Plant Based Dispersions: Novel sprayable frost protectants for tree fruit reproductive buds

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ABSTRACT

While potential losses from cold damage are predicted to increase as a result of climate change, frost mitigation technologies used by tree fruit growers have remained mostly unchanged from the last few decades of the 20th century. Plant-based dispersions (PBD) are aqueous solutions containing plant-derived, cellulose-based nanomaterials such as cellulose nanocrystals (CNC) and cellulose nanofibers (CNF). These have unique physical and chemical properties, including low thermal conductivity, and can be sprayed onto trees, forming a thin (25µm-40µm), durable insulating film around the surface of the buds. My research objectives were to (1) investigate the ability of PBDs to protect dormant and developing floral tissue at different stages of development, (2) demonstrate the mechanisms involved in PBD protection in-vivo. Several small and large-scale field trials were carried out on in apple (Malus domestica Borkh.) and sweet cherry (Prunus avium L.) to quantify the changes in cold sensitivity and duration of effect on treated buds at a variety of developmental stages from dormancy to anthesis using controlled freezing and differential thermal analysis (DTA) techniques. Thermography and digital scanning calorimetry (DSC) studies were carried out on dormant apple and cherry buds to investigate the freezing and thermal behavior of PBD coated buds. Field trials showed that PBD could decrease the lethal temperature thresholds by 2-5.5°C for as long as 7 days post application, with concentration, source material, and time post application influencing effect and duration. Thermography revealed that thermal emissivity of buds treated decreased by an average of 16% with 3% CNC dispersions. DSC results indicate
lethal freezing occur in buds coated with 3% CNC at a temperature 3.2°C and 5.5°C lower than the control 1 and 3 days after application, respectively. PBDs represent a viable option as sprayable frost protectant which insulates reproductive buds and reduces cold sensitivity.