Effect of Botanical Insecticides on Coffee Berry Borer, *Hypothenemus hampei* (Ferrari) (Coleoptera : Scolytidae)

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ABSTRACT

In a laboratory study with eight botanicals against the coffee berry borer, *Hypothenemus hampei* (F.) showed that neem oil (3%) was superior (78.67%) to others in bringing about berry borer mortality, followed by TNAU NO 60 EC A 3%, TNAU NO 60 EC (3%) and NSKE 5%. In the field studies, NSKE 5% was superior to others botanicals and was followed by TNAU NO 60 EC A 3%, TNAU NO 60 EC C 3% and neem oil 3%. It was concluded that the variation noticed in effectiveness of the botanicals in the laboratory and field experiments may be due to the rate of photodegradation.

Key words : Botanicals, neem oil, neem kernel extract, coffee berry borer, *Hypothenemus hampei*

INTRODUCTION

Coffee, being an important commercial crop, is of concern that it is affected by a number of pests (Le-Pelley, 1968). Of them the coffee berry borer, *Hypothenemus hampei*, a native of Central Africa, is the most dreaded one in many of the coffee growing countries. In India, it was first noticed in February 1990 in a few plantations in Gudalur in the Nilgiris District of Tamil Nadu (Kumar *et al*., 1990). It is now prevalent in coffee growing areas of South India. It can cause 30-80 per cent damage to berries resulting in heavy crop loss.

Application of pesticides for the control of berry borer, though widely practised, is discouraged to avoid pesticide residues in coffee bean and the adverse effect on natural enemies of the berry borer and other beneficial fauna. Hence, there is an urgent need to develop an eco-friendly and effective insect pest management system in coffee. The present study was conducted to evaluate eight botanicals against the coffee berry borer.

MATERIAL AND METHODS

Laboratory Evalution

Eight botanicals *viz*., neem (*Azadirachta indica* A.Juss) seed kernel extract (NSKE) @ 5%, neem oils (Connercial, TNAU NO 60EC A & TNAU NO 60 EC C) (3%), acorus (*Acorus calamus* L,) extract (3%), pungam (*Pongamia glabra* Vent.) oil (3%), illuppai (*Madhuca latifolia* Gmel.)oil (3%), notchi (*Vitex negundo* L.) leaf extract (5%), TNAU NO 60 EC A (3%) (*A. indica*) and TNAU NO 60 EC C (3%) (*A. indica*). Chlorpyriphos 20 EC @ 3 ml/lit was the standard check. An untreated check was maintained. Each treatment was replicated thrice.

Effect of Spray on Coffee Berries

One hundred coffee berries of uniform size were collected and were sprayed with the botanicals at stipulated concentration using a hand-operated atomizer. Water spray on berries was considered as untreated check. The treated berries were kept over moistened filter paper kept in a plastic container and covered with muslin cloth. The entire set up was replicated thrice. Hundred pre-starved (24 hrs.) beetles were released into each container and the number of berries bored was recorded on the 3rd, 5th, 7th and 10th day after release; per cent infestation was worked out.

Effect of Direct Spray on Adult Berry Borer

In another experiment, botanicals were sprayed on the berry borer beetles (50 numbers), using a hand-operated atomizer. The beetles were provided with bean scrapings as food. Mortality was recorded on the 3rd, 5th, 7th and 10th day after treatment and the corrected per cent mortality was calculated.

Field Evaluation

Two field experiments were conducted at the Regional Coffee Research Station (RCRS), Thandigudi during July 2004 and 2005 in randomized block design (RBD) using the arabica variety Sln.7-3 (S.3708). The plots had coffee plants of eighteen years old with coffee berry borer infestation. The nine treatments as in the laboratory studies and an untreated check were imposed. Each treatment was replicated thrice. The treatments were imposed using a hand-operated knapsack sprayer of 16 litres capacity. Berry borer- infested-plants were tagged using coloured cloth for each treatment. Three rounds of application were done; first one on the day when initial infestation was recorded, followed by second and third on 21st and 42nd day after the first spray. Teepol 0.1 per cent was added as a spreader in all the spray treatments. The total number of berries and number of berries showing

Table 1. Effect of botanicals against coffee berry borer in the laboratory

Treatments	Per cent reduction over untreated check * (Days after application)				
	3	5	7	10	Mean
T1	76.04 [d]	74.67 [d]	71.33 [e]	67.51 [e]	72.38 [e]
T2	81.25 [b]	79.33 [b]	78.84 [c]	77.16 [b]	78.67 [b]
T3	47.92 [e]	48.00 [e]	60.53 [f]	41.12 [f]	46.37 [f]
T4	41.67 [f]	42. 67 [f]	48.00 [g]	33.81 [g]	38.81 [g]
T5	31.25 [h]	38.00 [g]	38.33 [h]	28.83 [h]	32.21 [h]
T6	39.38 [g]	34.67 [h]	35.56 [i]	26.90 [i]	31.39 [i]
T7	82.29 [b]	78.67 [b]	91.45 [b]	74.37 [c]	76.91 [c]
T8	78.13 [c]	76.00 [cd]	73.62 [d]	72.59 [d]	74.57 [d]
T9	98.96 [a]	97.67 [a]	97.42 [a]	96.45 [a]	97. 41 [a]

In a column, means followed by a common letter (s) are not significantly different by DMRT (P=0.05)

T1 = Neem seed kernel extract (5%), T2= Neem oil (3%), T3= Acorus extract (3%), T4= Pungam oil (3%), T5= Illuppai oil (3%), T6= Notchi leaf extract (5%), T7 = TNAU NO 60 EC A (3%), T8= TNAU NO 60 EC C (3%), T9= Chlorpyriphos (0.06%)

bore hole were recorded from two secondary branches of each of the five treated plants per replication on the 5th, 10 th, 15 th and 20 th day after each round of treatment. The per cent berry borer infestation was computed. Data collected from various laboratory and field experiments were analysed using standard statistical procedures. The percentage values were subjected to angular or *arc - sine* transformation; square root transformation was followed for converting the population / numbers. The treatment means were compared using Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1985).

RESULTS AND DISCUSSION

The results of the laboratory and field experiments conducted with eight botanicals against coffee berry borer are presented hereunder (Tables 1-4).

Table 3. Field evaluation of selected botanicals against coffee berry borer (Season 2004-05)

Treat ments	Per cent reduction over untreated check* (Days after spraying)															
	First spray					Second spray					Third spray					
	5	10	15	20	Mean	5	10	15	20	Mean	5	10	15	20	Mean	Over all mean
T1	30.82 [b]	45.79 [b]	49.73 [b]	43.39 [b]	42.66 [b]	58.36 [b]	66.34 [ab]	75.03 [b]	75.03 [b]	69.07 [b]	80.21 [b]	87.31 [b]	92.19 [b]	94.28 [b]	88.57	66.77 [b]
T2	21.69 [d]	29.84 [e]	39.68 [e]	43.29 [bc]	34.18 [c]	48.97 [d]	56.09 [bc]	65.78 [e]	62.19 [e]	58.59 [d]	69.23 [d]	74.88 [d]	82.83 [d]	88.53 [c]	78.96 [e]	57.24 [e]
T3	16.07 [e]	26.96 [f]	40.07 [d]	30.62 [f]	28.75 [c]	44.95 [f]	53.42 [bc]	62.62 [f]	59.12 [gh]	55.36 [e]	63.11 [e]	65.89 [e]	65.77 [e]	66.36 [d]	65.28 [f]	49.80 [f]
T4	10.08 [a]	18.13 [i]	30.24 [h]	30.32 [f]	22.72 [d]	41.41 [g]	50.31 [bc]	55.12 [i]	60.63 [f]	52.25 [g]	60.11 [f]	63.46 [e]	66.15 [e]	64.96 [d]	63.68 [f]	46.22 [f]
T5	16.00 [e]	24.89 [g]	34.91 [g]	34.84 [de]	28.15 [d]	45.79 [e]	54.04 [bc]	57.09 [g]	62.82 [e]	55.28 [e]	61.25 [e]	65.14 [e]	65.77 [e]	65.40 [d]	64.39 [f]	49.27 [f]
T6	16.25 [e]	23.07 [h]	29.80 [i]	31.86 [ef]	25.65 [d]	45.62 [e]	53.67 [c]	56.78 [h]	58.15 [h]	53.81 [f]	62.06 [e]	64.58 [e]	65.22 [e]	64.37 [d]	64.05 [f]	47.84 [f]
T7	26.97 [c]	39.02 [c]	44.57 [c]	40.56 [bc]	38.06 [b]	52.10 [c]	60.84 [b]	70.56 [c]	70.59 [c]	63.95 [c]	75.99 [c]	82.74 [c]	88.41 [c]	90.96 [c]	84.60 [c]	62.20 [c]
T8	26.73 [c]	30.78 [d]	38.47 [f]	37.08 [cd]	33.57 [c]	51.12 [c]	56.29 [bc]	67.56 [d]	64.18 [d]	60.11 [c]	69.95 [d]	75.85 [d]	85.43 [cd]	89.26 [c]	80.23 [d]	59.97 [d]
T9	38.89 [a]	50.21 [a]	71.35 [a]	78.58 [a]	60.83 [a]	86.58 [a]	91.39 [a]	95.06 [a]	96.31 [a]	92.55 [a]	98.10 [a]	100.00 [a]	100.00 [a]	100.00 [a]	99.55 [a]	4.315 [a]

In a column, means followed by a common letter (s) are not significantly different by DMRT (P=0.05)

Table 2. Effect of botanicals on the mortality of coffee berry borer (In laboratory condition)

Treatments	Corrected per cent mortality + (Days after application)				
	3	5	7	10	Mean
T1	7.15 (15.50)^{d}	19.25 (26.02)^{e}	42.00 (40.39)^{d}	55.66 (48.25)^{d}	31.01(32.54)^{d}
T2	8.50 (16.85)^{b}	25.25 (30.16)^{b}	50.00 (45.00)^{b}	66.00 (54.33)^{b}	37.43 (36.61)^{b}
T3	4.10 (11.68)^{h}	14.10 (22.05)^{g}	20.31(26.78)^{ef}	29.30 (32.77)^{e}	16.95 (23.32)^{f}
T4	3.00 (9.97)^{i}	12.30 (20.53)^{h}	18.00 (25.10)^{fg}	25.00 (30.00)^{f}	14.51 (21.4)^{h}
T5	4.50 (21.4)^{g}	12.40 (20.61)^{h}	17.10 (24.42)^{g}	26.00 (30.65)^{f}	15.00 (21.98)^{g}
T6	5.00 (12.92)^{f}	15.31 (23.03)^{f}	22.20 (28.11)^{e}	31.30 (34.01)^{e}	18.45 (24.51)^{e}
T7	6.75 (15.05)e	20.25 (23.74)^{d}	46.00 (42.70)^{c}	61.00 (51.35)^{c}	33.50 (33.21)^{c}
T8	8.00 (16.43)^{c}	22.00 (27.97)^{c}	45.35 (42.33)^{c}	57.45 (49.28)^{d}	33.20 (34.00)^{c}
T9	24.00 (29.33)^{a}	64.75 (53.58)^{a}	100.00 (89.71)^{a}	100.00 (89.71)^{a}	72.18 (65.58)^{a}

+ Data corrected by using Abbott's formula

Figures in parentheses are arcsine transformed values

In a column, means followed by a common letter (s) are not significantly different by DMRT (P=0.05)

Laboratory Studies

Effect of Spray on Coffee Berries

Of the eight botanicals tested, neem oil 3% was found to be the most effective one in inducing mortality of the berry borer. The mortality was 77.16 to 81.25 per cent at all the intervals of observation with a mean of 78.67 per cent mortality over control. The other botanicals in the descending order of efficacy were TNAU NO 60 EC A 3%, TNAU NO 60 EC C 3% and NSKE 5% with corresponding mean per cent mortality of 76.91, 74.57 and 72.38 per cent, respectively (Table 1). Earlier Vijayalakshmi (2000) recorded that the extract of garlic and kemisal (neem product) were found effective in bringing about 90-95 per cent mortality when tested under laboratory conditions but not so promising in the field. Saravanan and Chozhan (2003) reported that 0.05% spray of neem-methanol extract was effective in controlling coffee berry borer.

Effect of Direct Spray on Adult Berry Borer

Evaluation with direct sprays revealed that chlorpyriphos 0.06% was the most effective with the highest mortality of 72.18 per cent over untreated check (Table 2), followed by neem oil (37.43%), TNAU NO 60 EC A (33.50%), TNAU NO 60 EC C (33.20%) and NSKE (31.01%). Sreedharan *et al*. (2001) earlier has also reported that the maximum mortality of coffee berry borer adults recorded was 38 per cent with the neem formulation of Achook 2 per cent.

Field Evaluation

The data on the per cent reduction in berry borer infestation due to different treatments with botanicals and standard check during 2004-05 and 2005-06 are presented in the Tables 3 and 4 respectively. During 2004-05 spray with chlorpyriphos (0.06%) was, as expected, superior in reducing the berry borer infestation by 60.83, 92.55 and 99.55 per cent, after first, second and third sprays, respectively. Among the botanicals tested, NSKE 5% was the best significantly reduced infestation of berry borer with a mean per cent reduction of 42.66, 69.07 and 88.57 after first, second and third sprays, respectively. The overall mean per cent reduction in infestation of berry borer after the first, second and third spray was 84.31 in chlorpyriphos treatment. This was followed by NSKE, TNAU NO 60 EC A, TNAU NO 60 EC C and neem oil (3%) with corresponding per cent reduction of 66.77, 62.20, 59.97 and 57.24 (Table 3). The trend was similar in the second season (2005 – 06) trial too (Table 4). The overall data of two seasons revealed that chlorpyriphos treatment was the best in reducing the berry borer infestation with a reduction of 83.48 per cent over untreated check. Among the botanicals tested, NSKE was the best with 65.15% reduction followed by TNAU NO 60 EC A, TNAU NO 60 EC C and neem oil 3% with per cent reduction of 60.85, 58.33 and 56.56 per cent respectively. The least reduction of infestation was recorded from pungam oil (40.39%) and notchi leaf extract (40.77%); they were on a par with each other. Illuppai oil (44.02%) and acorus extract (44.40%) were better than the former ones(Table 4).

In the present investigation, among the eight botanicals tested, NSKE (5%) proved to be the best recording highest per cent (65.15%) reduction in berry borer infestation. Neem oil (3%) was also good as it caused 56.56 per cent reduction, but next to TNAU NO 60 EC A (3%). This may be due to the repellent and antifeedant properties of neem products. However, the variation noticed in the

Table 4. Field evaluation of selected botanicals against coffee berry borer (Season 2005-06)

Treat ments	Per cent reduction over untreated check* (Days after spraying)															
	First spray					Second spray					Third spray					
	5	10	15	20	Mean	5	10	15	20	Mean	5	10	15	20	Mean	Over all mean
T1	31.11^{b}	38.95^{b}	52.30^{b}	44.49^{b}	42.32^{b}	53.52^{b}	68.75^{b}	69.69^{b}	67.43^{b}	64.99^{b}	77.61^{b}	87.37^{b}	92.49^{b}	94.60^{b}	88.13^{b}	65.15^{b}
T2	24.25^{d}	26.71^{e}	42.76^{e}	34.48^{e}	33.12^{e}	49.22^{d}	53.83^{e}	65.26^{c}	57.15^{e}	56.53^{e}	65.46^{e}	80.34^{e}	86.24^{e}	87.26^{e}	80.03^{e}	56.56^{e}
T3	9.74^{h}	16.22^{f}	32.69^{f}	27.75^{f}	22.79^{g}	38.75^{e}	47.34^{f}	52.26^{d}	48.41^{f}	46.83^{f}	55.92^{f}	62.35^{f}	68.67^{f}	66.93^{f}	63.60^{f}	44.40^{f}
T4	13.17^{f}	9.37^{h}	28.27^{h}	23.75^{g}	19.96^{h}	32.94^{g}	41.70^{g}	48.66^{e}	43.91^{h}	41.99^{h}	49.65^{g}	41.33^{g}	65.05^{g}	62.91^{h}	59.21^{h}	40.39^{h}
T5	16.10^{e}	13.64^{g}	30.29^{g}	27.23^{f}	25.15^{f}	37.05^{e}	46.00^{f}	51.09^{d}	46.78^{fg}	45.39^{g}	50.65^{g}	61.73^{f}	67.71^{f}	65.33^{g}	61.51^{g}	44.02^{g}
T6	11.73^{g}	7.78^{h}	25.87^{i}	20.98^{h}	18.68^{h}	35.36^{f}	41.05^{g}	48.99^{e}	45.32^{gh}	42.82^{h}	49.17^{g}	60.30^{f}	67.28^{f}	65.93^{g}	60.80^{h}	40.77^{h}
T7	29.92^{b}	34.58^{c}	47.98^{c}	39.79^{c}	39.24^{c}	51.65^{c}	58.04^{c}	65.88^{c}	60.55^{c}	59.10^{c}	70.12^{c}	83.65^{c}	90.62^{c}	91.75^{c}	84.20^{c}	60.85^{c}
T8	25.19^{c}	30.96^{d}	45.77^{d}	35.22^{d}	34.29^{d}	49.86^{d}	56.49^{d}	65.55^{c}	59.14^{d}	57.92^{d}	68.59^{d}	82.58^{d}	88.59^{d}	90.76^{d}	82.78^{d}	58.33^{d}
T9	37.58^{a}	60.77^{a}	70.08^{a}	72.44^{a}	60.96^{a}	81.15^{a}	88.69^{a}	94.76^{a}	96.16^{a}	90.35^{a}	96.86^{a}	99.51^{a}	100.0^{a}	100.0^{a}	99.12^{a}	83.48^{a}

* Each value is the mean of three replications

In a column, means followed by a common letter (s) are not significantly different by DMRT (P=0.05)

effectiveness of NSKE 5% and neem oil 3% on coffee berry borer in the field and laboratory studies may be attributed to photodegradation. This is in corroboration with the findings of Lagunes *et al*. (1998) who found that 2% and 5% aqueous extracts of neem seeds registered 73 and 75 per cent reduction of coffee berry borer infestation respectively. As the botanicals are less toxic than the recommended insecticide, they do not bring about a sudden reduction of the population. The present study demonstrates the value of using botanicals in population regulation of the coffee berry borer.

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