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Determination of relative toxicity and base line data of different insecticides against cotton mealybug (*Phenacoccus solenopsis* Tinsley)

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A B S T R A C T

Laboratory bioassay was conducted to determine the toxicity of some insecticides and their LC_{50} values against 3rd instar nymphs of cotton mealybug, *Phenacoccus solenopsis* in the Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur during 2012. Both treated food untreated insect and treated food treated insect methods were followed. The lowest LC_{50} values through treated food untreated insect method were recorded in chlorpyriphos 20 EC (226 ppm) and dichlorvos 75 EC (282 ppm) in treated food treated insect method, which was 8.89 and 7.13 times more relatively toxic in respective method after 24 hours when compared to the standard check flonicamid 50 WG. Based on the LC_{50} values (ppm) and relative toxicity, the descending order of toxicity was chlorpyriphos 20 EC (226) > dichlorvos 75 EC (282) > triazophos 40 EC (369) > spinosad 45 SC (630) > endosulfan 75 EC (950) through treated food untreated insect method and chlorpyriphos 20 EC (113) > triazophos 40 EC (217) > dichlorvos 75 EC (237) > endosulfan 75 EC (253) > spinosad 45 SC (937) through treated food and treated insect method.

Keywords: Relative toxicity, insecticides, LC_{50}, *Phenacoccus solenopsis*

Introduction

Mealybug commonly known as Pseudococcids, are ubiquitous group of sap sucking plant insect, in recent years has attended the status of major pests in India. They belong to the family Pseudococcidae, super family Coccoidea and order Hemiptera. The cotton mealybug, *Phenacoccus solenopsis* was first reported from the U.S. in 1898. It has remained a serious pest of vegetable and floricultural crops and has a wide geographical distribution (Williams & Willink 1992; Fuchs *et al.* 1991). In India, it has attended the status of major pest of cotton (Arif *et al*. 2009; Nagrare *et al*. 2009; Kulkarni & Adsule 2010). Cotton mealybug in India is known to be introduced from Pakistan (Anonymous 2006). The pest secretes sweet honey dew which encourages the black sooty mould which adversely effects photosynthetic activity. The honey dew also attracts ants which in turn help their dispersion from plant to plant. Cotton mealybug was also reported to damage on china rose in Nigeria (Akintola & Ande 2008) and 10-60% in North and Central zones of India (Tanwar *et al.* 2011).

Geiger and Danne (2001) observed that the chemical control of mealybug may be effective due to their cryptic lifestyle and often such sprays create a negative impact even on its natural enemies. However, this stage lasts only for few days and subsequently it attends the cover the mealy substance and ensure protection from insecticides (Yousuf *et al*. 2007).

Dean *et al*. (1971) also made such observation as they were able to suppress the insecticide of mealybug to a certain extend since the insecticidal spray hardly hit the insect due to presence of waxy, mealy covering. Determination of lethal concentration of any known or unknown chemical against any organism in laboratory is highly rewarding to decide the application of biocide in the field. With this view, the present study was carried out to determine the relative toxicity of some insecticides against *P. solenopsis* so that data obtained could be utilized in modern plant protection practices for managing this pest in West Bengal condition.

Materials and Methods

Rearing of cotton mealybug on growing potato

An initial population of cotton mealybug was collected from china rose plant in the University campus (Bidhan Chandra Krishi Viswavidyalaya) and the culture of the cotton mealybug was done on sprouting potato in plastic container in the laboratory of the Department of Agricultural Entomology. Cotton mealybug can easily be reared and multiplied under laboratory conditions on growing potato. Fine field soil was taken and mixed with vermicompost (1:1). A plastic container (45 cm × 30cm) was filled (about 3 cm) with it and 15 sprouted potato placed on the soil maintaining a distance of 5 cm. The soil was moistened and mealybug was released after ten days on growing potato and population was well established for bioassay.

Bioassay through treated food untreated insect (leaf dip method) and treated food treated insect methods

The selected insecticides viz. flonicamid 50% WG (4gm/L, 2gm/L, 1gm/L, 0.5gm/L, 0.250gm/L and 0.125gm/L), spinosad 45% SC (1.6ml/L, 0.8ml/L, 0.4ml/L, 0.2ml/L, 0.1ml/L and 0.05ml/L), dichlorvos 75% EC (2ml/L, 1ml/L, 0.5ml/L, 0.25ml/L, 125ml/L and 0.060ml/L), chlorpyriphos 20% EC (2.5ml/L, 1.25ml/L, 0.625ml/L, 0.312ml/L, 0.156ml/L and 0.078ml/L), triazophos 40% EC (4ml/L, 2ml/L, 1ml/L, 0.5ml/L, 0.25ml/L and 0.125ml/L) and endosulfan75% EC (4ml/ L, 2ml/L, 1ml/L, 0.5ml/L, 0.25ml/L and 0.125ml/L) with thrice replications of each dose were used for bioassay. Fresh tender cotton leaves were collected from untreated cotton fields and washed with fresh water. The petiole of each leaf was wrapped with wet cotton wool to keep the leaves fresh for longer period and dried under shade to evaporate the moisture for better movement of mealybug and placed individually in petridish. All the treatments were replicated thrice. The leaves were dipped in respective insecticide solution and dried under shade and placed individually in petridish. Twenty five 3rd instar nymphs were released per replication in each petridish on the treated leaf. In case of treated food treated insect method, nymphs were released through camel brush in each petridish on the leaf and respective solution was sprayed with hand atomizer and covered the upper portion of petridish with muslin cloth and then tied with rubber band. More than two generation insects were taken for bioassay study.

Collection and analysis of data

The mortality data was recorded after 24 and 48 hours after treatment. Data were analyzed through POLO PLUS (Probit and Logit Analysis) Statistical Analysis Software version 2.

Results and Discussion

Treated food untreated insect method

Results revealed that the LC_{50} values of flonicamid 50% WG, spinosad 45% SC, dichlorvos 75% EC, chlorpyriphos 20% EC, triazophos 40% EC and endosulfan75% EC were 2010, 630, 282, 226, 369 and 950 ppm respectively at 24 hours after treatment (Table 1). The respective LC_{50} values were observed 885, 192, 81, 65, 184 and 333 ppm, against 3rd instar nymphs at 48 hours after treatment (Table 2). Chlorpyriphos was relatively more toxic (8.89) followed by dichlorvos (7.13), triazophos (5.45), spinosad (3.19) and endosulfan (2.10) against *P. solenopsis* at 24 hours after exposure. The acute toxicity (LC_{50} value at 24 hours) of chlorpyriphos was highest mortality of cotton mealybug as compared to others (Table 1). The LC_{50} values (ppm) of this chemical was 226 ppm followed by dichlorvos (282), triazophos (369), spinosad (630) and endosulfan (950). Flonicamid was comparatively less toxic in both exposure hours and it was taken as the standard check.

Treated food treated insect method

Chlorpyriphos was relatively more toxic than others at 24 hours after exposure. The lowest LC_{50} value was recorded (after 24 hours) in chlorpyriphos which exhibited the highest mortality of cotton mealybug as compared to others. The LC_{50} value of this chemical was 113 ppm followed by triazophos (217 ppm), diclorvos (237) endosulfan (253 ppm) and spinosad (937 ppm). Based on the relative toxicity, the descending order of toxicity was chlorpyriphos (27.36) > triazophos (14.25) > dichlorvos (13.05) > endosulfan (12.22) > spinosad (3.30). Again flonicamid was less toxic and it was taken as the standard check (Table 3).

LC_{50} value of chlorpyriphos and dichlorvos against *P. solenopsis* was similar with the observation of Suresh *et al.* (2010) wherein the effectiveness of chlorpyriphos, dichlorvos and other insecticides against cotton mealybug under laboratory condition through leaf dip method were documented. On the basis of overall efficacy, 100 per cent reduction of *P. solenopsis* was recorded in chlorpyriphos followed by dichlorvos (90%). Tanwar *et al.* (2007) reported that chlorpyriphos was effective against mealybug both in laboratory bioassay and in the field. Dhawan *et al.* (2008) also found higher toxicity of chlorpyriphos than endosulfan. Nagrare *et al.* (2011) tested some insecticides against *P. solenopsis* under the laboratory conditions and reported better performance of chlorpyriphos followed by triazophos, diclorvos, endosulfan and spinosad. Banu *et al*. (2010) also found effectiveness of chlorpyriphos against *P. solenopsis* and *Paracoccus marginatus* in laboratory condition. Mandal and Chatterjee (2012) reported that chlorpyriphos, triazophos, dichlorvos and endosulfan were effective in controlling mealybug (*P. solenopsis*) infestation in china rose. Our results further confirm the previous reports.

Now-a-days mealy bug is a devastating emerging nuisance in West Bengal condition especially on china rose, jute, cotton and others. Our present investigation revealed that triazophos, chlorpyriphos and dichlorvos were the most effective insecticides to curb this menace.

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Table 1

Dosage-mortality response through treated food untreated insect method and LC_{50} values of different insecticides (24 hours exposure)

Treatment	Heterogeneity $\chi^2(4)$	Regression equation (y =)	LC_{50} (ppm)	Fiducial limit	Relative toxicity	Order of toxicity
Flonicamid 50% WG	2.119	1.250x- 0.579	2010	1500- 3035	1.00	VI
Spinosad 45% SC	0.951	1.175x- 0.174	630	472- 940	3.19	IV
Dichlorvos 75% EC	3.102	2.175x+ 0.922	282	241- 321	7.13	II
Chlorpyriphos 20% EC	10.257	1.043x- 0.056	226	137- 522	8.89	I
Triazophos 40% EC	1.002	1.199x+ 0.042	369	302- 456	5.45	III
Endosulfan 75% EC	1.316	1.288x- 0.388	950	5600- 910	2.10	V

Table 2

Dosage-mortality response through treated food untreated insect method and LC_{50} values of different insecticides (48 hours exposure)

Treatment	Heterogeneity $\chi^2(4)$	Regression equation (y =)	LC_{50} (ppm)	Fiducial limit	Relative toxicity	Order of toxicity
Flonicamid 50% WG	0.545	1.303x- 0.323	885	719- 1136	1.00	VI
Spinosad 45% SC	2.00	1.118x+ 0.413	192	155- 243	4.61	IV
Dichlorvos 75% EC	3.056	1.917x+ 1.089	81	70- 93	10.93	II
Chlorpyriphos 20% EC	13.963	1.354x+ 0.662	65	39- 102	13.62	I
Triazophos 40% EC	4.1756	1.422x+ 0.478	184	143- 232	4.81	III
Endosulfan 75% EC	0.781	1.479x+ 0.032	333	281- 397	2.66	V

Table 3

Dosage-mortality response through treated food treated insect method and LC_{50} values of different insecticides (24 hours exposure)

Treatment	Heterogeneity $\chi^2(4)$	Regression equation (y =)	LC_{50} (ppm)	Fiducial limit	Relative toxicity	Order of toxicity
Flonicamid 50% WG	0.689	0.888x- 0.702	3092	1940- 6471	1.00	VI
Spinosad 45% SC	3.807	0.958x- 0.305	937	600- 1740	3.30	V
Dichlorvos 75% EC	10.989	1.518x+ 0.759	237	162- 342	13.05	III
Chlorpyriphos 20% EC	5.815	1.073x+ 0.266	113	79- 167	27.36	I
Triazophos 40% EC	0.838	1.325x+ 0.351	217	178- 261	14.25	II
Endosulfan 75% EC	2.411	1.523x+ 0.213	253	215- 299	12.22	IV

Table 4

Dosage-mortality response through treated food treated insect method and LC_{50} values of different insecticides (48 hours exposure)

Treatment	Heterogeneity $\chi^2(4)$	Regression equation (y =)	LC_{50} (ppm)	Fiducial limit	Relative toxicity	Order of toxicity
Flonicamid 50% WG	1.553	1.250x- 0.005	505	416- 623	1.00	VI
Spinosad 45% SC	2.884	1.130x+ 0.247	272	217- 356	1.86	V
Dichlorvos 75% EC	6.0727	1.488x+ 0.939	175	129- 229	2.88	III
Chlorpyriphos 20% EC	6.937	1.117x+ 0.551	64	42- 92	7.89	I
Triazophos 40% EC	0.735	1.200x+ 0.546	140	109- 173	3.60	II
Endosulfan 75% EC	3.363	1.698x+ 0.544	191	163- 224	2.64	IV