2. SUMMARY

Application of geometric methods for the determination of contact angle and surface free energy to characterise leaf surfaces

The study of the contact angle is critical for understanding the interactions between liquids and solid surfaces, which directly influences the effectiveness of plant protection treatments conducted through spraying. Accurate determination of leaf wettability is essential for optimizing pesticide application, enhancing their efficacy, and minimizing the environmental impact.

In this doctoral dissertation, it was hypothesized that droplet dimensioning from both side and top views for the purpose of calculating the contact angle, based on geometric relationships, enables the characterization of leaf wettability and free surface energy across a full range of contact angles, as well as various leaf surface properties and measurement liquids. The hypothesis was tested by addressing research objectives that included evaluating the influence of leaf surface structures, such as waxy crystalline formations and trichomes, along with other factors like solar exposure, seasonality, and fungal infections, on leaf wettability. The suitability of droplet dimensioning from both side and top views for calculating the contact angle and free surface energy was investigated, with novel mathematical approaches applied for top-view contact angle calculations on leaves.

The findings confirmed that the contact angle is not a constant value for leaf surfaces but varies depending on the season and leaf age. A higher presence of wax structures and trichomes on leaf surfaces reduced wettability, a trend particularly observed in three of the four sections of the *Spirea* genus studied. Significant differences in wettability were found between the adaxial (upper) and abaxial (lower) leaf surfaces, with the adaxial surface generally being more wettable, resulting in a lower contact angle. Additionally, sunlight exposure affected leaf wettability – contact angles were larger, and wettability was lower, in sunlit areas compared to shaded ones. The development of powdery mildew generally reduced leaf wettability in most of the plants studied. The research demonstrated that the contact angle, calculated based on geometric relationships, is an effective measure of leaf wettability and can be used for surface characterization. It was also confirmed that the contact angle can be calculated using two data sets: droplet spread and height (Mack's method) or droplet spread and volume (Bikerman's method).

Although widely used, Mack's method can be prone to observational errors, particularly for droplets with elliptical spreading and low contact angles. In contrast, Bikerman's method proved to be more reliable, especially on well-wettable surfaces, as it minimized observational errors. When adjuvants that reduce the contact angle were used, Bikerman's method was simpler to apply and less error-prone than Mack's method. The measurement of droplet spread in the side view, combined with droplet volume in Bikerman's formula, allowed accurate contact angle calculations over the same range as Mack's method. The method of contact angle calculation did not affect the accuracy of free surface energy calculations, confirming that both Mack's and Bikerman's methods can be applied for this purpose.

In conclusion, the study's findings confirm that various factors influence leaf wettability, and Mack's and Bikerman's methods can be effectively employed to determine the contact angle and characterize the free surface energy of leaves under different conditions.