Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(3): 1049-1053

Received: 10-03-2020
Accepted: 12-04-2020

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Efficacy of different bio-pesticides against brinjal mite, *Tetranychus urticae* Koch

NB Patel, RK Thumar and CC Patel

Abstract
An experiment was conducted to assess the efficacy of different nine bio-pesticides against brinjal mite viz. tobacco decoction 2%, neem seed kernel extract 5%, neem oil 0.5%, Azadirachtin 0.0006% (Gronim), Azadirachtin 0.0006% (Vanguard), Azadirachtin 0.0006% (Neemazal), *Lecanicilium lecanii* 0.4%, *Metarhizium anisopliae* 0.4% and *Beauveria bassiana* 0.4% compared with control. Of these, neem oil 0.5% found most effective followed by NSKE 5% against mite. The bio-pesticides Neemazal 0.0006% and Gronim 0.0006% also proved better in suppressing mite population in brinjal. The treatment of *B. bassiana* 0.4% proved least effective in mitigating the mite population in brinjal as it recorded significantly the highest population of the pest.

Keywords: *Tetranychus urticae*, bio-pesticides, efficacy, brinjal, mite

1. Introduction
Brinjal (*Solanum melongena* L.) is one of the most important vegetable of India. It is a member of family Solanaceae and is a native of India, grown throughout the country and grown in all seasons [1]. In India, brinjal crop is subjected to attack by a number of insect-pests right from nursery stage till harvesting which affects crop cultivation and acts as a limiting factor in the profitable cultivation. The brinjal crop is prone to attack by 44 pests [2], 36 insects [3], whereas 53 insects reported attacking brinjal crop [4]. Among them, shoot and fruit borer, *Leucinodes orbonalis* Guenee; jassid, *Amrasca biguttula biguttula* (Ishida); whitefly, *Bemisia tabaci* Gennadius; ; stem borer, *Euzophera perticella* Ragonot; aphid, *Aphis gossypii* Glover and non-insect pests like mites especially two spotted spider mite, *Tetranychus urticae* Koch are the main bottle necks in brinjal productivity [5]. Among non-insect pests, mites are considerable notorious pests and gaining tremendous importance in recent years owing to their devastating nature and damage potential. Red spider mites ranked as a major threat next to shoot and fruit borer in brinjal crop [6]. The two spotted spider mite, *T. urticae* is a cosmopolitan agricultural pest belonging to an assemblage of web-spinning mites. These mites are minute, found in large colonies on the underside of leaves underneath fine silky webs and feed using piercing and sucking process that damages plant cells and tissues. This behaviour leads to the appearance of characteristic yellow chlorotic spots on leaves, photosynthesis declines, stomata remains closed and transpiration decreases, finally affecting the quality and quantitative yield of brinjal crop. An average yield reduction was estimated 26 to 39 per cent under Bangalore conditions [7] and 15.29 to81.10 per cent under south Gujarat conditions [8].
Now-a-days, numbers of new molecules are available in the market for pest management in different crops and they are also less toxic to natural enemies as well as human being. So by using these types of molecules, we can manage brinjal mites. Besides chemical insecticides, some botanicals and their readymade products are available in the market. Bio-pesticides are also found effective for the management of mites. So, there is a need to study the bio-efficacy of different bio-pesticides for the effective and economical control of brinjal mites. Therefore, the present study was carried out to insight the knowledge on this aspect.

2. Materials and Methods
Field experiments were carried out to evaluate different bio-pesticides against *T. urticae* on brinjal during *kharif-rabi* seasons of 2014-15 and 2015-16 at main Vegetable Research Station, Anand Agricultural University, Anand, Gujarat.
The experiment was laid out in Randomized Block Design with ten bio-pesticides treatments including control and with three replications.

For the purpose, brinjal variety Doli-5 was transplanted in 2nd week of September at a spacing of 90 x 60 cm having plot size 4.5 x 3.6 m. All the recommended agronomical practices were followed for raising the crop.

The treatments included tobacco decoction 2%, neem seed kernel extract 5%, neem oil 0.5%, Azadirachtin 0.0006% (Gronim), Azadirachtin 0.0006% (Vanguard), Azadirachtin 0.0006% (Neemazal), *Lecanicilium lecanii* 0.4%, *Metarhizium anisopliae* 0.4% and *Beauveria bassiana* 0.4% along with untreated control. The treatments were applied with the help of Knapsack sprayer. The first spray of respective bio-pesticides was applied on the appearance of mite and second spray after 15 days of first spray.

To ascertain the field efficacy of various bio-pesticides against *T. urticae*, observations on mite population were recorded by randomly selecting five plants from each plot. From each plant, three leaves one each from top, middle and bottom canopies were sampled and spider mite population which include mobile stage was recorded one day before spraying (pre-treatment) and 3, 7, 10 and 15 days after spraying using a stereo-binocular microscope. The mite population was recorded in 4.0 cm^2 (2.0 × 2.0 cm) area per leaf. Considering the activity of mite, two sprays were given during the crop period.

The data from the field experiments were subjected to $\sqrt{X+0.5}$ transformation and analyzed statistically for comparing treatments following Analysis of Variance technique (ANOVA) for Randomized Block Design (RBD) and the results were interpreted at 5% level of significance.

3. Results and Discussion

The year wise data on bio-efficacy of different bio-pesticides against spider mite, *T. urticae* infecting brinjal are presented hereunder:

3.1 Year 2014-15: The data (Table 1) on population of brinjal mite, *T. urticae* population recorded before spray showed non-significant difference among different treatments indicated that the mite population was uniformly distributed in all the experimental plots.

The data of pooled over periods for the first spray revealed that the reduction in mite population was significantly higher in plots treated with neem oil 0.5% (3.62 mites/4cm^2 leaf) than rest of the bio-pesticides treated plots, except NSKE 5% (3.66 mites/4cm^2 leaf) with which it remained at par. On the other hand, treatment of *B. bassiana* (9.30 mites/4 cm^2 leaf) proved least effective against mite, however, this bio-pesticide exhibited significantly lower incidence of mite than the untreated control (16.06 mites/4 cm^2 leaf).

The pooled data computed for the second spray registered significantly least number of mites (2.81 mites/4 cm^2 leaf) in the plots sprayed with neem oil 0.5%. The plots sprayed with NSKE 5% also proved better bio-pesticide for mite control and stood next to neem oil. Amongst the different bio-pesticides tested, *B. bassiana* 0.4% proved inferior (9.42 mites/4 cm^2 leaf) in suppressing the mite incidence in brinjal, however, this bio-pesticide exhibited less number of mites (16.81 mites/4 cm^2 leaf) in comparison to unsprayed plots.

Pooled over periods and sprays data computed for *kharif-rabi*, 2014-15 indicated that significantly least numbers of mites (3.22 mites/4 cm^2 leaf) were observed in plots treated with neem oil (0.5%) followed by NSKE 5% (3.46 mites/4 cm^2 leaf). Amongst the bio-pesticides, maximum (9.36 mites/4 cm^2 leaf) incidence of the pest was observed in plots sprayed with *B. bassiana* 0.4% followed by *L. lecanii* 0.4% (7.74 mites/4 cm^2 leaf) and *M. anisopliae* 0.4% (7.45 mites/4 cm^2 leaf).

3.2 Year 2015-16: Data (Table 2) on mite, *T. urticae* population recorded before imposing of bio-pesticidal spray showed non-significant variation among the different treatments indicating uniform distribution of the pest in all experimental plots.

Pooled over periods data worked out for the first spray indicated that significantly least (3.19 mites/4 cm^2 leaf) number of mites were observed in the plots treated with neem oil 0.5%. It was followed by NSKE 5% (4.47 mites/4 cm^2 leaf) and neemazal 0.0006% (4.56 mites/4 cm^2 leaf). The treatment of *M. anisopliae* 0.4%, tobacco decoction 2% and Gronim 0.0006% were found moderately effective, whereas *B. bassiana* 0.4% proved least effective in suppressing the mite population.

Pooled data computed for second spray indicated that significantly less number of mites was observed in all the treated plots over untreated control. The plots received with spray of neem oil (0.5%) showed significantly least (2.63 mites/4 cm^2 leaf) population of mite while comparison with rest of the bio-pesticidal treatments. Plots treated with NSKE 5% and neemazal 0.0006% exhibited 3.83 and 4.25 mites per leaf, respectively. These bio-pesticides also proved better in mitigating the mite menace in brinjal and stood next to neem oil 0.5%. The treatment of *M. anisopliae* 0.4% and tobacco decoction 2% found moderately effective, whereas *B. bassiana* 0.4% proved inferior in suppressing the mite population.

Pooled over period and spray data for *kharif-rabi*, 2015-16 indicated that the treatment of neem oil (0.5%) registered significantly least (2.89 mites/4 cm^2 leaf) number of mites than rest of the treatments. However, the plots treated with NSKE 5% (4.12 mites/4 cm^2 leaf) and neemazal 0.0006% (4.38 mites/4 cm^2 leaf) proved better in reducing mite population and stood next to neem oil 0.5%. Amongst the bio-pesticides, maximum (9.30 mites/4 cm^2 leaf) incidence of the pest was observed in plots sprayed with *B. bassiana*.

The pooled over data of two years were presented in Table 3, showed that minimum (3.07 mites/4 cm^2 leaf) population of mite, *T. urticae* in plots sprayed with neem oil (0.5%) followed by NSKE 5% (3.78 mites/4 cm^2 leaf). These biopesticides found most effective against mites as they exhibited lower number of the pest over rest of the bio-pesticides. In respect of mite incidence, Neemazal 0.0006% and Gronim 0.0006% also proved better biopesticides in suppressing mite population in brinjal. The treatment of *B. bassiana* 0.4% proved least effective in mitigating the mite population in brinjal as it recorded significantly highest (9.30 mites/4 cm^2 leaf) population of the pest.

On the basis of aforesaid experimental results, it can be concluded that neem oil 0.5% evolved as best bio-pesticide by registering minimum population of mite on brinjal followed by NSKE 5%.

The effectiveness of neem oil as foliar spray against *T. urticae* noticed in present study is in agreement with Ramaraju *et al.* (1995) [9] observed that the application of neem oil (5%) found most effective against eggs of brinjal mite, *T. urticae*. Neem oil 2% caused up to 30 per cent mortality of *T. urticae* infesting brinjal at Varanasi (Anonymous, 2000) [10]. Ramaraju (2001) [11] reported that the application of neem oil (3%) suppressed mite, *T. urticae* population from 36.76 to

59.43% in the field experiment of brinjal. Roopa (2005) [12] found that neem oil at 2 per cent was effective against *T. macfarlanei* on brinjal. Patil and Nandihalli (2009) [13] reported that the lowest numbers of eggs as well as adults of *T. macfarlanei* were recorded from neem oil treated plots in aubergine.

The treatment of neem seed kernel extract 5% (NSKE 5%) proved as moderately effective bio-pesticide in controlling mite, *T. urticae* population in present investigation which is in conformity with the findings of Urs (1990) [14] who reported that the effectiveness of neem leaf and seed kernel extract against red spider mite, *T. urticae* in brinjal. Jhala *et al.* (1998) [15] evaluated the efficacy of various botanicals against adults of *T. cinnabarinus* in brinjal and found that NSKE 5% caused 64.77% mortality of mite. In the field experiment on brinjal, NSKE 5% recorded 42.95 to 59.95 per cent reduction of red spider mite, *T. urticae* population after two rounds of spraying (Ramaraju, 2001) [11]. Roopa (2005) [12] reported that NSKE at 5 per cent was effective against *T. macfarlanei* on brinjal at Dharwad.

4. Conclusion

The efficacy of different bio-pesticides was tested against spider mite, *T. urticae* infesting brinjal under the field conditions. Among all the available bio-pesticides, the treatment comprise with neem oil 0.5% was found most superior over rest of the treatments in terms of reducing the spider mite population however, it was followed by NSKE 5%. The treatment of *Beauveria bassiana* proved least effective in mitigating the mite population in brinjal as they recorded significantly highest population of the pest. Thus, it showed that among different bio-pesticides evaluated, neem oil 0.5% and NSKE 5% found effective against brinjal mite, *T. urticae.*

Table 1: Effectiveness of different bio-pesticides against brinjal mite, *T. urticae* during *kharif-rabi*, 2014-15

Treatments	Number of mites/ leaf											
	Before spray	1st spray (DAS)				Pooled	2nd spray (DAS)				Pooled	Pooled over periods and sprays
		3	7	10	15		3	7	10	15		
Tobacco decoction 2%	2.58* (6.16)	2.49bcd (5.70)	2.50bc (5.75)	2.62bc (6.36)	2.54abc (5.95)	2.54c (5.95)	2.63cd (6.42)	2.56cd (6.05)	2.67bc (6.63)	2.86bc (7.68)	2.68d (6.68)	2.61cd (6.31)
Neem seed kernel extract 5%	2.46 (5.55)	2.02ab (3.58)	1.83a (2.85)	1.96a (3.34)	2.37a (5.12)	2.04a (3.66)	1.97ab (3.38)	1.81ab (2.78)	1.74a (2.53)	2.22a (4.43)	1.93ab (3.22)	1.99a (3.46)
Neem oil 0.5%	2.55 (6.00)	1.95a (3.30)	1.80a (2.74)	1.97a (3.38)	2.41ab (5.31)	2.03a (3.62)	1.82a (2.81)	1.53a (1.84)	1.75a (2.56)	2.19a (4.30)	1.82a (2.81)	1.93a (3.22)
Azadirachtin 0.0006% (Gronim)	2.66 (6.58)	2.52cd (5.85)	2.47bc (5.60)	2.64bc (6.47)	2.75abcd (7.06)	2.60c (6.26)	2.41bc (5.31)	2.29bc (4.74)	2.33b (4.93)	2.43ab (5.40)	2.36c (5.07)	2.48bc (5.65)
Azadirachtin 0.0006% (Vanguard)	2.76 (7.12)	2.53cd (5.90)	2.47bc (5.60)	2.61bc (6.31)	2.73abcd (6.95)	2.59c (6.21)	2.61cd (6.31)	2.54cd (5.95)	2.70bc (6.79)	2.82bc (7.45)	2.67d (6.63)	2.62cd (6.36)
Azadirachtin 0.0006% (Neemazal)	2.66 (6.58)	2.35abc (5.02)	2.19ab (4.30)	2.12ab (3.99)	2.45ab (5.50)	2.28b (4.70)	2.14ab (4.08)	1.99ab (3.46)	1.92a (3.19)	2.28a (4.70)	2.08b (3.83)	2.18ab (4.25)
Lecanicillium lecanii 0.4%	2.76 (7.12)	2.58cd (6.16)	2.67bcd (6.63)	2.82cd (7.45)	2.94cd (8.14)	2.75c (7.06)	2.81cd (7.40)	2.95de (8.20)	3.11d (9.17)	3.11c (9.17)	3.00ef (8.50)	2.87de (7.74)
Metarhizium anisopliae 0.4%	2.83 (7.51)	2.74cd (7.01)	2.74cd (7.01)	2.64bc (6.47)	2.81bcd (7.40)	2.73c (6.95)	2.80cd (7.34)	2.74cde (7.01)	3.04cd (8.74)	3.04c (8.74)	2.91e (7.97)	2.82de (7.45)
Beauveria bassiana 0.4%	2.81 (7.40)	2.99d (8.44)	3.14d (9.36)	3.25d (10.06)	3.14d (9.36)	3.13d (9.30)	3.07d (8.92)	3.12e (9.23)	3.24d (10.00)	3.18c (9.61)	3.15f (9.42)	3.14e (9.36)
Untreated Control	3.01 (8.56)	3.61e (12.53)	4.03e (15.74)	4.44e (19.21)	4.21e (17.22)	4.07e (16.06)	3.95e (15.10)	4.15f (16.72)	4.44e (19.21)	4.10d (16.31)	4.16g (16.81)	4.12f (16.47)
S.Em. ± T	0.20	0.15	0.16	0.16	0.13	0.08	0.14	0.15	0.12	0.14	0.07	0.10
P	-	-	-	-	-	0.05	-	-	-	-	0.04	0.03
S	-	-	-	-	-	-	-	-	-	-	-	0.02
T x P	-	-	-	-	-	0.15	-	-	-	-	0.14	0.06
T x S	-	-	-	-	-	-	-	-	-	-	-	0.04
S x P	-	-	-	-	-	-	-	-	-	-	-	0.08
T x S x P	-	-	-	-	-	-	-	-	-	-	-	0.11
C. V. (%)	12.53	10.27	10.50	10.01	8.01	9.69	9.23	10.08	8.03	8.88	9.06	7.42

* Figures in parentheses are retransformed values; those outside are $\sqrt{x+0.5}$ transformed values;
Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance; NS = Not Significant; DAS = Days after spraying

Table 2: Effectiveness of different bio-pesticides against brinjal mite, *T. urticae* during *kharif-rabi*, 2015-16

Treatments	Number of mites/ leaf *											
	Before spray	1st spray (DAS)				Pooled	2nd spray (DAS)				Pooled	Pooled over periods and sprays
		3	7	10	15		3	7	10	15		
Tobacco decoction 2%	2.84* (7.57)	2.76bcd (7.12)	2.63cd (6.42)	2.70cd (6.79)	2.82cd (7.45)	2.72cd (6.90)	2.70d (6.79)	2.54de (5.95)	2.71bc (6.84)	2.03a (3.62)	2.49c (5.70)	2.61cd (6.31)
Neem seed kernel extract 5%	2.80 (7.34)	2.40ab (5.26)	2.15ab (4.12)	2.08ab (3.83)	2.29ab (4.74)	2.23b (4.47)	2.12bc (3.99)	1.97bc (3.38)	2.15a (4.12)	2.10ab (3.91)	2.08b (3.83)	2.15b (4.12)
Neem oil 0.5%	2.81 (7.40)	2.19a (4.30)	1.84a (2.89)	1.73a (2.49)	1.93a (3.22)	1.92a (3.19)	1.57a (1.96)	1.47a (1.66)	2.01a (3.54)	2.02a (3.58)	1.77a (2.63)	1.84a (2.89)
Azadirachtin 0.0006% (Gronim)	2.89 (7.85)	2.84bcd (7.57)	2.73d (6.95)	2.81cd (7.40)	2.79cd (7.28)	2.79cde (7.28)	2.59d (6.21)	2.53de (5.90)	2.80bc (7.34)	3.23d (9.93)	2.79d (7.28)	2.79cde (7.28)
Azadirachtin 0.0006% (Vanguard)	3.06 (8.86)	2.99cd (8.44)	2.92d (8.03)	2.93cd (8.08)	3.00cd (8.50)	2.96ef (8.26)	2.89d (7.85)	2.79de (7.28)	3.03bc (8.68)	3.07cd (8.92)	2.94de (8.14)	2.95ef (8.20)
Azadirachtin 0.0006% (Neemazal)	2.94 (8.14)	2.55abc (6.00)	2.20abc (4.34)	2.09ab (3.87)	2.15a (4.12)	2.25b (4.56)	2.06b (3.74)	1.89ab (3.07)	2.15a (4.12)	2.60bc (6.26)	2.18b (4.25)	2.21b (4.38)
Lecanicillium lecanii 0.4%	2.96 (8.26)	2.92cd (8.03)	2.82d (7.45)	2.91cd (7.97)	2.87cd (7.74)	2.88def (7.79)	2.76d (7.12)	2.73de (6.95)	2.90bc (7.91)	3.06cd (8.86)	2.86d (7.68)	2.87def (7.74)
Metarhizium anisopliae 0.4%	2.90 (7.91)	2.71bcd (6.84)	2.58bcd (6.16)	2.52bc (5.85)	2.65bc (6.52)	2.61c (6.31)	2.52cd (5.85)	2.39cd (5.21)	2.52ab (5.85)	2.35ab (5.02)	2.45c (5.50)	2.53c (5.90)
Beauveria bassiana 0.4%	2.86 (7.68)	3.11de (9.17)	3.03d (8.68)	3.08d (8.99)	3.16d (9.49)	3.10f (9.11)	2.97d (8.32)	3.03e (8.68)	3.20c (9.74)	3.45d (11.40)	3.16e (9.49)	3.13f (9.30)
Untreated Control	2.99 (8.44)	3.55e (12.10)	3.85e (14.32)	3.98e (15.34)	4.14e (16.64)	3.88g (14.55)	3.95e (15.10)	4.11f (16.39)	4.34d (18.34)	4.45e (19.30)	4.21f (17.22)	4.05g (15.90)
S.Em. ± T	0.19	0.14	0.14	0.14	0.15	0.07	0.14	0.15	0.16	0.17	0.08	0.10
P	-	-	-	-	-	0.05	-	-	-	-	0.05	0.03
S	-	-	-	-	-	-	-	-	-	-	-	0.02
T x P	-	-	-	-	-	0.14	-	-	-	-	0.15	0.06
T x S	-	-	-	-	-	-	-	-	-	-	-	0.04
S x P	-	-	-	-	-	-	-	-	-	-	-	0.09
T x S x P	-	-	-	-	-	-	-	-	-	-	-	0.12
C. V. (%)	11.54	8.73	9.26	8.83	9.15	8.99	9.44	9.89	9.67	10.19	9.82	7.97

* Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$ transformed values;
Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance; NS = Not Significant; DAS = Days after spraying

Table 3: Effect of different biopesticides against brinjal mite, *T. urticae*

Treatments	Number of mites/ leaf		
	2014-15	2015-16	Pooled
Tobacco decoction 2%	2.61cd (6.31)*	2.61cd (6.31)	2.61c (6.31)
Neem seed kernel extract 5%	1.99a (3.46)	2.15b (4.12)	2.07ab (3.78)
Neem oil 0.5%	1.93a (3.22)	1.84a (2.89)	1.89a (3.07)
Azadirachtin 0.0006% (Gronim)	2.48bc (5.65)	2.79cde (7.28)	2.63c (6.42)
Azadirachtin 0.0006% (Vanguard)	2.62cd (6.36)	2.95ef (8.20)	2.79cd (7.28)
Azadirachtin 0.0006% (Neemazal)	2.18ab (4.25)	2.21b (4.38)	2.20b (4.34)
Lecanicillium lecanii 0.4%	2.87de (7.74)	2.87def (7.74)	2.87d (7.74)
Metarhizium anisopliae 0.4%	2.82de (7.45)	2.53c (5.90)	2.67cd (6.63)
Beauveria bassiana 0.4%	3.14e (9.36)	3.13f (9.30)	3.13e (9.30)
Untreated Control	4.12f (16.47)	4.05g (15.90)	4.08f (16.15)
S. Em. ± Treatment (T)	0.10	0.10	0.07
Period (P)	0.03	0.03	0.02
Spray (S)	0.02	0.02	0.01
Year (Y)	-	-	0.03
T x P	0.06	0.06	0.06
T x S	0.04	0.04	0.08
T x Y	-	-	0.10
P x S	0.08	0.09	0.06
P x Y	-	-	0.02

S x Y	-	-	0.02
T x P x S	0.11	0.12	0.09
T x P x Y	-	-	0.09
T x S x Y	-	-	0.06
P x S x Y	-	-	0.04
T x P x S x Y	-	-	0.12
C. V. %	7.42	7.97	7.71

* Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$ transformed values
Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance; NS = Not significant

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