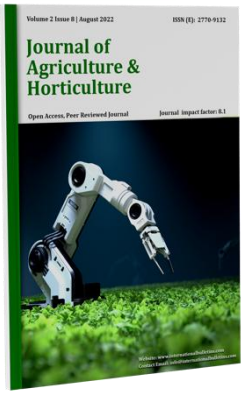

INVESTIGATION OF CHLOROPHYLL CONTENT IN 'MIYABI FUJI' APPLE BUDS

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Abstract

This study investigates the temporal dynamics of chlorophyll content in floral and non-floral buds of 'Miyabi Fuji' apple trees. Chlorophyll levels were assessed at two distinct stages prior to bud burst. Initially, floral buds exhibited lower chlorophyll concentrations compared to non-floral buds; however, as bud burst approached, a notable increase in chlorophyll content was observed in the floral buds.

Spectral analysis using visible and near-infrared (VIS–NIR) spectrometry revealed that non-floral buds showed greater light absorption within the 670–720 nm range, whereas floral buds demonstrated reduced absorbance in this spectral window. In contrast, both bud types exhibited active light absorption in the near-infrared range above 930 nm and below 1016 nm.

These results underscore the potential of near-infrared spectrometry as a reliable and non-destructive method for differentiating between floral and non-floral buds in apple trees, offering valuable insights for early phenological assessments and precision horticultural practices.

Keywords: Miyabi Fuji, apple buds, chlorophyll level, near-infrared spectrum, non-destructive analysis.

Introduction

Early identification of flowering and non-flowering buds in apple trees is of critical scientific and practical importance for planning productivity and optimizing agro-technical interventions in horticulture. The amount of chlorophyll in buds—and its changes over time—is one of the key indicators for assessing the physiological status and photosynthetic activity of the plant (Peñuelas et al., 1993; Gitelson & Merzlyak, 1995). Spectral absorption characteristics of chlorophyll show significant variation particularly in the wavelength ranges of 670–720 nm and 950–970 nm, which enables evaluation of water content and pigment concentration (Sims & Gamon, 2002; Li et al., 2019).

In recent years, significant scientific advances have been made in detecting structural changes in apple leaves and buds through near-infrared (NIR) and hyperspectral analysis methods. For instance, Zhang et al. (2023) and Ta et al. (2021) achieved high-accuracy results in determining chlorophyll content using machine learning models such as CatBoost and Random Forest, based on VIS–NIR spectral data. These approaches are proving increasingly useful not only for leaf-level analysis but also for identifying developmental stages in buds. Furthermore, the use of spectrometry has expanded the potential for non-destructive (non-invasive) evaluation of plant condition.

From this perspective, Botirov (2021) conducted studies on the prediction of flowering and non-flowering bud status in 'Miyabi Fuji' apple trees using visible and near-infrared

spectrometry. In his research, a correlation was identified between chlorophyll levels in buds and their spectral absorption characteristics, with notable differences observed in the 670–720 nm and 930–1016 nm ranges. These findings enabled the early-stage identification of flower buds in the 'Miyabi Fuji' cultivar, further reinforcing the practical value of non-destructive spectral techniques. Thus, this research provides a solid scientific foundation for the effective use of modern optical technologies in evaluating the physiological activity of apple buds.

Main Section

In our study, chlorophyll levels were measured in both floral and non-floral buds at two distinct time points prior to bud burst. The results revealed statistically significant differences between the two bud types. Specifically, floral buds exhibited notably lower chlorophyll concentrations compared to non-floral buds (see Figure 1).

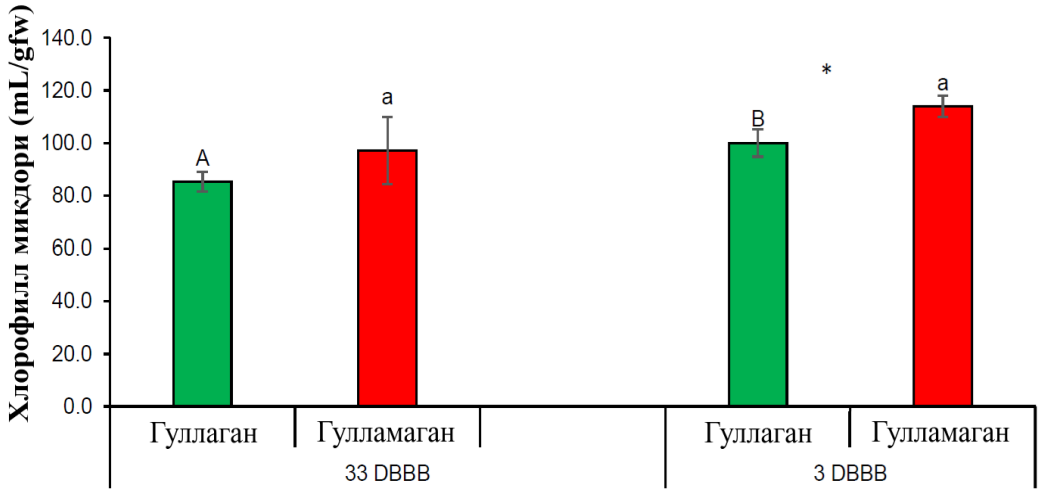
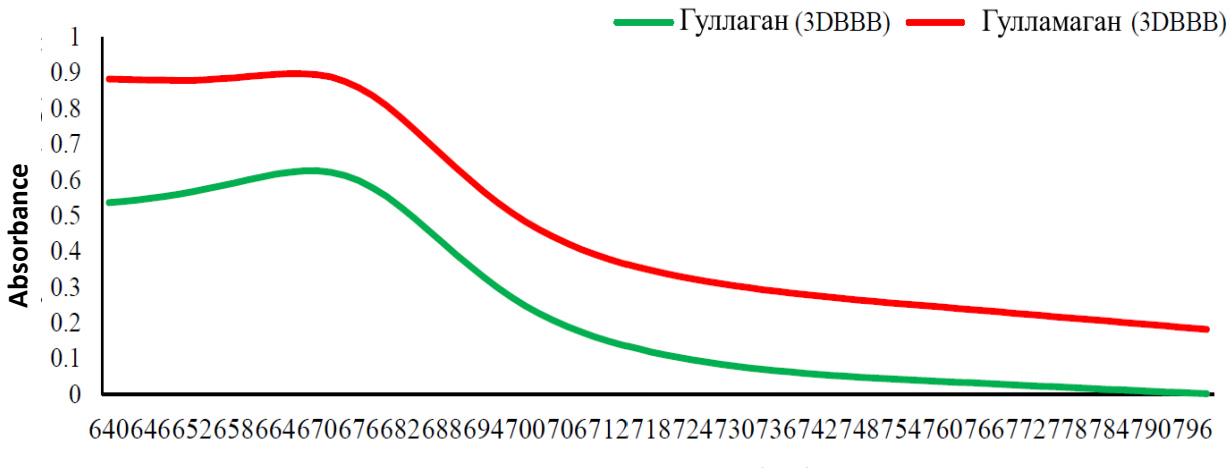


Figure 1. Chlorophyll Content Variation: Comparative Analysis of Floral and Non-Floral Buds at 33 and 3 Days Before Bud Burst (DBBB).

Values are presented as mean ± standard error. Different letters indicate statistically significant differences between dates based on the T-test (P ≤ 0.05).

Chlorophyll levels in floral buds varied significantly across sampling dates, with a marked increase observed as bud burst approached.

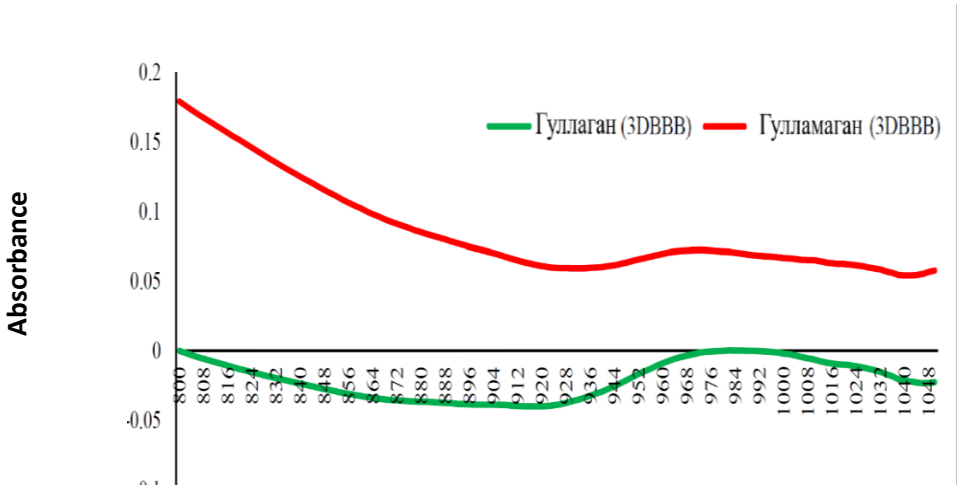
In the visible spectrum, three days before bud burst, non-floral buds exhibited higher light absorbance compared to floral buds (see Figure 2).



Wavelength, nm

Figure 2. Spectral Absorbance of Visible Light in Flowering and Non-Flowering Buds of the 'Miyabi Fuji' Apple Cultivar on March 31, 2021. DBBB – Days Before Bud Burst.

A sharp decline in spectral absorbance was observed between 670 nm and 720 nm. As shown by the near-infrared spectrometry data collected three days before bud burst, absorbance in floral buds was lower than in non-floral buds. Furthermore, both floral and non-floral buds exhibited active light absorbance at wavelengths above 930 nm and below 1016 nm (see Figure 3).



Wavelength, nm

Figure 3. Near-Infrared Spectral Absorbance of Flowering and Non-Flowering Buds in the 'Miyabi Fuji' Apple Cultivar. DBBB – Days Before Bud Burst.

Conclusion

The findings of this study reveal clear differences in chlorophyll content and spectral absorbance characteristics between flowering and non-flowering buds of the 'Miyabi Fuji' apple cultivar. Floral buds exhibited lower chlorophyll levels at earlier stages, which increased sharply as bud burst approached. In the visible spectrum (670–720 nm), non-floral buds

showed higher light absorbance, whereas in the near-infrared range (930–1016 nm), both bud types demonstrated active absorption.

These results confirm the scientific and practical potential of near-infrared spectrometry as a non-destructive tool for early identification of floral buds. Future studies are recommended to extend measurements across broader wavelength ranges to further enhance the accuracy and reliability of the results..

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