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Quantitative Analysis of Leaf Damage and Rachis Oviposition in Leafhopper *(Yelahanka montana)* (Hemiptera: Cicadellidae) on Neem Plant

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Abstract: ***The present study was conducted to evaluate the oviposition behaviour and feeding damage caused by the leafhopper Yelahanka montana on neem, Azadirachta indica". The leaf area, feeding holes, damaged area, oviposition markings and oviposition % of ten infected neem twigs were studied manually by geometric techniques. Significant differences were observed in oviposition and feeding injury on different twigs. The highest leaf damage (65.01 ± 0.21%) and oviposition percentage (11.06%) were observed in Twig-7, and the lowest in Twig-1. A positive relationship was found between oviposition activity and feeding damage. The study indicates that oviposition marks and feeding injury can be used as important indicators of leafhopper infestation in neem plants. Statistical analysis using Two-way ANOVA revealed highly significant differences among observations (p < 0.001).***

Keywords: *Azadirachta indica*, Leafhopper, Oviposition, Feeding damage

1. Introduction

Azadirachta indica A Juss., commonly known as Neem, is a highly esteemed tree species that belongs to the Meliaceae family. This family is noted for its unique bioactive compounds called meliacins or limonoids, which enhance their biological and ecological importance. (Das et al, 1984). *Azadirachta indica* is native to the Indian subcontinent and has a broad distribution across tropical and subtropical areas, especially in India, Bangladesh, Pakistan, and Nepal. (Schmutterer,2005). *Azadirachta indica* originates from Persian language, which translates to "the noble tree of India," emphasizing its cultural and environmental importance. (Kumar and Navaratnam, 2013). The leaves of *Azadirachta indica* have been historically used to treat rheumatism, chronic syphilitic lesions, ulcers, and numerous skin infections. (Biswas et al 2002).Different parts of *Azadirachta indica*—including the bark, leaves, roots, flowers, and fruits-have long been employed in the traditional treatment of blood disorders, biliary infections, itching, skin ulcers, and burning sensations (Schmutterer,2002).Because of its wide array of therapeutic and medicinal benefits, *Azadirachta indica* is frequently referred to in literature as the "Village pharmacy," "Doctor Tree," "Wonder Tree of India," and the "Bitter Gem" (Girish and Shankara, 2008).

Leafhoppers comprise a diverse group of insects worldwide. Young, nymph and grown-up adult sustain themselves for taking plant juices by making holes in the bottom of leaves. The influence of variable weather patterns on agriculture exceedingly substantial (Dhaliwal et al., 2004). Leafhoppers are economically important pests because they suck sap from crop plants and inject toxic saliva into plant tissues, thereby reducing plant vigour. The symptoms resulting from leafhopper species also transmit infections, including viruses, phytoplasmas, spiro-plasmas, and bacteria, to plants (Nault, 1989).

Leafhoppers, members of the order Auchenorrhyncha, feed on the sap and are abundant across most terrestrial habitats. While their precise functional value remains uncertain, their significant biomass in plants layers and tree canopies suggests they are a key component of terrestrial food chains (Waloff, 1980).

The feeding damage by insects greatly reduces the healthy photosynthetic tissue and changes the normal physiological activities of plants (Dhaliwal et al., 2010). Measurement of leaf area and damaged area provides reliable information on the extent of herbivory caused by phytophagous insects. Manual geometric methods offer reasonably accurate estimates of leaf area in comparison with advanced analytical techniques and are especially useful in ecological and entomological studies (Šesták et al., 1971). Machado et al. (2016) compared manual and digital methods of estimating leaf injury and concluded that geometric methods are still reliable and effective, particularly in field-based studies where digital resources are limited.

Female leafhoppers cause injury to host plants not only through feeding activity but also during oviposition. Oviposition is when the female lays eggs by inserting them into soft plant tissues using a special ovipositor. The punctures, cuts and lesions formed in the tissues of leaves, petioles or rachis (Metcalf et al., 1993) are the cause of the mechanical damage to the plant.

2. Materials and Methods

The present investigation was conducted during February–March 2026 for a period of 10 consecutive days (25 February to 6 March 2026) under prevailing temperature and humidity conditions. The study aimed to assess leaf damage and oviposition injury caused by the leafhopper *Yelahanka montana* on neem, *Azadirachta indica.* Ten neem trees were selected randomly from the study area, and one infested twig was collected from each tree, resulting in a total of ten twigs for analysis. Materials used during the experiment included infested twigs, white chart paper, measuring scale, calculator, and hygrometer.

The length of each twig was measured from the basal to terminal end using a measuring scale and recorded in centimeters. Leaves from each twig were examined individually for feeding damage. The length and breadth of each leaf were measured manually, and leaf area was estimated using the ellipse formula:

$$A = \frac{\pi}{4} \times L \times B$$

where A represents leaf area, L is leaf length, and B is leaf breadth. The number of feeding holes present on each leaf was counted manually, and the damaged area was calculated using the circular area formula:

A=πr2

where r represents the radius of the hole. Total damaged area was obtained by summing the area of all holes present on a leaf. Leaf damage percentage was then calculated using the following formula:

$$\text{Leaf Damage (\%)} = \frac{\text{Area of holes}}{\text{Leaf area}} \times 100$$

For assessment of oviposition injury, the rachis of each neem twig was carefully examined for oviposition punctures caused by *Yelahanka montana*. The length and breadth of the rachis were measured, and rachis area was calculated using the formula:

$$A = L \times B$$

The oviposition-affected area on the rachis was also measured manually using the same formula. Oviposition percentage was calculated as follows:

$$\text{Oviposition Percentage} = \frac{\text{Oviposition area}}{\text{Rachis area}} \times 100$$

All observations including twig length, leaf area, number of holes, area of holes, leaf damage percentage, oviposition area, and oviposition percentage were recorded systematically, and mean values of all parameters were calculated for analysis and interpretation of results.

Figure 1: Collection of twigs

Figure 2: Collected Twigs

Figure 3: Experimental Set-up

3. Result

After conducting the experiment for 10 consecutive days, significant variation in leaf damage and oviposition percentage of leafhopper was observed among different twigs. Maximum leaf damage was recorded in Twig–7 with 65.01 ± 0.21% damage, followed by Twig–6 (51.04 ± 0.29%), indicating severe feeding activity of the pest. Twig–8, Twig–9 and Twig–10 also showed comparatively higher damage percentages ranging from 44.57 ± 0.08 to 45.56 ± 0.08%. Moderate damage was observed in Twig–4 (40.05 ± 0.14%) and Twig–5 (35.02 ± 0.16%), whereas minimum damage was recorded in Twig–1 (3.46 ± 0.09%). The increase in number of holes and area of holes directly contributed to increased percentage leaf damage. Similarly, oviposition observations revealed that maximum oviposition percentage was recorded in Twig–7 (11.06%), followed by Twig–10 (8.49%), Twig–9 (8.24%) and Twig–8 (8.16%). Minimum oviposition percentage was observed in Twig–1 (2.58%), indicating lower preference of the insect for egg laying. A gradual increase in oviposition marks and oviposition area was observed from Twig–1 to Twig–7. The results indicated a positive relationship between oviposition activity and feeding damage, where twigs receiving higher oviposition preference subsequently exhibited greater leaf damage. Overall, the study confirms that higher oviposition activity leads to greater feeding damage and increased infestation percentage. The difference observed was highly significant with a p-value of less than 0.001($p<0.001$).

Two-way ANOVA was performed for statistical analysis and Graphs were made with the help of GRAPH PRISM 10.2.0. software.

Table 1: Damage percentage of Twigs

No. of Twigs	Area of Leaf (cm²)	No. of Holes	Area of Holes(cm²)	Damage (%)
1	5.80 ± 0.03	1.50 ± 0.17	0.20 ± 0.01	3.46 ± 0.09
2	20.00 ± 0.06	20.00 ± 0.21	4.99 ± 0.05	24.95 ± 0.19
3	5.40 ± 0.02	2.50 ± 0.17	0.55 ± 0.01	10.11 ± 0.09
4	22.00 ± 0.04	22.00 ± 0.21	8.81 ± 0.04	40.05 ± 0.14
5	4.90 ± 0.02	6.60 ± 0.17	1.72 ± 0.01	35.02 ± 0.16
6	4.70 ± 0.02	8.50 ± 0.17	2.40 ± 0.03	51.04 ± 0.29
7	4.60 ± 0.02	10.60 ± 0.17	3.00 ± 0.03	65.01 ± 0.21
8	17.80 ± 0.02	15.00 ± 0.21	8.00 ± 0.03	44.94 ± 0.09
9	17.50 ± 0.02	14.60 ± 0.16	7.80 ± 0.03	44.57 ± 0.08
10	18.00 ± 0.02	15.00 ± 0.21	8.20 ± 0.03	45.56 ± 0.08

(The data was analysed using analysis of Two-way Anova and significance was tested at 5% level (P = 0.05) and 1% level (P = 0.01%)

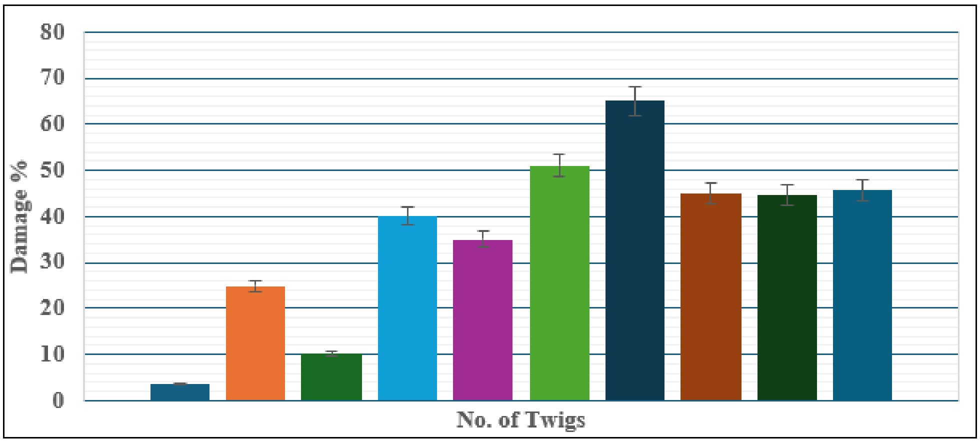

Figure 4: Graph showing mean damage percentage of twigs caused by Leafhopper

Table 2: Oviposition percentage of Twigs

Twig No.	Area of Rachis (cm²)	No. of Oviposition Marks	Total Oviposition Area (cm²)	Oviposition (%)
1	3.1	1	0.08	2.58
2	3.3	2	0.15	4.55
3	3.6	3	0.25	6.94
4	3.9	3	0.3	7.69
5	4.1	2	0.22	5.37
6	4.4	3	0.35	7.95
7	4.7	4	0.52	11.06
8	4.9	3	0.4	8.16
9	5.1	3	0.42	8.24
10	5.3	3	0.45	8.49
Mean ± SE	4.44 ± 0.22	2.70 ± 0.24	0.31 ± 0.05	7.10 ± 0.74

(The data was analysed using analysis of Two-way Anova and significance was tested at 5% level (P = 0.05) and 1% level (P = 0.01%)

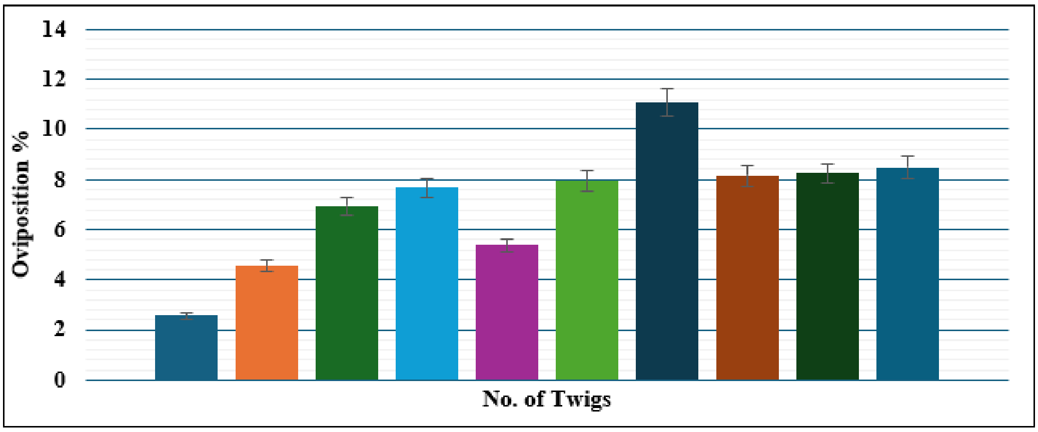

Figure 5: Graph showing mean oviposition percentage of twigs caused by Leafhopper

4. Discussion

Leafhoppers are dangerous sap sucking insects which harm the plant tissues by continuous sucking of cell sap that reduces photosynthetic area and disturbs normal physiological processes of plants (Dhaliwal et al., 2010). Oviposition behaviour is positively correlated with infestation intensity, with twigs with higher oviposition marks showing greater feeding damage. Continuous feeding by nymphs and adults resulted in tissue damage and a reduction in plant vigour (Metcalf et al., 1993). Feeding by hemipteran pests causes damage to the plants which gradually reduces plant health and the amount of chlorophyll and photosynthetic efficiency of leaves (Chapman, 1998).

5. Conclusion

The leafhoppers caused considerable damage to leaves and twigs by feeding and oviposition. The positive correlation between egg-laying behaviour and infestation intensity is evident from the increased percentage of feeding injury and leaf damage associated with an increase in oviposition punctures. The continual sap feeding by nymphs and adults reduced healthy photosynthetic tissue, with a negative impact on plant vigour. The results of the present study suggest that oviposition marks and feeding damage could be important indicators of the extent of leafhopper infestation on host plants.

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