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SCREENING OF BOTANICALS FOR THEIR REPELLENT PROPERTIES TO BANANA PSEUDOSTEM BORER *ODOIPORUS LONGICOLLIS*, OLIVIER

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ABSTRACT

Leaf extracts of few botanicals, plant and mineral oils were tested for their efficacy on the mortality, repellence and antifeedant properties to adults of pseudostem borer of banana *Odoiporus longicollis* Olivier, under laboratory condition. Fresh banana leaf sheaths dipped in aqueous crude plant extracts and few plant and mineral oils were used for the bioassays. In choice bio assay, extracts of *Ocimum sanctum* and *Lantana camara* showed highest repellency (0.33 weevils after 48 hours), whereas it was least in *Cymbopogan* and *Pongamia* oil. In no choice test lowest feeding and weight loss due to feeding was recorded in treatments with *Ocimum sanctum* (4.20 % feeding and 6.67 % weight loss) and *Lantana camara* (3.95% feeding area and 7.71 % weight loss) after 48 hours of treatment. All botanicals showed considerably less antifeedent activity and mortality against adult weevils. Neem products such as NSKE and neem oil showed less feeding, where as highest feeding was observed in control followed by lemon grass and *Pongamia* oil. The data indicates the potential of *Lantana camara* 10 % leaf extract as candidate botanical which exhibited less antifeedant and toxic properties but can be potentially used as repellent for the adult weevils under field condition.

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INTRODUCTION

The pseudostem borer of banana, *Odoiporus longicollis* (Olivier) is one of the serious monophagous pest limiting the production and productivity of bananas. This pest is widely distributed in India and it has been estimated that the pseudostem weevil causes 10-90% yield loss depending on the infestation stage and management efficiency. Adults are attracted by the volatiles released by the banana plants. Females oviposit in the leaf sheaths. The larvae after hatching out from egg feed on tissues of the succulent sheath by tunneling extensively and may reach as far as the core stem. If larvae emerge during the advanced pre-flowering stage of the plant, the ascending flower bud and the peduncle inside the pseudostem can be eaten and damaged, resulting in non-emergence of the flower bud which decays inside the pseudostem (Padmanaban and Sathiamoorthy, 2001). In advanced stages of infestation, the stem exhibits extensive tunneling both in the leaf sheath and in the central stem. If the infestation commences at the time of flowering, the inner stem and peduncle are tunneled after flowering and the fruits do not develop properly. Tunneled stem gets weakened and may break due to wind or inability to bear the weight of the maturing bunch. Due to long life span of adult weevils and endophytic nature of grubs, conventional methods of pest management are ineffective against this pest. At present, use of synthetic chemicals, especially stem injection of a systemic organophosphorus compound (e.g. Monocrotophos) is the only extensively used method for controlling this pest. But indiscriminate use of chemical pesticides is creating environment related issues such as residues of insecticides in food commodities, resistance of pest to the insecticides, threat to other non targeted organisms.

Due to this environmental concern, banana cultivation is shifting towards organic production. Thus one of the possible ways for managing the pest is deterring the adult weevils from oviposition. In recent years, research has focused on the bioactivity, application methods, cost effectiveness and sustainable use of botanical pesticides against insect pests (Talukder and Howse, 1993). Botanicals are derived from the plant materials which are very effective in controlling the insect- pest because of they possess various properties such as repellant, knock down, antifeedant and ovipositional deterrents. They are less hazardous, biodegradable and eco-friendly. Use of most of the botanicals is acceptable in organic cultivations. Keeping this in view, the present investigation was carried out for the evaluation of potential botanicals with repellent/feeding deterrent and toxic effects against pseudostem borer of banana.

MATERIALS AND METHODS

Laboratory experiments were conducted under ambient and protected conditions at Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore.

Insects

Adults of banana pseudostem borer, *Odoiporus longicollis* were collected from

banana fields in and around Coimbatore using pseudostem traps. They were maintained in the laboratory at ambient temperature in 10 liter plastic drums (45 cm depth) and provided with pseudostem discs (30 cm length). Freshly emerged adults were used for the study to avoid cross contamination.

Preparation of crude leaf extracts

Crude leaf extracts of selected botanicals were tested. The fresh leaf samples of botanicals except Neem oil, *Pongamia* oil and horticultural mineral oil were separately collected in sufficient quantities from field in Coimbatore of Tamil Nadu during June 2015. The leaf materials were dried under shade for one week and further oven-dried at 35ºC for 48 hours (Ogendo, 2003). The dried leaves were ground to a fine powder using mixer- grinder. One hundred grams of the powdered leaves were allowed to stand soaked in 1 liter distilled water for 12 hours and the extract was filtered through a muslin cloth and collected in a glass jar. For preparing Neem seed extract (NSE 5 %), dried seeds of *Azadirachta indica* (Neem) was ground to powder. Fifty grams of powder soaked in one liter water for 6 hours was used after filtration. Three per cent emulsion of Neem and *Pongamia* oil and 5 % emulsion of horticultural mineral oil were prepared using 1 ml of Tween 20 per liter of water.

Bioassay of repellency (Choice test)

Several botanicals were screened for their feeding deterrent/ repellent properties and toxicity against banana pseudostem borer. Free choice and no choice tests were conducted under laboratory conditions during 2015. The treatments consisted of leaf extracts of *Ocimum sanctum* (Tulsi), *Lantana camara*, Eucalyptus, *Pongamia pinnata* (Karanj), *Vitex negundo* (Notchi), *Cymbopogan* sp (lemon grass), Neem seed kernel extract (5%), Neem oil 3 %, *Pongamia* (Karanj) oil 3%, Horticultural mineral oil (HMO) 5 % and untreated control. Leaf sheaths of common susceptible banana cultivar 'Nendran' were used for bioassay. For conducting choice tests, uniform size pieces of leaf sheaths (25 × 5 cm^2 size and 75 grams weight) were separately dipped in the extracts for 15 minutes. Leaf sheath dipped in ordinary water served as control. After air drying for 10 minutes, the leaf sheaths were placed in a big circular basin (50 cm diameter) (Fig. 1.), at equal distance from the center of the basin. Forty one day old adult weevils were released at the middle of the basin after starvation for 6 hrs. The mouth of the basin was closed with nylon net to avoid escape of the insects. The experiment was replicated 3 times.

Bioassay of antifeedant property: (No choice test)

For conducting the no choice test, uniform size pieces of banana leaf sheaths (25 × 5 cm^2 size and 75 grams weight) were separately dipped in the extracts and placed in individual plastic container of 5liter capacity. Ten one day old adult weevils were released into each container after starvation for 6 hrs. Each treatment was replicated thrice.

Observations

To see the repellence in choice test, the orientation of weevils towards leaf sheaths after 12 hours of release was recorded. The settlement of weevils was recorded for 24 and 48 hours after release. As weevils feed on surface of the leaf sheaths and also bore inside the leaf sheaths, the percent feeding area and per cent weight loss due to feeding 48 hours after release was calculated. In case of no choice test, mortality of weevils after 24 and 48 hours after release was recorded. The percent feeding area and per cent weight loss due to feeding 24 and 48 hours after release was also calculated. Per cent feeding area was calculated using graph paper.

Following formulae were used for calculating % feeding area and % weight loss due to feeding.

$$\% \text{ feeding area} = \frac{\text{Area fed } (mm^2)}{\text{Total area } (mm^2)} \times 100$$

$$\% \text{ weight loss} = \frac{A - B}{A} \times 100$$

Where,

A = Initial weight

B = Final weight

Statistical analysis

The experiment was conducted in Completely Randomized Block Design and the data obtained was subjected to Analysis of variance (2 way) and Duncan Multiple Range test after suitable data transformation.

RESULTS AND DISCUSSION

Under choice test, no adult weevil oriented towards leaf sheath treated with *Ocimum sanctum* and *Lantana camara* when observed 12 hours after release of insects. Less number of weevils were oriented towards leaf sheaths treated with *Eucalyptus* (0.67) and *Pongamia pinnata* leaf extract (0.67), whereas, highest orientation was observed in control treatment (13.33) followed by *Cymbopogan* sp (11.00) and *Pongamia* oil (6.67). Highest numbers of adult weevils were settled in control treatment at 24 HAR (14.00) and 48 HAR (14.00), which was on par with *Cymbopogan* sp (11.00 at 24 HAR and 11.67 at 48 HAR). Mean number of weevils settled at *Pongamia* oil was 6.67 and 8.00, 24 HAR and 48 HAR respectively. Significant and varying degree of repellence was observed in all other treatments (Table 1.) which shows the potential of these botanicals as repellents and oviposition deterrents. Under choice test, highest feeding (7.53 % feeding area) and weight loss due to feeding (30.13 %) 48 HAR was observed in control, while lowest feeding and weight loss due to feeding was recorded in treatments with *Ocimum sanctum* and *Lantana camara* (Table 1.). Considerably less feeding and weight loss due to feeding was observed in all other treatments except *Cymbopogan* and *Pongamia* oil.

In case of bioassay of antifeedant activity (no choice test), highest per cent feeding area (7.01 %) and weight loss due to feeding (18.30 %) 24 HAR was observed in control which was statistically on par with *Cymbopogan*. Considerably more feeding (5.07 % feeding area and 13.40 % weight loss due to feeding) was recorded in *Pongamia* oil. The performance of *Ocimum sanctum* and *Lantana camara* were consistent in containing both feeding area and weight loss due to feeding at 48 HAR (Table 2.).

Data on toxicity showed that all the botanicals tested showed limited toxicity against *Odoiporus longicollis*. 13.33 %

Table 1: Repellent activity of botanicals against *Odoiporus longicollis* under choice test

Sr. No.	Treatment details	Orientation response 12 HAR*	Settlement response*		% Feeding area after 48 HAR*	% Weight loss after 48 HAR*
			24 HAR	48 HAR		
1	*Ocimum sanctum* 10 %	$0^{f}(0.71)$	$0^{e}(0.71)$	$0.33^{d}(0.91)$	$1.94^{h}(8.00)$	$5.00^{h}(12.92)$
2	*Lantana camara*10 %	$0^{f}(0.71)$	$0.33^{de}(0.91)$	$0.33^{d}(0.91)$	$1.99^{h}(8.11)$	$4.15^{i}(11.76)$
3	*Eucalyptus* sp 10 %	$0.67^{ef}(1.08)$	$0.33^{de}(0.91)$	$0.67^{d}(1.08)$	$2.63^{e}(9.33)$	$5.40^{h}(13.43)$
4	*Pongamia pinnata*10 %	$0.67^{ef}(1.08)$	$1^{cde}(1.22)$	$1^{cd}(1.22)$	$2.73^{e}(9.50)$	$7.46^{g}(15.85)$
5	*Vitex negundo*10 %	$1.33^{de}(1.35)$	$1^{cde}(1.22)$	$0.67^{cd}(1.08)$	$2.97^{d}(9.92)$	$8.51^{f}(16.96)$
6	*Cymbopogan* sp 10 %	$11.00^{a}(3.39)$	$11.00^{ab}(3.34)$	$11.67^{a}(3.49)$	$6.74^{b}(15.05)$	$28.60^{b}(32.33)$
7	NSKE (5 %)	$2.67^{c}(1.78)$	$1.33^{cd}(1.35)$	$1.33^{cd}(1.35)$	$2.39^{f}(8.90)$	$10.13^{d}(18.56)$
8	Neem Oil (3 %)	$1.67^{cde}(1.47)$	$2.00^{c}(1.58)$	$2.00^{c}(1.58)$	$2.41^{f}(8.94)$	$9.48^{e}(17.94)$
9	*Pongamia* Oil (3 %)	$6.67^{b}(2.68)$	$8.00^{b}(2.92)$	$7.33^{b}(2.80)$	$4.2^{c}(11.83)$	$20.80^{c}(27.13)$
10	HMO (5 %)	$2.00^{cd}(1.58)$	$1.33^{cd}(1.35)$	$0.67^{cd}(1.08)$	$2.23^{g}(8.59)$	$9.00^{ef}(17.46)$
11	Control	$13.33^{a}(3.72)$	$14.00^{a}(3.81)$	$14.00^{a}(3.81)$	$7.35^{a}(15.73)$	$30.13^{a}(33.29)$
	SE d	0.2031	0.2272	0.2659	0.1343	0.2580
	CD (P = 0.05)	0.4212	0.4712	0.5514	0.2786	0.5350

HAR = Hours after release; *Mean of three replications; Values in the parentheses for mean are square root transformed values and for percent data are arc sin transformed values. In a column, means followed by the common letter(s) are not significant in DMRT @ 5% level of significance.

Table 2: Antifeedant activity of botanicals against *Odoiporus longicollis* under no choice test

Sr. No.	Treatment details	% Feeding area*		% Weight loss*	
		24 HAR	48 HAR	24 HAR	48 HAR
1	*Ocimum sanctum* 10 %	$3.30^{de}(10.46)$	$4.20^{d}(11.83)$	$2.50^{h}(9.10)$	$6.67^{i}(14.96)$
2	*Lantana camara*10 %	$2.71^{h}(9.47)$	$3.95^{ef}(11.47)$	$2.33^{i}(8.79)$	$7.71^{h}(16.12)$
3	*Eucalyptus* sp 10 %	$3.04^{fg}(10.05)$	$4.11^{de}(11.70)$	$3.32^{g}(10.51)$	$8.49^{g}(16.94)$
4	*Pongamia pinnata*10 %	$3.08^{f}(10.10)$	$4.07^{de}(11.64)$	$4.42^{f}(12.14)$	$10.17^{e}(18.60)$
5	*Vitex negundo*10 %	$3.27^{e}(10.43)$	$4.26^{d}(11.91)$	$5.76^{e}(13.89)$	$9.08^{f}(17.53)$
6	*Cymbopogan* sp 10 %	$6.06^{b}(14.25)$	$7.15^{b}(15.51)$	$18.60^{a}(25.57)$	$24.33^{a}(29.64)$
7	NSKE (5 %)	$3.46^{d}(10.72)$	$4.15^{de}(11.76)$	$10.10^{d}(18.53)$	$14.82^{c}(22.64)$
8	Neem Oil (3 %)	$2.92^{g}(9.84)$	$3.41^{g}(10.65)$	$12.00^{c}(20.24)$	$15.36^{bc}(23.08)$
9	*Pongamia* Oil (3 %)	$5.07^{g}(13.01)$	$5.67^{c}(13.78)$	$13.40^{b}(21.47)$	$15.97^{b}(23.56)$
10	HMO (5 %)	$3.34^{de}(10.53)$	$3.74^{f}(11.15)$	$9.78^{d}(18.23)$	$12.95^{d}(21.09)$
11	Control	$7.01^{a}(15.35)$	$7.61^{a}(16.01)$	$18.30^{a}(25.33)$	$25.04^{a}(30.03)$
	SE d	0.1183	0.1595	0.1418	0.2323
	CD (P = 0.05)	0.2452	0.3308	0.2940	0.4817

HAR = Hours after release; *Mean of three replications; Values in the parentheses are arc sin transformed values. In a column, means followed by the common letter(s) are not significant in DMRT @ 5% level of significance.

mortality was recorded at 48 HAR in treatment with Neem seed extract which was on par with Neem oil, *Pongamia* oil, horticultural mineral oil and *Lantana camara*. No mortality was recorded in control and *Cymbopogan* (Table 3.).

DISCUSSION

Our findings are partially in accordance with Bhagawati *et al.*, (2009) who reported high repellent and feeding deterrent activity of neem oil and pongmia oil against *Odoiporus longicollis*. Sahayaraj and Kombiah (2015) detected the active compounds of essential oils from stems of *Tephrosia purpurea* and *Ipomea carnea* and showed their potential as natural repellents for the control of *Odoiporus longicollis* which suggest the potential of botanicals against pseudostem weevil. Similar types of results were observed by Chauhan and Srivastava (2014) who evaluated the antifeedant activity of acetone extract of five plant species *viz. Ocimum sanctum* (Tulsi), *Cinnamomum tamala* (Tejpatra), *Cinnamomum zeylanicum* (Dalchini), *Eucalyptus citriodora* (Eucalyptus) and *Pongamia pinnata* (Karanj), against tobacco caterpillar (*Spodoptera litura* Fabricius). On the basis of preference index extracts from *O. sanctum, C. tamala* and *P. pinnata* were categorized as extremely antifeedant while others viz., *C. zeylanicum* and *E. citriodora* were moderately antifeedent. In our study we found good repellent and antifeedent activity of *Ocimum sanctum* and *Eucalyptus*. Maji *et al.*(2014) evaluated effect of ethanolic extracts of few botanicals viz. neem leaf, rhizome of ginger, garlic and turmeric, eucalyptus leaf and leaf of *Lantana camera* on biological parameters of pulse beetle (*Callosobruchus chinensis* L.) in pea. They found that these botanicals were effective in suppressing some biological parameters such as egg laid/seed, egg laid/day, oviposition period, hatchability per cent, adult formation and adult survivorship while prolonged some developmental stage such as incubation period and larval-pupal period. Leaf extract of *Ocimum sanctum* (Tulsi) was found effective in repelling the pseudostem weevil with efficient antifeedent effect. Repellent activity of *Ocimum sanctum* has been reported in many insects. A leaf extract of holy basil *Ocimum sanctum*, containing eugenol (53.4%), as the major volatile when placed on cotton pads(0.3mg) attract melon flies from a distance of 0.8 km (Roomi *et al.*,1993). Thus, melon fruit fly can also be controlled through use of *O. sanctum* as the border crop sprayed with protein

Table 3: Toxicity of different botanicals against *Odoiporus longicollis*

Sr. No.	Treatment details	Mortality (%)* 24 HAR	48 HAR
1	*Ocimum sanctum* 10 %	3.33^{d}(10.52)	3.33^{c}(10.52)
2	*Lantana camara*10 %	10^{b}(18.43)	13.33^{a}(21.42)
3	*Eucalyptus* sp 10 %	0^{e}(0.00)	3.33^{c}(10.52)
4	*Pongamia pinnata*10 %	3.33^{c}(10.52)	10^{b}(18.43)
5	*Vitex negundo*10 %	0^{e}(0.00)	10^{b}(18.43)
6	*Cymbopogan* sp 10 %	0^{e}(0.00)	0^{d}(0.00)
7	NSKE (5 %)	13.33^{a}(21.42)	13.33 ^{a}(21.42)
8	Neem Oil (3 %)	6.67^{c}(14.96)	13.33 ^{a}(21.42)
9	*Pongamia* Oil (3 %)	10^{b}(18.43)	13.33 ^{a}(21.42)
10	HMO (5 %)	6.67^{c}(14.96)	13.33 ^{a}(21.42)
11	Control	0^{e}(0.00)	0^{d}(0.00)
	SE d	0.1354	0.1906
	CD (P=0.05)	0.2808	0.3952

HAR = Hours after release; *Mean of three replications; Values in the parentheses are arc sin transformed values. In a column, means followed by the common letter(s) are not significant in DMRT @ 5% level of significance.

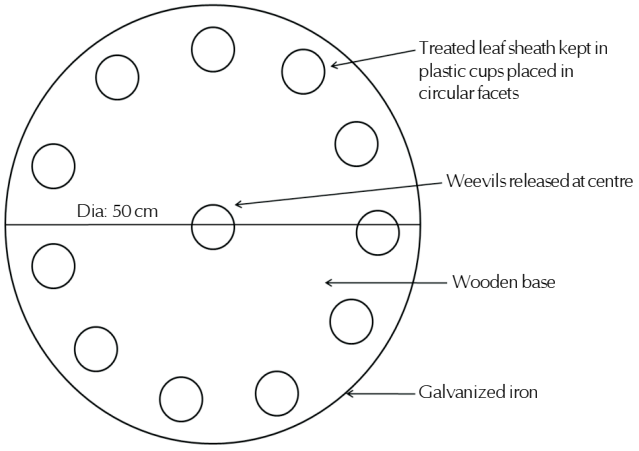

Figure 1: Experimental set up for studying orientation and settling response (Choice bioassay) of adults of *Odoiporus longicollis*

bait containing toxicant. Planting of *Ocimum sanctum* can be planted in between rows of banana which can help for repelling pseudostem weevil. Insecticidal, repellent and antifeedent activity of *Azadirachta indica* is globally acclaimed. Active constituents in the seed/fruit of *A. indica* include Azadirachtin and Nimolinone (Prakash and Rao, 1997). In present study Neem seed extract (5 %) and Neem oil (3 %) caused highest mortality of pseudostem weevil. Our results are in agreement with Gold and Messiaen (2000) who found that dipping of suckers in a 20% seed solution of *A. Indica* at planting protected young suckers from weevil attack by reducing oviposition through its repellent effect on adult weevils. These constituents appeared to have repelled the banana weevil. Inyang and Emosairue (2005) found that 5 % and 10 % extract of neem seed was effective in repelling banana weevil, (*Cosmopolites sordidus*) with higher antifeedent activity.

Although the botanicals showed less toxicity against pseudostem borer but they can potentially be used as repellents and oviposition deterrents to avoid the infestation level. Our results are in confirmation with the results of Tinzaara *et al.* (2006) who evaluated the potential of many botanicals against banana weevil, *Cosmopolites sordidus*. Results obtained from this laboratory study demonstrate the effectiveness of *Lantana camara* as a potential candidate to check alighting, oviposition and feeding of *Odoiporus longicollis* under field condition.

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