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SHORT COMMUNICATION

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Pruning slash drives ambrosia beetle (Curculionidae: Scolytinae, Platypodinae) activity in *Khaya grandifoliola* C.DC.: Slash removal as a preventive management strategy

Resíduos de poda aumentam a atividade de besouros da ambrosia (Curculionidae: Scolytinae, Platypodinae) em *Khaya grandifoliola* C.DC.: A remoção dos resíduos como estratégia preventiva de manejo

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Abstract

1. This study evaluated pruning practices and slash management on ambrosia beetle attacks in a *Khaya grandifoliola* C. DC. plantation in São Roque de Minas, Brazil (March–May 2018).
2. Three treatments comprised of non-pruned controls, pruned trees with slash removal and pruned trees with slash retention; attack intensity on standing trees was assessed via weekly visual inspections counting holes—evidence of beetle boring into trunks—with frass or gum.
3. Slash retention significantly increased beetle activity, likely by providing breeding substrate that may contribute to local population build-up and subsequent colonization of nearby trees.
4. No attacks occurred in slash-removal plot, confirming residue removal prevents ambrosia beetle attacks.
5. Attacked trees exuded gum, demonstrating *K. grandifoliola*'s effective defence that killed pioneer beetles.
6. Prompt slash removal constitutes essential integrated pest management for sustainable African mahogany plantations.

KEYWORDS
African mahogany, *Euplatypus parallelus*, gummosis, integrated pest management

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INTRODUCTION

The most commonly planted African mahogany species in Brazil is *Khaya grandifoliola* C. DC. (Meliaceae) (Ferraz Filho et al., 2021). Originally introduced in the 1990s under the misidentification *K. ivorensis* A. Chev. (Falesi & Baena, 1999), it was correctly identified as *K. grandifoliola* only after a systematic taxonomic study conducted in 2019 (ABPMA, 2020; Ferraz Filho et al., 2021). This error has led to inaccuracies throughout much of the Brazilian scientific literature on the species, particularly in entomology (Covre, Caron, & Flechtmann, 2025).

Despite ongoing taxonomic uncertainties, numerous insect species are associated with *K. grandifoliola* in Brazil, most of which are beetle species (Covre, Caron, & Flechtmann, 2025). Several of these, reported from Brazilian *K. grandifoliola* plantations, raise quarantine concerns for timber-importing countries. Notable examples include *Xylosandrus crassiusculus* (Motschulsky) and *Euwallacea fornicatus* (Eichhoff) (Curculionidae: Scolytinae) (Covre et al., 2021, 2024), *Apate terebrans* (Pallas) (Bostrichidae) (Covre et al., 2018; Luna et al., 2018; Matrangolo et al., 2016) and *Megaplatypus mutatus* (Chapuis) (Curculionidae: Platypodinae) (Covre, Haack, et al., 2025). If not properly studied and managed, these ambrosia and woodboring beetles, especially the quarantine pests (EPPO, 2025), could threaten Brazilian *K. grandifoliola* timber exports.

Ambrosia and woodboring beetles damage this species' primary resource: its timber. Silvicultural practices, such as leaving slash in plots after thinning, increase susceptibility to beetle attacks in its plantations (Cristovam et al., 2018) and other forest species (Fettig et al., 2012; Foit, 2015b; Kelsey, 1994; Thibault & Moreau, 2016). Pruning practices similarly influence beetle infestation rates in forest plantations (Byers et al., 1980; Covre, Haack, et al., 2025; Okwori, 2012; Svihra, 1994).

Pruning, a widely adopted silvicultural practice, produces knot-free wood and maximizes main-stem value (Ribeiro et al., 2002; Zobel, 1992). This technique is especially critical for high-value timber species such as African mahogany, where trunk aesthetics and structural quality are paramount (França et al., 2023). However, pruning can inadvertently increase susceptibility to beetle attacks: Mechanical injuries from branch removal trigger kairomones and stress-induced volatile organic compound release (Covre, Haack, et al., 2025; Yuan et al., 2025). These chemical cues enable beetles to locate and select hosts via chemical communication, often signalling weakened or recently damaged hosts (Cavaletto et al., 2023; Ranger et al., 2015).

Slash left on the forest floor may continue emitting attractive volatiles for extended periods, acting as olfactory beacons that draw beetles into the plantation (De Groot et al., 2025; Foit, 2015a, 2015b; Kelsey, 1994; Špoula & Kula, 2024). This slash provides suitable substrates for feeding, oviposition and larval development, acting as infestation sources that promote later beetle attacks on standing trees (Cristovam et al., 2018; Foit, 2015a). Despite pruning's widespread use, its implications for pest dynamics, particularly slash management, remain poorly understood.

We therefore investigated the links among pruning practices, slash management and beetle attack incidence to help develop sustainable integrated pest management strategies for *K. grandifoliola* plantations.

METHODS

Study site and experimental design

The study was conducted in a 6-ha *Khaya grandifoliola* C. DC. stand (20°7′18.13″ S 46°26′23.40″ W) in São Roque de Minas, state of Minas Gerais, Brazil. Established in December 2013 with 1675 trees at 6 × 6 m spacing, the stand was divided into three treatments: (1) slash-removal (pruned with branches removed from the plot, 1.9-ha – 530 trees), (2) slash retention (pruned with branches left on the ground, 1.8-ha – 503 trees) and (3) non-pruned (control, 2.3-ha – 642 trees). At the beginning of the experiment, trees averaged 15.6 cm diameter at breast height (DBH) and 6.5 m bole height. All trees selected for pruning were georeferenced, with 34 in the slash-removal treatment and 58 in the slash-retention treatment; pruning was applied consistently to all trees, typically involving the removal of one branch per tree at heights between 5 and 6 m (Figure 1).

Monitoring of *Khaya grandifoliola* attacked trees

All 1675 trees were inspected before pruning on 28 March 2018, with no beetle attacks detected. Weekly monitoring followed from 4 April to 9 May 2018 (seven inspections in total) via visual inspection of all 1675 trees. Beetle attacks, identified by holes expelling gum or frass (Figure S1c,d), were counted, maximum attack height was recorded and the tree phytosanitary status was noted.

Gum masses with attached beetles were collected during inspections for beetle identification. On the final inspection, five branches—selected among the most attacked from the slash retention plot—were also collected. Samples (gums and branches) were sent to UNESP Entomology Laboratory for determination of the beetle species. Voucher specimens were deposited in the Museum of Entomology FEIS/UNESP (MEFEIS) in Ilha Solteira, São Paulo state, Brazil.

Spatial dispersion analysis

Attack intensity for each sampled tree was quantified as the total number of entrance holes containing frass or gum. Georeferenced coordinates of attacked trees and their attack intensities were subjected to spatial dispersion analysis.

The spatial distribution of attacked trees and total attack intensity (sum of holes) were analysed via Kernel density estimation (KDE) (Silverman, 1986) in R (R Core Team, 2024), producing a heat map of high-infestation areas. Experimental plots were delineated in QGIS (QGIS Development Team, 2024) and exported as shapefiles, then imported into R using the *sf* package (Simple Features)

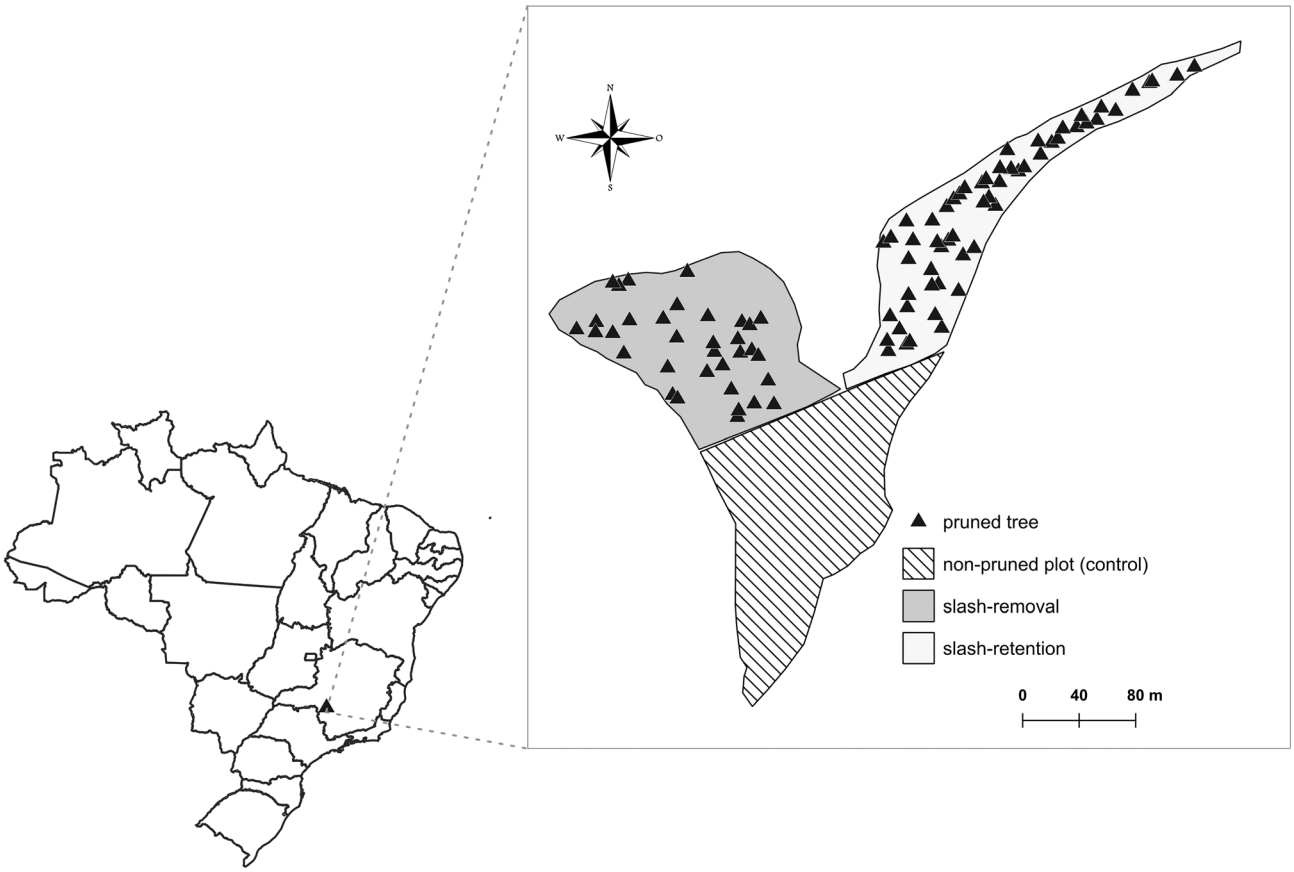


FIGURE 1 *Khaya grandifoliola* plantation treatment plots: treatment plots: non-pruned (control), slash-removal (pruned with branches removed) and slash retention (pruned with branches left on the ground). São Roque de Minas, Minas Gerais, Brazil (March–May 2018).

(Pebesma, 2018). Plot boundaries were overlaid on the KDE heat map using the *ggplot2* package (Wickham, 2016).

RESULTS AND DISCUSSION

Monitoring of *Khaya grandifoliola* attacked trees

Beetle attacks occurred almost exclusively in the slash-retention treatment, among the three evaluated conditions (slash removal, slash retention and non-pruned plots). Only one attacked tree was recorded in the slash-removal treatment (20°7′15.33″ S 46°26′26.64″ W), where wind breakage of the crown likely generated localized host volatiles similar to those produced by retained pruning residues (Abraham et al., 2014). This tree exhibited two gum-exuding holes on 19 April 2018. The number of attacked trees increased during the first 4 weeks of monitoring and subsequently declined (Table 1). All attacked trees maintained normal canopy phytosanitary status. Attacks by *Euplatypus parallelus* (Fabricius) (Curculionidae: Platypodinae) were concentrated on the lower portions of the trunk, within 3.5 m above ground level (range 0–3.5 m; mean 1.8 m), based on the maximum attack height recorded at each inspection (Table 1).

The concentration of attacks within the slash-retention treatment indicates that retained pruning residues played a central role in mediating host selection by beetles. Although pruning wounds can induce volatile emissions from injured tissues (Yuan et al., 2025), pruning alone—as represented by the slash-removal treatment—proved insufficient to attract attacks. Instead, slash left on the ground likely acted as a persistent source of host-derived kairomones from freshly cut or stressed tissues, producing stronger and longer-lasting volatile plumes than the transient emissions from wounds on standing trees. Selective pruning likely increased host stress and the emission of volatiles that attract ambrosia beetles, as reported for stressed trees in temperate regions (Beaver, 2013; Cavaletto et al., 2021; Miller & Rabaglia, 2009). Within our study, slash retention coincided with a spatial concentration of attacks on nearby standing trees. However, because volatiles from slash or standing trees were not measured, the role of olfactory cues in mediating this pattern remains speculative. The single attack recorded in the slash-removal treatment may relate to a wind-broken crown that remained in the plot until inspection. This suggests that freshly damaged plant material could facilitate beetle attack, possibly by producing host-stress cues.

The vertical distribution of *E. parallelus* attacks may explain the observed pattern. Most attacks occurred below 2 m above ground, consistent with typical flight heights reported for Neotropical

TABLE 1 Date of visual inspections, number of attacked *Khaya grandifoliola* trees, mean maximum height of ambrosia beetle holes (in meters) and number of gum- or frass-exuding holes in the slash-retention treatment of a *K. grandifoliola* stand. São Roque de Minas, state of Minas Gerais, Brazil.

Inspection	Date	No. of trees	Height (m)	No. of gum	No. of frass
1	03/28/2018	0	0.0	0	0
2	04/04/2018	10	2.0	105	15
3	04/11/2018	24	2.0	155	3
4	04/19/2018	5	3.0	38	0
5	04/25/2018	3	2.0	5	0
6	05/02/2018	1	3.5	1	0
7	05/09/2018	0	0.0	0	0

ambrosia beetles (Covre et al., 2021; Gerónimo-Torres et al., 2025; Igeta et al., 2004). We therefore hypothesize that ground-level slash enhances host detection within the beetles' main flight corridor. Mechanical injuries induce volatile compound release in plants, though emission composition and dynamics vary by species and conditions (Yuan et al., 2025). Thus, low-lying slash may provide more detectable cues, while pruning wounds at 5–6 m release volatiles above the primary flight zone, where dispersion could reduce their efficacy. However, the chemical ecology of *E. parallelus* remains poorly understood, and these mechanisms were not tested here.

The temporal pattern of attacks further reflects the dynamics of volatile production from fresh pruning residues. Attacks increased during the first 4 weeks following pruning, then declined as slash aged (Table 1). Immediately after cutting, physiologically active branches can emit substantial quantities of host-derived volatiles associated with fresh wounds, desiccation stress and early tissue degradation (Guenther et al., 1996). These emissions may persist for days or weeks, creating strong olfactory cues that attract beetles (Švihra & Koehler, 1981). As branches dry and begin to decompose, volatile release decreases markedly, reducing the chemical cues available for host location (Flechtmann et al., 1999). The temporal decline in attacks therefore corresponds closely to the physiological timeline of volatile production from fresh slash.

At the peak of activity, 24 attacked trees were recorded during the second week after pruning, with most entry holes exuding gum and some expelling frass (Table 1). Subsequently, the number of new or active attacks declined to zero. This pattern suggests that although slash-derived volatiles initially attracted pioneer beetles, the trees' endogenous defences effectively prevented successful colonization. In members of the Meliaceae, rapid gum exudation following bark injury forms a primary defence barrier (Pennington & Styles, 1975). Similar responses have been reported in *Khaya grandifoliola* and *Khaya senegalensis* against beetles (Covre et al., 2018; Covre, Haack, et al., 2025; Pelozato et al., 2018). In the present study, gum exuding from the initial attack holes immobilized male *E. parallelus* adults before they could attract females, thereby preventing mating, gallery formation and larval establishment. As platypodine beetles typically rely on males as pioneer colonizers that select hosts and subsequently attract females (Beaver, 2013; Ytsma, 1989), their immobilization effectively halted the colonization process. Gum-trapped males recovered from the exudate confirm the effectiveness of this defensive barrier, indicating that African mahogany can neutralize early attacks even when beetles are attracted to the vicinity.

Beetle species associated with gum and pruning residues

Males of *E. parallelus* ($n = 27$) were the only beetles recovered from gum exudates collected from attacked trees of *K. grandifoliola*, and all specimens were dead. Their presence confirms that the gum exudation response effectively immobilized the pioneering individuals responsible for initiating attacks.

Branches collected during the final inspection of the slash-retention treatment revealed a diverse assemblage of beetles. A total of 12 species were identified (Table S1), including nine species in the subfamily Scolytinae (Curculionidae): *Cnestus retusus* (Eichhoff), *Corthylus pharax* Schedl, *Dryocoetoides cristatus* (Fabricius), *Hypothenemus eruditus* Westwood, *Microcorthylus minimus* Schedl, *Premnobius cavipennis* Eichhoff, *Xyleborus spinulosus* Blandford, *Xyleborus squamulatus* Eichhoff and *Xyleborinus linearicollis* (Schedl); two species in Platypodinae: *E. parallelus* and *Teloplatypus ratzeburgii* (Chapuis); and one in Bostrichidae: *Xyloperthella picea* (Olivier). The most abundant species was *E. parallelus*, represented by 22 individuals in a 1:1 sex ratio. Larvae and pupae of *D. cristatus* and *X. spinulosus* were also present, demonstrating successful colonization of these branches by at least these species. Additionally, a cerambycid larva was detected in all branches except branch "C", although rearing attempts failed to yield adults for identification.

The presence of multiple species developing within pruning residues indicates that freshly cut branches serve as suitable colonization substrates for a diverse guild of beetles. In one case, a single branch measuring 162 cm × 6 cm hosted six species simultaneously, suggesting niche partitioning among colonizers based on body size, feeding strategy and successional stage. Fresh slash tends to favour small xylomycetophagous beetles such as Scolytinae and Platypodinae, whereas more advanced stages of drying and decay can be exploited by larger true wood feeders, including Bostrichidae and Cerambycidae (Batchudur et al., 2025; Ulyshen, 2016; Zou et al., 2023).

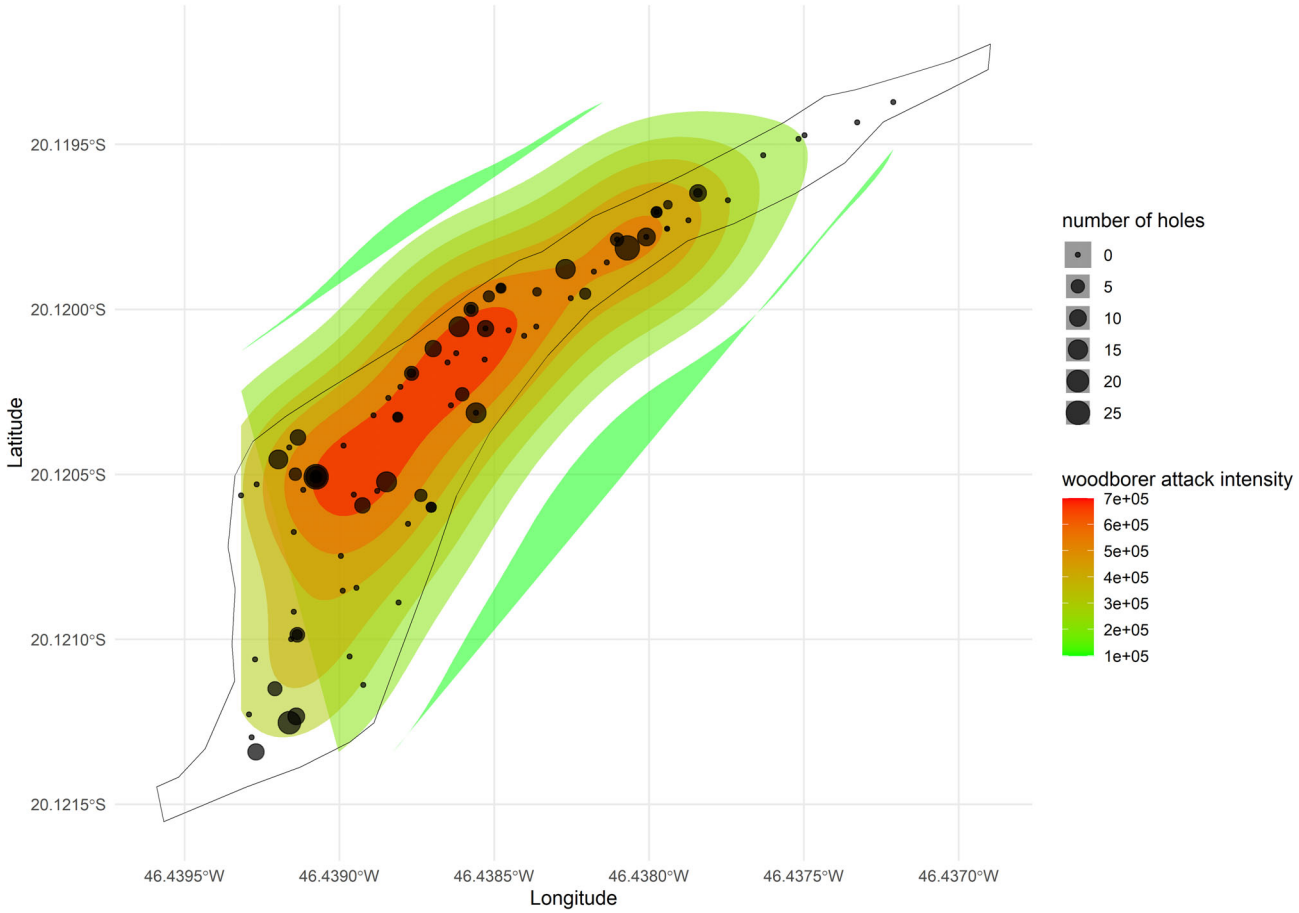


FIGURE 2 Kernel density estimation (KDE) heat map of ambrosia beetle attack intensity (total frass/gum holes per tree) in *Khaya grandifoliola* slash-retention treatment, São Roque de Minas, Minas Gerais, Brazil. Black dots mark georeferenced attacked trees (circle size: 0 −≥25 holes); KDE gradients: 1×10^5 to 7×10^5. Dashed lines delimit the experimental area.

Notably, *E. parallelus*—the species responsible for attacking standing trees—was able to colonize pruning residues successfully, as indicated by the balanced sex ratio among adults recovered from the branches. This observation demonstrates that although gum defences prevented colonization of live trees, the species was fully capable of reproducing in freshly cut wood. Development of *E. parallelus* and other potential pests within slash suggests that retained pruning residues can function as local population reservoirs, increasing beetle abundance and consequently elevating the risk of attack on nearby trees. All 12 beetle species detected in this study have previously been reported in association with African mahogany (Covre, Caron, & Flechtmann, 2025), reinforcing the role of pruning residues as key substrates sustaining beetle diversity and population growth in these plantation systems.

Spatial dispersion of attacks

Kernel density estimation (KDE) analysis revealed a heterogeneous and aggregated spatial pattern of beetle attacks associated with the slash-retention treatment (Figure 2). Areas with the highest attack intensities were concentrated in the northern and central-western portions of the plot, as indicated by the red and orange isopleths of the heat map. Trees exhibiting the greatest number of entry holes (≥25 holes) were primarily located within or immediately adjacent to these high-density core areas, demonstrating spatial dependence between infestation intensity and proximity to retained slash (Figures 1 and 2).

This spatial clustering further supports the hypothesis that slash acted as a focal source of attractive kairomones. Volatile plumes emitted from retained pruning residues likely created localized zones of increased beetle activity, leading to concentrated attacks on nearby trees. Such chemically mediated aggregation is consistent with the host-finding behaviour reported for many ambrosia and bark beetles, which rely heavily on plant-derived volatiles to locate suitable substrates (Beaver, 2013; Miller & Rabaglia, 2009).

Implications for pest management

Together, these results demonstrate that pruning residue management strongly influences beetle activity in *K. grandifoliola* plantations.

Retained slash functions both as a volatile source attracting beetles to nearby trees and as a breeding substrate capable of sustaining diverse beetle populations. Although African mahogany possesses an effective defensive response—rapid gum exudation capable of immobilizing pioneering males of *E. parallelus*—this mechanism primarily prevents colonization rather than attraction. Consequently, high beetle populations developing in retained slash could still increase attack pressure on surrounding trees.

Rapid pruning-residue removal may prevent ambrosia beetle attacks on standing trees under the conditions tested here. However, residue management carries broader ecological implications, such as impacts on natural enemies and beetle population dynamics. We therefore recommend integrating this practice within an IPM framework, with further studies needed to evaluate its long-term sustainability in African mahogany plantations.

AUTHOR CONTRIBUTIONS

LSC: conceptualization; data curation; formal analysis; methodology; visualization; writing – original draft. **CAHF:** conceptualization; methodology; visualization; supervision; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data used in this manuscript are available from the UNESP Institutional Repository https://hdl.handle.net/11449/318899 (Flechtmann, 2026).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Table S1. Branch length (cm), diameter (cm), number of holes and number of beetles per species (in parenthesis) from *Khaya grandifoliola* slash-retention treatment. Stand of *K. grandifoliola*, São Roque de Minas, state of Minas Gerais, Brazil.

Figure S1. *Khaya grandifoliola* plantation in São Roque de Minas, Minas Gerais. A and B—pruned slash-retention plot; C—ambrosia beetle entry hole with frass; D—gum exudate from *Euplatypus parallelus* hole.

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