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Measurements and simulation of internal fan-driven airflow in a commercial greenhouse

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ABSTRACT

Increasingly in large scale commercial greenhouses, internal fans are deployed as a tool to help optimize growing conditions. Fans are typically mounted near the ceiling in a grid pattern with the flow direction parallel to crop rows. Fans are typically run at a constant speed, full time. The resulting airflow helps regulate temperature, and humidity, distribute carbon dioxide, and aid in plant transpiration. This study examines a specific fan type and spatial configuration in a seven-meter-tall 2.6-hectare Venlo style greenhouse, with a mature crop of vertically grown vine tomatoes. Ultrasonic air velocity measurements in three dimensions were taken at prescribed locations surrounding a fan. The fan's output was also measured in a grid pattern to better understand it's flow pattern, and to establish the necessary input flow pattern used in a CFD simulation. The CFD model represent a domain for a repeating section of the greenhouse, and accounts for momentum losses due to the crop, as a porous media, the surrounding support structure and the end walls perpendicular to the airflow direction. The side walls of the repeating domain are given a paired cyclic boundary condition. The results of the simulation are compared with the measurements, and suggestions for refinement and improvement are made. Also, a preliminary look how light abatement curtains may impact the overall flow pattern is presented.