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Application of toxicological compatibility of sweet flag and nirgundi extract against cotton strainer, *Dysdercus koenigii* Fabr. (Hemiptera: Pyrrhocoridae) on okra, *Abelmoschus esculentus*

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Abstract
The field experiment was laid down in randomized block design (RBD), three treatments, each treatment replicated thrice and three botanical extractives and untreated control at Research farm of Fattepur village Kanpur Nagar affiliated to Department of Zoology, D.B.S. Collage, biopotency of sweet flag, *Acorus calamus* extract at 0.5, 1.0 and 2.0 per cent extract were tested against of nymphs and adults of cotton bug, *Dysdercus koenigii* Fabr. On okra, *Abelmoschus esculentus* Linn. (Moench) was found 73.33, 83.33 and 100.00 per cent mean mortality per cent respectively. It is followed by nirgundi or legundi, *Vitex negundo* leaves extract at the rate of 0.5, 1.0 and 2.0 per cent extract showed 73.33, 76.66 and 93.33 per cent mean mortality of nymphs and adults of *D. koenigii* Fabr. Respectively. Other treatments of *Cinnamonum aromaticum* extract showed in decreasing order of their efficacy *i.e.* 16.66, 23.33 and 33.33 mean mortality of bugs, respectively. This research work highlights various biorational botanical extractives that have some potential as controlling agent for nymphs and adults of *D. koenigii* Fabr.

Keywords: Botanical extractives, *Dysdercus koenigii*, *Acorus calamus*, Sweet flage, nirgundi

1. Introduction
Dysdercus koenigii Fabricius is one of the major pests of okra in India [1]. *D. koenigii* is commonly known as red cotton bug (RCB) or cotton stainer. It belongs to the family Pyrrhocoridae under Hemiptera and class insecta. It is a major pest of cotton, okra [2], legumes and red gram, Portia tree and orange. It is widely distributed and known from India [3, 4, 5], Pakistan [6], Florida [7], Philippines [8] and U.S.A [9]. It is known as cotton strainer CS) and its name derived from the habit of staining cotton balls with indelible brownish-yellow lint [10]. It is a sap sucking pest which sucks the sap of the plant.
In India, it is found in Gujarat, Uttar Pradesh, Bihar, Madhya Pradesh and Tamil Nadu reported bt Kapur, 1956 [3] It damages the crop plant by sucking the sap from leaves and the developing fruits [2]. Both adult and nymphal instars reduce the fruit quality and crop yield. Its biology was studied during the year 2016 [10]. *Dysdercus Koenigii* Fabr. (Hemiptera: Pyrrhocoridae) commonly known as red cotton bug (RCB) or cotton strainer (CS) is one of the important okra pest. It belongs to the family Pyrrhocoridae under Hemiptera and class insecta. It occurs in countries like USA, China, Afghanistan, India, Pakistan and Florida etc. It is a major pest of cotton, okra and other malvaceous and non-malvaceous plants.
There are two species of *Dysdercus* Species (*D. koenigii* and *D. cingulatus*) which cause loss in cotton. Chemical control of red cotton bug using insecticides of common use has done in many time leave residues that may remain viable for noticeable periods and these are not safe and ecofriendly. Botanical insecticides are non-biodegradable, causing environmental pollution, hazardous to human being and mammalian stock, risky to handlers and applicators.
The synthetic chemical insecticides are very effective and used in okra insect pest management for a long time and to ensure higher crop and vegetable yield [11]. The excessive and injudicious use of these chemical pesticides led to many problems like development of resistance, induction of resurgence, environment pollutions and human health [12]. The side effects have forced to look for naturally occurring eco-friendly indigenous herbal alternatives to chemical pesticides especially for vegetables like okra where fruits are plucked at an interval of every 2-3 days [13].

Okra contains large quantities of carbohydrate, potassium, vitamin B, vitamin C, protein, folic acid, and calcium. It's low in calories and has high dietary fiber content. Okra is a nutritious vegetable which plays an important role to meet the demand of vegetables of the India when vegetable are scanty in the market. Okra mucilage is suitable for medicinal and industrial application [14].

Botanicals are naturally occurring chemicals extracted from plants. Plant origin insecticides generally do not pose toxic hazards safe to human and domestic stock [15, 16]. This communicate on includes some observations on the effect of certain plant origin insecticides of the pest [17].

Studies were carried out during 2020 to find the biorational insecticidal effect of certain extracts and to explore the management of nymphs and adults of *D. koenigii* under field conditions. Mean mortality was recorded at interval of 24hrs, 48 hrs and 72 hrs after their release. Data on mean nymphs and adults was observed and statistically analysed. The study will help in developing new aspect in pest management strategy against *D. koenigii*.

2. Materials and Methods

2.1 Rearing of *Dysdercus koenigii* Fabricius

Collection and rearing of *D. koenigii*: The adults of *D. koenigii* were collected from cotton field of Fattehpur village of Kanpur, Uttar [Pradesh, India affiliated to Department of Zoology, Entomology, D.B.S.P.G College C.S.J.M. University, Kanpur, India, during February, 2020. Rearing was done under laboratory conditions (28±2 ºC, 70-75% RH, 11L: 13D photoperiod) in plastic chamber (4×4 inches) on soaked fuzzy okra-seeds (Azad bhindi-1). The plastic chambers were half filled with sterilized soil as natural medium for oviposition. Okra seeds were replaced every day from plastic chamber. Filter paper was placed on the soil to maintain moderate moisture level in the plastic chamber. Filter paper was also changed on daily basis.

2.2 Extraction of plant extracts

Acorus calamus Linn. Rhizomes, *Cinnamonum aromaticum* Nees. Seeds and *Vitex negundo* Linn. Leaves were collected in the vicinity of Kanpur Nagar dried in shade and make them powder farm and extracted them with the help of soxhlet apparatus using petrolium ether (PE) as solvent. The concentration of 0.5, 0.1 and 2.0 per cent of *Acorus calamus*, *Cinnamonum aromaticum* Nees. And *Vitex negundo* Linn. were prepared in water using triton x-100 at the rate of 0.5 percent as emulsifier and benzene at the rate of 5.0 percent as solvent. To test the insecticidal properties, the field trials were performed during March and April 2020 in experimental field at Fattepur village affiliated to department of Zoology, D.B.S. College, C.S.J.M. University, Kanpur, Uttar Pradesh, India.

2.3 Layout of experimental Field

A field experiment was laid in randomized block design (RBD) with five treatments including untreated control, replicated three times (Table 1). The crop was sown in second week of November 2020 in plot size of 4.2 m x 3 m with 30cm row to row distance and 10cm plant to plant distance. The calculated quantity of each botanicals was sprayed with the help of hand operated knapsack sprayer. The spraying was done two times.

Three different botanicals treatments and control using water and emulsified water and untreated control were evaluated for the assessment of their comparative performance against mustard aphid. The observation on the aphid incidence was recorded 1 day before spray as pre treatment and 3,7,10, and 15 days after spraying as the post treatment counts. The population of red cotton bugs were counted during early morning on 10cm central top twig per plant and population of natural enemies were also recorded.

3. Experimental Procedure

The plant extracts were tested by dry film technique in the field conditions. For any extract three concentration and two controls, one with emulsifier and second without spraying were used. Paired polythene bags tagged with plant were selected for this work. For preparing a film 1.0 ml. of the insecticidal preparation was pured into a polythene bags half and it was gently shaken till the liquid phase evaporated leaving behind on the polythene bags covered leaves a uniform dry film of plant extracts. Ten red cotton bugs, *D. koenigii* were introduced into one such polythene bag covered leaves. The bugs were given a continuous exposure to the insecticidal films for two hours. After the treatment the bugs from each paired polythene bags covered leaves were transferred to a separate clean polythene bags covered leaves containing fresh okra leaves as food. Mouth of polythene bags covered leaves was kept in position with rubber band around it. Observations on mortality of bugs were recorded after 24, 48 and 72 hours of their release.

Table 1: Details of different botanicals as insecticides against *Dysdercus Koenigii*

Treatment	Treatment detail	Natural order	Natural Faimly	Natural order	Plant parts used
T1	*Acorus calamus* Linn.	Sweet flag	Acoraceae	Acorales	Rhizomes
T2	*Cinnamonum aromaticum* Nees.	Cassia	Luraceae	Luirales	Seeds
T3	*Vitex negundo* Linn.	Legundi	Lamiaceae	Lamialels	Leaves
T4	Water +Emulsified water				
T5	Untreated Control				

Table 2: Details of different botanicals as insecticides against *Dysdercus Koenigii*

S. No.	Concentration (%)	Amount of Stock Solution (ml)	Amount of Benzene (ml)	Amount of Emulsifiable Water (ml)	Total Amount (ml)
1	0.50	5.00	20.00	475.00	500.00
2	1.00	10.00	15.00	475.00	500.00
3	2.0-	20.00	5.00	475.00	500.00

4. Results and Discussion

The data, on the mortality percentage from the laboratory and field experiments are given in table 3. From the data on the mortality of bugs presented in table 1, it is evident that in all the sets of experiment spraying *of Acorus calamus* Linn. emulsion and in dry film resulted in killing of bugs, *Acorus calamus* Linn. 0.5, 1.0 and 2.0 percent gave 86.6, 96.6 and 100.00 percent bug mean mortality under field experiments and 73.33, 83.33 and 100.00 percent mean mortality of bugs after 72 hours spraying (table 3).

Infestation of *Dysdercus koenigii* Fabr.

Table 3: Mean mortality percentage reduction of *Dysdercus koenigii* Fabr.

Treatments	Conc.	Mortality percentage after		
Extract		24hrs	48hrs	72hrs
Acorus calamus	0.5	16.66	30.33	73.33
Acorus calamus	1.0	20.00	46.66	83.33
Acorus calamus	2.0	26.66	46.66	100.00
Mean mortality %		21.10	41.21	85.55
Control (Water+E.water)	-	00.00	00.00	13.33
Control (Untreated)	-	00.00	00.00	00.00
Standard Error (SE)		3.86	3.16	3.49
Critical Difference (CD) at 5.0%		14.85	12.14	13.42

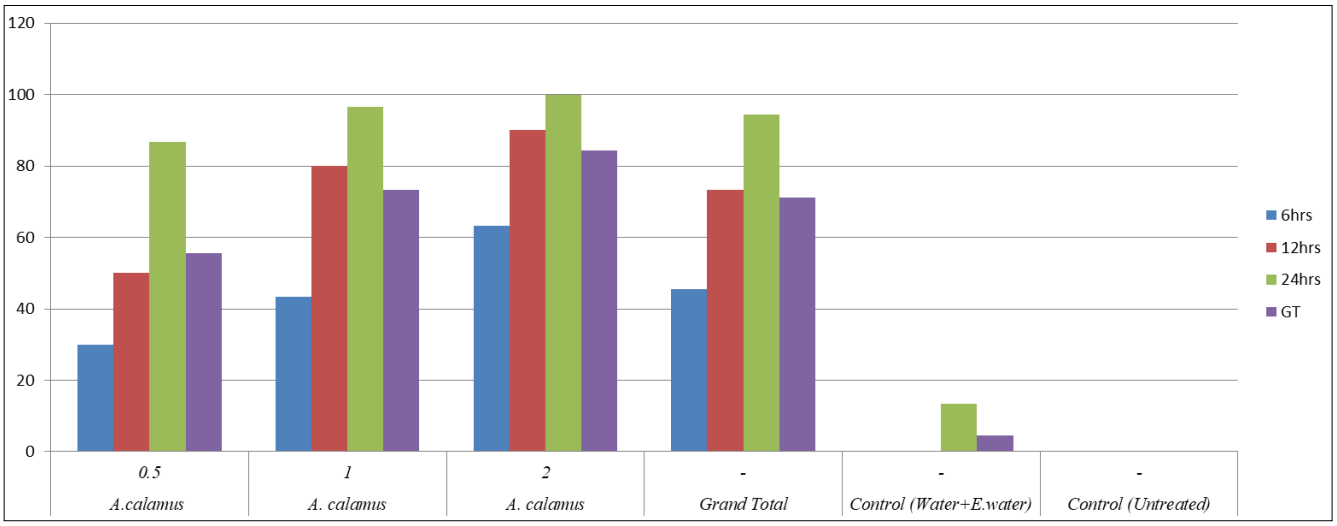

Fig 1: Toxicological bioefficacy of *A. calamus* against red cotton bug, *Dysdercus koenigii* Fabr. Under field condition

The data, on the mortality percentage from the laboratory and field experiments are given in table 3. From the data on the mortality of bugs presented in table 3, it is evident that in all the sets of experiment spraying *of Acorus calamus* Linn. emulsion and in dry film resulted in mean mortality of bugs. *Acorus calamus* Linn. 0.5, 1.0 and 2.0 percent gave 86.6, 96.6 and 100.00 percent in field experiments after 24 hours and 73.33, 83.33 and 100.00 percent killing of bugs after 72 hours spraying (table 3 and figure 1).

Table 4: Mean mortality percentage reduction of *Dysdercus koenigii* Fabr.

Treatments	Conc.	Mortality percentage after		
Extract		**24hrs**	**48hrs**	**72hrs**
Cinnamonum aromaticum	0.5	00.00	03.33	16.66
Cinnamonum aromaticum	1.0	00.00	03.33	23.33
Cinnamonum aromaticum	2.0	00.00	06.66	33.33
Mean mortality %	-	00.00	04.44	24.44
Control (Water+E.water)	-	00.00	00.00	00.00
Control (Untreated)	-	00.00	00.00	00.00
Standard Error (SE)	-	3.49	03.94	02.78
Critical Difference (CD) at 5.0%	-	13.42	15.14	10.70

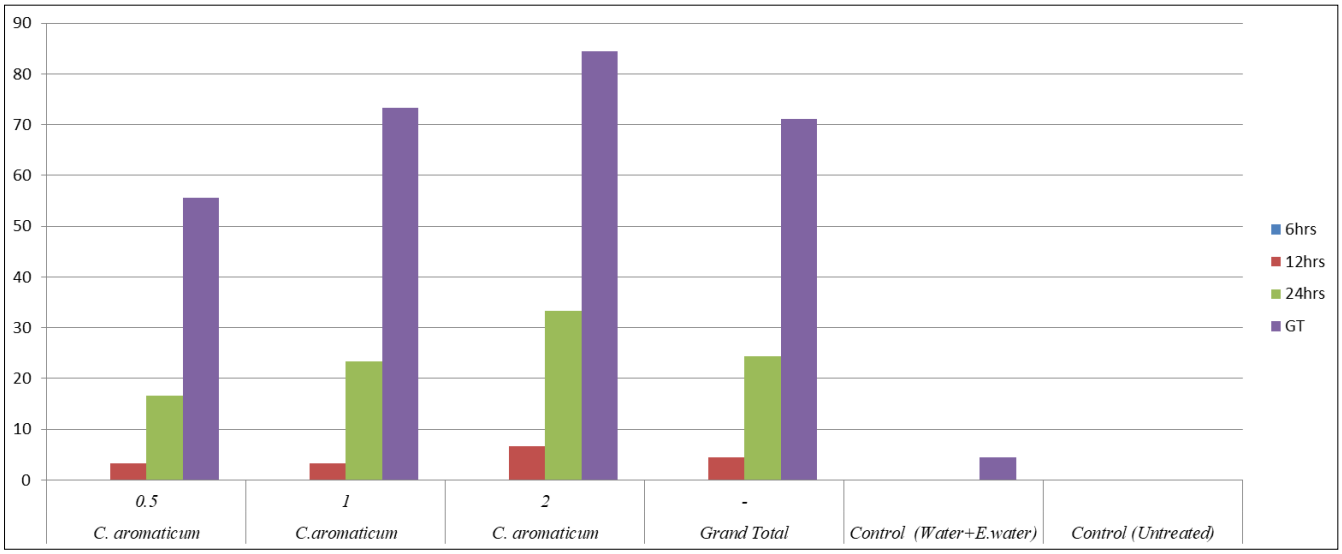

Fig 2: Toxicological bioefficacy of *C. aromaticum* against red cotton bug, *Dysdercus koenigii* Fabr. under field condition

The data, on the mortality percentage from the laboratory and field experiments are given in table 4. From the data on the mortality of bugs presented in table 1, it is evident that in all the sets of experiment spraying of *Cinnamonum aromaticum* emulsion and in dry film resulted in mean mortality of bugs. *C. aromaticum* 0.5, 1.0 and 2.0 percent gave 16.66, 23.33 and 24.44 percent per-cent killing of bugs after 72 hours spraying (table 4 and figure 2) in field experiments.

Table 5: Mean mortality percentage reduction of *Dysdercus koenigii* Fabr

Treatments	Conc.	Mortality percentage after		
Extract		24hrs	48hrs	72hrs
Vitex negundo	0.5	16.66	40.00	73.00
Vitex negundo	1.0	16.66	43.33	76.66
Vitex negundo	2.0	26.66	63.33	93.33
Grand Total		19.99	48.88	80.99
Control (Water+E.water)		00.00	00.00	13.33
Control (Untreated)		00.00	00.00	00.00
Standard Error (SE)		3.49	3.94	2.78
Critical Difference (CD) at 5.0%		13.42	15.14	10.70

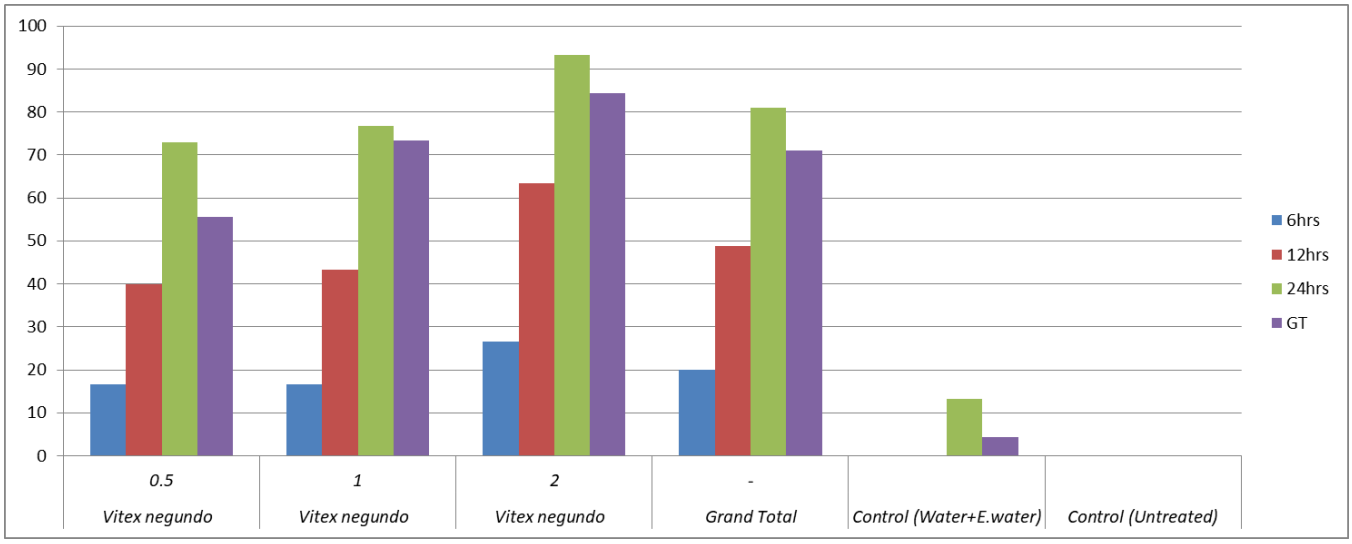

Fig 3: Toxicological bioefficacy of *Vitex negundo* against red cotton bug, *Dysdercus koenigii* Fabr. Under field condition

The data, on the mortality percentage from the field experiments are given in table 5. From the data on the mortality of bugs presented in table 3, it is evident that in all the sets of experiment spraying of *Vitex negundo* emulsion and in dry film resulted in killing of bugs. *Vitex negundo* 0.5, 1.0 and 2.0 percent gave 73.00, 76.66 and 93.33 percent killing of bugs after 72 hours spraying (table 5 and figure 3).

The result obtained in percent investigation to be conformity with those reported insecticidal activity of *Acorus calamus* by Dixit *et al.* 1956 [19], Mukherjee and Govind 1959 [20], Jilani *et al.* 1988 [21], Jilani. and Saxena, 1990 [22], Risha *et al.* 1990 [23], Parvathi and Jamil (1999) [24], and Chandel *et al.* 2005 observed significant mortality to their test inset [25].

Subramanium (1942) reported insecticidal effect of rhizomes

powder of *A. calamus* against household insects, bird lice, bed bugs and cloth-moths [33].

Pradhan *et al.* (1958) used plant extracts as insecticides against *A. foveicollis, A. proxima* and *Galerucella birmanica* and gave the significant mortality [24].

Bai S. K. and Kandaswamy C. (1985) tested *Vitex negundo* Linn. and *Stachytarpheta urticifolia* leaves extract against *Spodoptera litura* Fabr. larvae and reported considerable larval mortality [25].

Risha *et al*. (1990) tested the *Acorus calamus* oil against *C. chinensis, S. granarius, S. oryzae* and *T. casteneum* which were exposed to vapour from 10 ml. oil in 400 ml. desiccater for 72 hours. The vapour caused 98.9 per cent, 33.00 per cent and 17.00 per cent mortality to the *C. chinensis, S. grenarious* and *O. oryzae*, respectively [26].

Adiroubane and Letchoumanane (1998) conducted a field experiment to evaluate efficacy of 3 plant extracts, sacred basil (*Ocimum sanctum*), Malabar nut (*Adhatoda vesica*), Chinese chaste tree (*Vitex negundo*) and synthetic insecticides (endosulfan and carbaryl) and their combination products in controlling *Okra* jassids, *Amrasca biguttula biguttula* and fruit-borers, *Earias* spp. by spraying them at 10, 25 and 40 days after sowing. All the treatments suppressed both the jassid population and fruit borer incidence [27].

Chandel *et al*. (2001) tested the rhizome extract of *Acorus calamus at* 80 ppm in to 20 gm lots of wheat flour on larvae and adults of *T. casteneum* and reported a 60.00 percent mortality after 24 hrs [28].

Rao *et al.* (2002) studied the joint action potential of neem (Azadirachta indica) in combination with sweet flag (*Acorus calamus*) (S) and pungam (*Pongamia glabra* [*P. pinnata*]) (P) at 1:1:1 (NSP I), 2:1:1 (NSP II) and 3:1:1 (NSP III) ratios (v/v) for antifeedent and growth inhibitory effects on *E. vittella* and reported reduction in food intake by *E. vittella* in all the treatments compared to the control. NSP I (60 EC) at 0.3% have gave 80 per cent feeding protection over control against third instar larvae of *E. vittella* [29].

Rao *et al*. (2003) studied the potential of neem extract (*Azadirachta indica*) (N) with extracts of sweet-flag (*Acorus calamus*) (S) and Pungam (*Pongamia glabra* [*P. pinnata*]) (P) at 1:1:1 (NSP I), 2:1:1 (NSP II) and 3:1:1 (NSP III) (v/v) ratios for the control of *E. vittella* in the laboratory. The mixtures were more effective than individual treatments. The mortality of shoot and fruit borer was maximum (93.33%) in NSP (I) compared to neem alone [30].

Kim *et al.* (2003) reported that strong insecticidal activity against adults of S. oryzae and C. chinensis was obtained with extracts from *A. calamus* var. angustatus, *A. gramineus, C. cassia, C. sieboldii, I. verum, E. caryophyllata F. vulgare* as well ascinnamon oil, horseradish oil and mustard oil. Among them, *C. cassia* extract, *C. sieboldii* extract, cinnamon oil, horseradish oil, and mustard oil against adults of *Sitophilus oryzae* (L.) and *Callosobruchus chinensis* (L.) [31].

Dubey *et al.* 2004 reported that *Acorus calamus, Vitex negundo* and *Ageratum conyzoides* observed considerable mean mortality to the caterpillar *Spilosoma obliqua* Walker [32].

Chandel *et al.* 2011 reported that 2.0 per cent *Acorus calamus* Linn. and its isolates β-asarone, acorenone, possess significant mortality to nymphs and adults of painted bug, *Bagrada cruciferarum* Kirk [33].

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