sup>d</sup>
T <sub>8</sub>	5.97 (2.54)	6.07 (2.56)	5.00 (2.34)	5.43 (2.43)	5.93 (2.53)	5.13 (2.36)	7.00 (2.73)	6.40 (2.62)	5.23 (2.37)	5.67 (2.47)	6.13 (2.57)	5.12 (2.37)	6.03 (2.64)	5.76 (2.50) <sup>cd</sup>
T <sub>9</sub>	6.62 (2.67)	7.07 (2.75)	7.30 (2.78)	7.33 (2.79)	8.03 (2.92)	9.43 (3.15)	11.00 (3.39)	12.50 (3.59)	14.17 (3.82)	17.00 (4.17)	9.20 (3.11)	10.30 (3.29)	11.78 (3.72)	10.43 (3.30) <sup>e</sup>
S.Em. ±	0.084	0.140	0.173	0.159	0.172	0.161	0.165	0.213	0.182	0.192	0.087	0.103	0.106	0.077
CD (0.05)	NS	0.417	0.514	0.473	0.512	0.479	0.491	0.634	0.540	0.571	0.260	0.306	0.315	0.229
CV %	5.78	9.77	13.08	11.45	12.05	11.59	11.10	13.73	12.06	12.31	5.90	7.29	7.12	5.26

\*Figures in the parenthesis are square root + 0.5 transformed value and those outside are original value. DNMR has been used.

**Table 2:** Effectiveness of various entomopathogens and botanicals against mango hopper during 2022-23.

Treatment	No. of hoppers per panicle													Overall Pooled (3 Sprays)
	I Spray				II Spray			III Spray			Pooled			
	BS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS	9 DAS	
T <sub>1</sub>	4.25 (2.18)*	4.81 (2.28)	2.86 (1.83)	4.17 (2.15)	4.55 (2.23)	4.15 (2.14)	4.87 (2.31)	5.15 (2.36)	4.16 (2.15)	3.97 (2.05)	4.84 (2.19)	3.72 (2.05)	4.34 (2.19)	4.30 (2.19) <sup>a</sup>
T <sub>2</sub>	4.12 (2.15)	4.72 (2.27)	2.74 (1.77)	3.77 (2.04)	3.82 (2.06)	3.37 (1.95)	4.28 (2.13)	4.44 (2.17)	3.75 (2.04)	3.70 (2.03)	4.33 (2.10)	3.29 (1.93)	3.92 (2.10)	3.84 (2.08) <sup>a</sup>
T <sub>3</sub>	4.41 (2.20)	5.86 (2.51)	3.92 (2.08)	5.24 (2.39)	5.38 (2.41)	5.29 (2.40)	5.46 (2.43)	5.34 (2.37)	5.10 (2.34)	4.81 (2.27)	5.53 (2.38)	4.77 (2.29)	5.17 (2.38)	5.16 (2.38) <sup>b</sup>
T <sub>4</sub>	5.15 (2.38)	6.55 (2.65)	4.87 (2.31)	5.64 (2.48)	6.81 (2.70)	6.11 (2.57)	6.48 (2.64)	6.89 (2.70)	6.35 (2.61)	6.11 (2.57)	6.75 (2.56)	5.78 (2.50)	6.08 (2.56)	6.20 (2.59) <sup>cd</sup>
T <sub>5</sub>	5.37 (2.42)	7.20 (2.77)	5.34 (2.39)	5.85 (2.51)	6.83 (2.70)	6.68 (2.67)	6.75 (2.68)	6.92 (2.72)	6.70 (2.68)	6.58 (2.65)	6.98 (2.62)	6.24 (2.59)	6.39 (2.62)	6.54 (2.65) <sup>cd</sup>
T <sub>6</sub>	4.78 (2.29)	6.12 (2.57)	4.21 (2.17)	5.42 (2.42)	5.49 (2.45)	5.46 (2.43)	5.99 (2.54)	5.94 (2.54)	5.45 (2.44)	5.34 (2.40)	5.85 (2.46)	5.04 (2.35)	5.58 (2.46)	5.49 (2.45) <sup>bc</sup>
T <sub>7</sub>	5.55 (2.46)	7.20 (2.77)	5.95 (2.52)	6.90 (2.71)	7.16 (2.76)	7.18 (2.75)	7.26 (2.79)	7.18 (2.77)	6.94 (2.71)	6.73 (2.69)	7.18 (2.73)	6.69 (2.67)	6.96 (2.73)	6.94 (2.73) <sup>d</sup>
T <sub>8</sub>	4.96 (2.34)	6.47 (2.64)	4.66 (2.27)	5.48 (2.44)	5.73 (2.49)	5.57 (2.45)	6.27 (2.59)	6.45 (2.63)	5.56 (2.44)	5.42 (2.42)	6.22 (2.49)	5.26 (2.40)	5.72 (2.49)	5.73 (2.50) <sup>bc</sup>
T <sub>9</sub>	5.60 (2.47)	7.87 (2.89)	7.55 (2.83)	8.16 (2.93)	8.37 (2.98)	9.17 (3.11)	10.48 (3.31)	12.06 (3.53)	13.85 (3.78)	15.50 (3.99)	9.43 (3.44)	10.19 (3.27)	11.38 (3.44)	10.34 (3.29) <sup>e</sup>
S.Em. ±	0.092	0.133	0.171	0.162	0.149	0.154	0.173	0.208	0.183	0.209	0.090	0.103	0.080	0.063
CD (0.05)	NS	0.395	0.507	0.482	0.444	0.458	0.514	0.618	0.543	0.620	0.266	0.305	0.237	0.188
CV %	6.88	8.88	13.18	11.46	10.23	10.69	11.52	13.62	12.28	14.09	5.98	7.26	5.42	4.31

\*Figures in the parenthesis are square root + 0.5 transformed value and those outside are original value. DNMR has been used.

**Table 3:** Effectiveness of various entomopathogens and botanicals against mango hopper during 2023-24.

Treatment	No. of hoppers per panicle												Overall Pooled (3 Sprays)	
	I Spray			II Spray			III Spray			Pooled				
	BS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS		9 DAS
T <sub>1</sub>	4.80 (2.30)*	4.54 (2.22)	2.87 (1.84)	3.93 (2.09)	4.09 (2.11)	3.91 (2.08)	4.72 (2.28)	4.73 (2.27)	4.22 (2.16)	4.31 (2.14)	4.45 (2.22)	3.67 (2.04)	4.32 (2.19)	4.15 (2.15) <sup>a</sup>
T <sub>2</sub>	4.58 (2.25)	4.32 (2.18)	2.79 (1.79)	3.65 (2.01)	3.61 (2.00)	3.24 (1.92)	4.06 (2.13)	4.51 (2.19)	3.65 (2.01)	3.75 (2.04)	4.15 (2.14)	3.23 (1.92)	3.82 (2.08)	3.73 (2.05) <sup>a</sup>
T <sub>3</sub>	4.88 (2.31)	5.59 (2.46)	4.06 (2.12)	5.09 (2.35)	5.03 (2.32)	4.85 (2.31)	5.51 (2.45)	5.13 (2.35)	5.10 (2.34)	5.16 (2.35)	5.25 (2.39)	4.67 (2.27)	5.25 (2.40)	5.06 (2.36) <sup>b</sup>
T <sub>4</sub>	5.68 (2.49)	6.37 (2.62)	5.35 (2.39)	5.70 (2.48)	6.43 (2.63)	6.25 (2.59)	6.59 (2.65)	6.86 (2.71)	7.11 (2.75)	6.81 (2.70)	6.55 (2.66)	6.24 (2.59)	6.37 (2.62)	6.39 (2.62) <sup>cd</sup>
T <sub>5</sub>	5.82 (2.51)	6.81 (2.70)	6.03 (2.54)	6.72 (2.68)	6.90 (2.71)	6.80 (2.68)	6.80 (2.70)	7.38 (2.81)	7.16 (2.75)	7.47 (2.82)	7.03 (2.74)	6.66 (2.67)	7.00 (2.74)	6.90 (2.72) <sup>d</sup>
T <sub>6</sub>	5.55 (2.46)	6.23 (2.59)	4.46 (2.22)	5.41 (2.42)	5.77 (2.50)	5.31 (2.40)	6.14 (2.57)	6.15 (2.58)	5.34 (2.39)	5.49 (2.43)	6.05 (2.56)	5.04 (2.35)	5.68 (2.48)	5.59 (2.47) <sup>bc</sup>
T <sub>7</sub>	5.60 (2.46)	6.35 (2.61)	4.96 (2.33)	5.57 (2.46)	6.08 (2.56)	5.96 (2.54)	6.33 (2.60)	6.72 (2.67)	6.50 (2.64)	6.57 (2.66)	6.39 (2.62)	5.81 (2.51)	6.16 (2.58)	6.12 (2.57) <sup>bcd</sup>
T <sub>8</sub>	5.43 (2.44)	5.88 (2.52)	4.43 (2.22)	5.36 (2.41)	5.72 (2.49)	5.13 (2.36)	6.04 (2.55)	6.12 (2.56)	5.17 (2.38)	5.41 (2.42)	5.91 (2.53)	4.91 (2.32)	5.60 (2.47)	5.47 (2.44) <sup>bc</sup>
T <sub>9</sub>	6.07 (2.56)	7.13 (2.76)	7.38 (2.79)	7.71 (2.85)	8.15 (2.94)	9.26 (3.12)	10.69 (3.34)	12.56 (3.60)	13.70 (3.76)	16.20 (4.09)	9.28 (3.12)	10.11 (3.26)	11.54 (3.47)	10.31 (3.29) <sup>e</sup>
S.Em. ±	0.087	0.126	0.174	0.160	0.182	0.158	0.119	0.203	0.181	0.187	0.092	0.106	0.081	0.068
CD (0.05)	NS	0.375	0.517	0.476	0.542	0.468	0.355	0.603	0.537	0.556	0.274	0.314	0.239	0.202
CV %	6.20	8.68	13.42	11.47	12.78	11.17	7.99	13.35	12.15	12.33	6.26	7.52	5.45	4.68

\*Figures in the parenthesis are square root + 0.5 transformed value and those outside are original value. DNMRT has been used.

**Table 4:** Effectiveness of various entomopathogens and botanicals against mango hopper during 2021-24 (Pooled)

Treatment	No. of hoppers per panicle												Overall Pooled (3 Sprays)	
	I Spray			II Spray			III Spr			Pooled				
	BS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS	9 DAS	3 DAS	7 DAS		9 DAS
T <sub>1</sub>	4.82 (2.30)*	4.56 (2.23)	2.90 (1.84)	3.97 (2.10)	4.24 (2.15)	3.93 (2.09)	4.84 (2.29)	5.07 (2.34)	4.25 (2.17)	4.34 (2.15)	4.62 (2.26)	3.69 (2.05)	4.38 (2.20)	4.23 (2.17) <sup>a</sup>
T <sub>2</sub>	4.60 (2.25)	4.33 (2.18)	2.82 (1.79)	3.68 (2.02)	3.64 (2.01)	3.27 (1.92)	4.08 (2.11)	4.54 (2.19)	3.68 (2.02)	3.78 (2.05)	4.17 (2.15)	3.26 (1.93)	3.85 (2.08)	3.76 (2.06) <sup>a</sup>
T <sub>3</sub>	4.94 (2.32)	5.61 (2.46)	4.10 (2.13)	5.13 (2.36)	5.30 (2.38)	4.88 (2.32)	5.55 (2.45)	5.57 (2.43)	5.12 (2.35)	5.19 (2.36)	5.49 (2.44)	4.70 (2.28)	5.29 (2.41)	5.16 (2.38) <sup>b</sup>
T <sub>4</sub>	5.68 (2.48)	6.37 (2.62)	5.14 (2.36)	5.63 (2.47)	6.41 (2.62)	6.08 (2.56)	6.31 (2.60)	6.84 (2.70)	6.73 (2.68)	6.67 (2.67)	6.54 (2.65)	5.98 (2.54)	6.21 (2.59)	6.24 (2.60) <sup>cd</sup>
T <sub>5</sub>	5.84 (2.51)	6.83 (2.70)	5.60 (2.44)	6.07 (2.55)	6.61 (2.66)	6.47 (2.63)	6.52 (2.64)	7.07 (2.75)	7.15 (2.76)	7.07 (2.75)	6.83 (2.71)	6.41 (2.62)	6.55 (2.65)	6.60 (2.66) <sup>cd</sup>
T <sub>6</sub>	5.57 (2.46)	6.03 (2.55)	4.46 (2.22)	5.41 (2.42)	5.72 (2.49)	5.21 (2.38)	6.10 (2.56)	6.11 (2.57)	5.34 (2.41)	5.49 (2.43)	5.95 (2.54)	5.00 (2.34)	5.67 (2.48)	5.54 (2.46) <sup>bc</sup>
T <sub>7</sub>	5.59 (2.46)	6.81 (2.70)	5.70 (2.48)	6.44 (2.63)	6.73 (2.68)	6.55 (2.63)	6.68 (2.67)	7.19 (2.76)	6.98 (2.72)	7.21 (2.77)	6.91 (2.72)	6.41 (2.62)	6.77 (2.69)	6.70 (2.68) <sup>d</sup>
T <sub>8</sub>	5.45 (2.44)	6.14 (2.58)	4.70 (2.28)	5.42 (2.43)	5.79 (2.50)	5.28 (2.39)	6.44 (2.63)	6.32 (2.60)	5.32 (2.40)	5.50 (2.44)	6.09 (2.56)	5.10 (2.36)	5.79 (2.51)	5.66 (2.48) <sup>bcd</sup>
T <sub>9</sub>	6.09 (2.56)	7.35 (2.80)	7.41 (2.80)	7.74 (2.86)	8.19 (2.94)	9.29 (3.13)	10.73 (3.35)	12.37 (3.57)	13.91 (3.79)	16.23 (4.08)	9.30 (3.13)	10.20 (3.27)	11.57 (3.47)	10.36 (3.29) <sup>e</sup>
S.Em. + (T)	0.051	0.077	0.100	0.093	0.097	0.091	0.089	0.120	0.105	0.113	0.052	0.060	0.052	0.040
YXT	0.09	0.13	0.17	0.16	0.17	0.16	0.15	0.21	0.18	0.20	0.09	0.10	0.09	0.07
CD (0.05) (T)	0.144	0.218	0.283	0.263	0.276	0.258	0.253	0.341	0.298	0.321	0.147	0.170	0.147	0.114
YXT	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV %	6.27	9.11	13.23	11.46	11.72	11.15	10.33	13.57	12.17	12.91	6.05	7.36	6.06	4.76

\*Figures in the parenthesis are square root + 0.5 transformed value and those outside are original value. DNMRT has been used

**Result and Discussion**

Three entomopathogens with two botanicals were evaluated against the mango hopper. Population of mango hoppers was remained non-significant in all treatments before imposition of spray during 2021-22 (Table 1). All treatments remained significantly superior over untreated control at different post spray interval. The overall pooled data of three sprays revealed that the significantly lowest

incidence of hopper population was recorded in the treatment T<sub>2</sub> (*Beauveria bassiana* 1.15 WP @ 60g/10 lit.) (3.70 hopper/panicle) found most effective treatment which was at par with T<sub>1</sub> (*Metarhizium anisopliae* 1.15 WP @ 60g/10 lit.) (4.25 hopper/panicle). Moreover, the control treatment recorded significantly highest hopper per panicle (10.43) compared to the other treatments.

During 2022-23, population of mango hoppers was remained non-significant in all treatments before imposition of spray (Table 2). All treatments remained significantly superior over untreated control at different post spray interval. The overall pooled data of three sprays revealed that the significantly lowest incidence of hopper population was recorded in the treatment T<sub>2</sub> (*Beauveria bassiana* 1.15 WP @ 60g/10 lit.) (3.84 hopper/panicle) found most effective treatment which was at par with T<sub>1</sub> (*Metarhizium anisopliae* 1.15 WP @ 60g/10 lit.) (4.30 hopper/panicle). Moreover, the control treatment recorded significantly highest hopper per panicle (10.34) as compared to the other treatments.

Population of mango hoppers was remained non-significant in all treatments before imposition of spray (Table 3). All treatments remained significantly superior over untreated control at different post spray interval. The overall pooled data of three sprays revealed that the significantly lowest incidence of hopper population was recorded in the treatment T<sub>2</sub> (*Beauveria bassiana* 1.15 WP @ 60g/10 lit.) (3.73 hopper/panicle) found most effective treatment which was at par with T<sub>1</sub> (*Metarhizium anisopliae* 1.15 WP @ 60g/10 lit.) (4.15 hopper/panicle). Moreover, the control treatment recorded significantly highest hopper per panicle (10.31) as compared to the other treatments during 2023-24. Pooled data over year revealed that populations of mango hoppers were remained nonsignificant in all nine treatments before imposition of spray (Table 1). All treatments remained significantly superior over untreated control at different post spray interval. The pooled data showed that significantly lowest population was recorded in T<sub>2</sub> (*Beauveria bassiana* 1.15 WP (1 x 10<sup>8</sup> cfu/g) (4.17 hopper/panicle) which was at par with T<sub>1</sub> (*Metarhizium anisopliae* 1.15 WP (1 x 10<sup>8</sup> cfu/g) (4.62 hopper/panicle) after 3 days spray. Similar trend were observed at 7 and 9 days after spray. Overall results of pooled data indicated that lower hopper population was recorded in T<sub>2</sub> (3.76 hopper/panicle) which was at par with T<sub>1</sub> (4.23 hopper/panicle). Moreover, significantly highest hopper population (10.36 hopper/panicle) was recorded in untreated control as compared to other treatments. These results were close agreement with Srivastava and Tandon (1986)<sup>[11]</sup> who reported the efficacy of *Verticillium lecanii* against mango hopper in Uttar Pradesh. Gurav (2012)<sup>[4]</sup> reported *V. lecanii* @ 109 cfu/ml as the most effective treatment with 93.34% mortality of mango hopper at Dapoli, Maharashtra. Turkhade (2015)<sup>[14]</sup> who studied the combination effect of different entomopathogens, reported that the combination of *V. lecanii* + *M. anisopliae* + *B. bassiana* was effective against mango hopper at Dapoli, Maharashtra. Valvi *et al.* (2018)<sup>[15]</sup> recorded the minimum number of the hoppers were recorded in trees given mixed application of *Leccaniicillium leccanii* + *Metarhizium anisopliae* (0.59 hoppers /5panicles) and sole application of *Metarhizium anisopliae* (1.11 hoppers /5panicles).

## References

- Adnan SM, Uddin MM, Alam MJ. Management of mango hopper, *Idioscopus clypealis*, using chemical insecticides and neem oil. The Scientific World Journal,2014:2014:1–5. <https://doi.org/10.1155/2014/709614>.
- Anonymous. Agriculture Statistics of Pakistan. Government of Pakistan, Ministry of Food, Agriculture

- and Livestock. Economic, Trade and Investment Wing. Islamabad, Pakistan, 2011.
- FAO. The Food and Agriculture Organization database (FAOSTAT), 2007.
- Gurav PK. Evaluation of entomopathogenic fungi and botanicals for the management of mango hopper and thrips. M.Sc. (Agri.) thesis submitted to Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra, 2012.
- Joshi PC, Kumar S. Effect of some meteorological factors on seasonal abundance of *Idioscopus nitidulus* (Walker) (Hemiptera: Cicadellidae) in mango orchards of Haridwar (India). New York Science Journal,2012:5:101–103.
- Masoodi KZ, Amin I, Mansoor S. Chapter 11: Botanicals from the Himalayas with anticancer potential—an emphasis on Kashmir Himalayas. In: Munir Ozturk M, Egamberdieva D, Pesic M, editors. Biodiversity and Biomedicine—Our Future. Academic Press, London, 2020, 189–234.
- Munj AY, Halgekar NY, Salvi BR. Effective management module to minimize the crop loss in Alphonso mango due to mango hopper. Environment and Ecology,2015:33(4B):1969–1971.
- Ojokoh AO. Effect of fermentation on the chemical composition of mango, *Mangifera indica* L. African Journal of Biotechnology,2007:6:1979–198.
- Patel JR, Shekh AM, Ratanpara HC. Seasonal incidence and effect of minimum temperature and vapour pressure on the population of mango hoppers in middle Gujarat. Gujarat Agricultural University Research Journal,2004:20:5–8.
- Salunkhe DK, Desai BB. Post Harvest Technology of Fruits. Vol.1. Boca Raton, Fla, USA: CRC Press: 1994.
- Srivastava RP, Tandon PL. Natural occurrence of two entomogenous fungi pathogenic to mango leaf hopper. Indian Journal of Plant Pathology,1986:4:121–123.
- Tharanathan RN, Yashoda HM, Prabha TN. Mango (*Mangifera indica* L.), “the king of fruits”—an overview. Food Reviews International,2006:22(2):95–123.
- Thiruvani T, Ganesh Kumar M, Kuttalam S. Field evaluation of a new indigenous thiamethoxam 25% WG formulation against mango hopper. Pestology,2014:38(4):76–78.
- Turkhade PD. Ecofriendly management of mango hopper *Idioscopus niveosparus*. M.Sc. (Agri.) thesis submitted to Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra, 2015.
- Valvi AS, Mohite PB, Tarate SP. Efficacy of various entomopathogenic fungi against mango hopper (*Amritodus atkinsoni* Leth.). Journal of Pharmacognosy and Phytochemistry,2018:7(5):1847–1851.