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ECO-FRIENDLY PEST MANAGEMENT: COMPARING THE EFFICACY OF NEEM AND CEDAR WOOD OILS ON CALLOSOBRUCHUS CHINENSIS L

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Abstract

This study aimed to compare the fumigant potential and ovipositional behavior of neem oil, Himalayan cedar wood oil, and their combination against the pulse beetle, Callosobruchus chinensis L. The cedar wood oil was found to exhibit the highest knock-down effect of up to 100% at 3% concentration, while neem oil demonstrated the least corrected % knock-down. The mortality rate was highest in cedar wood oil rather than neem oil and their combination. However, the combined treatment of neem oil and cedar wood oil at 3% concentration exhibited a mortality rate comparable to cedar wood oil 3% concentration. In an ovipositional behavioral experiment, cedar wood oil-treated chickpea grains had the highest mean number of eggs laid per 5 females compared to neem oil-treated grains. This study suggests the joint action potential of Himalayan cedar wood oil with neem oil and its possible use in the formulation of botanical insecticides. The utilization of naturally occurring sources of pesticides becomes essential due to the lack of quick biodegradability of synthetic pesticides, leading to the accumulation of residues, development of insect resistance, and destruction of beneficial arthropods and aquatic animals.

Introduction:

With the increasing concern over the environmental impact of synthetic pesticides, naturally occurring pesticidal sources have become a focus of research. The neem tree, Azadirachta indica, and the Himalayan cedar wood, Cedrus deodara, have been identified as potential biopesticides due to their several biopotentials and eco-friendliness. The neem products have been studied for about two decades and found to be active against more than 400 insect species. Reports suggest that neem compounds/derivatives impact the behavior and physiology of several major stored grain insect pests, such as Sitophilus oryzae, Trogoderma granarium, and Callosobruchusspp. Similarly, Himalayan cedar wood oil has also been reported to be toxic to the pulse beetle, Callosobruchus chinensis, and a grain protectant against Sitophilus oryzae. The comparative study of the neem oil, Himalayan cedar wood oil, and their combination was performed against adult C. chinensis to explore their joint action potential. The study assessed the fumigant potential and ovipositional behavior of these oils at varying

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concentrations. The study suggests the utilization of these naturally occurring sources of pesticides and their joint action potential in the formulation of botanical insecticides. The study highlights the importance of developing eco-friendly pest control methods that are species-specific and biodegradable.

Materials and methods Insect Culture

The experiment was conducted in the Entomology Laboratory, Division of Plant Quarantine, ICAR-National Bureau of Plant Genetic Resources, New Delhi during June 2020 to August
2020. The pulse beetle, *Callosobruchus chinensis* was mass reared in the Entomology
Laboratory, Division of Plant Quarantine, ICAR-National Bureau of Plant Genetic Resources, New Delhi during June 2020 to August 2020 on chickpea grains in jars at an average temperature of 25 ± 1°C and 69 ± 5% RH with alternating light and dark periods of 12 h.

Fumigant/Contact Action Test

Healthy, active and uniform sized adults of *C. chinensis* were treated with neem oil, cedar wood oil and their combination (1:1) at 3, 2 and 1% concentration in methanol + acetone (1:1) solvent. Test insects were anesthetized by using diethyl ether. Twenty anesthetized adult beetles were kept in a clean and dry Petri dish (size: 10-cm dia X 1-cm high) and 1 ml of solution was sprayed as described by Singh and Singh (1991). Each treatment was replicated three times. Control insects were treated with 1 ml spray of methanol + acetone (1:1) solvent. **Direct Toxicity Test**

Fresh, healthy and active adult pulse beetles were treated with the neem oil, cedar wood oil and their combination (1:1) at 3,2 and 1% at a dose of 0.5 µl per insect by Arnold hand microapplicator (Mis Burkard, UK) as described by Singh and Jain (1987). All treatments were replicated three times. Observations of both fumigant and direct toxicity tests were recorded after 24 and 48 h of treatment. Data on fumigant and direct toxicity tests are presented in Table1

Ovipositional Behavioural Tests

The gender of freshly emerged adults of *C. chinensis* was determined. Males and females, 5 each, were released in a Petri dish containing 20 chickpea grains treated with neem oil, cedar wood oil and their combinations (1:1) 3, 2 and 1% concentrations. In each concentration 1 ml of spray fluid was used. Each treatment was replicated three times. The number of eggs laid on chickpea grains after 5 days of treatment was observed and expressed as average number of eggs laid/5 females (Table 2). All the three experiments were carried out at an average temperature of 25 ± 10/0 C and 69 ± 5% RH.

Results

Fumigant/Contact Action

Table 1 shows that cedar wood oil treated adults of *C. chinensis* had very high fumigant effect of 100, 100 and 96% knockdown at 3, 2 and 1% concentrations, respectively, over both neem oil alone and

Table 1. Toxicity of neem (*Azadirachta indica*) and cedar wood (*Cedrus deodara*) oils against the pulse beetle (*Callosobruchus chinensis*)

Treatment	**Fumigant/Contact Action**		**Direct Toxicity**	
	Mortality percentage after		**Mortality percentage after**	
	24h	**48h**	**24h**	**48h**
Neem oil 3%	62.66	61.30	3.33	0.00
Neem oil 2%	45.33	56.54	3.33	1.66
Neem oil 1%	32.00	47.02	3.33	0.00
Cedar wood oil 3%	100.00	89.28	1.66	3.66

Cedar wood oil 2%	100.00	68.75	5.00	0.00
Cedar wood oil 1%	96.00	40.77	0.00	0.00
Neem oil + cedar wood oil (1: 1) 3%	96.00	72.32	1.66	1.66
Neem oil + cedar wood oil (1: 1) 2%	84.00	28.57	0.00	0.00
Neem oil + cedar wood oil (1: 1) 1%	51.66	21.72	0.00	0.00

neem oil + cedar wood oil combination after 24 h of treatment. The same concentrations of cedar wood oil, after 48 h of treatment, caused mortality of 89.28, 68.75 and 40.77%, respectively. Cedar wood oil, neem oil + cedar wood oil combinations (1:1) also caused appreciable knockdown at 1, 2 and 3% concentrations, which ranged between 51.66 and

96.00%. For neem oil it ranged between only 32 and 62.66%. The 3% treatment of neem oil + cedar wood oil caused 72.32% mortality after 48 h of treatment; the other two concentrations (2 and 1%) exhibited low mortality. In the same experiment observations on the behavioural responses of *C. chinensis* adults after 2 h of treatment of oils at different concentrations showed that the cedar wood oil and its combinations had knockdown effect besides being recovered from the effect of anesthesia. The insects were very lethargic and they were unable to get up from their upside-down position due to knock-down effect. The insects in neem controls, after only 2 h, were active and fast moving, similar to controls. The same situation prevailed 20 h after treatment.

Table 2. Effect of neem (*Azadirachta indica*) oil and cedar wood (*Cedrus deodara*) oil on the oviposition of the pulse beetle (*Callosobruchus chinensis*).

Treatment	**Average number of eggs laid per 5 females**
Neem oil 3%	98.33
Neem oil 2%	118.67
Neem oil 1%	57.00
Cedar wood oil 3%	134.33
Cedar wood oil 2%	114.00
Cedar wood oil 1%	112.33
Neem oil + cedar wood oil (1: 1) 3%	95.67
Neem oil + cedar wood oil (1: 1) 2%	84.67
Neem oil + cedar wood oil (1: 1) 1%	87.00
Control	89.67

Direct Toxic Effect Application of neem oil, cedar wood oil, and their combination in three different concentrations at the dose of 0.5 J.11 per insect through Arnold hand microapplicator did not show any remarkable toxic effect to the adults of *C. chinensis* after 24 and even 48 h of treatment (Table 1). Effect on Oviposition Behaviour It is evident from Table 2 that number of eggs per five females of 134.3, 114 and 112.3 were recorded at 3, 2 and 1% concentration of cedar wood oil, respectively, when compared to control (89.67 eggs/5 females) on chickpea grains after 5 days of treatment. But the neem oil treated chick pea grains at 3, 2 and 1% concentration had 98.3, 118.6 and 57 eggs/5 females and normal ovipositional behaviour was observed among cedar wood oil + neem oil (1:1) combination treatments (3, 2 and 1% concentrations) which ranged between 84.67 and 95.67 eggs/5 females, at par with control.

Discussion

Neem oil, cedar wood oil and their combinations (1:1) tested each at 3, 2 and 1% concentrations showed a dose-dependent mortality of *C. chinensis* adults (Table 1). A knockdown effect to the tune of 100% was noticed in

cedar wood oil treatments. Further, cedar wood oil 3% exhibited a high mortality of 89.28% and was followed by neem oil + cedar wood oil (1:1) 3% (72.32%) and cedar wood oil 2% (68.75%) after 48 h of treatment. This might possibly be due to the fumigant effect of cedar wood oil as is evident from the present study, where the cedar wood oil and its combination treatments showed quick knock-down effect even within 2 h of treatment. Similar observations have been made by Singh and Rao (1985) where Himalayan cedar wood oil treated *C. chinensis* adults suffered 50% mortality even at 1% concentration; however, they have not worked out the combination effect of cedar wood oil with neem oil. In the present study, neem oil 3% caused 61.30% mortality of *C. chinensis* adults following next to the cedar wood oil 3 and 2% and neem oil + cedar wood oil 3% concentrations, after 48 h of treatment. It is evident from the earlier work and from the present study that the mortality under neem oil was due to both contact and fumigant effects. But the neem oil tested at 0.5 µl dose in the present study did not show any contact effect. This might be due to low dosage or low contact toxic principle applied on each individual insect in this experiment. No specific reference is available on the combined potential of neem oil with cedar wood oil. It is interesting, in the present study, that only 3% concentration of neem oil + cedar wood (1:1) showed mortality on par with cedar wood oil 3% concentration. It proves the combined potentials of both the oils, though tested at 50% dose (from individual oils) at 3% concentration. The lower concentrations (2 and 1%) of neem oil + cedar wood oil were least effective. This might possibly be due to low doses of both the oils. Ovipositional behaviour of the pulse beetle due to treatments of chickpea grains showed that Himalayan cedar wood oil treated seeds were infested with the highest number of eggs/5 females (134.33, 114 and 112.33); neem oil had 98.33, 118.67 and 57 eggs/5 females, at 3, 2, and 1% concentrations, respectively (Table 2). Normal ovipositional as observed in control was recorded in neem oil + cedar wood oil (1:1) at all concentrations. More number of eggs laid in cedar wood oil as well as neem oil treatments may be nonviables since forced egg laying. This ovipositional behaviour of laying eggs by the pulse beetle may also be attributed to the vapour effect of cedar wood oil and neem oil on females moving on the seeds to lay eggs under no choice condition. This area of investigation on physiological and biochemical approach may be studied in future. It has been pointed out by Saxena (1995) that the increased use of neem materials may lead to tolerant pest species, as it is evidenced from a cereal grain pest, *Oryzaephilus surinamensis* and *O. acuminatus* which survive on old neem kernels itself. In this context, combination of cedar wood oil with neem oil will certainly enhance the biopotentials of neem and vice versa. Evidently, development of tolerance/resistance may be managed by using two kinds of potent materials together because chances of developing tolerance/resistance is considered to be more with one type of compound as compared to one-time application of two types of formulated materials. Further, addition of certain chemicals to slow down the evaporational loss of the essential oil which is to be mixed with neem oil or any other botanical insecticide(s) may also be attempted to use the essential oils effectively in insect pest management.

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