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Persistent toxicity studies on shoot and fruit borer in brinjal and toxicity studies on citrus psyllids *Diaphorina citri* Kuwayama under laboratory condition

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Abstract
The insecticidal treatments differed considerably in their persistence, period of efficacy and index of persistent toxicity. At 48 hours of treatment, high mortality was observed with chlorpyriphos 2000 ml/ha (95.83%) and 79.17% with chlorpyriphos 1500 ml/ha and the persistent toxicity (PT) values were 4600.0, 3800.0 respectively. The higher dose of chlorpyriphos 20 EC treatments were the most persistent and Dursban 20 EC, lower dose of chlorpyriphos was the least. Contact toxicity results showed that, Chlorpyriphos 20 EC 1000 ml/ha registered 100 per cent mortality and chlorpyriphos 20 EC 750 ml/ha (100%) followed by chlorpyriphos 20 EC 500 ml/ha (96.67%) and Dursban 20 EC 500 ml/ha (93.33%), dimethoate 30 EC 500 ml/ha (90.00%) and chlorpyriphos 20 EC 250 ml/ha (86.67%). Higher Mortality of the psyllids in adult feeding experiments was recorded with chlorpyriphos 20 EC at 1000 ml/ha (100%) and chlorpyriphos 20 EC at 750 ml/ha (100%) The other effective treatments were; chlorpyriphos 20 EC at 500 ml/ha (96.67%) and Dursban 20 EC at 500 ml/ha (93.33%) dimethoate 30 EC at 500 ml/ha (90.00%) and chlorpyriphos 20 EC at 250 ml/ha (86.67%).

Keywords: Shoot and fruit borer, *Diaphorina citri* Kuwayama, chlorpyriphos 20 EC, persistent toxicity

Introduction
It is important to determine the persistent toxicity of insecticides, so as to fix interval between applications to minimize the insecticidal interventions and to make cost effective insect control, besides determining safer waiting periods.
However, it is essential to assess the persistence before the insecticides application. In the present study, persistent toxicity of chlorpyriphos 20 EC was tested against against brinjal shoot and fruit borer and toxicity studies was conducted to evaluate the chlorpyriphos 20 EC against citrus psyllids *diaphorina citri* under laboratory condition.

Materials and Methods
Persistent toxicity of chlorpyriphos 20 EC against brinjal shoot and fruit borer
Studies were conducted at the Department of Agricultural Entomology, Tamil Nadu Agricultural Entomology, Coimbatore in a completely randomized design. Pot culture trials were conducted in glass house in to assess the persistent toxicity of chlorpyriphos 20 EC against shoot and fruit borer on brinjal (BSFB).

Mass culture of *Leucinodes orbonalis*
Mass culturing of brinjal shoot and fruit borer was done as per the standard procedure described by Rajalakshmi *et al*. (2005) [4].
For mass culturing, BSFB damaged brinjal fruits harbouring live larvae were collected from farmer's field. The fruits were placed in plastic trays containing dry river sand in a culture room at 25 ± 2 °C and 75-85% RH. The fully grown larvae that came out of the fruits were allowed to pupate in dry river sand. The pupae were collected and placed in a jar covered with black muslin cloth for adult emergence. Emerging moths were sexed and confined @ 10 pairs in oviposition substrate.
Cotton swabs dipped in honey solution (5% sugar and 0.1% multivitamin Zincovit drops, Apex laboratories Ltd, Chennai, India) was provided as adult feed. Flat creamy, yellow scaly eggs were laid on the leaf surface / black muslin cloth. Eggs laid black muslin clothes were placed in containers lined with black muslin cloth for larval emergence. After 3-4 days the hatched neonate larvae were transferred to potato tubers.

Medium sized tender potato tubers were washed well in water and a suspension containing 500 mg l^{-1} of carbendazim and 40 mg of streptomycin sulphate. Tubers were slightly peeled in three to four places and newly hatched neonate larvae at the rate of10 larvae/tuber were placed over dry river sand individually inside a plastic container covered with muslin cloth.

The matured larvae came out of potato and pupated in dry river sand medium. Subsequent to pupation, adult emergence and oviposition were followed as described earlier with field collected brinjal fruits. Second instar larvae were used for bioassay trials.

Treatments

The insecticides used in the present investigation and their dosages were as follows

S. No	Treatment	Dose (g.a.i./ha)	Product (ml/ha)
1	Chlorpyriphos 20 EC	100	750
2	Chlorpyriphos 20 EC	200	1000
3	Chlorpyriphos 20 EC	300	1500
4	Chlorpyriphos 20 EC	400	2000
5	Dursban 20 EC	200	1000
6	Untreated Check	-	-

Method of assessment

At the time of fruiting, potted brinjal plants (4plants / replication) were sprayed with different doses of insecticides. After spraying, three fruits were collected from treated brinjal plants and six larvae of *Leucinodes orbonalis* from culture were released into fruits @ 2 larvae / fruit on three fruits per replicate and allowed to feed in a transparent plastic box covered with white muslin cloth at room temperature. For introduction of larvae into the fruit, holes were made on fruits from two sides for about 0.5 cm depth with a cork screw borer and into the each hole, one larva was introduced. Mortality was recorded at 12, 24, 48 hours after treatment based on the presence/absence of fresh excreta. Untreated check was maintained by spraying distilled water alone.

Persistence toxicity index (P X T) was worked out as, Persistence toxicity index = Mean per cent mortality (%) × Period for which toxicity persisted (hours)

Evaluation of contact toxicity of chlorpyriphos 20 EC against citrus psyllids *Diaphorina citri* Kuwayama

Treatments

The insecticides used in the present investigation and their dosages were as follows.

S. No	Treatment	Dose (%)	Product (ml/ha)
1	Chlorpyriphos 20 EC	0.01	250
2	Chlorpyriphos 20 EC	0.02	500
3	Chlorpyriphos 20 EC	0.03	750
4	Chlorpyriphos 20 EC	0.04	1000
5	Dursban 20 EC	0.02	500
6	Dimethoate 30 EC	0.03	500
7	Untreated check	-	-

Filter paper discs were wetted with 1 ml of different concentrations of insecticides, replicated thrice in a completely randomized design and allowed to dry for 30 minutes. Shade dried filter paper was placed in the petri dish and ten adults collected from field were released. Before releasing, the insects were starved for 30 minutes. The insects were allowed to crawl over insecticide treated filter paper. After 15 minutes of exposure, the adults were transferred to test tubes and field collected tender citrus leaves were given as feed. Since mortality was observed quickly, the observations were made on the mortality of adults (15, 30, 45, 60 minutes after treatment) and the per cent mortality was worked out by,

$$\text{Per cent adult mortality} = \frac{\text{No. of adult psyllids dead}}{\text{Total number of psyllids treated}} \times 100$$

Evaluation of toxicity of chlorpyriphos 20 EC to citrus psyllids by adult feeding

Tender leaves of citrus collected from field were sprayed with 1 ml of different concentrations of insecticides using an atomizer, replicated thrice in a completely randomized design and allowed to dry for

15 minutes. Then the leaves were placed over the moist filter paper in the petri dish and ten adults collected from field were released. Before releasing, the insects were starved for 30 minutes. The insects were allowed to feed over treated leaves. After, 30 minutes of exposure, the adults were transferred to test tubes and field collected fresh tender citrus leaves were given as feed. The observations were made on the mortality of adults (15, 30, 45, 60 minutes after treatment) and the per cent mortality was worked out as,

$$\text{Per cent adult mortality} = \frac{\text{No. of adult dead}}{\text{Total number of adults}} \times 100$$

Results and Discussion

Persistent toxicity of chlorpyriphos 20 EC against brinjal shoot and fruit borer

The persistent toxicity (PT) values were 4600.0, 3800.0, 3000.0, 2800.0 and 1800.00 with mortality per cent of 95.83, 79.17, 62.50, 58.33 and 37.50 for chlorpyriphos 20 EC 2000, 1500, 1000, Dursban 1000 and chlorpyriphos 750 ml/ha respectively. (Table 1). The higher dose of chlorpyriphos 20 EC treatments were the most persistent and Dursban 20 EC, lower dose of chlorpyriphos was the least.

. The results showed PT values of 4600, 3800 and 3000 with chlorpyriphos 2000, 1500, 1000 ml/ha respectively (Table 1). At 48 hours of treatment, high mortality was observed with chlorpyriphos 2000 ml/ha (95.83%) and 79.17% with chlorpyriphos 1500 ml/ha. These results are in line with Kavuri Yogi and Aswani Kumar (2013) [2] who reported that chlorpyriphos 20 SC at 2 ml/lit was persistent for 6 hrs (PT=112.08), 12 hrs (287.28), 24 hrs (1450.32), 48 hrs (3380.64), 72 hrs (3916.08) and for 96 hrs (3456.00) against *Helicoverpa armigera* on chickpea. Razmi *et al*. (1991) [5] also observed that the residues of malathion, quinalphos and dimethoate caused quick knock down till four days as evidenced by the LT_{50} values of 3.33, 3.35, 3.97 days respectively against brinjal shoot and fruit borer.

Evaluation of contact toxicity of chlorpyriphos 20 EC against citrus psyllids

Chlorpyriphos 20 EC 1000 ml/ha registered 100 per cent mortality and chlorpyriphos 20 EC 750 ml/ha (100%) (Table 2) followed by chlorpyriphos 20 EC 500 ml/ha (96.67%) and Dursban 20 EC 500 ml/ha (93.33%), dimethoate 30 EC 500

ml/ha (90.00%) and chlorpyriphos 20 EC 250 ml/ha (86.67%).

Toxicity of chlorpyriphos 20 EC against citrus psyllids by adult feeding

The mortality was high due to chlorpyriphos 20 EC 1000 ml/ha (100%) and chlorpyriphos 20 EC 750 ml/ha (100%) (Table 3) after 60 minutes. This was followed by chlorpyriphos 20 EC 500 ml/ha (93.33%), Dursban 20 EC 500 ml/ha (90.00%), dimethoate 30 EC 500 ml/ha (86.67%) and chlorpyriphos 20 EC 250 ml/ha (83.33%).

Higher mortality of the psyllids was recorded with chlorpyriphos 20 EC at 1000 ml/ha (100%) and chlorpyriphos 20 EC at 750 ml/ha (100%) (Table 2). The other effective treatments were; chlorpyriphos 20 EC at 500 ml/ha (96.67%) and Dursban

20 EC at 500 ml/ha (93.33%) dimethoate 30 EC at 500 ml/ha (90.00%) and chlorpyriphos 20 EC at 250 ml/ha (86.67%).

These results are in accordance with that of Singh *et al*. (1995) who registered that monocrotophos (0.05%) gave 100 per cent mortality upto nine days after treatment.

In adult feeding method also higher mortality of psyllids was observed with chlorpyriphos 20 EC at 1000 ml/ha (100%) and chlorpyriphos 20 EC at 750 ml/ha (100%) (Table 3) followed by chlorpyriphos 20 EC at 500 ml/ha (93.33%) and Dursban 20 EC at 500 ml/ha (90.00%), dimethoate 30 EC at 500 ml/ha (86.67%) and chlorpyriphos 20 EC at 250 ml/ha (83.33%) in order.

This was in conformity with the results of Puri and Singh (1977) [3] who reported higher persistent toxicity (PT = 1730.40) of monocrotophos with 0.2 g a.i per plant as foliar spray against nymphs of psyllid. Abbaszadeh *et al*. (2011) [1] also registered that dimethoate 40 EC at 1 ml/lit recorded 83.2 per cent mortality, 21 days after spraying in lime field. In the present study also, more than 80 per cent mortality of adult psyllids was observed.

Table 1: Persistent toxicity of chlorpyriphos 20 EC against brinjal shoot and fruit borer

Treatment	Dose (ml.ha $^{-1}$)	After 12 h*		After 24 h*		After 48 h*	
		Mortality (%)	PT index	Mortality (%)	PT index	Mortality (%)	PT index
Chlorpyriphos 20 EC	750	12.50	150.00	16.67	400.00	37.50	1800.00
Chlorpyriphos 20 EC	1000	16.67	200.00	27.78	666.67	62.50	3000.00
Chlorpyriphos 20 EC	1500	20.83	250.00	33.33	800.00	79.17	3800.00
Chlorpyriphos 20 EC	2000	20.83	250.00	41.67	1000.00	95.83	4600.00
Dursban 20 EC (standard check - ES)	1000	16.67	200.00	25.00	600.00	58.33	2800.00
Untreated check	-	-	-	-	-		-

Mean of four observations *
P- Period of persistence (hrs)
T- Toxicity (Mortality %)

Table 2: Evaluation of contact toxicity of chlorpyriphos 20 EC against adult citrus psyllids

Treatment	Dose (ml.ha $^{-1}$)	After 15 min *		After 30 min*		After 45 min*		After 60 min*		Mean mortality (%)
		Mortality (%) (n = 10)	Corrected mortality (%)	Mortality (%)	Corrected mortality (%)	Mortality (%)	Corrected mortality (%)	Mortality (%)	Corrected mortality (%)	
Chlorpyriphos 20 EC	250	26.67 (31.00)^{a}	24.14	66.67 (54.78)^{a}	65.52	76.67 (61.22)^{a}	75.87	86.67 (68.86)^{b}	86.21	64.17
Chlorpyriphos 20 EC	500	33.33 (35.22)^{a}	31.03	70.00 (56.79)^{a}	68.97	83.33 (66.14)^{a}	82.76	96.67 (83.86)^{ab}	96.56	70.83
Chlorpyriphos 20 EC	750	36.67 (37.22)^{a}	34.49	73.33 (59.00)^{a}	72.41	90.00 (71.57)^{a}	89.66	100.00 (90.00)^{ab}	100.00	75.00
Chlorpyriphos 20 EC	1000	36.67 (37.22)^{a}	34.49	73.33 (59.00)^{a}	72.41	93.33 (77.71)^{a}	93.10	100.00 (90.00)^{a}	100.00	75.83
Dursban 20 EC (standard check - ES)	500	33.33 (35.22)^{a}	31.03	70.00 (56.79)^{a}	68.97	80.00 (63.93)^{a}	79.31	93.33 (77.71)^{ab}	93.10	69.17
Dimethoate 30 EC	500	26.67 (31.00)^{a}	24.14	66.67 (54.78)^{a}	65.52	80.00 (63.93)^{a}	79.31	90.00 (75.00)^{b}	89.66	65.83
Untreated check	-	3.33 (6.14)^{b}	-	3.33 (6.14)^{b}	-	3.33 (6.14)^{b}	-	3.33 (6.14)^{b}	-	3.33

Mean of three observations * n - No of insects treated ES – Existing source Figures in parentheses are arcsine transformed
Per cent mortality in a column followed by the same superscripts are not significantly different according to DMRT at P=0.05.

Table 3: Evaluation of toxicity of chlorpyriphos 20 EC against citrus psyllids by adult feeding

Treatment	Dose (ml.ha $^{-1}$)	After 15 min *		After 30 min*		After 45 min*		After 60 min*		Mean mortality (%)
		Mortality (%) (n = 10)	Corrected mortality (%)	Mortality (%)	Corrected mortality (%)	Mortality (%)	Corrected mortality (%)	Mortality (%)	Corrected mortality (%)	
Chlorpyriphos 20 EC	250	10.00 (18.43)^{b}	10.00	20.00 (26.57)^{a}	17.24	46.67 (43.08)^{b}	42.86	83.33 (66.14)^{b}	82.14	40.00
Chlorpyriphos 20 EC	500	13.33 (21.14)^{ab}	13.33	23.33 (28.78)^{a}	20.69	60.00 (50.77)^{ab}	57.14	93.33 (77.71)^{ab}	92.85	47.50
Chlorpyriphos 20 EC	750	16.67 (23.86)^{ab}	16.67	26.67 (31.00)^{a}	24.14	63.33 (52.86)^{a}	60.71	100.00 (90.00)^{a}	100.00	51.67

Chlorpyriphos 20 EC	1000	20.00 (26.07)^{ab}	20.00	30.00 (33.00)^{a}	27.59	66.67 (55.07)^{a}	64.29	100.00 (90.00)^{a}	100.00	54.17
Dursban 20 EC (standard check - ES)	500	13.33 (21.14)^{ab}	13.33	23.33 (28.78)^{a}	20.69	56.67 (48.85)^{ab}	53.57	90.00 (75.00)^{ab}	89.29	45.83
Dimethoate 30 EC	500	10.00 (18.43)^{b}	10.00	20.00 (26.57)^{a}	17.24	50.00 (45.00)^{b}	46.43	86.67 (72.78)^{b}	85.72	41.67
Untreated check	-	0.00 (0.28)^{a}	-	3.33 (6.14)^{b}	-	6.67 (8.86)^{b}	-	6.67 (8.86)^{b}	-	4.17

Mean of three observations * n - No of insects treated ES – Existing source Figures in parentheses are arcsine transformed
Per cent mortality in a column followed by the same superscripts are not significantly different according to DMRT at P=0.05

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