The Bioscan 10(1): 217-220, 2015
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

DETERMINATION BIO-EFFICACY OF INSECTICIDES AGAINST LITCHI STINK BUG, *TESSARATOMA JAVANICA* (THUNBERG) (HEMIPTERA: TESSARATOMIDAE): AN EMERGING MAJOR PEST OF LITCHI, *LITCHI CHINENSIS* SONN

JAIPAL SINGH CHOUDHARY[1]*, MOANARO[1], NAIYAR NAAZ[1] AND MD. IDRIS[2]
[1]ICAR Research Complex for Eastern Region, Research Centre, Plandu - 834 010, Ranchi, Jharkhand, INDIA
[2]ICAR Research Complex for Eastern Region, ICAR Parisar,
P. O. Bihar Veterinary College, Patna - 800 014, Bihar, INDIA
e-mail: choudhary.jaipal@gmail.com

KEYWORDS
Litchi stink bug
Litchi
LC_{50}
Tessaratoma javanica

Received on :
15.11.2014

Accepted on :
10.01.2015

***Corresponding author**

ABSTRACT
Keeping in view of damage potentiality of litchi stink bug, dose mortality response of seventeen numbers of insecticides was evaluated to find out efficacious alternative for management of litchi stink bug menace. Among the evaluated insecticides *viz.,* Dichlorvos 76 EC showed maximum mortality (100%) followed by 86.67 per cent mortality to 1st instar nymphs by Acephate 75 SP, quinalphos 25 EC and thiodicarb 75 WP within 24 hours at field dosage of insecticides. The data on relative toxicity against 1st instar nymphs revealed that chlorantraniliprole, thiacloprid, thiodicarb and spinosad were 36.83, 27.62, 22.10 and 10.04 times more toxic with reference to novaluron, respectively. The order of toxicity based on LC_{50} values, chlorantraniliprole, thiacloprid, thiodicarb and acephate were found efficacious. Therefore, it is suggesting that field mortality of younger stages of stink bug nymphs could be enhanced by increasing concentration of chlorantraniliprole, thiacloprid, thiodicarb and spinosad which can be incorporate into management modules of stink bugs.

INTRODUCTION

Litchi (*Litchi chinensis* Sonn.) (Family: Sapindaceae) is one of the most important sub-tropical fruit tree. It is highly prized fruits in India and other part of world because of its excellent flavor and rarity. India is the second largest producer of litchi in the world after China with an area and production of 77600 ha and 497300 t, respectively during 2010-11 (Anonymous, 2012). Eastern India comprising of Bihar, Jharkhand and West Bengal accounts for 85 percent of the total litchi production in the country. In Jharkhand, litchi is grown in an area of 4300 ha with the production of 35900 tonnes of fruit (Anonymous, 2012).

It is well known that litchi can be difficult to grow, and after that consistent yields are to maintain very hard. Biotic stresses are also among major obstacles to maintaining high quality fruit and high yields (Singh, 2002). *Tessaratoma javanica* is considered as a minor pest of litchi in India and low incidence of pest has been reported from different regions of India (Kumar *et al.,* 2008). A recent outbreak of this pest in Jharkhand has been observed in litchi orchards and drawing present attention to the researchers for effective management strategies (Choudhary *et al.,* 2013). This stink bug also reported to causes considerable damage to the leaves, growing buds and tender young shoots of Kusum, *Schleichera oleosa* plants, an important host for *kusumi* strain of lac insect (Singh *et al.,* 2009). It has been estimated that 70-90% of losses may cause to litchi yields in worst years.

The adult as well as nymphs both causes direct damage by sucking the sap on the flowers and fruits, which may wilt and die and ultimately to fall down (Waite and Hwang, 2002). When disturbed the stink bug secrete an acid fluid which induces wilting of young leaves and causes brown spots on old leaves and fruits reducing their economical value (Bootam and Leksawasdi, 1994). In sever attack it leads to heavy fruit dropping and ultimately total damage to the litchi crop. At present in available literature data for the management of litchi stink bug in India is not to a great extent. Keeping in view, an effort have been made in-vivo to select the most effective insecticides and the proper stage of bugs to suppress the population build up of litchi stink bug. The study will facilitate to develop effective management modules against this recent emerging pest.

MATERIALS AND METHODS

The laboratory bioassay was conducted to evaluate seventeen commercially available insecticides for estimation of mortality at field dose of insecticide, median lethal concentration (LC_{50}), relative toxicity against different stages of stink bug. The used insecticides belong to different chemical groups with wide range mode of action.

Stink bugs for bioassay

First and third instar nymphs of *T. javanica* were collected from the research farm of ICAR, research complex for eastern region, research centre, Ranchi (23° 452 N, 85° 302 E, elevation 620 m above msl) during the month of March. Nymphs were brought in to laboratory and kept at 25°C for an hour for conditioning before experiment and were kept at 25°C for an hour for conditioning before experiment.

Bioassay for assessment of mortality at field dose of insecticides

Efficacy of all the insecticides was tested with three replications with given recommended dose. Five nymphs were used for each replication. The desired insecticides concentrations were sprayed directly on the insects in petri plates of 10 cm diameter by a hand atomizer sprayer. After the insecticides sprays were dried, the treated insects were transferred to separate rearing jars containing fresh tender shoots of litchi for feeding. The sprayer was cleaned between each chemical application. All the jars were wrapped with moist cotton in order to remain the shoots fresh and kept at 25°C in growth chamber. One untreated control (water sprayed only) with same procedure was also maintained for comparison. The reduction in survivability of nymphs resulted from different treatments was recorded after 24 hrs and moribund nymphs were counted as dead.

Statistical analysis

The corrected percent mortality was determined by using Abbott's formula (1925).

$$\text{Corected \% mortality} = (1 - \frac{\text{No. of nymphs in treated plates after treatment}}{\text{No. of nymphs in control plates after treatment}}) \times 100$$

The data on corrected percent mortality were subjected to arcsine transformation before analysis. All the data were analyzed using SPSS version 16. Means were separated by Tukey's test for pair-wise comparison.

Construction of bioassay for assessment of median lethal concentration (lc_{50}) and relative toxicity

Concentrations used in bioassay were determined based on preliminary bioassay. Serial dilutions as v/v basis of active ingredients of the test insecticides were prepared using distilled water. All the treatments were tested in four different concentrations with three replications for evaluating the lethal concentrations. Procedure for construction of bioassay and observation of data were same as bioassay done for assessment of mortality at field dose. The data thus obtained, were expressed as LC_{50} values and estimated by probit analysis using basic LD_{50} program version by Trevors (1986). The values of relative toxicity of different insecticides were calculated by given formula

$$\text{Relative toxicity} = \frac{LC_{50} \text{ of least toxic insecticide}}{LC_{50} \text{ of more toxic insecticide}}$$

RESULTS

In the present study, *T. javanica* exhibited differential responses to all insecticides at different stages of life on recommended dosage (Table 1). Perusal of data revealed that dichlorvos treatment was superior among all tested insecticides with the highest percent mortality with 80% and 100% mortality to the third and first instar nymphs, respectively where as Quinalphos, triazophos and thiodicarb were found at par with dichlorvos. Acephate, acetamiprid and thiacloprid showed medium level of mortality to both stages of nymphs.

Spinosad and indoxacarb gave low mortality with 26.67% to third instar nymphs but 53.33% mortality was observed in first instar nymphs. It is evident from the data that the less effective treatment with lowest mortality 6.67% was exhibited by imidacloprid and spiromesifen to third instars followed by 20% mortality by flubendiamide and buprofenzin.

Relative toxicity of different insecticides against 1st instar nymphs of *T. javanica*

Bio-efficacy of various insecticides was also compared based on their LC_{50} values. On the basis of LC_{50}, chlorantraniliprole

Table 1: Mean per cent mortality of different stages of *T. javanica* exposed to different insecticides treatments

Insecticides	Formulations	Concentration (%)	Mean per cent mortality of 1st Instar nymphs (24 h)	Mean per cent mortality of 3rd instar nymphs (24 h)
Imidacloprid	17.8 SL	0.005	33.33 (35.26) [a]	6.67 (14.96) [a]
Dichlorvos (DDVP)	76 EC	0.05	100 (90.00) [c]	80.00 (63.46) [c]
Quinalphos	25 EC	0.05	86.67 (68.58) [bc]	73.33 (58.90) [c]
Flubendiamide	480 SC	0.009	26.67(31.09) [a]	20.00 (26.56) [a]
Emamectin benzoate	5 SG	0.0015	53.33 (46.91) [ab]	33.33 (35.26) [ab]
Acephate	75 SP	0.05	86.67 (68.58) [bc]	53.33 (46.91) [bc]
Indoxacarb	14.5 SC	0.02	53.33 (46.91) [ab]	26.67 (31.09) [ab]
Novaluron	10 EC	0.04	53.33 (46.91) [ab]	40.00 (39.23) [b]
Triazophos	40 EC	0.05	86.67 (68.58) [bc]	73.33 (58.90) [c]
Acetamiprid	20 SP	0.005	66.67 (55.06) [b]	53.33 (46.91) [bc]
Chlorantraniliprole	18.5 SC	0.006	73.33 (58.90) [b]	46.67 (43.09) [b]
Buprofenzin	25%SC	0.05	46.67 (43.09) [a]	20.00 (26.56) [a]
Spiromesifen	22.9 SC	0.009	26.67 (31.09) [a]	6.67 (14.96) [a]
Spinosad	2.5 SC	0.007	53.33 (46.91) [ab]	26.67 (31.09) [ab]
Thiodicarb	75 WP	0.01	86.67 (68.58) [bc]	73.33 (58.90) [c]
Diafenthiuron	50 WP	0.05	60.00 (50.77) [a]	46.67 (43.09) [b]
Thiacloprid	21.7 SC	0.006	80.00 (63.46) [b]	53.33 (46.91) [bc]

Mean values followed by the same letters within a column are not significantly different ($p > 0.05$, Tukey's HSD). Data were subjected to arcsine transformation before analysis of variance; figures in parentheses are arcsine transformed values

Table 2: Comparative bioefficacy activity (LC_{50}) of various commercially available insecticides against 1st instars nymph of *T. javanica* (After 24 hours)

Insecticides	Heterogeneity χ^2	*df*	b±SE	LC_{50}	Fiducial limits (%) minimum	maximum	Relative toxicity
Imidacloprid	14.65	10	1.42±0.36	0.038	0.016	0.166	5.81
Dichlorvos (DDVP)	7.27	10	2.38±0.55	0.023	0.012	0.035	9.60
Quinalphos	8.59	10	2.04±0.48	0.026	0.013	0.042	8.5
Flubendiamide	3.24	10	1.33±0.38	0.026	0.014	0.103	8.5
Emamectin benzoate	5.08	10	0.99+0.33	0.039	0.016	0.706	5.66
Acephate	9.04	10	1.45±0.38	0.027	0.010	0.049	8.18
Indoxacarb	5.65	10	1.79±0.67	0.044	0.028	0.206	5.02
Novaluron	7.00	10	1.23±0.343	0.221	0.111	0.831	1
Triazophos	4.46	10	1.23±0.333	0.038	0.015	0.075	5.81
Acetamiprid	9.90	10	1.14±0.339	0.023	0.010	0.052	9.60
Chlorantraniliprole	1.14	10	2.77±1.13	0.006	0.002	0.008	36.83
Buprofenzin	7.32	10	0.972±0.34	0.056	0.025	0.477	3.94
Spiromesifen	4.82	10	1.01±0.38	0.148	0.058	0.782	1.49
Spinosad	5.26	10	1.41±0.35	0.022	0.012	0.043	10.04
Thiodicarb	3.79	10	1.95±0.45	0.010	0.005	0.016	22.10
Diafenthiuron	5.30	10	1.20±0.36	0.067	0.034	0.333	3.29
Thiacloprid	5.03	10	1.77±0.45	0.008	0.004	0.016	27.62

LC_{50} = Concentration calculated to give 50% mortality

Table3: Comparative bioefficacy activity (LC_{50}) of various commercially available insecticides against 3rd instars nymph of *T. javanica* (After 24 hours)

Insecticides	Heterogeneity χ^2	*df*	b±SE	LC_{50}	Fiducial limits (%) minimum	maximum	Relative toxicity
Imidacloprid	9.67	10	0.472±0.09	0.052	0.011	0.211	4.42
Dichlorvos (DDVP)	6.71	10	2.42±0.41	0.028	0.003	0.081	8.21
Quinalphos	5.14	10	2.14±0.51	0.031	0.006	0.122	7.41
Flubendiamide	2.13	10	0.97±0.27	0.033	0.007	0.123	7.60
Emamectin benzoate	8.15	10	1.23+0.35	0.054	0.013	0.271	4.25
Acephate	6.13	10	2.53±0.36	0.031	0.023	0.098	7.41
Indoxacarb	6.23	10	1.15±0.53	0.047	0.032	0.301	4.89
Novaluron	6.64	10	1.13±0.29	0.23	0.131	0.772	1
Triazophos	5.13	10	1.51±0.37	0.039	0.0153	0.081	5.89
Acetamiprid	8.97	10	1.27±0.419	0.030	0.013	0.061	7.66
Chlorantraniliprole	2.71	10	1.81±0.91	0.008	0.003	0.010	28.75
Buprofenzin	5.17	10	1.02±0.31	0.064	0.011	0.233	3.59
Spiromesifen	5.67	10	1.17±0.31	0.0171	0.037	0.691	13.45
Spinosad	2.63	10	0.97±0.29	0.029	0.034	0.98	7.39
Thiodicarb	1.76	10	1.12±0.41	0.014	0.003	0.051	16.42
Diafenthiuron	4.17	10	0.87±0.28	0.073	0.008	0.129	3.15
Thiacloprid	2.13	10	1.13±0.41	0.010	0.003	0.053	23

LC_{50} = Concentration calculated to give 50% mortality

was found as most effective insecticide against both stages of nymphs of stink bug. Maximum LC_{50} was recorded in treatment with novaluron (0.22%) and found to be least toxic one (Table 2 and 3). Higher LC_{50} value indicated low efficacy of tested molecules against test organism. Taking relative toxicity of novaluron as unity, the order of toxicity of insecticides against litchi stink bug was Chlorantraniliprole > Thiacloprid > Thiodicarb and Spinosad, with their relative toxicity values being 36.83, 27.62, 22.10 and 10.04, respectively. The differences in the rates of death between classes of insecticides and stages of insect can be clearly seen (Table 2 and 3).

DISCUSSION

Based on field dosage the percent mortality obtained dichlorvos, quinalphos and triazophos performed the best and found equally toxic to both the nymphal stages. Toxicity of carbosulfan with 100% mortality was reported in *T. javanica* by Singh *et al.* (2009). Though these insecticides are broad spectrum organophosphate which persists in the enviroment and harmful to beneficial insects cannot be ignored. Despite the high mortality rates that may be achieved with these insecticides, in general they also kill natural enemies jeopardizing biological control (Dent, 1995) and so need to be used cautiously in order to meet current resistance management strategies.

Based on lethal concentrations and relative toxicity, newer insecticides such as chlorantraniliprole, thiacloprid, thiodicarb and spinosad were found to have high to moderately mortality. However these insecticides were reported mostly in controlling lepidopterous pests in many crops but similarly Singh *et al.*

(2009) have also been reported effective use of indoxacarb and spinosad against stink bugs in Kusum.

In the present study, laboratory bioassays using novaluron, spiromesifen, imidacloprid and buprofenzin showed lowest mortality among the treatments.Spiromesifens are mostly use in reducing mites and whiteflies where as others are use in controlling hoppers, jassids, thrips and lepidopteran larvae. Pest mortality by these insecticides is expected to be affected over a number of generations and laboratory bioassays of the type used in the present study may not be accurately determine the effectiveness due to causes a variety of effects including paralysis and inhibition of metabolic processes, feeding and moulting. Novaluron has translaminar and systemic activity and inhibits pest feeding. Pests may survive for a few days after application, but without causing plant damage. These insecticides (novaluron and spiromesifen) are reported to demonstrate useful selectivity towards biological control agents and bees (Van Toor *et al.,* 2008) and may be compatible with existing IPM programmes. So, application recommendations emphasize early season use, to promote feeding inhibition, early moulting and a reduction in fecundity.

It is obvious from the present study that all insecticides gave differential mortality but toxicity trend was higher in first instar nymphs from field dosage. On the recommended field dosage, cholarantraniliprole, thiacloprid, thiodicarb and spinosad were found moderately toxic but based on lethal concentration all were found superior against first instar nymphs of stink bug. Therefore, field mortality of younger stages of stink bug nymphs could be enhanced by increasing insecticides concentration of cholarantraniliprole, thiacloprid, thiodicarb and spinosad. Although, laboratory bioassays measures pest mortality over fixed periods, and may not accurately reflect the action of insecticides that reduce feeding or interfere with pest populations over longer intervals. Field tests are therefore required to determine the efficacy of the above IPM compatible insecticides under field conditions.

REFERENCES

Abbott, W. S. 1925. A method of computing the effectiveness of an insecticide. *J. Economic Entomology*. **18**: 265-267.

Anonymous 2012. Area and production estimates for horticulture crops for 2010-2011. National Horticulture Board, Government of India. *http://nhb.gov.in/area%20_production.html*. Accessed 13 November 2013.

Boontam, N. and Leksawasdi, P. 1994. Secret of the longan stink bug, (*Tessaratoma papillosa* Drury: Pentatomidae: Hemiptera). *J. the Science Faculty of Chiang Mai University*. **21**: 8-13.

Choudhary, J. S., Prabhakar, C. S., Moanaro, Das, B. and Kumar, S. 2013. Litchi stink bug (*Tessaratoma Javanica*) outbreak in Jharkhand , India on litchi. *Phytoparasitica*. **41(1):** 73-77.

Dent, D. (ed.) 1995. Integrated Pest Management. *Chapman and Hall, London*. p. 356.

Kumar, H., Mittal, V., Gupta, A. and Singh, C. P. 2008. Population dynamics and seasonal occurrence of *Tessaratoma javanica* (Thunberg) in litchi orchards. *Annals of Plant Protection Sciences*. **16:** 70-73.

Singh, J. P., Jaiswal, A. K., Monobrullah, Md. and Patamajhi, P. 2009. Bioefficacy of insecticides against pentatomid bugs, *Tessaratoma javanica* Thunb.: A sporadic pest of Kusum, *Schleichera oleosa*. *Indian J. Entomology*. **71(3):** 259-273.

Singh, R. B. 2002. Welcome address. In: Papademetriou, M.K., Dent, F.J. (Eds.), Lychee Production in the Asia-Pacific Region. *Food and Agricultural Organization of UN, Regional Office for Asia and the Pacific, Bangkok, Thailand*, pp. 2-4

Trevors, J. T. 1986. A BASIC programme for estimating LD_{50} value using the IBM-PC. *Bulletin of Environmental Contamination and Toxicology*. **37:** 18.

Van Toor, R. F., Martin N, Teulon, D. A. J. 2008. Tomato/potato psyllid in New Zealand: immediate and future options for control with insecticides in covered crops-revised August 2008. Crop and Food Research Confidential Report No 2223. *New Zealand Institute for Crop and Food Research Limited, Christchurch, New Zealand*. p. 28.

Waite, G. K. and Hwang, J. S. 2002. Pests of litchi and longan. In: Peña JE, Sharp JL, Wyzoki M (eds) Tropical fruit pests and pollinators, biology, economic importance, natural enemies and control. *CAB International, Wallingford*, pp. 331-359.