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Efficacy of Different Insecticides and Bio-Rationals Against Papaya Mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococidae) Infestation in Home Gardens

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Abstract: Papaw mealybug, *Paracoccus marginatus* causes severe economic losses in crops mainly in papaw, *Carica papaya* due to its damage following symptoms such as yellowing, crinckling distortion of leaves and sooty mould development. Yield loss was resulted due to its heavy feeding. Ten chemicals such as Imidachloprid, Acetamipride, Acephate, Thiomethoxam, Chloran Traniliprole, Profenofos, Abamactin, Diazinon and Thiocyclin Hydrogen Oxalate in recommended levels, six bio-rationales such as Neem leaves fermented solution (1 g/ml), Neem leaf extract (20 g/ml), *Pavetta* leaf extract (20 g/ml), Garlic extract (20 g/ml), Vermi wash and Cow urine (100% V/V) were tested for their efficacy in laboratory. Mortality of *P. marginatus* was assessed after 0.5, 3, 6, 24 and 48 h of exposure. All the experiments designed according to complete randomized design (CRD). Highest percentage of mortality (100 %) obtained using Imidachloprid, Thiomethoxam and Thiocyclin Hydrogen Oxalate in recommended levels. Garlic bulb extract (20 g/ml), *Pavetta* leaf extract (20 g/ml) and fermented cow urine (100% V/V) given higher suppressive effect among the six bio-rationals. Garlic bulb extract, *Pavetta* leaf extract and fermented cow urine given 87.9 %, 83.3 %, 75.8 % mortality in *P. marginatus* after 48 h of exposure. LD_{50} value of garlic bulb extract, *Pavetta* leaf extract and cow urine solution against *P. marginatus* were 7.18 g/ml, 7.6 g/ml and 40.62 % (V/V) respectively on 72 h of exposure.

Key words: Garlic Bulb Extract · *Pavetta* Leaf Extract · Cow urine · Mortality · LD50

INTRODUCTION

Paracoccus marginatus (Hemiptera: Pseudococcidae) native to Mexico [1], is a havoc pest of papaw, due to its wide host range and high dispersal nature moreover unpredictable climate change, in Sri Lanka. It is an invasive pest to Sri Lanka and first reported in Colombo and Gampaha districts in July 2008 [2]. In India also, first reported from Coimbatore in July 2008 [3]. *P. marginatus* is also infesting large number of fruit crops, vegetable crops and ornamental plants. It damages huge number of plants belonging to 22 families from Asia [3] and also reported in more than 40 plant species in Sri Lanka [2]. Among them, *Acacia*, *Acalypha*, *Ananus*, *Annona*, *Bidens*, *Capsicum*, *Hibiscus*, *Ipomoea*, *Mangifera*, *Manihot*, *Persea*, *Plumeria*, *Punica*, *Solanum*, *Vigna*, *Carica papaya* and *Parthenium hysterophorus* are the preferred hosts of *P. marginatus* [3].

P. marginatus damages directly on leaves, fruits and ultimately reduces fruit quality. Infestation of the mealybug appears as clusters of cotton-like masses on the above-ground portion of plants with long waxy filaments. Immature and adult stages of *P. marginatus* suck the sap of the plant and weaken it. The leaves become crinkled, yellowish and wither. The honeydew excreted by the bug and the associated black sooty mould formation impairs photosynthetic efficiency and gaseous exchange of the affected plants [1].

Bio-control agents such as *Acerophagus papayae*, *Anagyrus loecki*, *Pseudleptomastix Mexicana* are the potential identified parasitoids and also few Coleopteran predators are suppressing *P. marginatus* population naturally [1]. Even though, they are giving promising solution in few localities because of the environmental variation did not help to adapt.

Furthermore, fish oil, resin soap, *Azadirechtin* and white mineral oils gave partially effective control against

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P. marginatus. Fungal pathogens such as *Verticillium lecanii*, *Metarhizium anisopliae and Beauveria bassiana* cause 40-50 % mortality on *P. marginatus* [4]. Tobacco medicine (100%), tobacco leaf extract (20%), mahogani seed oil (5%), castor seed oil (5%) and neem seed oil (5%) also used to manage *P. marginatus* [5]. Controlling of this small polyphagous pest is difficult task but for decades, commercial growers solely depended on chemical insecticides. Repeated usage of highly poisonous chemicals ends up with pest resurgence and resistance and human health hazards [6]. Moreover, many insecticides are being banded in Sri Lanka. Therefore, a research carried out to find out an effective and environmentally safe method for controlling papaya mealybug by using bio-rationals and screening of best chemicals as a fire fighting tool.

MATERIALS AND METHODS

The experiments were carried out in Department of Agricultural Biology, Faculty of Agriculture, University of Jaffna at the temperature of 28±1°C and 75% Relative humidity. *P. marginatus* infested papaw fruits were obtained from severely affected papaw fields in Jaffna region. Each infested fruits were placed in separate chambers and allowed to settle down. The treatments were applied using a hand sprayer on the *P. marginatus* infested fruits and the fruit were kept 0.6 m away from the sprayer, initial and final counts were taken with the help of camel hairbrush

In-vitro* Assessment of Different Chemicals Against *P. marginatus: For this experiment, 50 even aged immature *P. marginatus* infested papaw fruits were used with initial count in one side of the periphery and *P. marginatus* in other side was removed. Different insecticides were selected as treatments to compare with untreated control (Table 1).

In-vitro* Assessment of Bio-rationals Against *P. marginatus: In this experiment, 28 even aged immature *P. marginatus* infested papaw fruits were used with initial count in one side of the periphery and *P. marginatus* in other side was removed. Different bio-rationals were applied to compare with untreated control (Table 2).

***In-vitro* Evaluation of Bio-rationals in Different Concentrations:** Efficacy of screened bio-rationals such as garlic bulb extract, *Pavetta* leaf extract and Fermented cow urine were evaluated at different concentration. Garlic extracts and *Pavetta* leaf extracts were prepared in 5, 10, 15, 20 g/ml concentrations and Cow urine solutions were prepared in 25 %, 50 %, 75 % and 100 % (V/V) concentrations. The effects of bio-rationales in different concentrations were compared with untreated control.

Statistical Analysis: All the experiments were designed according to complete randomized design (CRD). Obtained data were statistically analyzed using SAS package and the significance among the treatments determined according to Dunnett mean separation test at 95 % of confidence interval.

Table 1: Insecticides used for screening against *P. marginatus*

Treatments	Chemical name	Trade name	Recommended Concentration (Per a litre)
T1	Imidachloprid	Admire	1ml
T2	Acetamiprid	Mosplan	1g
T3	Acephate	Asie	1g
T4	Thiomethoxam	Actara	1g
T5	Chloran traniliprole	Coragen	0.19 ml
T6	Profenofos	Selecron	2 ml
T7	Abamactin	Mitsu	0.6 ml
T8	Diazinon	Diazol	1.5 ml
T9	Thiocyclin hydrogen oxalate	Evisect	2.5 g
T10	Control	----	-----

Values in a column with different letters are significantly different at 0.05 *a*

Table 2: Bio-rationals used for screening against *P. marginatus*

Treatment number	Name of the treatment	Concentration
T1	Neem leaves fermented solution	1 kg Neem leaves were fermented in 1 litre water
T2	Neem leaf extract	500 g Neem leaves + 25 ml water
T3	*Pavetta* leaf extract	500 g *Pavetta* leaves + 25 ml water
T4	Garlic extract	500 g Garlic bulbs + 25 ml water
T5	Vermi wash	Obtained from Earthworm unit
T6	Fermented cow urine 1 litre cow urine fermented for 1 week+ 250 g ash fermented for 3 days	
T7	Control	

Values in a column with different letters are significantly different at 0.05 *a*

RESULTS

In-vitro* Assessment of Different Chemicals Against *Paracoccus Marginatus: Table 3 shows that, mortality percentage of *P. marginatus* in all different chemical treatments applied in this experiment were significant with untreated control mortality at 95 % confident interval.

In-vitro* Study on Effect of Bio-rationals Against *Paracoccus Marginatus: Table 4 shows, mortality percentage of *P. marginatus* using all bio-rationals exhibited significant effect, compared with control. The effectiveness of bio-rationales in controlling *P. marginatus* highlighted. Based on this experiment garlic bulb extract, Pavetta leaf extract and fermented cow urine were shown their suppressive effect.

***In-vitro* Evaluation of Bio-rationals in Different Concentrations:** Mean mortality percentage of *P. marginatus* in different concentrations of garlic bulb extracts, *Pavetta* leaf extracts and cow urine solutions given in Table 5, Table 6 and Table 7 respectively. According to that LD_{50} of garlic bulb extracts, *Pavetta* leaf extracts and cow urine solutions were 7.18 g/ml, 7.6 g/ml, 40.62% (V/V), respectively in 72 h of exposure.

DISCUSSION

Chemical insecticides such as Profenofos 50 EC (2 ml/litre), Chlorpyriphos 20 EC (2 ml/litre), Buprofezin 25 EC (2 ml/litre), Dimethoate 30 EC (2 ml/litre), Thiomethoxam 25 WG (0.6 g/litre) and Imidachloprid 17.8 SL (0.6 ml /litre) are used against *P. marginatus* [6]. According to Walker *et al.* [7] Acephate, Carbaryl, Chlorpyrifos, Diazinon, Dimethoate, Malathion and White mineral oils also used. *P. marginatus* protected by thick waxy coating, therefore twice the normal dose is applied when treating for *P. marginatus*. Repeated use of chemical insecticide causes the chances for development of resistance on the pest and non-target effects on natural enemies [6]. The findings of this study reveal that efficacy of the different chemicals in controlling *P. marginatus*. Highest percentage of mortality (100 %) obtained using Imidachloprid (100 %), Thiomethoxam (100 %) and Thiocyclin Hydrogen Oxalate (100 %). The effectiveness of bio-rationales in controlling *P. marginatus* also highlighted. Mortality percentage of *P. marginatus* using all bio-rationales exhibited significant effect, compared with control. Considering environment rather than chemical insecticides, bio-rationals give eco-friendly management against *P. marginatus* [1]. According to Razaq and Sofriani [8], fermented cow urine can be used as organic pesticide. Cow urine contains large quantities of nitrogen as well as significant quantities of dissolved phosphates and potassium. Neem based pesticides are easy to prepare cheap and highly effective and thus constitute an important source of pesticide. Neem bio pesticides provide long-term protection to plants against pests and safer to beneficial organisms such as natural enemies [9]. Prowse *et al*. [10] stated that garlic extract has pesticidal properties cause lethal effect against insect pests and less harmful effect to environment than chemical insecticides. According to Nalwar *et al* [11] neem seeds extracts and *Allium sativum* extracts are effective for control coffee mealybugs. Meenachi *et al*. [12] stated that, vermi wash is a liquid

Table 3: *In vitro* assessment of different chemicals against *Paracoccus marginatus*

	Mortality percentage				
Treatments	30 min	3 h	6 h	24 h	48 h
T_1(Imidachloprid)	98.549 [a]	99.179 [a]	100.000 [a]	100.000 [a]	100.000 [a]
T_2 (Acetamipride)	88.873 [b]	94.715 [b]	95.330 [b]	96.124 [b]	97.046 [b]
T_3 (Acephate)	44.650 [e]	49.338 [g]	60.246 [e]	66.721 [d]	69.371 [d]
T_4 (Thiomethoxam)	98.395 [a]	100.000 [a]	100.000 [a]	100.000 [a]	100.000 [a]
T5 (Chlorantraniliprole)	78.357 [c]	81.837 [c]	86.488 [d]	92.262 [c]	94.132 [c]
T_6 (Profenofos)	70.272 [d]	77.649 [d]	90.431 [c]	96.209 [b]	96.947 [b]
T_7 (Abamactin)	37.730 [f]	53.286 [f]	60.171 [e]	65.172 [d]	66.669 [e]
T_8 (Diazinon)	37.671 [f]	75.135 [e]	91.692 [c]	99.425 [a]	99.601 [a]
T_9 (Thiocyclin Hydrogen Oxalate)	97.722 [a]	98.489 [a]	100.000 [a]	100.000 [a]	100.000 [a]
T_{10} (Control)	0 [g]	0 [h]	0 [f]	0 [e]	0 [f]

Values in a column with different letters are significantly different at 0.05 *a*

Table 4: Effectiveness of different bio-rationals in *In-vitro* study against *P. marginatus*

	Mortality percentage				
Bio-rationals	0.5 h	3 h	6 h	24 h	48 h
(T_1) Neem leaf fermented solution (1 g/ml)	26.433 [d]	33.409 [d]	41.708 [c]	49.018 [d]	50.135 [c]
T_2) Neem leaf extract (20 g/ml)	28.761 [d]	34.404 [d]	46.437 [c]	52.473 [d]	54.156 [c]
(T_3) *Pavetta* leaf extract (20 g/ml)	60.869 [a]	69.405 [b]	77.543 [a]	80.242 [b]	83.308 [a]
(T_4) Garlic extract (20 g/ml)	56.915 [b]	80.232 [a]	82.067 [a]	85.824 [a]	87.848 [a]
(T_5) Vermi-wash (100% V/V)	27.870 [d]	36.837 [d]	43.869 [c]	50.939 [d]	52.545 [c]
(T_6) Fermented cow urine (100% V/V)	52.369 [c]	57.224 [c]	65.273 [b]	68.905 [c]	75.813 [b]
(T_7) Control	0 [e]	0 [e]	0 [d]	0 [e]	0 [d]

Values in a column with different letters are significantly different at 0.05 *a*

Table 5: Evaluation of Garlic bulb extract in different concentration against *P. marginatus*

		Mortality percentage					
Treatments	Concentrations (g/ml)	0.5 h	3 h	6 h	24 h	48 h	72 h
Garlic bulb extract	20	54.076 [a]	72.991 [a]	78.720 [a]	84.492 [a]	86.739 [a]	88.178 [a]
	15	38.013 [b]	57.116 [b]	63.463 [b]	69.894 [b]	80.546 [b]	83.522 [b]
	10	16.793 [c]	33.434 [c]	42.666 [c]	47.662 [c]	55.142 [c]	65.753 [c]
	5	9.971 [d]	14.359 [d]	18.966 [d]	23.856 [d]	29.943 [d]	37.809 [d]
control	-	0 [e]	0 [e]	0 [e]	0 [e]	0 [e]	0 [e]

Values in a column with different letters are significantly different at 0.05 *a*

Table 6: Evaluation of *Pavetta* leaf extract in different concentration against *P. marginatus*

		Mortality percentage *					
Treatments	Concentrations (g/ml)	0.5 h	3 h	6 h	24 h	48 h	72 h
Pavetta leaf extract	20	58.593 [a]	67.005 [a]	74.960 [a]	79.997 [a]	82.803 [a]	86.420 [a]
	15	40.638 [b]	49.831 [b]	59.894 [b]	66.659 [b]	75.817 [b]	81.225 [b]
	10	17.793 [c]	28.602 [c]	38.537 [c]	43.917 [c]	51.953 [c]	63.314 [c]
	5	7.387 [d]	11.318 [d]	16.089 [d]	21.145 [d]	27.460 [d]	35.604 [d]
control	-	0 [e]	0 [e]	0 [e]	0 [e]	0 [e]	0 [e]

Values in a column with different letters are significantly different at 0.05 *a*

Table 7: Evaluation of Cow urine solutions in different concentration against *P. marginatus*

		Mortality percentage					
Treatments	Concentrations (V/V %)	0.5 h	3 h	6 h	24 h	48 h	72 h
Cow urine	100	52.738 [a]	57.797 [a]	65.668 [a]	68.596 [a]	72.301 [a]	76.081 [a]
	75	23.636 [b]	37.117 [b]	49.694 [b]	58.177 [b]	65.792 [b]	72.314 [b]
	50	11.265 [c]	21.050 [c]	31.981 [c]	37.917 [c]	46.837 [c]	58.273 [c]
	25	6.302 [d]	10.279 [d]	15.107 [d]	20.224 [d]	26.613 [d]	36.234 [d]
control	-	0 [e]	0 [e]	0 [e]	0 [e]	0 [e]	0 [e]

Values in a column with different letters are significantly different at 0.05 *a*

extract of vermicompost and have micro and macro nutrients along with several plant growth hormones, enzymes and vitamins, which enhance the growth, productivity and provide protection against diseases and pests. *Pavetta* leaves extract also used as a bio-pesticide and provides environmentally safe pest management [13]. In this experiment, garlic bulb extract provided higher mortality percentage (87.9%) on *P. marginatus* after 48 hours of exposure and all other five bio-rationals such as *Pavetta* leaf extract, fermented cow urine, neem leaves extract, fermented neem leaves solution and vermi-wash given more than 50 % mortality on *P. marginatus* after 48 hours. According to this, considering environment and other beneficial organisms, bio-rationals had considerable effect on reducing *P. marginatus* population.

CONCLUSION

Ten chemicals such as Imidachloprid, Acetamipride, Acephate, Thiomethoxam, Chloran Traniliprole, Profenofos, Abamactin, Diazinon and Thiocyclin Hydrogen Oxalate gave more than 50 % mortality in *P. marginatus*. Garlic bulb extract, *Pavetta* leaf extract and fermented cow urine suppressed *P. marginatus* significantly after 48 hours of exposure. LD_{50} value of garlic bulb extract, *Pavetta* leaf extract and cow urine solution against *P. marginatus* was 7.18 g/ml, 7.6 g/ml and 40.62 % (V/V), respectively on 72 hours of exposure.

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REFERENCES

1. Mani, M., C. Shivaraju and A.N. Shylesha, 2012. *Paracoccus marginatus* an invasive mealybug of papaya and its biological control- An over view. Journal of Biological Control, 26(3): 201-216.
2. Galanihe, L.D., M.U.P. Jayasundera, A. Vithana, N. Asselaarachchi and G.W. Watson, 2010. Occurrence, distribution and control of papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae), an invasive alien pest in Sri Lanka. Tropical Agricultural Research and Extension, 13(3): 81-86.
3. Muniappan, R., B.M. Shepard, G.W. Watson, G.R. Carner, D. Sartiami, A. Rauf and M.D. Hammig, 2008. First Report of the papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae), in Indonesia and India. Journal of Agricultural and Urban Entomology, 25(1): 37-40.
4. Banu, J.G., T. Suruliveru, M. Amutha and N. Gapalakrishnan, 2010. Susceptibility of cotton mealybug, *Paracoccus marginatus* to entomopathogenic fungi. Ann Pl Prot Sci., 18: 247-248.
5. Ahamed, K.N., M.A. Al-Helal, N.E.P. Khanom and S. Bulbul, 2011. Control strategies of papaya mealybug, *Paracoccus marginatus* Williams & Williank infesting vegetable crops in Bangaladesh. The Journal of Plant Protection Sciences, 3(1): 44-47.
6. Tanwar, R.K., P. Jeyakumar and S. Vennila, 2010. Papaya mealybug and its management strategies. National Centre for Integrated Pest Management, pp: 1-26.
7. Walker, A., M. Hoy and D. Meyerdirk, 2003. Papaya mealybug (*Paracoccus marginatus* Williams and Granara de Willink (Insecta: Hemiptera: Pseudococcidae). Featured Creatures. Entomology and Nematology Department, Florida Cooperative Extension Service, Institute of Food and agricultural Sciences, University of Florida, Gainesville, FL. EENY-302, pp: 1-6.
8. Rozaq, P. and N. Sofriani, 2009. Organic pesticide from urine and spices modification. Asian Journal of Food and Agro-Industry, pp: 105-111.
9. Girish, K. and B.S. Shankara, 2008. Neem a green treasure. Electronic journal of Biology, 4(3): 102-111.
10. Prowse, G.M., T.S. Galloway and A. Foggo, 2006. Insecticidal activity of garlic juice in two dipteran pests. Agricultural and Forest Entomology, 8(1): 1-6.
11. Nalwar, Y.S., M.A. Sayyed, S.S. Mokle, P.R. Zanwar and Y.B. Vibhute, 2009. Synthesis and insect antifeedent activity of some new chalcones against *Phenacoccus solanopsis*. World Journal of Chemistry, 4(2): 123-126.
12. Meenatchi, R., R.S. Giraddi, V.S. Patil, A.S. Vastrad and D.P. Biradar, 2011. Effect of vermitechnologies on jasmine insect pests. Karnataka Journal of Agricultural Sciences, 24(3): 312-315.
13. Gunarathna, T.V.N.M. and M.M.S.C. Karunaratne, 2009. Laboratory evaluation of some Sri Lankan plants as post-harvest grain protectants for the control of rice weevil *Sitophilus oryzae*. Vidyodaya Journal of Science, 2(14): 69-83.