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TOXICITY OF INSECTICIDES ON INDIAN HONEY BEE *APIS CERANA INDICA* F. AND STINGLESS BEE *TETRAGONULA IRIDIPENNIS* S. IN CASHEW

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ABSTRACT

The contact toxicity of insecticides used in the cashew ecosystem viz., thiamethoxam, carbosulfan, buprofezin, lambdacyhalothrin, imidacloprid, chlorpyriphos and profenophos were evaluated against Indian bee *Apis cerana indica* F., and stingless bee *Tetragonula iridipennis* S. under laboratory conditions. It was observed that buprofezin caused the least mortality of 21.48 and 19.91% with *A. cerana indica* and *T. iridipennis*, respectively; chlorpyriphos led to maximum mortality of 100% to with both the bees, and thus highly toxic at 24 hours after treatment (HAT). Imidacloprid led to >70% mortality with both the bee species at 24 HAT, while it varied from 40 to 60% the bees with thiamethoxam, carbosulfan and lambda cyhalothrin at 24 HAT.

Key words: Cashew, contact toxicity, insecticides, *Apis cerana indica*, *Tetragonula iridipennis*, buprofezin, thiamethoxam, carbosulfan, lambda cyhalothrin, imidacloprid, chlorpyriphos, profenophos

Bees act as major pollinators in a wide range of agricultural, horticultural crops and wild plants (Klein et al., 2007). Bees are reliable pollinators, as they visit flowers systematically to collect nectar and pollen. It is estimated that 80% of pollination by insects is done by bees (Abrol, 2012). Cashew is a cross pollinated tree crop (Pavithran and Ravidranathan, 1974). It posseses both staminate and hermaphrodite flowers on the same panicle (Thimmaraju et al., 1980). Reddi (1987) suggested that cashew plants allow approximately 27% of their properly pollinated flowers to turn into fruits. Only 10.5% yield is obtained due to under-pollination and this has been demonstrated using stigmatic-pollen load evaluation data. In nature, approximately 25-72% of the stigmas had been observed unpollinated due to limitation in pollinators resulting in lower yields. Cashew flowers generate large quantities of nectar that lures more pollinators. The main pollinating agents of cashew are ants, wasps and honey bees. Pollinators play a significant role in the fruit set of cashew (Frietas and Paxton, 1996). Two groups of bees viz., halictid and honey bees regularly visit fresh flowers of cashew in coastal Karnataka (Sundararaju, 2000).

The major insect pests of cashew include tea mosquito bug (*Helopeltis antonii* Sign.), and cashew stem and root borer (*Plocaederus ferrugineus* L.). The minor pests of cashew include leaf miner (*Acrocercops syngramma* M.), leaf and blossom webber (*Lamida moncusalis* Wlk.), leaf thrips (*Selenothrips rubrocinctus* Giard.), flower thrips (*Scirtothrips dorsalis* H.), shoot tip caterpillar (*Anarsia epotias* M.), leaf weevil (*Neculla pollinaria* Baly) and apple and nut borer (*Thylacoptila paurosema* Meyrick) (Vanitha and Saroj, 2015). For the management of these, many insecticides are advocated in the cashew ecosystem. These may have direct and indirect consequences on pollinators of cashew. When insecticides are utilized reasonably, their adverse effects on the pollinators are comparable with those on target organisms (Davis, 1989). Loss of honey bees will directly affect honey production and indirectly affect crop production due to insufficient pollination. Non target impact of insecticides on honey bees excessively causes sublethal effects, direct mortality, and repellent effects; and also cause the toxicity residues on floral parts and nectar of crops (Desneux et al., 2007). Honey bee behaviour such as communication dances, return flights, orientation and foraging efficacy during floral visits are getting affected when it gets direct contact with insecticides or insecticide-treated floral parts during insecticide application (Vandame et al., 1995). The present study analyses the impact of insecticides used in the cashew ecosystem on the Indian bee *Apis cerana indica* F. and stingless bee *Tetragonula iridipennis* S.

MATERIALS AND METHODS

Evaluation of contact toxicity of insecticides

Table 1. Contact toxicity of insecticides to *A. cerana indica* and *T. iridipennis*

Treatment	Dose	Cumulative mortality (%)*							
		A. cerana indica				*T. iridipennis*			
		3 HAT	6 HAT	12 HAT	24 HAT#	3 HAT	6 HAT	12 HAT#	24 HAT#
T_1-Thiamethoxam 25WG	0.6 g/ l	0.00** (0.91)^{a}	13.33 (21.42)^{b}	33.33 (35.26)^{cd}	42.59 (40.74)^{c}	20.00 (26.57)^{b}	26.67 (31.09)^{c}	35.55 (36.60)^{c}	43.52 (41.28)^{c}
T_2-Carbosulfan 25EC	1 ml/ l	10.00 (18.43)^{b}	16.67 (24.09)^{b}	40.00 (39.23)^{de}	42.96 (40.95)^{c}	16.67 (24.09)^{b}	20.00 (26.57)^{c}	28.52 (32.28)^{bc}	47.69 (43.67)^{c}
T_3-Buprofezin 25SC	1 ml/ l	0.00 (0.91)^{a}	3.33 (10.52)^{a}	13.33 (21.42)^{b}	21.48 (27.61)^{b}	3.33 (10.52)^{a}	6.67 (14.96)^{b}	17.78 (24.94)^{b}	19.91 (26.50)^{b}
T_4-Lambdacyhalothrin 5EC	0.6 ml/ l	3.33 (10.52)^{a}	10.00 (18.43)^{b}	23.33 (28.88)^{bc}	45.92 (42.66)^{c}	13.33 (21.42)^{b}	43.33 (41.17)^{d}	64.08 (53.18)^{d}	68.06 (55.58)^{d}
T_5-Imidacloprid 17.8SL	0.6 ml/ l	20.00 (26.57)^{b}	36.67 (37.27)^{c}	53.33 (46.91)^{e}	71.11 (57.49)^{d}	40.00 (39.23)^{c}	46.67 (43.09)^{d}	64.45 (53.40)^{d}	75.93 (60.62)^{d}
T_6-Chlorpyriphos 20EC	1.5 ml/ l	73.33 (58.91)^{c}	83.33 (65.91)^{d}	100.00** (89.09)^{f}	100.00 (89.09)^{e}	76.67 (61.12)^{d}	83.33 (65.91)^{f}	100.00 (89.09)^{f}	100.00 (89.09)^{e}
T_7-Profenophos 50EC	1.5 ml/ l	66.67 (54.74)^{c}	76.67 (61.12)^{d}	100.00 (89.09)^{f}	100.00 (89.09)^{e}	56.67 (48.83)^{c}	63.33 (52.73)^{e}	82.22 (65.06)^{e}	96.28 (78.88)^{e}
T_8-Untreated check	Water	0.00 (0.91)^{a}	0.00 (0.91)^{a}	0.00 (0.91)^{a}	0.00 (0.91)^{a}	0.00 (0.91)^{a}	0.00 (0.91)^{a}	0.00 (0.91)^{a}	0.00 (0.91)^{a}
S.Ed		3.99	3.92	4.09	3.26	5.41	3.60	4.76	4.39

*Mean of three replications; ** Figures in parentheses arc sine transformed with formulae: 1/4n for 0% and 100-1/4n for 100%; Values followed by same letter(s) do not differ significantly at p=0.05 (DMRT); #Corrected mortality; HAT-Hours after treatment

against honey bees such as *A. cerana indica* and *T. iridipennis* was carried out in the laboratory during July-August 2021 following the methodology of Stanley et al. (2009). The worker bees required for the study were obtained from the Apiary unit of Insectary, Department of Agricultural Entomology, Agricultural College and Research Institute (TNAU), Madurai. Field dose of different concentrations of insecticides viz., thiamethoxam 25WG @ 0.6 g/ l, carbosulfan 25EC @ 1 ml/ l, buprofezin 25SC @ 1 ml/ l, lambda cyhalothrin 5EC @ 0.6 ml/ l, imidacloprid 17.8SL @ 0.6 ml/ l, chlorpyriphos 20EC @ 1.5 ml/ l and profenophos 50EC @ 1.5 ml/ l were prepared using distilled water and untreated check (water alone) served as control. Plastic containers of 250 ml capacity were used for the experiment. The filter paper bits of size 6x 5.5 cm were made according to the bottom size of the container, and 0.5 ml of insecticides were applied to the filter paper using a 1 ml micropipette. Treated filter papers were dried for 20 min and then placed in the container. Honey bees were immobilized by keeping them in refrigerator for 5 min; and then released into the plastic container @ 10/ container and covered with a muslin cloth to provide proper aeration. After 1 hr of exposure, honey bees were transferred to the polyethylene bags and provided with 40% sucrose solution in cotton wool as feed. The mortality of bees was recorded at 3, 6, 12 and 24 hr after treatment and % mortality was calculated. Abbott's correction was applied if mortality occurs in the control treatment. The mortality values were transformed to arc sine values and then analyzed in SPSS software. Grouping of means was done by DMRT at p=0.05 (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Data on the mortality of *A. cerana indica* and *T. iridipennis* due to contact toxicity of insecticides are presented in Table 1. At 24 HAT, buprofezin 25SC @ 1 ml/ l recorded the least mortality of 21.48 and 19.91% to *A. cerana indica* and *T. iridipennis*. It was followed by thiamethoxam 25WG @ 0.6 g/ l which resulted in 42.59 and 43.52% mortality to both the bee species and was on par with carbosulfan 25EC @ 1 ml/ l (42.96 and 47.69%) at 24 HAT. Lambda cyhalothrin 5EC @ 0.6 ml/ l caused a mortality of 45.92 and 68.06% to *A. cerana indica* and *T. iridipennis*. The maximum mortality of *A. cerana indica* (100.0%) was observed in chlorpyriphos 20EC @ 1.5 ml/ l and profenophos 50EC @ 1.5 ml/ l at 24 HAT. In the case of *T. iridipennis*, the mortality caused by chlorpyriphos and profenophos was 100 and 96.28%, respectively during 24 HAT. The present study revealed that chlorpyriphos and profenophos were highly toxic to both *A. cerana indica* and *T. iridipennis*. These results corroborate with the findings of Stanley et al. (2015) who reported that chlorpyriphos and profenophos at their field recommended doses caused 100% mortality to *A. cerana indica* at 24 HAT in filter paper disc bioassay. Also, Leite et al. (2020) observed that chlorpyriphos at the field recommend dose caused 100% mortality to stingless bee *Tetragonisca angustula* at 1 HAT on contact with the treated surface. In the present study, the mortality caused by imidacloprid was found to be higher than that of lambda cyhalothrin at 24 HAT to both *A. cerana indica* and *T. iridipennis*. These results derive support from Bailey et al. (2005) that the order of toxicity of insecticides to *Apis mellifera* by direct contact assay was clothianidin>carbofuran>imida cloprid=spinosad>lambda-cyhalothrin>Bt. Carbosulfan caused less mortality to both species of bees at 24 HAT. This is in contrast with the findings of Akca et al. (2009) on carbosulfan at the field recommended doses with *A. mellifera* by residual film method. Thiamethoxam caused less mortality when compared with imidacloprid. This is in agreement with the findings of Jeyalakshmi et al. (2011) on *A. cerana indica.* From the results of the laboratory studies, it was observed that buprofezin was found to be safer to both *A. cerana indica* and *T. iridipennis*. This is supported by Alexander et al. (2013).

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