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Assessing the Temporal Variations in Light Interception and their Impact on Above-Ground Biomass Production in Wet Zone Rubber Plantations

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Abstract

Rubber (*Hevea brasiliensis*) is an important crop in Sri Lanka, primarily cultivated for latex production. However, the monoculture nature of rubber plantations has a significant impact on the overall above-ground biomass production that can lead to economic vulnerability due to fluctuations in rubber prices. This study aimed to find a novel method to investigate the temporal variations in the light environment in wet zone rubber plantations and their influence on above-ground biomass (AGB) production. The research involved the selection of rubber fields ranging from 4 to 33 years in the Salawa rubber plantation for comprehensive data collection. The hemispherical photography analysis method was used at a five-year age series to determine the canopy cover, which indicates the amount of light intercepted by the rubber trees and leaf area index (LAI). It was determined through hemispherical photographs captured using a Canon EOS 70D camera fitted with a fisheye lens. Image analysis was done using Adobe Photoshop and Hemi-view canopy analysis software (version 2.1). Then, the light interception was calculated by taking the difference between the total radiation above the canopy, corrected for intercepting surface orientation and the Total radiation below the canopy, corrected for intercepting surface orientation values. The amount of AGB was estimated using an allometric equation based on diameter at breast height and tree height. The light interception was then analysed in association with LAI to identify their influence on AGB by developing mathematical models. The findings indicated that younger rubber trees consistently captured more solar radiation over the study period compared to mature trees. From December 2022 to May 2023, there was a notable increasing trend in light distribution within the plantation, reaching its peak in May. Maximum light interception occurred in the 8-year-old rubber field during this period, reaching 7,512.63 μmol m^2 s^{-1} when the LAI peaked. However, despite a strong and positive correlation between cumulative PAR interception and LAI, light interception within the canopy displayed significant temporal heterogeneity across the study period, with May exhibiting the highest levels, followed by February, and the lowest in December. Notably, there was no consistent and predictable relationship between cumulative light interception and AGB across the rubber fields during the six-month study period. Therefore, these findings emphasize the need for further research and a complex approach to understanding the relationship between environmental variables and rubber cultivation for the selection of methodologies in plantation management.

Keywords: *Hevea brasiliensis,* Hemispherical photography, Above-ground biomass, Temporal variations, Light interception