



RESEARCH ARTICLE

Improper pruning practices increase the intensity of infestation of *Indarbela* sp. (Cossidae:Lepidoptera) in *Dalbergia sissoo* Roxb. plantation

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Abstract

The present study investigated the relationship between wounds on *Dalbergia sissoo* Roxb. trees and infestation by *Indarbela* sp. Field observations revealed that improperly pruned trees exhibited a greater number of wounds, primarily caused by incorrect pruning practices, which served as favourable sites for caterpillar shelter, oviposition and stem boring. Correlation analysis demonstrated a strong positive association between wound incidence and the number of active holes, with coefficients of $r = 0.836$ at improperly pruned (T1) site and $r = 0.752$ at non-pruned (T2) site. Regression analysis indicated that wounds accounted for 69.9 % and 62.6 % of infestation variation in improperly pruned and non-pruned site, respectively. Comparative analysis using t-test confirmed significantly higher infestation levels in improperly pruned trees (mean = 5.5 active holes/tree) than in non-pruned trees (mean = 1.5 active holes/tree; $t_{0.05} = 2.024$, $p = 1.30 \times 10^{-6}$). The study highlights that improper pruning practices exacerbate *Indarbela* sp. infestation by creating suitable microhabitats for caterpillar development, leading to cyclical damage and increased active holes. Adoption of proper pruning techniques are essential to reduce infestation and maintain the health of *D. sissoo* plantations.

Keywords: bark eating caterpillar (BEC); infestation; pruning injury; borer infestation

Introduction

The Shisham (*Dalbergia sissoo* Roxb.) is a fast-growing deciduous tree that belongs to the family Fabaceae, sub-family Faboidae and genus *Dalbergia* is native to the Indian subcontinent (1, 2). It is a fast-growing deciduous tree that has a number of uses (3, 4). It is a durable and resistant wood that is commonly used for construction, furniture and marine grade plywood (5, 6). Its uses extend beyond just timber production, as it is also commonly cultivated as a landscaping tree in urban areas such as parks, schools and highways (7). Furthermore, *D. sissoo* has economic importance in horticulture, forestry and agro-forestry, as it serves as fodder, fuel wood and timber (1, 8). Additionally, this versatile tree also has medicinal properties and is used in traditional Ayurvedic medicine to treat various ailments (9). With its ability to fix nitrogen and improve soil fertility through leaf decomposition, *D. sissoo* is an important species for agro forestry (10, 11). Overall, *D. sissoo* offers a variety of benefits to the environment and landscape and is a highly valued tree in South Asian countries (11). Besides this, *D. sissoo* is adversely affected by various insect pests in both nursery and plantation condition (12). Among them *Indarbela* sp. (Cossidae:Lepidoptera) commonly known as bark eating caterpillar (BEC) is one of the important insect pests of *D. sissoo* that causes significant damage to *D. sissoo* plantation.

Indarbela sp. is a notorious and highly polyphagous pest of various horticultural and forest trees (13–15). Life cycle of this pest is annual with one generation per year. Adults start emerging during onset of monsoon (May to June). Females oviposit eggs under loose bark in cluster. Eggs hatch in 15–25 days. Larvae hatch out initially feed on the bark and subsequently bore into the trunk or branches usually at forks of angles to a depth of 15–25 cm. The larva under silken galleries due to its nocturnal nature, the larva emerges at night from the tunnel and eats the bark of the tree near the hole. The occurred of the *Indarbela* sp. is regular and different host crops and found its infestation throughout the year. Males are smaller than females. If enough bark is eaten away, even large trees are disturbed by the interrupted sap flow, they may fail to flush and drying of the branches occur. Large dark brown webby masses, comprising chewed wooden particles and fecal matter are conspicuously seen hanging loosely on the bark of the affected tree. Generally single larva found in one tunnel. Larval period is about 8–10 months. Pupation takes place within the larval tunnel, with the cephalic end of the pupa slightly protruding outside. The pupal period is about 15–25 days (16). Hence, considering *Indarbela* sp. is a serious pest this study was conducted to determine the infestation level in relation to pruning practices of *D. sissoo* trees.

Materials and Methods

Study area

The study was conducted at two *D. sissoo* plantation sites located at the Agriculture Science Centre's farm, Indira Gandhi National Tribal University, Amarkantak, Madhya Pradesh, India. Both the sites were located at Latitude 22°47'56.75 N and Longitude 81°44'31.01 E respectively (Fig. 1). The sites represented 2 treatments: (i) improperly pruned plantations (Treatment 1) and (ii) non-pruned plantations (Treatment 2).

Sampling procedure

A total of 20 trees were randomly selected from each treatment site, serving as replications. On each tree, the number of active infestation holes created by *Indarbela* sp. and the wounds resulting from improper pruning were carefully recorded.

Data collection

Observations were made by direct counting of active holes and pruning wounds on each tree. These measurements provided quantitative data on infestation intensity and pruning damage.

Statistical analysis

To evaluate the relationship between pruning wounds and infestation intensity, correlation and regression analyses were performed at a 1 % level of significance. The infestation levels between the 2 treatments were compared using an independent samples t-test at a 5 % level of significance. Prior to statistical analysis, square root transformation was applied to the raw data to normalise distributions and improve the accuracy of the results.

Results and Discussion

The present investigation revealed a clear and statistically significant association between the presence of wounds on *D. sissoo* trees and infestation by *Indarbela* sp. as indicated by the number of active borer holes. Wounds on tree trunks and branches were predominantly the result of improper pruning practices, including

indiscriminate cutting and forcible removal of branches using manual force. Such injuries appeared to create favourable conditions for the establishment and development of *Indarbela* sp. leading to increased infestation intensity (Fig. 2). Trees with a greater frequency of wounds consistently exhibited a higher number of active holes, indicating enhanced susceptibility to borer attack.

Correlation analysis quantitatively confirmed this relationship, demonstrating a strong and positive association between wound incidence and infestation level. The correlation coefficient was higher at improperly pruned sites ($r = 0.836$), indicating a very strong relationship, while lower ($r = 0.752$) was recorded at non-pruned sites (Table 1). These results suggest that although *Indarbela* sp. infestation can occur in the absence of pruning-related injuries, the presence of wounds substantially increases the likelihood and severity of infestation.

Regression analysis further substantiated the influence of wounds on infestation dynamics. The regression models indicated that the number of wounds on *D. sissoo* trees had a direct and measurable effect on the number of active holes produced by *Indarbela* sp. The coefficient of determination (R^2) revealed that wounds accounted for 69.9 % of the total variation in infestation at improperly pruned sites and 62.6 % at non-pruned sites (Fig. 3). This high proportion of explained variance highlights the dominant role of mechanical injuries in facilitating borer infestation, while also indicating the possible contribution of additional environmental or biological factors.

To further evaluate differences in infestation intensity between improperly pruned and non-pruned sites, a t-test was performed at the 5 % level of significance. The analysis showed a highly significant difference in mean infestation levels between the 2 site categories. Improperly pruned sites recorded a markedly higher mean number of active holes (5.5 holes per tree) compared to non-pruned sites (1.5 holes per tree) ($t_{0.05} = 2.024$, $p = 1.30 \times 10^{-6}$) (Fig. 4, Table 2). This statistically significant difference confirms that improper pruning practices substantially elevate the risk and

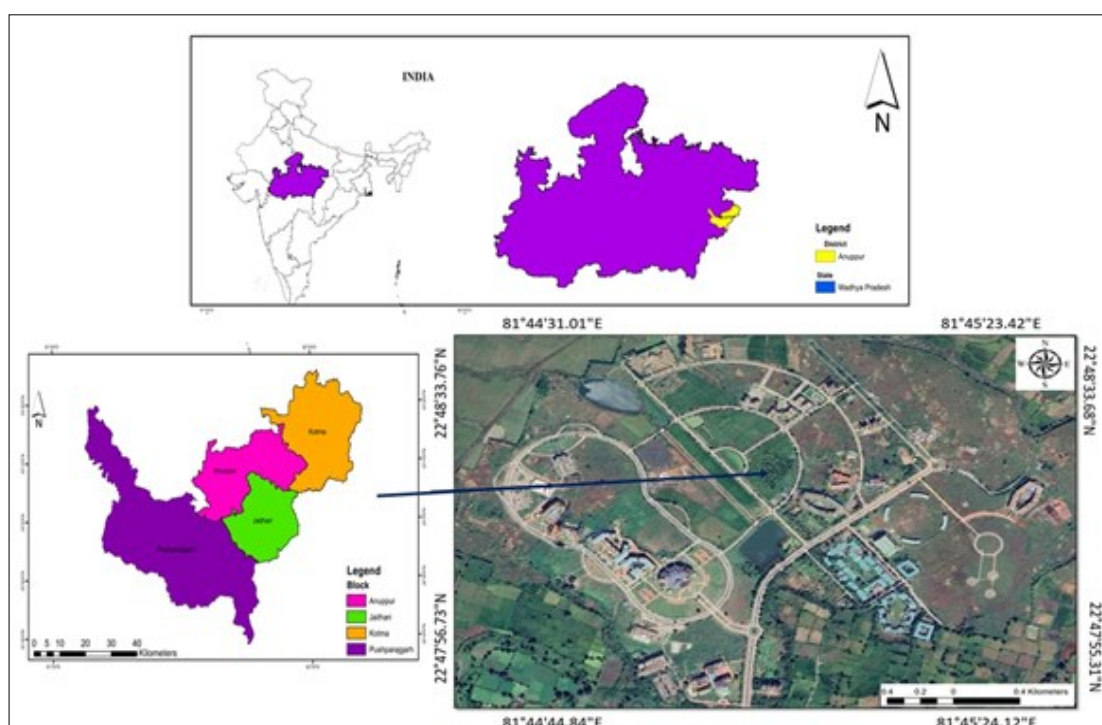


Fig. 1. Study sites (Source: Arc GIS 10.4 and Google earth)

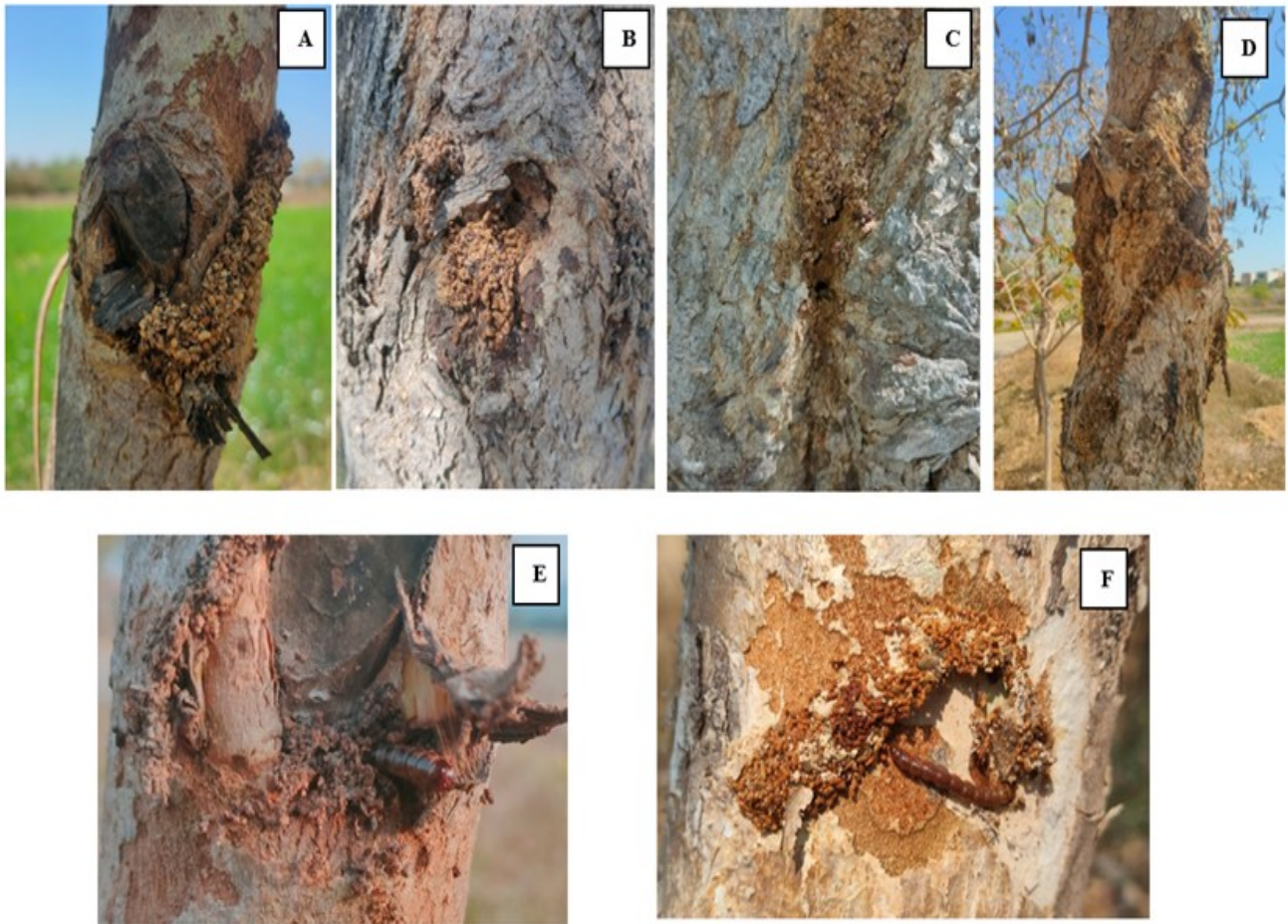


Fig. 2. (A-D) Infestation of *Indarbela* sp. on wounds caused by improper pruning, (E) Larva of *Indarbela* sp. coming out from the hole made by it in wound, (F) Larva of *Indarbela* sp. feeding on *D. sissoo*.

Table 1. Number of wounds and active holes at both sites

Sl. No. of trees	Improper pruned plantation		Non-pruned plantation	
	No. of wounds	No. of active holes	No. of wounds	No. of active holes
1	7 (2.73)	12 (3.54)	1 (1.22)	3 (1.87)
2	5 (2.34)	4 (2.12)	0 (0.71)	1 (1.22)
3	4 (2.12)	4 (2.12)	0 (0.71)	1 (1.22)
4	4 (2.12)	4 (2.12)	0 (0.71)	0 (0.71)
5	8 (2.91)	6 (2.55)	3 (1.87)	4 (2.12)
6	4 (2.12)	2 (1.58)	1 (1.22)	3 (1.87)
7	9 (3.08)	10 (3.24)	0 (0.71)	1 (1.22)
8	6 (2.55)	4 (2.12)	0 (0.71)	1 (1.22)
9	3 (1.87)	5 (2.35)	0 (0.71)	1 (1.22)
10	1 (1.22)	0 (0.71)	1 (1.22)	3 (1.87)
11	3 (1.87)	3 (1.87)	1 (1.22)	3 (1.87)
12	11 (3.39)	10 (3.24)	0 (0.71)	3 (1.87)
13	5 (2.34)	6 (2.55)	1 (1.22)	1 (1.22)
14	3 (1.87)	5 (2.35)	0 (0.71)	1 (1.22)
15	4 (2.12)	4 (2.12)	0 (0.71)	0 (0.71)
16	5 (2.34)	5 (2.35)	0 (0.71)	0 (0.71)
17	6 (2.55)	7 (2.74)	0 (0.71)	0 (0.71)
18	10 (3.24)	9 (3.08)	0 (0.71)	0 (0.71)
19	2 (1.58)	3 (1.87)	2 (1.59)	3 (1.87)
20	5 (2.34)	7 (2.74)	0 (0.71)	1 (1.22)
r	0.836064		0.752082	
p_{0.001}	4.40723E-06		0.000131022	

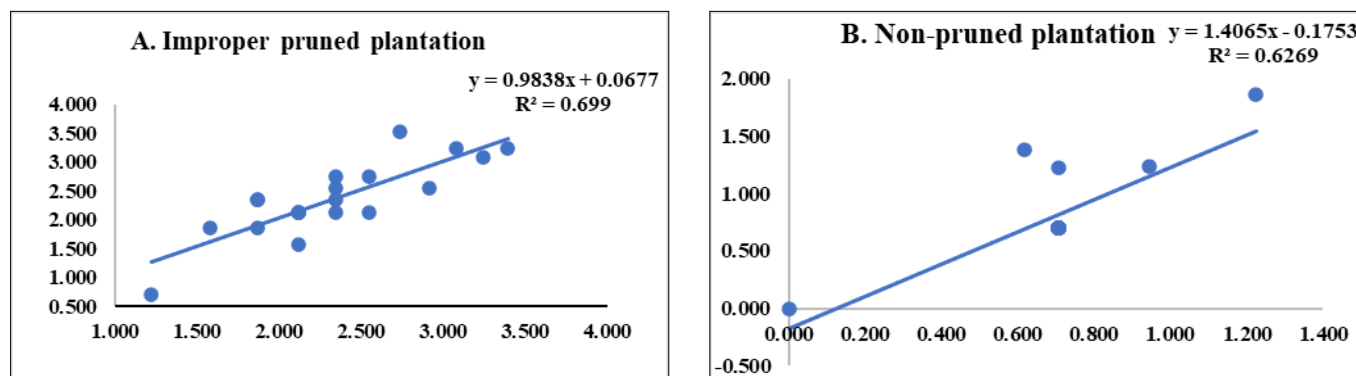


Fig. 3. Regression equations (A) Improper pruned plantation, (B) Non-pruned plantation.

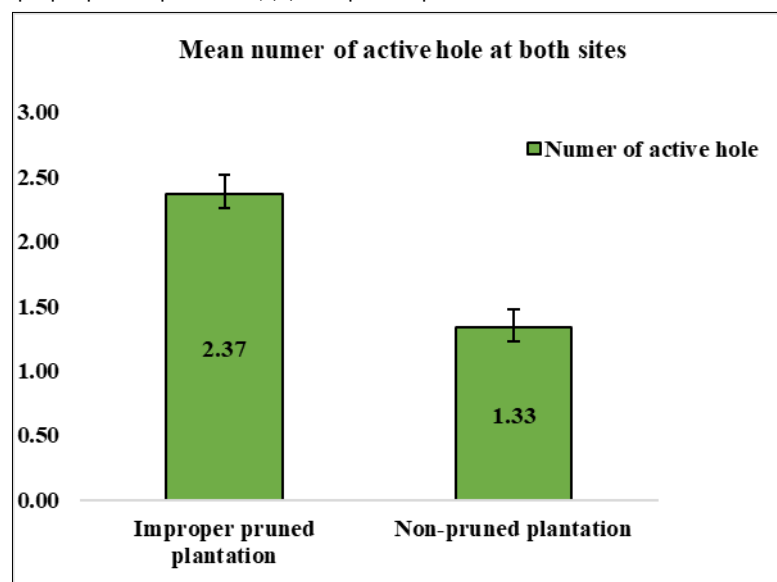


Fig. 4. Mean difference of active holes between improper pruned site and non-pruned site.

Table 2. Number of active holes of *Indarbela* sp.

Sl. No. of trees	Number of active holes	
	Improper pruned plantation	Non-pruned plantation
1	12 (3.54)	3 (1.87)
2	4 (2.12)	1 (1.22)
3	4 (2.12)	1 (1.22)
4	4 (2.12)	0 (0.71)
5	6 (2.55)	4 (2.12)
6	2 (1.58)	3 (1.87)
7	10 (3.24)	1 (1.22)
8	4 (2.12)	1 (1.22)
9	5 (2.35)	1 (1.22)
10	0 (0.71)	3 (1.87)
11	3 (1.87)	3 (1.87)
12	10 (3.24)	3 (1.87)
13	6 (2.55)	1 (1.22)
14	5 (2.35)	1 (1.22)
15	4 (2.12)	0 (0.71)
16	5 (2.35)	0 (0.71)
17	7 (2.74)	0 (0.71)
18	9 (3.08)	0 (0.71)
19	3 (1.87)	3 (1.87)
20	7 (2.74)	1 (1.22)
Mean	5.50 (2.37)	1.50 (1.33)
SD	2.96 (0.65)	1.32 (0.48)
±SD	0.66 (0.14)	0.29 (0.11)
t_{0.05}	2.024	
p	1.30E-06	

intensity of *Indarbela* sp. infestation in *D. sissoo* plantations.

The findings of the present study clearly demonstrate that the presence of wounds on *D. sissoo* trees plays a critical role in influencing infestation by *Indarbela* sp. The significant positive correlation observed between wound incidence and the number of active borer holes indicates that mechanical injuries act as important predisposing factors for infestation. Similar relationships between tree injury and borer infestation have been widely documented in forest entomology, where damaged or stressed trees are more vulnerable to pest attack than healthy trees (17, 18).

Improperly pruned sites exhibited a greater number of wounds resulting from incorrect pruning methods (19). These wounds create depressed areas on the stem due to the removal of bark, which provide favourable sheltering sites for caterpillars. Poorly maintained trees are therefore more susceptible to infestation by this pest (20). After hatching, the caterpillars take refuge within these wounds and subsequently bore downward into the stem, where they feed on the bark tissues, leading to progressive damage (21). This repeated and cyclical infestation behaviour results in a significantly higher number of active holes in improperly pruned trees compared to trees in non-pruned sites (13).

The stronger correlation coefficient and higher coefficient of determination observed at improperly pruned sites compared to non-pruned sites further indicate that the severity and frequency of wounds significantly influence infestation intensity. Similar findings have been documented in plantation forestry, where pruning injuries were positively associated with increased incidence of stem and trunk borers (22, 23). Although *Indarbela* sp. infestation was

also observed in non-pruned trees, the comparatively lower infestation levels suggest that wounds intensify rather than solely initiate infestation. This indicates the involvement of additional factors such as tree vigour, age, environmental stress and pest population dynamics, also influence the level of infestation (24, 25).

The significant difference in mean infestation levels between improperly pruned and non-pruned sites, as revealed by t-test analysis, further confirms the role of pruning-related injuries in increasing borer incidence. Trees subjected to improper pruning recorded substantially higher numbers of active holes, indicating prolonged exposure of wound sites and increased opportunities for repeated infestation. Similar trends have been reported for various forest tree species, where mechanical damage resulted in sustained borer activity and higher infestation intensity over time (18, 22, 26). Adoption of appropriate pruning techniques, avoidance of forcible branch removal, and timely management of wounds may significantly reduce *Indarbela* sp. infestation in *D. sissoo* plantation.

Conclusion

Improper pruning practices significantly increase the susceptibility of *D. sissoo* trees to infestation by *Indarbela* sp. Wounds created due to incorrect pruning methods serve as favourable sites for caterpillar shelter, oviposition, and subsequent boring activity, resulting in a higher number of active holes in improperly pruned trees. The strong positive relationship between wound incidence and infestation intensity clearly indicates that mechanical injuries play a crucial role in facilitating pest establishment and progression.

Furthermore, the significantly higher infestation levels observed at improperly pruned sites compared to non-pruned sites highlight the cumulative impact of poor tree management on pest incidence. Although infestation may occur in the absence of pruning-related injuries, the severity and frequency of wounds substantially enhance infestation levels. Therefore, adoption of proper pruning techniques, avoidance of forcible branch removal, and timely wound management are essential measures for reducing *Indarbela* sp. infestation in *D. sissoo* plantation.

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Authors' contributions

AK and SN designed the work, carried out survey, drafted the manuscript. BKN and RP critically evaluated the manuscript and DP prepared map and figures. All the authors read approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Smart Writer App and Chatgpt in order to improve language. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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