SHORT COMMUNICATION

Systemic effects of Neemazal - T/S® on the Rice Brown Planthopper, *Nilaparvata lugens* (Stal)

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Abstract: Laboratory bioassays were carried out to study the insecticidal, antifeedant and growth regulatory effects of Neemazal-T/S® (Azadirachtin 10,000 ppm) on the brown planthopper, *Nilaparvata lugens* using systemically treated rice seedlings of a susceptible variety Bg 94-1. Food intake of *N. lugens* measured by honeydew excretion decreased with the increasing concentration of Azadirachtin, indicating a distinct systemic antifeedant effect. Mortality of planthoppers also increased with the increase in Azadirachtin concentration. The highest mortality of 71% was observed with 50 ppm Azadirachtin solution. Plants systemically treated with Neemazal-T/S® and sprayed with Neemazal-T/S® resulted in growth inhibition and moulting disturbances in brown planthopper nymphs.

Key words: Antifeedant, azadirachtin, brown planthopper, growth inhibition, *Nilaparvata lugens*, systemic action,

INTRODUCTION

The rice brown planthopper, *Nilaparvata lugens* (Stal) is considered as one of the most important pests of rice in Sri Lanka.[1] The planthopper damage when severe, is characterized by "hopper burn" due to its intensive sap sucking. It also transmits virus diseases that often cause more severe reduction of yield than due to sap feeding.[2]

Azadirachtin, the main active ingredient of neem (*Azadirachta indica*) is known to exhibit antifeedant, insect repellent, insecticidal and sterilization properties. It also interferes with ecdysone, the key insect moulting hormone and prevents larvae and pupae from completing the moulting process.[3] Also, the systemic action of neem derivatives provides an important barrier to sucking insects and protects the plant parts, which grow after foliar spray.[4]

METHODS AND MATERIALS

Seeds of a susceptible rice variety Bg 94-1 obtained from the Rice Research and Development Institute (RRDI), Batalagoda were used in the host plant culture. Rice seedlings (21 d old) were potted with three seedlings per pot (10 cm height; 12 cm diameter) for the maintenance of the *N. lugens* culture. Potted rice plants (> 30 d old) used for culturing *N. lugens* were kept in aluminium trays containing water to ensure the humid microenvironment needed for the nymphal development. The cultures were inside rearing cages (44 cm × 35 cm × 60 cm) covered with fine mesh (15 mm × 15 mm). Potted plants in the rearing cages were replaced twice a week. About half the number of pots was removed each time and these were replaced with fresh potted plants. *N. lugens* on dried and wilted plants were dislodged by tapping the plants. These were distributed among the fresh plants before the removal of dried plants from the maintenance cage. The *N. lugens* culture was maintained at a temperature of 29.5 ±1.5°C and 85± 7% relative humidity with a 12 h photoperiod. For all the experiments, 30 d old rice plants (one plant/ pot) were used.

Five concentrations of Azadirachtin (10, 20, 30, 40, 50 ppm) were prepared from the commercial formulation. Neemazal-T/S® (10,000 ppm Azadirachtin) concentrations were prepared using distilled water for all the experiments. Roots of rice seedlings were immersed in 10 mL of test solutions for 12 h to evaluate the systemic effects of Azadirachtin on *N. lugens*. Control plants were treated with 10 mL of distilled water only.

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Systemic antifeedant effects of Azadirachtin on *N. lugens* were measured by using the bioassay technique described in previous studies.[5] The amount of honeydew excreted by *N. lugens* was considered as an index in assessing their feeding activity.

Six, 5th instar nymphs previously starved for 1 h were introduced into the bioassay chamber and allowed to feed on treated plants for 24 h and were then removed from the feeding chambers. The area of each honeydew spot was measured and the feeding activity was expressed as square millimeters of spot area.

To determine the insecticidal activity of Azadirachtin against *N. lugens,* five 5th instar nymphs were placed in the feeding chamber of each plant. The number of dead nymphs on the plant was recorded at 12 h intervals for 7 d. Each treatment was replicated six times.

Growth inhibitory effects of Azadirachtin on *N. lugens* were determined by testing five 3rd instar nymphs on root dip treated plants. In a similar test, potted rice plants were sprayed with 10 mL of Neemazal-T/S solution/plant using a spray applicator, 1 h prior to introducing nymphs. The control plants were sprayed with 10 mL of distilled water. In both tests, growth inhibitory action was measured in terms of the time taken for the development of nymphs to adult stage and the percentage of affected (dead and deformed) nymphs or/and adults. Five replicates were conducted for each treatment.

Data were subjected to statistical analysis (ANOVA, Tukey test at p= 0.05) where necessary.

RESULTS

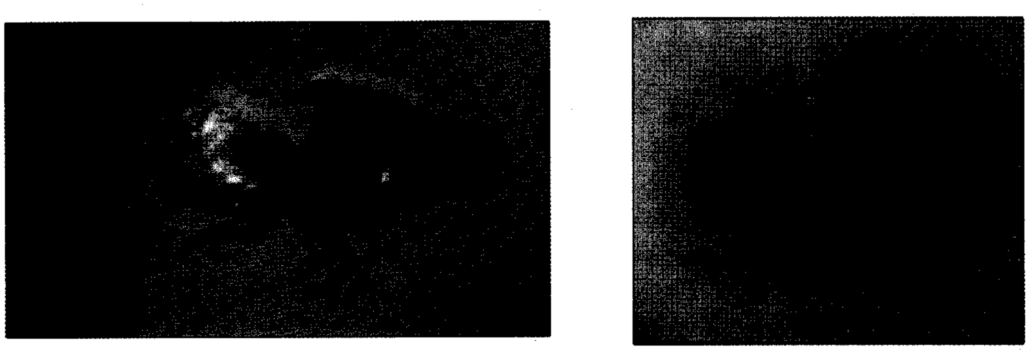
The areas of honeydew deposits on bromocresol green treated filter paper which is related to the food intake of *N. lugens* decreased significantly with Azadirachtin concentrations of 20 ppm or more (Table 1). Maximum reduction of food intake by *N. lugens* occurred on plants treated with 50 ppm, which was significantly higher than that of all the other treatments including the control.

All five concentrations of Azadirachtin also caused significantly high mortality compared to the control.

Table 1: Systemic effects of Azadirachtin on the feeding activity and development of *N. lugens* nymphs

Azadirachtin Concentration (ppm)	Area of Honeydew Deposits/mm2 (Mean ±SD)	% Individuals affected (dead and deformed)	
		Spray Application	Systemic Application
Control	501.67±25.82 a	2.2±1.3 a	1.7±0.2 a
10	451.67±22.06 a	20.0±4.1 b	12.0±7.8 b
20	289.17±71.79 b	40.0±4.1 bc	20.0±4.4 bc
30	232.83±82.38 bc	44.0±2.9 bc	24.0±8.9 c
40	196.67±66.46 c	60.0±2.0 c	40.0±4.4 c
50	102.33±41.38 d	80.0±2.1 cd	64.0±8.4 d

Means followed by similar letters in each column are not significantly different (Tukey Test at p=0.05)



(a) (b)

Figure 1: Developmental abnormalities in *N. lugens* a) adult with partly shed exuviae attached to the abdomen b) adult with deformed and curled-in wings.

The highest mortality (71%) was recorded with 50 ppm which was significantly different from all the other concentrations. It is noted that 24 h after treatment, Azadirachtin caused only 10-26% mortality of *N. lugens* nymphs. However, the mortality increased with time at all concentrations of Azadirachtin, reaching to the highest (71%) at 156 h after the treatment. No mortality was recorded in the control throughout the test period.

The time periods required to complete nymphal development (3rd instar to adult) after spray and root dip applications of Azadirachtin (50 ppm) showed that in both cases, the development period was significantly extended when compared with the control. In this study, the growth periods of *N. lugens* nymphs on root dip treated and sprayed plants were prolonged by 2 and 4 days respectively. At all concentrations, the spray application was more effective than the root dip application in retarding the growth of *N. lugens* nymphs (Table 1). Both methods of application led to premature death of nymphs. Malformations and different degrees of failure in moulting in nymphs and emerging adults were also observed (figure 2).

DISCUSSION

The potential of neem compounds as antifeedants is of significant importance in pest management as they are highly effective against many insect pests[3]. However, the use of such antifeedants as foliar sprays in crop protection has certain limitations as complete coverage of foliage is necessary for such applications to be effective. Also, sap suckers and internal feeders are generally unaffected. However these limitations could be overcome if these materials happen to possess systemic action. The present investigation clearly demonstrates a highly significant systemic antifeedant effect of a commercial production of Azadirachtin on *N. lugens*. In the present study, 80% reduction of the food intake was observed at 50 ppm of Azadirachtin concentration.

When *N. lugens* nymphs were introduced on to rice plants systemically treated with different concentrations of Azadirachtin, insect mortality was observed as secondary toxic effects of the compound. With 50 ppm of Azadirachtin, 70% mortality was recorded 6 days after exposure of *N. lugens* to treated plants. The insecticidal effect showed a steady increase with time. According to previous studies[6], Azadirachtin is one of the main components of neem having insecticidal properties. Azadirachtin does not seem to have an immediate knockdown effect on *N. lugens*, but has a delayed mortality effect.

Azadirachtin showed potential as a strong growth inhibitor as evident from the results of the bioassays with *N. lugens* nymphs. Spray applications and to a lesser extent, systemic applications of Azadirachtin were found to prevent normal development and increase the mortality of the *N. lugens* nymphs. Also, the duration of the nymphal stages was significantly increased by Azadirachtin and many nymphs died while attempting to moult from nymph to adult. It is clearly indicated by the formation of deformed insects resulting from both systemic and spray applications that Azadirachtin apparently acts as an ecdysis inhibitor. Many insects were unable to completely shed their nymphal exuviae during the moulting process and were observed with partially shed exuviae attached to their abdomens or legs. Nymphs that did become adults often were with deformed and curled wings.

In the present study, Azadiractin was found to have not only systemic antifeedant and toxic properties, but also insect growth regulatory properties acting upon physiological processes of *N. lugens*. Although foliar applications of neem compounds are highly effective against the pests, these products when applied to plants, are prone to rapid biodegradation when exposed to sunlight[7]. Systemic applications of Azadirachtin would therefore be better than foliar applications. Also, when systemically treated, any adverse effects of Azadirachtin to natural enemies of insect pests can be minimized. Hence, the findings of the present investigation show considerable potential of Neemazal-T/S® in controlling *N. lugens*.

References

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