研究论文

坡面单木圆锥形树冠投影边界的模型理论

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摘要　　遮荫作为树冠对辐射截留的集中表现，与林下环境，特别是光环境特征具有密切关系。为满足坡地人工林下作物、中药栽培环境模拟、预测和控制的理论需要，以圆锥形树冠为研究对象，借助几何光学中光的直线传播原理，根据水平投影与坡面投影的亲似对应关系，在坡平面直角坐标系内讨论树冠的坡面投影形状、确定投影关键点坐标，在测树因子、经纬度、坡度、坡向、时间（包括时刻和日期）等变化要素基础上建立坡面投影理论边界模型Z（x', y'）=0。经模拟验证，各时刻实测与计算阴影边界曲线相关系数大于等于0.928、显著水平（P）均达到0.01，表明该模型可较精确地描述正圆锥的坡面投影。在此基础上，进行模型的实用检验和分析，选择北半球中纬度单株樟子松，计算得到5月12日8：00～14：00树木遮荫影响最远到达东0.69倍树高、西1.18倍树高、南0.2倍树高、北0.4倍树高，绝大多数阴影位于近似扇环的区域内，计算结果符合北半球太阳视运动规律且实际观测结果与计算值之间相关系数为0.983（P=0.008），证明该模型适用于树冠的遮荫分析，并可能在邻体遮光干扰的进一步研究中发挥作用。最后讨论该模型的优点及局限性，明确模型在实际研究中合理运用的条件。

关键词　　坡面；圆锥形树冠；亲似对应；投影边界；模型

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Theoretical research on a model for predicting the shadow boundary of and individual conical crown on a slope

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Abstract Tree-shading could represent solar radiation intercepted by the tree crown. Understory light environment also had a close relation with tree-shading. The conical crown was studied because it was familiar and its shadow, whether on a flat plane or slope, was more complex than other crown profiles. The shadow profile of an individual conical crown on a slope was an ellipse or a closed curve composed of an ellipse and its two tangents, which depended on the relationship between the solar altitude (hs) and the base angle (A) of the cone. In the rectangular plane coordinate system，a theoretical model was developed, which took tree height (H), height below branch (h), crown radius(r), longitude (λ), latitude (φ), height (ht), slope(α), aspect (β), date (d) and time (t) into account to describe the shadow boundary of an individual conical crown on the slope. The model was based on geometrical optics theory and the corresponding and imitating principle between shadows on a flat plane and a slope. In the simulation test, the results of Spearman and Kendall's tau-b test showed all correlations between measured and calculated values of boundaries were not less than 0.928 and were significant at the 0.01 level (2-tailed) from 8:00 to 14:00. The model, therefore, was suitable to describe the shadow boundary of an individual cone, and the more the actual profile of the crown resembled a cone, the more accurate the simulated results. Furthermore, this model was practically used to forecast the variable scale of tree-shading of an individual tree species, Pinus sylvestris, in which the shadow of the crown always lied, from 8:00 to 14:00 on May 12th. Theoretically, this scale reached 0.69H on the east side of the tree, 1.18H on the west, 0.2H on the south and 0.4H on the north. The result was in accordance with the apparent motion rules of the sun and the correlation was 0.983 between observations and calculati

ons, though it was different from existing research. There were two possible reasons for this difference. One was that two scales were in different time spans respectively. The other reason was that this paper was based on the apparent motion rules of the sun and did not consider any aspects of plant ecology. Advantages and limitations of the model are listed which define how to use this model well with interrelated research.

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