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Toxicity and Mode of Action of Neem (*Azadirachta indica* A. Juss) Formulation on Rice Brown Planthopper (*Nilaparvata lugens* Stal.)

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ABSTRACT. Toxicity, residual activity, antifeedent effect, ovicidal activities, LC_{50} *and* LC_{90} *values of a crude water extract of neem seed kernel were studied on rice brown planthopper (BPH).*

Dosages of 1, 2.5 and 5% concentration of neem seed kernel water extract (NSKWE) caused significantly higher mortality compared to untreated control. Mortality was increased with the increase in concentration. The residual activity of NSKWE remain effective only at higher concentration (5%) up to ten days after treatment.

Food intake of BPH females and hatchability of eggs were decreased when plants were treated with 5% NSKWE. Kernel extract was two times more toxic than seed extract.

INTRODUCTION

The rice brown planthopper (BPH), *Nilaparvata lugens* (Stal.) is one of the most destructive insect pests of the modern green revolution during every crop season. In 1974, about 16,200 ha of paddy in the Ampara district was attacked and 2000 ha of rice was destroyed (Fernando, 1975).

Insecticides and host plant resistance are the primary components of management of this pest in Sri Lanka (Kudagamage and Nugaliyadda, 1981). However, continuous use of insecticides has lead to development of pest resistance and resurgence. The hopper resistance rice varieties are faced with the problem of development of pest biotypes and thus threaten their stability in several rice growing countries (Fernando, 1975).

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Due to the above factors there is a need for an alternative strategy which provides effective hopper control which is also safe for the environment.

The neem tree (*Azadirachta indica* A. Juss) has been found to be a promising source of natural pesticides. Several constituents of its leaves and seeds show marked insect control potential (Heyde, 1983). Almost every part of the tree is bitter, but the seed kernel posses the maximum deterrancy (Saxena, 1983). The present studies were to investigate different modes of action and toxicity of neem seed kernel water extract on rice brown planthopper.

MATERIALS AND METHODS

The experiments were carried out at the Entomology division, Central Agricultural Research Institute, Gannoruwa, Peradeniya, in 1990. The BPH used in the experiments were obtained from a laboratory culture reared on susceptible rice variety Bg 94 – 1. All the experiments were conducted in a plant house where temperature fluctuated between 20 – 30 C and mean R.H was 80%.

Neem kernel was obtained by decorticating the seeds. Fifty grams of kernel was ground to a fine powder and a liter of water was added. The mixture was stirred well and allowed to stand for 24 hours. Finally the mixture was used as stock solution for the experiments.

Experiment I: Mortality and residual toxicity of neem seed kernel water extract (NSKWE) on BPH nymph.

NSKWE spray solution of 1, 2.5 and 5% concentration were prepared from the fresh stock solution. Twenty to thirty days old potted rice plants of variety Bg 94 – 1 were placed on a revolving table and the above concentrations of NSKWE were sprayed by using an atomizer and pressure pump operating at pressure 0.7 kg/cm^2. Control plants were sprayed with distilled water.

After the treatment, a 10 cm diameter and 55 cm height cylindrical myler film cage was installed over each plant. Three hours after treatment, ten 5th instar nymphs were placed in the cage. Each treatment was replicated four times. The cumulative mortality was recorded at 24 to 96 hours after caging of nymphs.

To determine residual toxicity, a set of treated plants was infested with ten 5th instar nymphs 10 days after treatment (DAT) and at 14 DAT. Mortality was recorded at 24 to 96 hours after the introduction of nymphs. The treatments were arranged in a randomized complete block design.

Experiment II: **LC_{50} and LC_{90} values of whole seed and decorticated kernel of neem.**

NSKWE of 2.5, 3, 4, 4.5 and 5% concentration and neem whole seed water extracts of 5, 7, 8, 9 and 10% concentration of spray solution were prepared. Potted rice plants of rice variety Bg 94 - 1 (25 - 30 days old) were sprayed uniformly with the above concentrations separately with an atomizer. Control plants were sprayed with distilled water. These plants were then covered with myler cages and infested with ten 5th instar BPH nymphs. Mortality was recorded 48 hours after infestation. Each treatment was replicated three times.

Experiment III: **Feeding activity.**

Feeding rate of BPH was measured by the technique described by Pathak and Heinrich (1980). Thirty days old rice plants of variety Bg 94 - 1 was grown singly in 15 cm diameter plastic pots and sprayed with 5% concentration of NSKWE. Control plants were sprayed with distilled water.

Whatman No. 1 filter paper was impregnated twice with Bromocresol green solution (2 mg/ml ethanol). Then the filter paper changed to orange colour. Filter paper was then placed around the base of the test plant in a feeding chamber. A pair of brachyopterous female, previously starved for 4 - 5 hours, were placed in a feeding chamber and allowed to feed for 24 hours. Each treatment was replicated six times. Honeydew excreted by BPH was observed on treated filter paper as blue spots. The spots were traced on a tracing paper and placed on a graph paper and area of each spot was measured.

Experiment IV:Ovicidal activity.

Bg 94 – 1 rice plants were grown in wooden flats in the plant house and 25 day old seedlings were transplanted in plastic pots singly. Plastic oviposition cups (diameter of 15 cm and height of 10 cm) were installed at the basal portion of the plants. A pair of 5 th instar male and female were placed in each cup and allowed to mate and oviposit for 7 days. The plants containing BPH eggs were sprayed with 5% NSKWE using atomizer and pressure pump. Plants were sprayed with distilled water as control. Treatments were replicated six times.

The number of nymphs that hatched were recorded and nymphs were removed daily for 14 days. When hatching terminated, plants were dissected to determine unhatched eggs and percent hatchability.

RESULTS AND DISCUSSION

Toxicity

The 5, 2.5 and 1% NSKWE caused significant mortality of BPH nymphs compared to untreated control (Table 1). At higher concentration (5%) mortality was observed up to 85%. Hyde *et. al.*, (1983) found that exposure of nymphs of BPH, to rice seedlings treated with a neem seed extract reduced growth and increased mortality. This indicates the probable presence of an insecticidal compound in this extract. Jacobson (1986) reported that Azadirachtin, Meliantriol and Selannin are the specific compounds found in neem seeds having insecticidal properties. NSKWE does not have a knock down effect but has a delayed mortality effect, usually 3 – 5 DAT.

Residual activity

Residual activity of the NSKWE was tested at 10 and 14 days after caging (DAC) of BPH nymphs on treated rice seedlings. The mortality of 60 and 35 percentage were observed at 10 and 14 DAC, at 5% concentration, respectively but at 1% concentration mortality dropped down to 15%, at 14 DAC (Figure 1). A significant residual activity was observed only at higher concentration (5%). The lowest concentration (1%) does not posses significant residual toxicity at 10 and 14 DAT.

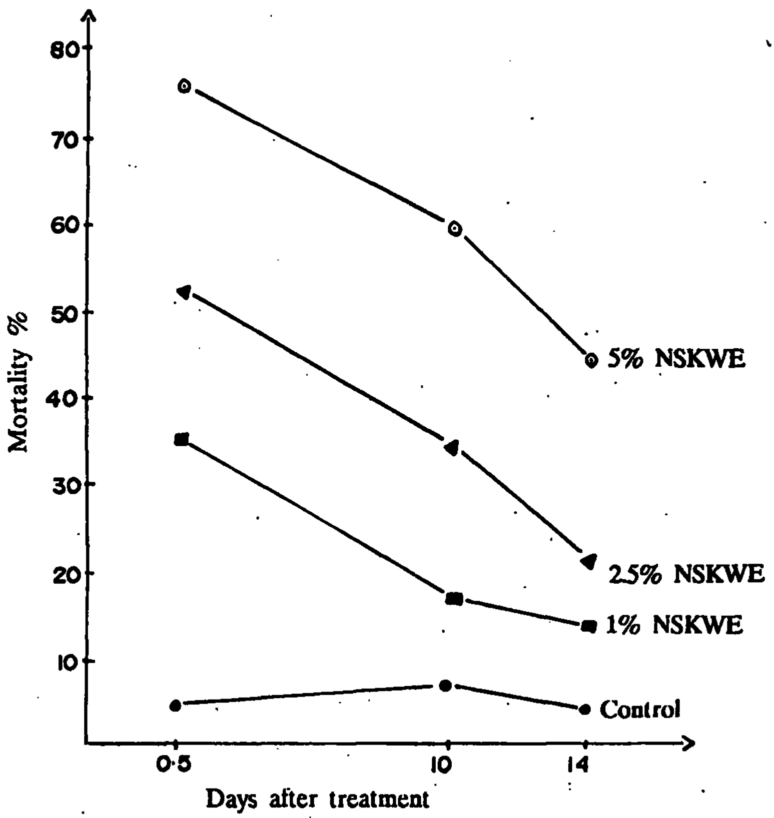

Figure 1. Residual activity of neem kernel water extracts at three concentrations against *N. Lugens* nymphs.

Table 1. Mortality and residual toxicity of NSK water extract against 5th instar *N. lugens* nymphs when placed on foliar sprayed plants.

NSK water extract (%)	Mean mortality (%)		
	0.5 DAC	10 DAC	14 DAC
1.0	35.0[a]	17.5[a]	15.0[ab]
2.5	62.5[b]	35.0[b]	22.5[b]
5.0	85.0[c]	60.0[c]	45.0[c]
Control (Untreated)	5.0[d]	7.5[a]	5.0[a]

NSK - Neem seed kernel DAC - Days after caging

Means, within a column followed by same letter are not significantly different at 5% level.

Comparison was done after Arcsin transformation

Photodegradation of antifeedent property has also been reported by Meisner *et. al.*, (1976). Improvement in the formulation and addition of chemical stabilizer against photodegradation may be necessary to prolong the effect of NSKWE.

LC values

The relative LC_{50} and LC_{90} values of the neem seed and neem kernel water extracts were studied. The log concentration *vs.* probit mortality response curve showed linear regression between concentration and mortality (Figure 2). LC_{50} and LC_{90} values of both neem kernel and neem seed extracts are shown in Table (2). The relative LC studies of both these extracts indicate that kernel extract is two times more toxic

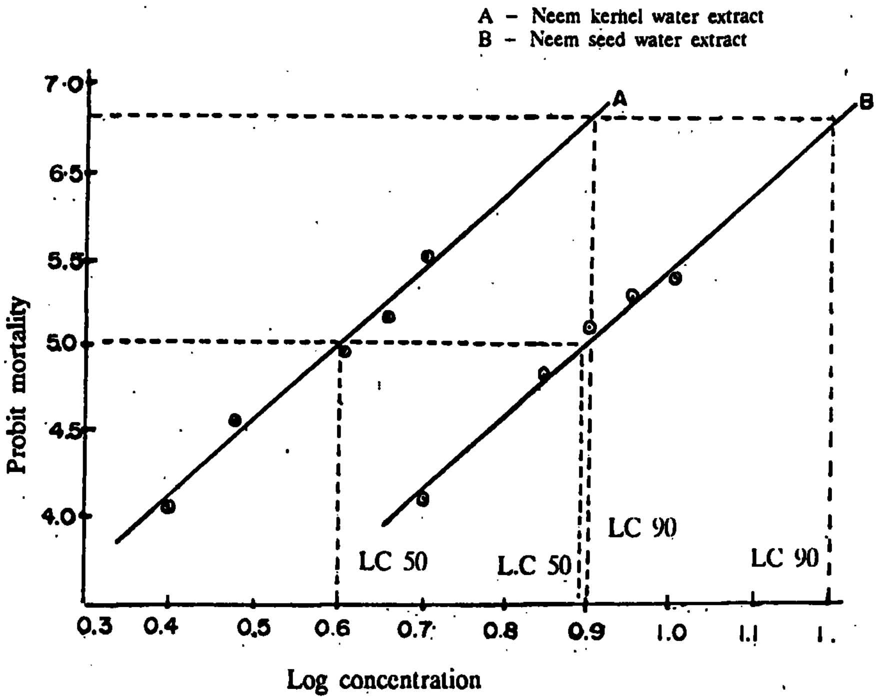

Figure 2. Log concentration – Probit mortality response curve of neem extracts against *N. lugens* nymphs.

Table 2. **Regression equation and correlation for two different neem formulations.**

Treatments	r	Regression equation	LC_{50}	LC_{90}
Neem seed water extract	0.947	Y = 1.166 + 4.262(x)	7.94	15.78
Neem seed kernel water extract	0.741	Y = 2.262 + 4.58(x)	3.96	7.59

Y = Probit mortality
X = Log concentration

than seed extract. This indicates that most of the active principle compounds are found in the kernel but not in the seed coat.

Feeding activity

BPH produce more honeydew on untreated control plants compared with NSKWE sprayed plants. The area of honeydew spots produced on untreated control was 157.6 mm^2, and on NSKWE sprayed plants it was 110 mm^2. Saxena and Pathak (1979) demonstrated that the amount of honeydew excreted by BPH was related to the amount of food ingested from the plant. At 5% NSKWE, food intake by BPH females decreased by 31% on treated plants. The restless behaviour of BPH reduce the duration of feeding and quantity of food intake on sprayed plants (Saxena *et. al.*, 1981). The deterrent effect resulting in reduced feeding on treated plants was evident in the poor growth and development of BPH nymphs and reduced adult survival.

Hatchability

NSKWE caused significant decrease in hatching of eggs compared to untreated control. NSKWE at 5% concentration, decreased the egg hatchability to 64.6% but in untreated control hatchability was 98.5%.

The eggs are laid within the leaf sheath at the base of the plant, so that they are some what protected from insecticides.

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