Bangladesh J. Nuclear Agric, 37(2): 81-88, 2023 *ISSN 0258-7130*

DOI: https://doi.org/10.3329/bjnag.v37i2.71783

EFFICACY OF ENTOMOPATHOGENS, BOTANICAL AND NEW GENERATION INSECTICIDES AGAINST PAPAYA MEALYBUG

A. Islam[1*], M. A. Haque[2], G. Das[2], A.A. Khan[3], M.A.A. Topu[1], M.S. Rahman[1], M.J. Hasan[1], M.L.R. Mollah[1] and M. Roknuzzaman[4]

Abstract

The papaya mealybug is an invasive polyphagus pest species causing several economic damages to a wide range of agricultural crop. Five new generation insecticides of different groups, one botanical and one entomopathogenic fungus (*Beauveria bassiana*) were evaluated in laboratory for their effectiveness in reducing mealybug incidence on papaya. The present study was conducted to evaluate the toxic effect of different insecticides at different concentration against *P.marginatus*. Among the 7 insecticides, Imixam 70 WDG (Imidacloprid+Thiamethoxam) was the most effective insecticide followed by Ravjum 14.5 SC (Indoxacarb), Saka 25 SC (Abamectin 5% +Spirodiclofen 20%), Imixan and Biotrin 0.5% (Matrin), Tundra 20 SP (Acetameprid), Antario (*Bacillus thuringiensis*+Abamectin) and *Beauveria bassiana,* respectively.All the selected insecticides provided their highest efficacy at their maximum doses as well as within 7-9 DAT, among them two new generation insecticides e.g. Saka 25 SC (Abamectin 5% +Spirodiclofen 20%) @ 1.0 ml/L, Ravjum 14.5 SC (Indoxacarb) @ 1.0 ml/L and the botanical insecticide Biotrin 0.5% upto 7 DAT would be effective in controlling papaya mealybug considering the efficacy. To confirmation of the results, need to be tested under field condition.

Key words: Papaya mealybug, new generation insecticides, Botanical, Entomopathogenic fungus

Introduction

The papaya mealybug (*Paracoccus marginatus* Williams and Granara de Willink) affects a variety of host plants, including the economically significant tropical fruits and ornamentals (P. Sakthivel, 2012). Insects may inhibit papaya growth, particularly from fruit set until harvest. Mealybug activity is highest in warm, dry weather (MAM Khan, 2014). *Paracoccus marginatus* is a native of Central America and spread to the Caribbean region and South America in the 1990s; since then it has accidentally been introduced to some islands in the Pacific region and some countries in Africa and Asia. We recorded its presence in China for the first time in 2013 from Guangdong Province and Yunnan Province in southern and southwestern China, respectively. (Muhammad Z Ahmed, 2015).

Females can only move by short-distance crawling or by being carried by air currents because they lack wings and female crawlers have four instars, and depending on

[1]Entomology Division, Bangladesh Institute of Nuclear Agriculture, BAU Campus, Mymensingh-2202
[2]Department of Entomology, BAU, Mymensingh-2202, [3]Maize Breeding Division, Bangladesh Wheat and Maize Research Institute, RS, Jamalpur, [4]Research Coordination Office, Bangladesh Institute of Nuclear Agriculture, BAU Campus, Mymensingh-2202, *Corresponding author's email: afsanabau201@gmail.com

the temperature, a generation lasts around one month. Males have five instars, the fourth of which is known as the pupa and is created in a cocoon (Amarasekare KG, 2010). The adult female is yellow and is covered with a white waxy coating. Adult females are approximately 2.2 mm long (1/16 inch) and 1.4 mm wide. A series of short waxy caudal filaments less than 1/4 the length of the body exis around the margin (Miller and Miller, 2002).

According to Tanwar *et al.* (2010) and Suganthy *et al.* (2012), the leaves become crinkled, yellowing, and withered. This mealybug excretes honeydew, which eventually grows into a sooty mold that covers the leaves, fruits, and stems, preventing photosynthesis and gas exchange. Chlorosis, plant stunting, deformed leaves, early leaf and fruit loss, significant honeydew accumulation, and host plant death are the consequences. Additionally, the mealybug leaves behind a thick, white, waxy substance that can render plants unusable (R.K. Tanwar, 2007).

It is thought that the papaya mealybug is a native of Mexico and/or Central America. *Paracoccus marginatus* was originally discovered in Mexico in 1995, according to (Williams and Granara de Willink, 1992). Papaya mealybug was discovered by IPM and CRSP (Collaborative Research Support Program) scientists in Joydebpur, Bangladesh, in May 2009. According to a recent assessment in Bangladesh, farmers are indiscriminately using various chemical insecticides that do not effectively manage the mealybug infestation that has affected roughly 40% of the papaya plants in the orchards (Khan et al., 2014).

In the search for safer insecticides technologies, more selective mode of action and reduced risks for non-target organisms and the environment, progress has been made in the last few years with development of new generation insecticides and use of entomopathogens and botanicals. Entomopathogenic fungi and botanical extracts (neem or eucalyptus) caused significant reduction in survival and fecundity of *S. avenae*. Therefore, they may be used as promising natural alternatives to synthetic insecticides against the wheat aphid species (Ali, 2019). Entomopathogenic fungi infests the host insects via digestion, respiration and through integument. New generation insecticides are developed to replace earlier, more toxic chemicals in effort to clean up the environmental and human health impacts of these older agricultural insecticides.

So, five new generation insecticides, botanical and entomopathogens would be evaluated against papaya mealybug in the laboratory as the alternatives of conventional insecticides to combat resistances development, effective control, inhibition of growth and development, to keep the natural enemies safe and fit these molecules in IPM packages. Therefore, the present research work was planned to evaluate the efficacy of five new generation insecticides such Antario, Imixam 70 WDG, Ravjum 14.5 SC, Saka 25 SC, Tundra 20 SP on the mortality of papaya mealybug under laboratory conditions. The misuse of conventional pesticides leads to a variety of problems, including secondary pest outbreaks, environmental contamination, food poisoning, and health risks. This is the nation's current catchphrase for limiting the use of broad-spectrum insecticides and promoting the use of substitute chemicals to create less poisonous fruits. Therefore, farmers may save the natural enemies and so save money on insecticidal expenditures if they use these compounds wisely.

The present study was therefore initiated with following objective:

- To elucidate the individual effects of selected new generation insecticides, entomopathogens and botanical against *Paracoccus marginatus* under laboratory condition.
- To find out the most effective treatment(s) in respect of mortality of *P. marginatus*.

Materials and Methods

The experiment was conducted in the laboratory, Department of Entomology, Bangladesh Agricultural University, Mymensingh from the period of July, 2021 to January, 2022.

Collection of papaya mealybug

Papaya mealybugs were collected from untreated papaya plant with leaves. Then ten insects were released on previously grown papaya seedlings until their settlements or adaptation in the laboratory condition. Regular checking was done for their movement as well as overall condition. Before conducting research, nymphs and adults were collected from the papaya seedlings and then kept in the petridish. Then collected mealybug was distributed in different petridish to know the effect of treatments according to the experimental objective. Populations of papaya mealybug were maintained in the laboratory until completion of the research work.

Insecticides

Commercial formulations of Antario (*Bacillus thuringiensis*+Abamectin) (recommended dose 2g/L)@ 0.5, 1.0, 1.5, 2.0 g/L, Imixam 70 WDG (Imidacloprid +Thiamethoxam) (recommended dose 0.15g/L) @ 0.1, 0.2, 0.3, 0.4 g/L, Ravjum 14.5SC (Indoxacarb) (recommended dose 1ml/L) @ 0.25, 0.50, 0.75, 1.0 ml/L, Saka 25 SC (Abamectin 5% +Spirodiclofen 20%) (recommended dose 2ml/L) @ 0.25, 0.50, 0.75, 1.0 ml/L, Tundra 20SP (Acetameprid) (recommended dose 0.25g/L) @ 0.2, 0.3, 0.4, 0.5 g/L were tested for their toxicity to *P.marginatus* under laboratory conditions. Besides one entomopathogens (*Beauveria bassiana*) @ 2.5, 5.0, 7.5, 10.0 g/L and one botanical, Biotrin 0.5 %(Matrin) (recommended dose 1.4 ml/L) @ 0.25, 0.50, 0.75, 1.0 ml/L were also evaluated against papaya mealybug. These insecticides were purchased from the local market and each insecticide was tested at four different concentrations.

Experimental procedure

To test the efficacy, insects were treated with selected entomopathogenic fungus, botanical and new generation insecticides using micro sprayer. At first, papaya seedlings were treated with selected insecticides with recommended specific concentrations using micro sprayer. The sprayer was done in such a way that the whole plant was thoroughly covered by spray material. After that, the treated plants were air-dried thoroughly using electric fan. Secondly, ten mealybugs were directly treated with selected insecticides using micropipette. Then, treated insects were carefully transferred on treated papaya plants using fine camel brush and special care was taken during transferring mealybugs to avoid and injury. After the release of mealybugs, each plant was placed individually on a special plastic tray with an inner and outer ring. The plant was placed on inner ring and the outer ring was filled with detergent water to prevent mealybugs escaping. Laboratory experiments was conducted with CRD consisted of seven treatments combinations. Four doses of each insecticide were provided as treatments. Each treatment was replicated thrice, and ten mealybugs were used for each replication. Care was taken to avoid spray drift on adjacent plants. The control plants were sprayed only with water.

Data collection parameter

Mortality of nymphs and adults of papaya mealybug.

For counting the dead insects, all the plants parts along with pot and soil surface was observed carefully. Small dead nymphs were counted using magnifying glass. The percentage of papaya mealybug mortality was calculated using the following formula:

% mortality =Po/Pr x 100.
Where,
Po=Number of papaya mealybug died, Pr=Number of treated mealybugs provided.

Calculation of fold increase in mortality over control: This was calculated by using the following formula:

Fold increase in mortality over control = Po/Pr x 100
Where,
Po= Mortality percentage in treated condition
Pr= Mortality percentage in control conditions.

Statistical analysis

The recorded data was compiled and tabulated for statistical analysis. Analysis of variance (ANOVA) was done with the help of computer package MSTAT. The mean differences among the treatments were adjudged with Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD).

Results and Discussions

The potency of five toxicants representing different chemical groups was assessed under laboratory conditions against *P.marginatus*. The result revealed that concentration of different insecticides had significant effect on the mortality of papaya mealybug and the effect was clearly time and dose dependent (Table 1).

Table 1. Percent mortality of papaya mealybug at different days after treatment (DAT) with different concentrations of chemical insecticides

Treatments	Percent mortality of papaya mealybug at different DAT			
	1 DAT	3 DAT	7 DAT	9 DAT
Antario @ 0.5 g/L	10.00 b	23.33 b	56.66 c	73.33 b
Antario @ 1.0 g/L	36.66a	46.66a	63.33 bc	73.33 b
Antario @ 1.5 g/L	43.33a	56.66a	70.00ab	76.66ab
Antario @ 2.0 g/L	36.66a	56.66a	73.33a	86.66a
Control	4.17b	8.33	12.50d	15.60c
CV (%)	20.31	14.65	8.79	9.85
F-test	**	**	**	**
Imixam @ 0.1 g/L	16.66 b	56.67 b	100.00a	100.00a
Imixam @ 0.2 g/L	20.00 b	60.00 b	100.00a	100.00a
Imixam @ 0.3 g/L	30.00a	100.00a	100.00a	100.00a
Imixam @ 0.4 g/L	33.33a	100.00a	100.00a	100.00a
Control	4.17c	4.17c	8.33b	12.50b
CV (%)	16.58	4.02	0.31	0.75
F-test	**	**	**	**
Tundra @ 0.2 g/L	43.33 c	56.66a	80.00a	86.66a
Tundra @ 0.3 g/L	50.00 b	60.00a	83.33a	90.00a
Tundra @ 0.4 g/L	56.66a	70.00a	83.33a	93.33a
Tundra @ 0.5 g/L	60.00a	70.00a	86.66a	96.66a
Control	4.17 d	4.17 b	8.33 b	12.50 b
CV (%)	7.89	16.28	11.58	8.38
F-test	**	**	**	**
Ravjum @ 0.25 ml/L	40.00 b	60.00 b	86.66 b	90.00 b
Ravjum @ 0.50 ml/L	46.66 b	70.00ab	90.00 b	100.00a
Ravjum @ 0.75 ml/L	50.00ab	76.66a	96.66a	100.00a
Ravjum @ 1.0 ml/L	60.00a	80.00a	100.00a	100.00a
Control	4.17c	4.17c	8.33c	12.50c
CV (%)	13.99	11.69	4.09	5.42
F-test	**	**	**	**
Saka @ 0.25 ml/L	33.33 c	50.00 c	80.00 c	100.00a
Saka @ 0.50 ml/L	50.00 b	56.66 b	83.33 bc	100.00a
Saka @ 0.75 ml/L	56.66a	60.00 b	86.67 b	100.00a
Saka @ 1.00 ml/L	60.00a	70.00a	100.00a	100.00a
control	4.17d	4.17d	8.33d	12.50b
CV (%)	8.46	5.43	4.68	0.75
F-test	**	**	**	**

Results indicated that mealybag mortality percent increased with time after insecticide sprayed. The results showed that Imixam 70 WDG (Imidacloprid +Thiamethoxam) was the most effective insecticide, achieving 100% mortality at the rate of 0.3 g/L after three days of treatment. Consequently, imidacloprid has a temporary but inhibitory effect on honey bees (Laura BORTOLOTTI, 2003) and it was found that imidacloprid was persistent in sample water and that it did not biodegrade rapidly in an aquatic environment (Tišler *et al*., 2009). Ravjum 14.5 SC (Indoxacarb) and Saka 25 SC (Abamectin 5%+Spirodiclofen 20 %) were also effective against *Paracoccus marginatus*. At 9 days after treatment, all concentrations, except 0.25 ml/L of Ravjum 14.5 SC and 1.0 ml/L of Saka 25 SC, resulted in 100% mortality. It may be appropriate to include indoxacarb in integrated pest control plans for management ((Swarna Hewa-Kapuge, 2003). Tundra 20 SP showed a mortality rate of 96% at 9 days after treatment at 0.5 g/L, which was the highest mortality rate observed for this insecticide. However, the mortality rate was only 43.33% at 1 day after treatment at 0.2 g/L, which was the lowest observed for any insecticide tested. Antario (*Bacillus thuringiensis* + Abamectin) showed the lowest mortality rate against *P. marginatus*, with a maximum mortality rate of 63.33% observed at 9 days after treatment at 2.0 ml/L. the study shows that Ravjum 14.5 SC and Saka 25 SC were effective insecticides against *P. marginatus*, Imixam shows highest mortality. Tundra 20 SP also showed promising results but with a lower efficacy than the previously mentioned insecticides.

Significant mortality rates were observed at different days after treatment (DAT) for both *Beauveria bassiana* and Biotrin. For *Beauveria bassiana*, the highest mortality rate (68.33%) was observed at the rate of10.0 g/L at 9 DAT. For Biotrin 0.5%, the highest mortality rate (100%) was attained with a 1.0 ml/L dose at 9 DAT. However, Biotrin was more effective than *Beauveria bassiana* in case of mealybag control. These results indicate the efficacy of these treatments in causing mortality in the studied organisms. Botanical compounds used for pest control are highly efficient in combating a wide range of harmful pests and diseases. Furthermore, they are readily accessible, cost-effective, easily degradable, and pose minimal risks to beneficial organisms (Ngegba *et al*., 2022). Considering the above facts, the botanical Biotrin 0.5% can be effective against *P.marginatus* management.

Table 2. Mean percent mortality of papaya mealybug at different DAT with different concentrations of entomopathogen and botanical

Treatments	Mean percent mortality of papaya mealybug at different DAT			
	1	3	7	9
Beauveria bassiana @ 2.5 g/L	0.00	4.16bc	16.33cd	25.00c
Beauveria bassiana @ 5.0 g/L	0.00	9.52ab	23.80bc	43.22b
Beauveria bassiana @ 7.5 g/L	0.00	15.07a	30.11ab	65.33a
Beauveria bassiana @ 10.0 g/L	0.00	17.16a	38.33ac	68.33a
Control	0.00	4.16c	8.33e	8.33d
CV (%)	--	15.60	13.21	17.71
F-test	NS	*	*	**
Biotrin @ 0.25 ml/L	20.00 d	40.00 d	60.00a	83.33a
Biotrin @ 0.5 ml/L	30.00 c	50.00 c	70.00a	90.00a
Biotrin @ 0.75 ml/L	50.00 b	60.00 b	83.33a	93.33a
Biotrin @ 1.0 ml/L	60.00a	70.00a	90.00a	100.00a
Control	4.17e	4.17e	8.33b	12.50b
CV (%)	6.81	5.97	7.86	3.41
P-level	**	**	**	**

Conclusion

spraying of three new generation insecticides e.g. Imixan 70 WDG @ 0.1g/L, Saka 25 SC (Abamectin 5% +Spirodiclofen 20%) @ 0.25 ml/L, Ravjum 14.5 SC (Indoxacarb) @ 0.5 ml/L and the botanical Biotrin 0.5 @ 1.0 ml/L would be the most effective management approach against *P. marginatus*. However, botanical insecticide Biotrin 0.5 should be recommended for environment friendly as well. To confirmation of the results need to be tested under field condition.

References

Ali, N. A. 2019. The efficacy of Insecticide Indoxacarb (Avaunt) against larval stage of House fly *Musca domestica* L. Research Journal of Pharmacy and Technology., **12**(5): 2363-2371.

Amarasekare, K.G., C. M. Mannion. 2010. Host instar susceptibility and selection and interspecific competition of three introduced parasitoids of the mealybug Paracoccus marginatus(Hemiptera:Pseudococcidae). Environmental Entomolg y., 39(5):1506-12.

Munwar, A., M. I. Mastoi., A. A. Gillal., A. Shehzad., A. R. Bhatti, and S. A. Zia. 2016. Effect of Different Mating Exposure Timings on the Reproductive Parameters of Papaya Mealybug, *Paracoccus Marginatus* (Hemiptera: Pseudococcidae). Pak Entomol., 38(1): 65-69.

Khan, M. A., M. J. Biswas., K. S. Ahmed and S. Sheheli. 2014. Outbreak of *Paracoccus marginatus* in Bangladesh and its control strategies in the fields. Progressive Agriculture., 25 (2): 17-22.

Bortolotti. L., R. Montanari, J. Marselino, P. Medrzycki., S. Maini and C. Porrini. 2003. Effects of sub-lethal imidacloprid doses on the homing rate and foraging activity of honey bees. Bulletin of Insectology., 56 (1): 63-67.

Miller. D. R., and G. L. Miller. 2002. Redescription of *Paracoccus marginatus* Williams and Granara de Willink (Hemiptera: Coccoidea: Pseudococcidae), including descriptions of the immature stages and adult male. Proceedings of the Entomological Society of Washington., 104 (1): 1-23

Ahmed. Z. M., J. J. Welch and A. Kawahara. 2015.Wolbachia in butterflies and moths: geographic structure in infection frequency. Frontiers in zoology., 12 (1): 16.

Ngegba. P.M., G. Cui., M. Z. Khalid and Zhong. G. 2022. Use of Botanical Pesticides in Agriculture as an Alternative to Synthetic Pesticides. J. of agriculture. 12(5): 600.

Madras Agricultural journal., P. Sakthivel., P. Karuppuchamy and Kalyanasundaram, M.2012. Host Plants of Invasive Papaya Mealybug, Paracoccus marginatus (Williams and Granara de Willink) in Tamil Nadu. Madras Agriculture Journal. 99 (7-9): 615-619.

Tanwar. K. R Tanwar., P. Jeyakumar and Monga, D. 2007. Mealybugs and their Management. New Delhi: National Centre for Integrated Pest Management. Technical Bulletin 19

Kapuge, S. H., S. McDougall and Hoffmann, A. A. 2003. Effects of Methoxyfenozide, Indoxacarb, and Other Insecticides on the Beneficial Egg Parasitoid Trichogramma nr. brassicae (Hymenoptera: Trichogrammatidae) Under Laboratory and Field Conditions. Journal of Economic Entomology., *96*(4): 1083–1090

Gill, R. J. 1994. Mealybugs of Central and South America. Annals of the Entomological Society of America., 87 (4): 487.