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Management of black aphid, *Pentalonia nigronervosa* (Coquerel) (Hemiptera: Aphididae) infesting banana under controlled field conditions

V Amsavalli, BD Shinde, AL Narangalkar, SV Sawardekar and MS Joshi

Abstract
The study on the management of black aphid was conducted at the Biological control unit, College of Agriculture, Dapoli, Dist. Ratnagiri, during the year 2022. The overall mean% mortality after two sprays revealed that the treatment T_6- imidacloprid 17.8 SL @ 0.053% was most effective treatment which recorded (90.07%) mortality of aphids. The next best treatment was T_7- acetamiprid 20 SP @ 0.1 percent with (83.17%) mortality. Whereas, T_5- neem oil 1% EC @ 1% recorded (82.00%) mortality, which was at par with T_4- pongamia oil 2% EC @ 2% (79.79%) mortality. Among the biopesticides tested, T_1- *Lecanicillium lecanii* $1x10^9$ cfu/ml @ 0.4% recorded the highest (75.81%) mortality of aphids. It was followed by T_3- *Beauveria bassiana* $1x10^8$ cfu/ml @ 0.5% and T_2- *Metarhizium anisopliae* $1x10^8$ cfu/ml @ 0.5% which registered (71.74%) and (65.46%) mortality, respectively. While the lowest mortality (10.21%) was observed in untreated control. However, all the treatments were significantly superior over control.

Keywords: Mortality, treatment, imidacloprid, neem oil, *Lecanicillium lecanii*, significant

Introduction
Banana *Musa paradisiaca* (Linn.) is the second most important fruit crop in India next to mango. It is a good source of potassium, phosphorus, calcium, magnesium and recommended for patients suffering from high blood pressure, arthritis, ulcer, gastroenteritis and kidney disorders. Musa species are native to tropical region of South - East Asian and Western Pacific regions (Robinson and Sauce, 2010) [6]. The world's largest producers of banana in 2017 were India and China, which together accounted for approximately 38% of total production. India is the largest producer of banana in the world, with a production of 308 lakh MT on 8.4 lakh hectares of land. Maharashtra ranks second in production of banana with 4,628.04 tonnes (2021-2022) that constitutes 14.26% of the national share. Jalgaon is a major banana growing district in Maharashtra occupying 50,000 hectares area under banana and headquartered "Mahabanana", a farmers marketing organisation in the year 2002. The banana aphid, *Pentalonia nigronervosa* Coquerel (Hemiptera: Aphididae), although has been considered as minor pest in India, causes damage both directly and indirectly to the banana growing tracts of the world. They do far more harm as vectors of banana bunchy top virus (BBTV), the etiological agent of banana bunchy top disease (BBTD). The affected leaves become short and stunted exhibiting rosetted or 'bunchy top' appearance at the apex of the plant (Ferreira *et al*, 1997) [2]. Biopesticides provide an eco-friendly alternative to the traditional pesticides. These pesticides are based on pathogenic microorganisms specific to a target pest, thereby providing an ecologically sound and effective solution to pest problems. Insecticidal oils kill insects on contact by distrupting gas exchange (respiration), cell membrane function or structure. They also kill them by disrupting their feeding on oil-covered surfaces (Catherine, 2010) [1]. Viral diseases had been considered practically incurable and the first aim in managing these kinds of diseases was to reduce or eliminate the aphid population within the field. This approach would reduce disease incidence and yield loss. Hence, the present investigation was carried out to study "Management of black aphid, *Pentalonia nigronervosa* (Coquerel) (Hemiptera: Aphididae) infesting banana".

2. Materials and methods
2.1 Maintenance of host plants and aphid culture
The study on management of *P. nigronervosa* was carried out at the Biological control unit,

College of Agriculture, Dapoli, Dist. Ratnagiri, in controlled field conditions. Small healthy tissue cultured Grand nine banana plants required for the study was taken from the Plant Biotechnology Centre, College of Agriculture, Dapoli. Initial culture of aphid was collected from farmers field in Palghar district, Maharashtra. In order to mass rear the aphids, they were transferred to new banana plants and maintained.

2.2 Experimental Details

A field experiment was conducted in Randomized Block Design with eight treatments and three replications during *Rabi* season of 2021-22 to study the management of black aphid, *P. nigronervosa* infesting banana using different insecticides. Seven different insecticides *viz*., T_1- *Lecanicillium lecanii* $1x10^9$ cfu/ml, T_2- *Metarhizium anisopliae* $1x10^8$ *cfu/ml*, T_3- *Beauveria bassiana* $1x10^8$ *cfu/ml*, T_4- pongamia oil 2% EC, T_5- neem oil 1% EC, T_6- imidacloprid 17.8 SL, T_7- acetamiprid 20 SP and T_8- untreated control were evaluated.

Tissue cultured Grand nine banana plants were transferred to the plastic plant potters containing mixture of FYM and red earth. Adequate time was given for the establishment of banana plants. Ten matured adult aphids were transferred to each plant using fine camel hair brush and kept undisturbed for a week allowing the aphids to multiply. After multiplication of aphids, five plants were kept in each treatment cage of size 4x4x4 ft^3 covered with shade net and water is sprinkled frequently to maintain the temperature and relative humidity.

2.3 Method and time of insecticide application

Actual quantity of spray solution required was calibrated prior to each spraying using water. The spraying was done with hand sprayer. The desired concentration of various insecticides were prepared on the basis of percentage of active ingredient present in respective trade product and sprayed to the plants thoroughly in the form of fine droplets using hand sprayer. The sprayer was washed off thoroughly after completion of spraying in each treatment. The spraying was done in early morning hours after sufficient infestation of aphid on banana.

2.4 Method of recording observations

Observations on number of aphids were taken from five plants of each treatment at 2, 5, 7 and 10 days after spraying of insecticides. The aphid count was taken from top, middle and bottom portions of the plant at each observation. The pre-count observations were recorded before application of insecticides at both the sprays. The second spray was given at the interval of fourteen days after the first spray. The average aphid population per five plants was worked out and data thus obtained were kept as pre count, for percentage data arc sine transformation were used and analysed statistically. Effectiveness of the treatments were judged based on the efficacy of the insecticides against *P. nigronervosa.* The results were presented as aphid% mortality with a comparison to densities found on the control. % control of aphid over control was calculated by using the following formula:

$$\text{Per cent mortality} = \frac{\text{No. of aphids died}}{\text{No. of aphids released}} \times 100$$

2.5 Statistical methods

The experimental data thus obtained was analysed statistically by applying OPSTAT package statistic program as applicable in Randomized Block Design (RBD). The range, mean, standard error (S.E.) and critical difference (C.D.) at 5% probability was worked out for comparison between treatments.

3. Results and Discussion

The mean% mortality after first spray revealed that the treatment T_6- imidacloprid 17.8 SL @ 0.053% was most effective and recorded maximum of 88.90% mortality of aphids. The next best treatment was T_7- acetamiprid 20 SP @ 0.1% with mortality of (82.30%) followed by T_5- neem oil 1% EC @ 1% with (80.87%) mortality, which was statistically at par with T_4- pongamia oil 2% EC @ 2% (79.00%) mortality. Among the biopesticides used T_1- *Lecanicillium lecanii* $1x10^9$ cfu/ml @ 0.4% recorded the highest of (74.99%) mortality of aphids. It was followed by T_3- *Beauveria bassiana* $1x10^8$ *cfu/ml* @ 0.5% and T_2- *Metarhizium anisopliae* $1x10^8$ *cfu/ml* @ 0.5% which registered (70.72%) and (63.77%) mortality respectively, while the lowest mortality (9.23%) was observed in T_8- untreated control (table 1).

The data pertaining to the efficacy of different insecticides against black aphid infesting banana at 2, 5, 7 and 10 days after second spray are furnished in (table 2). The mean% mortality after second spray revealed that the treatment T_6- imidacloprid 17.8 SL @ 0.053% was most effective which recorded maximum (91.24%) mortality of aphids and it was followed by T_7- acetamiprid 20 SP @ 0.1% (84.05%). The next best treatment was T_5- neem oil 1% EC @ 1% (83.13%), which was at par with T_4- pongamia oil 2% EC @ 2% (80.59%). T_1- *Lecanicillium lecanii* $1x10^9$ *cfu/ml* @ 0.4% recorded maximum of (76.63%) mortality of aphids among the biopesticides used. It was followed by T_3- *Beauveria bassiana* $1x10^8$ cfu/ml @ 0.5% and T_2- *Metarhizium anisopliae* $1x10^8$ cfu/ml @ 0.5% which registered (72.76%) and (67.15%) mortality, respectively. All the above treatments were superior over T_8- untreated control which recorded the lowest mortality of aphids (11.20%).

From the glimpse of (table 3), the observations recorded on second day after both the spray indicated that the treatment T_6- imidacloprid 17.8 SL @ 0.053% was found to be the most effective with (90.38%) mortality of aphids. The next best treatment was T_7- acetamiprid 20 SP @ 0.1% with (83.60%) mortality. The treatment T_5- neem oil 1% EC @ 1% recorded (82.32%) mortality, which was followed by T_4- pongamia oil 2% EC @ 2% (78.83%). The remaining treatment with T_1- *Lecanicillium lecanii* $1x10^9$ *cfu/ml* @ 0.4% recorded mortality (68.19%), Whereas T_3- *Beauveria bassiana* $1x10^8$ *cfu/ml* @ 0.5% (60.51%) and T_2- *Metarhizium anisopliae* $1x10^8$ *cfu/ml* @ 0.5% (58.64%) were found statistically at par with each other. The minimum mortality of aphids (10.53%) was noticed in T_8- untreated control. At fifth day after both the spray the minimum mortality of aphids (8.92%) was recorded in T_8- untreated control. The treatment T_6- imidacloprid 17.8 SL @ 0.053% recorded maximum of (93.38%) mortality of aphids, followed by T_7- acetamiprid 20 SP @ 0.1% with (84.43%) mortality. Treatment T_5- neem oil 1% EC @ 1% with (83.46%) mortality was the next best and it was followed by T_4- pongamia oil 2% EC @ 2% (80.96%) mortality. The% mortality of remaining treatments with mycoinsecticides *viz*., T_1- *Lecanicillium lecanii* $1x10^9$ *cfu/ml* @ 0.4% (78.04%), T_3- *Beauveria bassiana* $1x10^8$ *cfu/ml* @ 0.5% (75.35%) *and* T_2- *Metarhizium anisopliae* $1x10^8$ *cfu/ml* @ 0.5% (65.51%) were statistically effective over untreated control. At seven days after each of two spray, all the treatments were significantly superior over T_8- untreated control (10.73%). Among all treatments, T_6- imidacloprid 17.8 SL @ 0.053% recorded maximum mortality (88.87%). The next best treatment was T_7- acetamiprid 20 SP @ 0.1% with (82.73%) mortality. T_5-

neem oil 1% EC @ 1% recorded (81.36%) mortality and it was at par with T_1- *Lecanicillium lecanii 1x10^9 cfu/ml* @ 0.4% (80.16%) and T_4- pongamia oil 2% EC @ 2% (80.06%) mortality. T_3- *Beauveria bassiana 1x10^8 cfu/ml* @ 0.5% (78.37%) and T_2- *Metarhizium anisopliae 1x10^8 cfu/ml* @ 0.5% (71.23%) were respectively least effective but significantly superior over untreated control. Maximum mortality (87.64%) was recorded in the treatment T_6- imidacloprid 17.8 SL @ 0.053% at ten days after both the spray, followed by T_7- acetamiprid 20 SP @ 0.1% with (81.93%) mortality of aphids. The% mortality due to T_5- neem oil 1% EC @ 1% was (80.88%) was at par with T_4- pongamia oil 2% EC @ 2% (79.32%). The mortality of pest by entomopathogenic fungi *viz*., T_1- *Lecanicillium lecanii 1x10^9 cfu/ml* @ 0.4% was (76.85%), followed by T_3- *Beauveria bassiana 1x10^8 cfu/ml* @ 0.5% (72.74%) *and* T_2- *Metarhizium anisopliae 1x10^8 cfu/ml* @ 0.5% (66.45%). The minimum mortality of aphids (10.68%) was recorded in T_8- untreated control.

The overall mean% mortality after two sprays revealed that the treatment T_6- imidacloprid 17.8 SL @ 0.053% was most effective treatment which recorded (90.07%) mortality of aphids. The next best treatment was T_7- acetamiprid 20 SP @ 0.1% with (83.17%) mortality. Whereas, T_5- neem oil 1% EC @ 1% recorded (82.00%) mortality, which was at par with T_4- pongamia oil 2% EC @ 2% (79.79%) mortality. Among the biopesticides tested, T_1- *Lecanicillium lecanii 1x10^9 cfu/ml* @ 0.4% recorded the highest (75.81%) mortality of aphids. It was followed by T_3- *Beauveria bassiana 1x10^8 cfu/ml* @ 0.5% and T_2- *Metarhizium anisopliae 1x10^8 cfu/ml* @ 0.5% which registered (71.74%) and (65.46%) mortality, respectively. While the lowest mortality (10.21%) was observed in T_8- untreated control. However, all the treatments were significantly superior over untreated control. The data of mean% mortality of *P. nigronervosa* infesting banana at overall spray was graphically depicted in fig 1.

The results revealed that the application of insecticides had played a significant role in reducing aphid population. The results of present study are similar with the findings of the following workers. The observations noted with current investigation were in close accordance with Robson *et al.* (2007) [7], who recorded the efficacy of imidacloprid against *P. nigronervosa* by comparing insect mortality at four different insecticide concentrations (120, 60, 24, and 12 ppm) over one month. Aphids survived poorly on the plants applied with three highest concentration treatments (120, 60 and 24ppm) which resulted in high mortality over the 4-week-long period of testing. The results revealed that maximum mortality% was obtained with higher concentrations of imidacloprid.

The results are closely related to those of Kakati and Nath (2019) [3] who found that foliar spraying of imidacloprid @ 0.1% at 60, 90, 120 and 150 days after planting showed no bunchy top disease incidence (0.00%), zero insect vector population count in all the two cropping seasons. Insect vector population was recorded as 0.00 to 10.75%, average 3.39% in imidacloprid alone, which was followed by lowest incidence at azadirachtin @ 0.3%, dimethoate @ 0.2% and imidacloprid @ 0.025% + *V. lecanii* @ 1x 10^8 cfu/ml.

Mathew *et al.* (1998a)[4] observed that among the insecticides evaluated against black aphid, *Pentalonia nigronervosa* f. *caladii* of cardamom, *Verticillium chlamydosporium* caused highest mortality% of 84.6 and 75.4 in adults and nymphs. The next effective treatments in order were *Beauveria brongniartii* (60.2 and 56.2%) and *Metarhizium anisopliae* (55.1 and 70.2%)% mortality in adults and nymphs.

The abovementioned results were partially supported by Mathew *et al.* (1998b) [5], who investigated the effectiveness of various neem based insecticides for the control of *P. nigronervosa* on cardamom tillers in laboratory choice test, including nimbecidene, bioneem and margolin EC. Bioneem and Margolin EC. Prevented 100% settlement of aphids *P. nigronervosa* on the treated cardamom tillers at 0.5 and 1.0% concentrations, three days after treatment. For Nimbecidine and Margolin EC. the% mortality ranged from 23.7 to 46.8 at three days after treatment. In no-choice test, there was 100% prevention of settlement in Bioneem and Margolin EC. at 0.5 and 1.0% concentration. Bioneem 1.0% as well as Margolin EC. 0.5 and 1.0% checked the moulting of nymphs effectively, the prevention being 100%.

Saju *et al.* (1998) [8] revealed that turmeric oil was effective against the cardamom aphid *Pentalonia nigronervosa* (Coquerel). Out of the three concentrations tested, less no of aphids settled in the shoots treated with higher percentage i.e 1.0% followed by 0.5% and 0.1% concentrations, respectively. There was mortality of aphids at all concentrations, the highest being 10.86% at 1.0% concentration followed by 5.36% at 0.5% concentration and 3.55% at 0.1% concentration. The reduction in hatching was 11.3% at 1.0% concentration followed by 5.3% in 0.5 concentration and 3.0% in 0.1 concentration.

Table 1: Efficacy of insecticides against black aphid, *Pentalonia nigronervosa* (Coquerel) infesting banana after first spray

Tr. No.	Treatments	Conc. (%)	Pre count (Mean no. of aphids / 5 plants)	% Mortality				Mean% Mortality after first spray
				2DAS*	5DAS	7DAS	10DAS	
1	*Lecanicillium lecanii 1x10^9 cfu/ml*	0.4	41.53	67.82(55.43)**	77.63 (61.77)	78.59 (62.43)	75.94 (60.62)	74.99 (59.99)
2	*Metarhizium anisopliae 1x10^8 cfu/ml*	0.5	39.53	58.17 (49.70)	62.50 (52.23)	69.89 (56.72)	64.53 (53.44)	63.77 (52.99)
3	*Beauveria bassiana 1x10^8 cfu/ml*	0.5	43.20	59.04 (50.20)	74.62 (59.74)	77.20 (61.47)	72.05 (58.08)	70.72 (57.24)
4	Pongamia oil 2% EC	1	40.20	77.68 (61.80)	80.39 (63.71)	79.02 (62.73)	78.92 (62.66)	79.00 (62.72)
5	Neem oil 1% EC	1	46.60	81.63 (64.62)	82.29 (65.11)	79.81 (63.29)	79.78 (63.27)	80.87 (64.06)
6	Imidacloprid 17.8 SL	0.053	38.67	88.85 (70.49)	91.98 (73.54)	87.83 (69.58)	86.94 (68.81)	88.90 (70.53)
7	Acetamiprid 20 SP	0.1	43.70	82.44 (65.22)	84.00 (66.42)	81.95 (64.85)	80.81 (64.01)	82.30 (65.12)
8	Untreated Control	-	44.20	8.49 (16.94)	8.18 (16.61)	10.62 (19.01)	9.64 (18.08)	9.23 (17.68)
	S.Em. (±)	-	1.67	0.95	0.68	0.77	0.62	1.35
	CD at 5%	-	NS	2.88	2.07	2.34	1.90	4.06

*DAS - Days after Spraying **Figures in parentheses are arcsine values

Table 2: Efficacy of insecticides against black aphid, *Pentalonia nigronervosa* (Coquerel) infesting banana after second spray

Tr. No.	Treatments	Conc. (%)	Pre count (Mean no. of aphids / 5 plants)	% Mortality				Mean% Mortality after second spray
				2DAS*	5DAS	7DAS	10DAS	
1	*Lecanicillium lecanii* 1x10^9 cfu/ml	0.4	37.20	68.57 (55.90)**	78.46 (62.34)	81.74 (64.70)	77.76 (61.86)	76.63 (61.09)
2	*Metarhizium anisopliae* 1x10^8 cfu/ml	0.5	32.13	59.12 (50.25)	68.52 (55.87)	72.58 (58.42)	68.38 (55.78)	67.15 (55.02)
3	*Beauveria bassiana* 1x10^8 cfu/ml	0.5	32.27	61.98 (51.93)	76.08 (60.71)	79.54 (63.10)	73.44 (58.97)	72.76 (58.53)
4	Pongamia oil 2% EC	1	36.00	79.99 (63.42)	81.54 (64.55)	81.11 (64.23)	79.72 (63.23)	80.59 (63.85)
5	Neem oil 1% EC	1	36.40	83.01 (65.65)	84.63 (66.91)	82.91 (65.58)	81.99 (64.88)	83.13 (65.74)
6	Imidacloprid 17.8 SL	0.053	35.33	91.91 (73.47)	94.79 (76.80)	89.92 (71.48)	88.35 (70.04)	91.24 (72.78)
7	Acetamiprid 20 SP	0.1	35.33	84.77 (67.02)	84.87 (67.10)	83.52 (66.04)	83.06 (65.69)	84.05 (66.46)
8	Untreated Control	-	31.67	12.58 (20.77)	9.66 (18.10)	10.84 (19.22)	11.73 (20.02)	11.20 (19.55)
	S.Em. (±)	-	1.47	0.97	0.74	0.83	0.49	1.31
	CD at 5%	-	NS	2.94	2.27	2.53	1.51	3.93

*DAS - Days after Spraying **Figures in parentheses are arcsine values

Table 3: Overall efficacy of insecticides against black aphid, *Pentalonia nigronervosa* (Coquerel) infesting banana (Average of two sprays)

Tr. No.	Treatments	Conc. (%)	Precount (Mean no. of aphids / 5 plants)	% Mortality				Overall% Mortality
				2DAS*	5DAS	7DAS	10DAS	
1	*Lecanicillium lecanii* 1x10^9 cfu/ml	0.4	40.20	68.19 (55.66)**	78.04 (62.05)	80.16 (63.54)	76.85 (61.23)	75.81 (60.53)
2	*Metarhizium anisopliae* 1x10^8 cfu/ml	0.5	35.83	58.64 (49.97)	65.51 (54.03)	71.23 (57.56)	66.45 (54.60)	65.46 (54.00)
3	*Beauveria bassiana* 1x10^8 cfu/ml	0.5	37.73	60.51 (51.06)	75.35 (60.23)	78.37 (62.28)	72.74 (58.52)	71.74 (57.88)
4	Pongamia oil 2% EC	1	38.10	78.83 (62.60)	80.96 (64.12)	80.06 (63.47)	79.32 (62.95)	79.79 (63.28)
5	Neem oil 1% EC	1	41.50	82.32 (65.13)	83.46 (66.00)	81.36 (64.42)	80.88 (64.07)	82.00 (64.89)
6	Imidacloprid 17.8 SL	0.053	36.96	90.38 (71.93)	93.38 (75.09)	88.87 (70.51)	87.64 (69.41)	90.07 (71.63)
7	Acetamiprid 20 SP	0.1	40.66	83.60 (66.11)	84.43 (66.75)	82.73 (65.44)	81.93 (64.84)	83.17 (65.77)
8	Untreated Control	-	37.93	10.53 (18.93)	8.92 (17.37)	10.73 (19.12)	10.68 (19.07)	10.21 (18.63)
	S.Em. (±)	-	1.11	0.60	0.43	0.60	0.47	1.30
	CD at 5%	-	NS	1.84	1.32	1.83	1.44	3.92

*DAS-Days After Spraying **Figures in parentheses are arcsine values

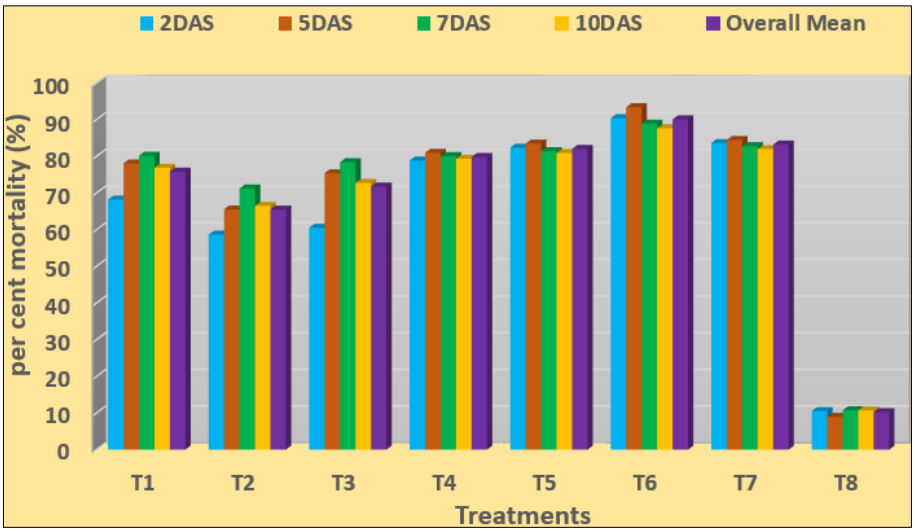

Fig 1: Mean% mortality of *P. nigronervosa* infesting banana at overall spray (Average of two sprays)

4. Conclusion

The overall results revealed that, even though *P. nigronervosa* is a serious pest of banana, it can be managed very effectively by following spray schedule as experienced in the present findings. The insecticides imidacloprid 17.8 SL, acetamiprid 20 SP and neem oil 1% EC were found to be the best insecticides in protecting the plants from aphid damage. The present investigation results are based on one season and one location data. Therefore, in order to arrive a sound conclusion, it is necessary to continue the studies with long duration trail including improved pest management practices based on IPM techniques to keep the pest infestation at low level and to get higher returns of yield.

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