Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(2): 2855-2858

Received: 12-01-2018
Accepted: 13-02-2018

Dr. Muhammad Babar Shahzad Afzal
Citrus Research Institute, Sargodha, Pakistan

Zaheer Sikandar
Citrus Research Institute, Sargodha, Pakistan

Ansa Banazeer
Department of Entomology, Faculty of Agricultural Sciences and Technology, Bahauddin Zakariya University, Multan

Muhammad Nawaz Khan
Citrus Research Institute, Sargodha, Pakistan

Abdul Aziz
Citrus Research Institute, Sargodha, Pakistan

Muhammad Raza Salik
Citrus Research Institute, Sargodha, Pakistan

Shaukat Nawaz
Citrus Research Institute, Sargodha, Pakistan

Correspondence
Dr. Muhammad Babar Shahzad Afzal
Citrus Research Institute, Sargodha, Pakistan

Efficacy of different insecticides under laboratory conditions against *Drosicha mangiferae* Green (Homoptera: Margarodidae) collected from citrus orchards of Sargodha, Pakistan

Dr. Muhammad Babar Shahzad Afzal, Zaheer Sikandar, Ansa Banazeer, Muhammad Nawaz Khan, Abdul Aziz, Muhammad Raza Salik and Shaukat Nawaz

Abstract
We tested the efficacy of eight different insecticides viz., acetamiprid, imidacloprid, profenofos, methidathion, bifenthrin, carbosulfan, buprofezin and spirotetramat against the adult female mango mealybug *Drosicha mangiferae* in the laboratory using leaf-dip bioassay method. The insects were collected from citrus orchard of Citrus Research Institute, Sargodha and were tested on different insecticide doses in the Entomology laboratory of Citrus Research Institute, Sargodha, Punjab, Pakistan, during the year 2017 in the month of April. The mortality data was analyzed by split plot design under CRD using statistix 8.1 version software. Results indicated that methidathion (T4) produced significantly higher mortality of 73.57% seven days after treatment while mortality due to bifenthrin (T5) was 59.996% four days after treatment but it decreased to 20% seven days after treatment. Profenofos (T3) produced higher mortality (58.07%) seven days after treatment but it was significantly less as compared to methidathion (T4). Carbosulfan (T6) showed good results four days after treatment with 59.81% mortality but mortality was decreased to 45.664% seven days after treatment. The order of effectiveness of insecticides is as: methidathion > profenofos > carbosulfan > bifenthrin. The insecticides, acetamiprid, imidacloprid, buprofezin and spirotetramat were found ineffective for the control of adult female mango mealybug. The judicious use of the insecticides methidathion, profenofos and carbosulfan is recommended to the citrus growers to control this important pest.

Keywords: Mango mealybug, citrus, insecticides, methidathion, mortality

1. Introduction
Citrus crop is cultivated successfully on very large area in Pakistan due to favourable climatic conditions [1]. In Pakistan, Punjab holds the key position in producing high quality and grade citrus fruits worldwide and Sargodha is the dominant in citrus production holding enormous export potential [2]. Oranges, grapefruits, mandarins (kinnow) and lemons are major groups of citrus; among these groups mandarins (Kinnow) is of greater importance to Pakistan [3]. Citrus is major source of vitamin C, alkaline salts, minerals, fruit sugar, with some quantity of vitamin A and B [4]. Many secondary metabolites such as alkaloids, flavonoids, limonoids, carotenoids and phenolic acids are also constituents of citrus fruits and are vital for human health due to their anti-cancer, anti-oxidative and anti-inflammatory effects [5].
Drosicha mangiferae (Homoptera: Margarodidae) is highly polyphagous, dimorphic and destructive pest due to very high fecundity and potential to cause serious crop losses [6]. Females of these pests lay eggs in the loose soil within the 2-3 meter radius of the attacked tree in July. The diapausing eggs start their hatching in December or January depending upon the temperature and emerging nymphs crawl to reach the upper parts of plants for feeding and development [7]. The nymphs and female bugs damage the plant by piercing and sucking the sap from tender shoots, leaves, and flower buds [8]. Feeding by these insects also causes decreased photosynthesis, lowering in plant respiration, curling, chlorosis, leaves abscission, decreased fruit formation, dwarfing and even death in severe cases [6]. The insect also produces honey dew resulting in sooty mold growth, which hinders the photosynthesis process [9]. The waxy coating on the body of adult female, clumped spatial distribution pattern and cryptic behaviour of mealybug, make many insecticidal applications ineffective for their control [10].

The use of insecticides to control the insect pest outbreak is one of the major tools of integrated pest management [11]. However, their intensive applications in the field are not free of costs as they impose selection pressure on the insect populations which result in resistance development in insects [7]. Other serious concerns due to the use of frequent insecticide applications in the field include environmental contamination, residue accumulations beyond tolerance levels, non-target effects on humans and beneficial fauna [12]. In Citrus orchards of Pakistan, about 5-6 applications of insecticides mainly from organophosphates are done as corrective measure for mealybugs from its emergence till next diapause. Mealybugs also have the ability to rapidly develop resistance to insecticides [13]. These insecticides therefore vary in their control efficacy, and control failure may occur [9]. Keeping in view the economic importance of mealybug for citrus and need for selection of best insecticide for the control of adult female mango mealybug, this study was done to screen the insecticides from different groups for their efficacy for the recommendations to farmers.

2. Materials and Methods

2.1 Study area

The present research work was done in the Entomology laboratory of Citrus Research Institute, Sargodha (32.0740° N, 72.6861° E), Punjab, Pakistan during the year 2017 in the month of April.

2.2 Insect collection

The adult female mealybugs were collected from different citrus plants which were not sprayed with any insecticide for last one month. The citrus plants were twelve year old and situated in the farm area of Citrus Research Institute, Sargodha. These insects were brought to the Entomology laboratory and kept in the transparent plastic jars covered with porous white cloth for aeration. Inside the jars, leaves of citrus with soft branches were given to the insects for feeding.

2.3 Insecticides

The insecticides tested for their efficacy on mealybugs and their tested doses are given below:

Table 1: List of Insecticides and their doses tested

Sr. No	Trade Name	Common name	Tested doses (mg or ml/40 ml H_2O)
1	Acetamiprid 20 SL	Acetamiprid	0.20, 0.10, 0.05 ml
2	Imidacloprid 25 WP	Imidacloprid	100, 50, 25 mg
3	Profenofos 50% EC	Profenofos	1.6, 0.8, 0.4 ml
4	Methidathion 40 EC	Methidathion	0.4, 0.20, 0.10 ml
5	Bifenthrin 10 EC	Bifenthrin	0.24, 0.12, 0.06 ml
6	Advantage 20 EC	Carbosulfan	0.40, 0.20, 0.10 ml
7	Buprofezin 25 WP	Buprofezin	0.48, 0.24, 0.12 mg
8	Movento 240 SC	Spirotetramat	0.08, 0.04, 0.02 ml

2.4. Leaf-dip bioassays

Eight insecticide formulations at three different doses were tested in the laboratory on the adult stage of female mango mealybug. Every insecticide was tested at three doses (levels) and each level was repeated five times. The doses used were determined from the field recommendation doses. Diluted insecticide solutions in 40 ml water were prepared and fresh citrus leaves were dipped in the solutions. After dipping, the leaves were air dried at room temperature and put in the Petri dishes whose bases were covered with moistened filter paper to prevent the leaves from dehydration. In each Petri dish 10 insects were released for feeding on insecticide treated leaves. In control, leaves treated with water were offered to insects. A total of 50 insects (10/replicate) were used for each dose (level) and 150 insects excluding control were used in each bioassay. In control treatment 50 insects were used in five replicates. Hence, total number of insects used per bioassay including control was 200. Mortality of insects was determined after 24h, 48h, 72h, 96h and 7days exposure. Insects that did not show any movement upon gentle touch with camel hair brush were declared dead [13].

2.5. Statistical analysis

The mortality data was analyzed by statistix 8.1 version software using the split plot design under Completely Randomized Design (CRD). The significance of treatment means were determined by LSD test at $\alpha = 0.05$.

3. Results

Among all the tested insecticides, methidathion (T4) has produced significantly higher mortality (73.57%) seven days after treatment at the concentration of 0.40 ml/40 ml water. Mortality due to bifenthrin (T5) started to increase upto four days after treatment (59.996%) but decreased to 20% seven days after treatment. Profenofos (T3) produced higher mortality (58.07%) seven days after treatment but it was significantly less as compared to methidathion (T4). Carbosulfan (T6) showed good results four days after treatment with 59.81% mortality but mortality was decreased to 45.664% seven days after treatment. Other insecticides such as buprofezin (T7), imidacloprid (T2) and acetamiprid (T1) were found least effective in controlling the adult female mealybug (Table 2).

Comparison of insecticides (treatments) irrespective of doses shows that methidathion (T4) produced 41.857% mortality seven days after treatment which is higher as compared to all other tested insecticides. Profenofos (T3) and carbosulfan (T6) almost produced similar mortalities (34.69% and 30.64%, respectively) seven days after treatment but significantly less than methidathion (T4) and higher than all other tested insecticides. Acetamiprid (T1) failed to produce any mortality in the treated mealybugs (Table 3).

Table 2: Response of mealybug to different insecticides at different doses

Insecticide (Treatment)	Doses tested in mg or ml/40 ml water	%Mortality				
		1 DAT*	2 DAT	3 DAT	4 DAT	7 DAT
Acetamiprid (T1)	0.2	0 C	0 C	0 D	0.00 E	12.00 EFGH
	0.1	0 C	0 C	0 D	0.00 E	8.00 GH
	0.05	0 C	0 C	0 D	0.00 E	4.00 GH
Imidacloprid (T2)	100	0 C	0 C	2.00 D	0.00 E	14.00 EFGH
	50	0 C	0 C	0 D	0.00 E	6.00 GH
	25	0 C	0 C	0 D	0.00 E	0.00 H
Profenofos (T3)	1.6	0 C	2 BC	8.2220 C	9.1660 DE	58.070 AB
	0.8	0 C	0 C	0 D	2.00 E	26.00 DEF
	0.4	0 C	0 C	0 D	0.00 E	20.00 DEFG
Methidathion (T4)	0.4	0 C	0 C	12.00 BC	23.22 C	73.570 A
	0.2	0 C	0 C	0 D	12.00 D	32.00 CD
	0.1	0 C	0 C	0 D	2.00 E	20.00 DEFG
Bifenthrin (T5)	0.12	28 A	22.258 A	34.902 A	59.996 A	20.00 DEFG
	0.06	10 B	4.00 B	2.00 D	4.00 DE	2.00 H
	0.03	4 C	0 C	0.00 D	2.00 E	0.00 H
Carbosulfan (T6)	0.4	0 C	0 C	14.00 B	59.814 A	45.664 BC
	0.2	0 C	0 C	2.00 D	36.66 B	32.282 CD
	0.1	0 C	0 C	0.00 D	0.00 E	14.00 EFGH
Buprofezin (T7)	0.48	0 C	0 C	0.00 D	0.00 E	6.00 GH
	0.24	0 C	0 C	0.00 D	0.00 E	2.00 H
	0.12	0 C	0 C	0.00 D	0.00 E	0.00 H
Spirotetramat (T8)	0.08	0 C	0 C	0.00 D	2.00 E	28.444 CDE
	0.04	0 C	0 C	0.00 D	0.00 E	2.00 H
	0.02	0 C	0 C	0.00 D	0.00 E	2.00 H
Control (T9)		0 C	0 C	0.00 D	0.00 E	0.00 FGH

*Days after treatment

Table 3: Comparison of insecticides to produce mortality in adult female mango mealybug

Insecticides	% Mortality				
	1 DAT	2 DAT	3 DAT	4 DAT	7 DAT
Acetamiprid (T1)	0.00 B	0.00 B	0.00 E	0.00 D	8.00 CD
Imidacloprid (T2)	0.00 B	0.00 B	0.6667 DE	0.00 D	6.667 CD
Profenofos (T3)	0.00 B	0.6667 B	2.7407 CD	3.7220 D	34.690 AB
Methidathion (T4)	0.00 B	0.00 B	4.00 BC	12.407 C	41.857 A
Bifenthrin (T5)	14.00 A	8.7527 A	12.301 A	21.999 B	7.333 CD
Carbosulfan (T6)	0.00 B	0.00 B	5.33 B	32.160 A	30.649 B
Buprofezin (T7)	0.00 B	0.00 B	0.00 E	0.00 D	2.667 D
Spirotetramat (T8)	0.00 B	0.00 B	0.00 E	0.6667 D	14.148 C
Control (T9)	0.00 B	0.00 B	0.00 E	0.00 D	3.33 D

4. Discussion

Mango mealybug is becoming a problematic pest in citrus orchards of Sargodha, Punjab, Pakistan and it is considered to be a difficult pest to control by insecticides. Farmers apply different sprays frequently in the citrus orchards to control the nymphal and adult female stages of this insect. In this study we have tested the insecticides from organophosphate (profenofos, and methidathion), pyrethroid (bifenthrin), carbamate (carbosulfan), and new chemistry (acetamiprid, imidacloprid, buprofezin, spirotetramat) groups.

The present study revealed that acetamiprid and imidacloprid failed to produce significant mortality in the adult female mealybug; which shows that these insecticides are ineffective for adult female mango mealybug. However, significantly greater efficacy was achieved by treating the insects with methidathion, profenofos, and carbosulfan in decreasing order, respectively. Buprofezin, and spirotetramat also proved to be least effective in killing the adult female mango mealybugs. Bifenthrin only showed its greater effectiveness 4 DAT, at higher concentration and produced 59.996% mortality. These findings suggest that a promising control of adult female mealybugs can be achieved by the application of methidathion, profenofos, carbosulfan, and bifenthrin. However, these insecticides must be used in rotational manner in order to avoid the insect from becoming resistant to single insecticide. The citrus growers apply the methidathion spray 5-6 times during a season for the control of adult female mealybugs. There is a need to reduce the frequency of its applications to preserve the efficacy of insecticide for longer time.

Similar to our findings, Karar *et al.* [14] reported that methidathion was the most effective insecticide for adult female mango mealybug in mango orchards with maximum mortality (73%) among all the tested insecticides. In our studies acetamiprid was found to be ineffective for mango mealybug adult female which is in contrast to findings of Karar *et al.* [14] who reported that acetamiprid was the second most effective insecticide with 71% mortality of the pest. Hussain *et al* [7] studied the efficacy of some insecticides against 1st and 2nd instar of mango mealybugs under the laboratory conditions by leaf-dip method, and concluded that profenofos produced maximum mortality of 93.3% and 86.67% in these instars, respectively. Similar to these studies we have also reported profenofos an effective insecticide after methidathion for the control of adult female mango mealybug. Our results are also similar to Aheer *et al.* [15] who

demonstrated that methidathion, chlorpyrifos, and profenofos were effective against cotton mealybug seven days after their applications. Similar to our studies, Lo *et al*. [16] also reported profenofos as an effective insecticide in single application for the control of mealybugs in vineyards while buprofezin was found to be least effective in controlling these mealybugs. Mansour *et al*. [17] reported methidathion as an effective insecticide similar to our findings but in contrast to our results they also showed imidacloprid, and spirotetramat effective for the control of vine mealybug in a Tunisian vineyard. In contrast to our results, Walton and Pringle, [18] also reported imidacloprid as a more effective insecticide than methidathion to suppress the population of vineyard mealybugs in South African vineyards.

5. Conclusion

It is concluded from the present study that in order to control the mango mealybug effectively in the adult stage, selection of appropriate insecticide is necessary. This study recommends the use of methidathion, profenofos and carbosulfan for the chemical control of adult female mango mealybug to the citrus growers. However, these insecticides must be used in judicial way as a part of Integrated Pest Management and other control tactics such as destruction of eggs in the soil before emergence from diapause in December, use of sticky and slippery bands around the trunk of trees to prevent the upward movement of nymphs to upper portion of trees and removal of alternate host plants in the citrus growing region must be integrated. In order to delay the resistance and cross-resistance development and to enhance the efficacy the recommended insecticides, their use in rotational manner is very important.

6. Acknowledgement

The authors are extremely thankful to Mr. Raja Shafqat, Assistant Research Officer (Plant Pathology), Citrus Research Institute, Sargodha for arranging the insecticides required in this study.

7. References

1. Syed R. Searching new avenues to enhance citrus fruit export. Daily Times Pakistan, 2007.
2. Ashraf S, Khan GA, Ali S, Iftikhar M, Mehmood N. Managing insect pests and diseases of citrus: on farm analysis from pakistan. Pakistan Journal of Phytopathology. 2014; 26: 301-307.
3. Abbas M, Saleem M, Saleem HM, Hafeez F, Hussain D, Ghaffar A. *et a.l* Population dynamics of citrus leafminer, *Phyllocnistis citrella* Stainton, and its control on citrus in nursery and orchard in Faisalabad. Wudpecker Journal of Agricultural Research. 2013; 2:183-188.
4. Shinde SS, Neharkar PS, Dhurve NG, Sawai HR, Lavhe NV, Masolkar DS. Evaluation of different insecticides against citrus leaf miner on Nagpur mandarin. Journal of Entomology and Zoology Studies. 2017; 5:1889-1892.
5. Lv X, Zhao S, Ning Z, Zeng H, Shu Y, Tao O, *et al* Citrus fruits as a treasure trove of active natural metabolites that potentially provide benefits for human health. Chemistry Central Journal. 2015; 9:68.
6. Karar H, Arif J, Hameed A, Ali A, Hussain M, Shah FH, *et al* Effect of cardinal directions and weather factors on population dynamics of mango mealybug, *Drosicha mangiferae* (Green) (Margarodidae: Homoptera) on Chaunsa cultivar of mango. Pakistan Journal of Zoology. 2013; 45:1541-1547.
7. Hussain SI, Saleem MA, Freed S. Toxicity of some insecticides to control mango mealy bug, *Drosicha mangiferae*, a serious pest of mango in Pakistan. Pakistan Journal of Zoology. 2012; 44:353-359.
8. Karar H, Arif MJ, Ali A, Hameed A, Abbas G, Abbas Q. Assessment of yield losses and impact of morphological markers of various mango (*Mangifera indica*) genotypes on mango mealybug (*Drosicha mangiferae* Green) (Homoptera: Margarodidae). Pakistan Journal of Zoology. 2012; 44:1643-1651.
9. Saeed S, Ahmad M, Ahmad M, Kwon YJ. Insecticidal control of the mealybug *Phenacoccus gossypiphilous* (Hemiptera: Pseudococcidae), a new pest of cotton in Pakistan. Entomological Research. 2007; 37:76-80.
10. Martins RF, Zina VE, Da Silva EB, Rebelo MT, Figueiredo E, Mendel Z *et al.* Isolation and characterization of fifteen polymorphic microsatellite loci for the citrus mealybug, *Planococcus citri* (Hemiptera: Pseudococcidae), and cross-amplification in two other mealybug species. Journal of Genetics. 2014; 93:75-78.
11. Díaz G, Ortiz R, Schettino B, Vega S, Gutiérrez R. Organochlorine pesticides residues in bottled drinking water from Mexico City. Bulletin of Environmental Contamination and Toxicology. 2009; 82:701-704.
12. Gonçalves CR, Marins AT, do Amaral AM, Leitemperger J, Severo ES, Moraes BS, *et al*. Biochemical Responses in Freshwater Fish Exposed to Insecticide Propoxur. Bulletin of Environmental Contamination and Toxicology. 2018; 100:524-528.
13. Afzal MBS, Shad SA, Abbas N, Ayyaz M, Walker WB. Cross-resistance, the stability of acetamiprid resistance and its effect on the biological parameters of cotton mealybug, *Phenacoccus solenopsis* (Homoptera: Pseudococcidae), in Pakistan. Pest management science. 2015; 71:151-158.
14. Karar HA, Arif MJ, Sayyed HA, Ashfaq M, Khan MA. Comparative efficacy of new and old insecticides for the control of mango mealybug (*Drosicha mangiferae* G.) in mango orchards. International Journal of Agriculture and Biology. 2010; 12:443-446.
15. Aheer GM, Ahmad R, Ali A. Efficacy of different insecticides against cotton mealybug, *Phenacoccus solani* Ferris. Journal of Agricultural Research. 2009; 47:47-52.
16. Lo P, Bell V, Walker J. Maximising the effectiveness of insecticides to control mealybugs in vineyards. New Zealand Plant Protection. 2009; 62:296-301.
17. Mansour R, Lebdi KG, Rezgui S. Assessment of the performance of some new insecticides for the control of the vine mealybug *Planococcus ficus* in a Tunisian vineyard. Entomologia Hellenica. 2010; 19:21-33.
18. Walton VM, Pringle K. *Planococcus ficus* (Signoret) (Hemiptera: Seudococcidae), a Key Pest in South African vineyards. Review. South African Journal for Enology and Viticulture. 2004; 25:54-62.