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Management of mango hopper using entomopathogens

AY Munj, PV Reddy, Gundappa, JK Bana and S Irulandi

Abstract
Mango hopper is an important pest of mango in India, causing severe yield losses. Many insecticides have been recommended so far for the management of mango hopper. These inorganic synthetic insecticides have many side effects including resurgence, resistance, residue, etc. Therefore, there is a need to recommend eco-friendly control measures for the management of mango hopper. Experiments were conducted at different mango research centers in different states of India for management of mango hopper with different entomopathogens during 2015-16 to 2017-18. The results revealed that the treatment of five sprays of *Metarrhizium anisopliae* (oil formulation @ 0.5 ml/l.) supplied by IIHR, Bengaluru was the most effective at Bengaluru and Periyakulam, whereas, the treatment of five sprays of *Verticillium lecanii* (Commercial product @ 5 gm/l.) was the most effective at Lucknow, Paria and Vengurle.

Keywords: Mango hopper, management, entomopathogens, *Metarrhizium anisopliae, Verticillium lecanii*

Introduction
Mango, *Mangifera indica* L. is an important fruit crop grown in India. It is found to be infested by more than 50 insect pests [1]. Mango hopper is one of the most serious pests responsible for about 60 percent losses in fruit yield [2]. Three species of mango hoppers *viz. Amritodus atkinsoni*, *Idioscopus clypealis* and *I. nitidulus* are commonly found all over India [3].
The female hoppers lay eggs in the midrib on the under surface of tender leaves and on the tender panicles at the time of panicle initiation. The incubation period is 3 to 5 days and nymphal period is 10 to 15 days [4]. The hopper incidence is severe during November to March in different parts of India [5]. The adult hoppers as well as nymphs damage all the tender part of mango *viz*., tender foliage, inflorescence and fruits. They suck cell sap from these plant parts, as a result there is twisting of tender leaves, blackening of inflorescence and shading of flowers. Also, the yield is badly affected. In addition, hoppers excrete honey dew like substance on which black sooty mould (*Capnodium mangiferae*) grows which interferes with the photosynthetic activity of leaves and reduces the market value of fruits [6].
Many inorganic insecticides have been recommended so far, for management of mango hopper throughout India [7-13]. However, harmful chemical insecticides used for the management of mango hopper created many problems like resistance, resurgence, residue among others.[14] Therefore, there is a need for eco-friendly practices for the management of mango hopper. The present study was conducted using different entomopathogens under the All India Co-ordinated Research Project on Fruits at five research institutes *viz*., IIHR-Bengaluru (Karnataka), CISH-Lucknow (Uttar Pradesh), AES-Paria (Gujarat), CHRI-Periyakulam (Tamil Nadu) and RFRS-Vengurle (Maharashtra).

Materials and Methods
The management trials were conducted at the five research institutes in 2015-16, 2016-17 and 2017-18. The experiments were conducted in a RBD with 7 treatments and 3 replications.

Treatment details

T_1	:	Foliar application of *Verticillium lecanii* @ 5 g/l ($1x10^8$ cfu/g) – commercial product
T_2	:	Foliar application of *Metarhizium anisopliae* (IIHR liquid formulation @ 1ml/10 l)
T_3	:	Foliar application of consortia of *M. anisopliae* + *B. bassiana* (IIHR liquid formulation @ 1ml/10 l)
T_4	:	Spray of IIHR formulation of *Metarhizium anisopliae* (IIHR oil formulation @ 0.5 ml/l)
T_5	:	Spray of IIHR formulation of *Beavaria bassiana* (IIHR liquid formulation @ 1ml/l)
T_6	:	1st spray of spinosad 45 SL @ 0.004% at panicle emergence stage followed by 2nd spray (21 days after 1st) with thiamethoxam @ 0.008% and 3rd need based spray of neemazal 10000 ppm @ 3ml/l (Standard Check)
T_7	:	Control

Spray schedule

1st spray - At panicle initiation stage
2nd spray- 7 days after 1st spray
3rd spray - 7 days after 2nd spray
4th spray - At pea nut stage
5th spray - At marble stage

Observations on hopper population

Ten panicles were labeled randomly on each tree and the number of hoppers (nymphs and adults) observed on these panicles were counted. The pre-treatment observations were recorded 24 hours before each spray and the post treatment observations were recorded 7 days after each spray.

Results and Discussion

The pooled data (2015-16 to 2017-18) recorded on the efficacy of different treatments against mango hopper at different centers are presented in table 1. The pre count observations recorded a day before insecticidal application were statistically non-significant at all the centers. This indicates that the mango hopper population was uniform throughout the experimental area. The data recorded 7 days after last spray revealed that for management of mango hopper, the treatment T_6 (Standard check) was the most effective at all the centers except in Lucknow.

Among the different entomopathogen treatments used, treatment T_4 (Spray of IIHR oil formulation of *Metarhizium anisopliae* @ 0.5 ml/l) was found to be the most effective at Bengaluru and Periyakulam and significantly superior to all other treatments. Treatment T_4 recorded the least hopper count at Bengaluru (1.04 hopper/panicle) and Periyakulam (10.90 hopper/panicle) at 7 days after last spray as against 11.57 and 22.79 hoppers/panicle in untreated control, respectively.

Apart from standard check, treatment T_1 (Foliar application of *Verticillium lecanii* @ 5 g/l – commercial product) was found to be the most effective for management of mango hopper at Lucknow, Paria and Vengurle and was significantly superior to the rest of the treatments at Lucknow and Paria, whereas, at Vengurle, it was at par with T_4. Treatment T_1 recorded the least hopper count at Lucknow (0.93 hopper/panicle), Paria (4.52 hopper/panicle) and Vengurle (0.80 hopper/panicle) as against 8.67, 10.72 and 5.53 hoppers/panicle in untreated control, respectively.

The yield data recorded under different treatments at different centers is presented in table 2. The data revealed that the maximum yield was recorded in treatment T_6 at Bengaluru (78.20 kg/tree), Paria (52.89 kg/tree), Periyakulam (66.17 kg/tree) and Vengurle (33.18 kg/tree). Treatment T_4 recorded the maximum yield at Bengaluru (71.45 kg/tree), Lucknow (57.16 kg/tree), Periyaluam (62.69 kg/tree) and Vengurle (31.39 kg/tree) and was significantly superior to rest of the treatments at Bengaluru, Lucknow and Periyakulam. However, at Vengurle, T_4 was at par with T_1. At Paria, treatment T_1 recorded the maximum yield (46.10 kg/tree) which was significantly superior to all other treatments.

The B:C ratio obtained under different treatments at different centers is presented in Table 2. The data revealed that, treatment T_4 recorded the maximum B:C ratio at Bengaluru (4.15), Lucknow (8.73), Periyakulam (2.29) and Vengurle (1.42). Whereas, at Paria the maximum B:C ratio was recorded under treatment T_5 (1.84) followed by T_1 (1.54).

These results are in close agreement with Srivastava[15] who reported the efficacy of *Verticillium lecanii* against mango hopper in Utttar Pradesh. Gurav[16] reported *V. lecanii* @ 10^9 cfu/ml. as the most effective treatment with 93.34% mortality of mango hopper at Dapoli, Maharashtra during 2012. Turkhade[17], 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 during 2014.

Table 1: Efficacy of different treatments against mango hopper (pooled data of 2015-16, 2016-17 and 2017-18)

Treatment	Hopper population/panicle									
	Bengaluru		Lucknow		Paria		Periyakulam		Vengurle	
	Pre count	After last spray	Pre Count	After last Spray	Pre count	After last spray	Pre count	After last spray	Pre count	After last spray
T_1	6.00 (2.45)*	2.10 (1.45)	6.20 (2.48)	0.93 (0.64)	8.76 (2.96)	4.52 (2.13)	15.85 (3.98)	15.72 (3.97)	8.43 (3.06)	0.80 (1.30)
T_2	5.86 (2.41)	2.74 (1.65)	6.93 (2.59)	3.93 (1.84)	8.31 (2.88)	6.67 (2.58)	17.02 (4.13)	13.61 (3.75)	7.87 (2.96)	1.58 (1.65)
T_3	7.22 (2.68)	2.93 (1.71)	7.90 (2.74)	4.07 (1.96)	7.67 (2.76)	6.72 (2.59)	15.75 (3.97)	14.97 (3.89)	8.97 (3.13)	1.42 (1.61)
T_4	6.66 (2.58)	1.04 (1.01)	7.42 (2.57)	4.23 (1.85)	7.99 (2.83)	5.67 (2.38)	16.19 (4.02)	10.90 (3.31)	8.42 (3.05)	0.96 (1.35)
T_5	5.93 (2.43)	4.06 (2.01)	8.03 (2.83)	5.90 (2.43)	8.40 (2.89)	5.75 (2.40)	17.97 (4.23)	15.13 (3.91)	8.38 3.04)	1.94 (1.74)
T_6	7.33 (2.70)	0.85 (0.92)	7.43 (2.64)	5.63 (2.04)	9.06 (3.01)	3.64 (1.51)	15.91 (3.99)	5.37 (2.29)	8.02 (2.99)	0.46 (1.14)
T_7	6.66	11.57	7.83	8.67	8.46	10.72	15.85	22.79	8.93	5.53 (2.44)

	(2.58)	(3.40)	(2.67)	(2.88)	(2.91)	(3.27)	(3.98)	(4.69)	(3.13)	
CD (0.5%)	N.S.	0.24	NS	0.20	N.S.	0.08	NS	0.40	N.S.	0.30

*indicates $\sqrt{n+1}$ transformed values

Table 2: Yield and B: C ratio recorded in different treatments (pooled data of 2015-16, 2016-17 and 2017-18)

Sr. No.	Treatment	Yield (kg/tree)									
		Bengaluru		Lucknow		Paria		Periyakulam		Vengurle	
		Yield	B:C ratio	Yield	B:C ratio	Yield	B:C ratio	Yield	B:C ratio	Yield	B:C ratio
1	T_1	61.95	1.27	37.27	4.47	46.10	1.54	48.87	1.75	30.97	1.38
2	T_2	57.60	3.23	29.63	2.02	34.14	1.01	51.62	1.89	28.17	1.23
3	T_3	59.30	3.46	27.55	1.29	36.67	1.36	50.71	2.11	27.81	1.20
4	T_4	71.45	4.15	57.16	8.73	39.75	1.10	62.89	2.29	31.39	1.42
5	T_5	50.15	2.24	36.50	4.35	42.76	1.80	49.42	1.79	28.93	1.22
6	T_6	78.20	3.36	53.67	4.37	52.89	2.60	66.17	2.52	33.18	1.50
7	T_7	33.40	-	20.77	--	19.63	-	43.62	-	24.00	-
	CD (0.5%)	8.43	-	2.70		3.70		1.23	-	2.96	

Conclusion

From the overall results, it can be concluded that for eco-friendly management of mango hopper, the oil based formulation of *M. anisopliae* supplied by IIHR, Bengaluru was the most effective at Bengaluru, Lucknow, Periyakulam and Vengurle, whereas, *V. lecanii* (commercial product) was found to be the most effective at Paria.

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