Angle-Dependent Measurement of the Shading Effect of Hail Protection Textiles for Sun Protection in Fruit and Berry Plantations

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Abstract

Hail protection nets are widely used in fruit and berry cultivation to prevent mechanical damage from hailstorms. Beyond this primary function, such textiles also provide shading, which can reduce sunburn damage and heat stress on fruit and thus offer an additional protective benefit. However, the shading effect of these textiles strongly depends on the angle of incident sunlight, which changes continuously over the course of the day and season, and this angle-dependent behavior has so far been insufficiently characterized.
In this study, the angle-dependent shading behavior of different textile materials was systematically investigated. A total of six hail protection fabrics were examined, comprising four commercially available standard fabrics and two textile materials specifically developed at Hochschule Hof. The objective was to characterize the extent to which the shading effect of the fabrics varies as a function of the angle of incidence of the incoming radiation. For this purpose, a custom-built measurement setup developed at Hochschule Hof was employed, allowing controlled measurements over an incidence angle range from 0∘ to 90∘. The optical response of the textile samples was quantified using a portable light sensor (T&D ISA-3151). The resulting measurements provide a basis for comparing the different fabrics and evaluating their suitability for applications in which the shading effect under varying solar irradiation angles is of particular relevance.

The results demonstrate a clear angle dependence of the shading effect for all tested textile materials. Depending on the material and angle of incidence, the degree of shading varied considerably, with values ranging from approximately 20 % at unfavorable incidence angles to substantially higher levels at other angles within the investigated range of 0∘ to 90∘. In addition to the general angular dependency, notable differences between the individual fabric types were observed, indicating that the optical properties and structural characteristics of the textiles have a significant influence on their shading performance. These differences

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highlight the potential for selecting and designing hail protection fabrics not only with regard to their primary function of protecting crops against hail, but also with respect to their secondary effects on the microclimatic conditions within the plantation.
From a practical perspective, these findings suggest that existing hail-netting infrastructure could be utilized to achieve an additional protective effect against excessive solar radiation without requiring separate shading systems. Appropriate orientation of the plantation structure could therefore represent a comparatively simple and low-cost strategy for improving the thermal and radiation environment of the crop while maintaining the primary protective function of the net.

Keywords: textile, hailnets, shading, solar, radiation, protection