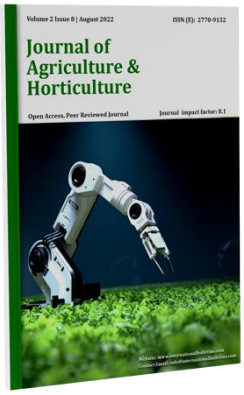

ASSESSMENT OF SPECTRAL CHANGES IN BUDS OVER DIFFERENT PERIODS

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Abstract

This study aims to discriminate between floral and non-floral buds of Miyabi Fuji apple using visible (VIS) and near-infrared (NIR) spectrometric measurements. Spectral absorbance data were collected 33 and 3 days before bud burst. Results show that in the 670–720 nm range, non-floral buds exhibited higher absorbance values at earlier stages, but these levels shifted significantly approaching bud burst. The study demonstrates the utility of non-destructive spectrometric techniques for bud status diagnosis.

Keywords: Miyabi Fuji, apple buds, VIS spectroscopy, NIR spectroscopy, non-destructive method

Introduction

The physiological state and flowering characteristics of apple buds are of significant importance in horticulture. Early detection of these factors is crucial for making informed agro-technical decisions, forecasting yields, and monitoring tree health. Peñuelas and colleagues (1993) have demonstrated that spectral absorbance in the 950-970 nm range, particularly in dried samples, can be utilized to assess plant water status and the active water index.

Sims and Gamon (2002) analyzed the relationship between spectral absorbance and leaf tissue pigments, showing that spectral data can be used to infer pigment concentrations and yield-related information. Near-infrared spectroscopy (NIR) methods, on the other hand, are widely used to monitor changes in plants without causing damage, as well as to evaluate parameters such as chlorophyll content.

Botirov et al. (2022) conducted an experiment on Fuji apple trees, where they differentiated between flower and non-flower buds using a VIS/NIR spectrometer. They achieved a classification accuracy of 75.9% based on spectral data collected three days prior.

Furthermore, the use of machine learning algorithms, including the cubic K-Nearest Neighbors (K-NN) method, has proven effective in classifying apple buds based on their spectral and chlorophyll data. These approaches combine spectrometric and statistical analysis techniques, thus expanding the possibilities for non-destructive diagnostics in agricultural applications.

Main Section

During the observations, it was noted that the absorbance of flower and non-flower buds decreased as the bud break approached (see Table 1, Figure 1).

Table 1

Flower and Non-Flower Buds: Distribution of Visible and Non-Visible Light Absorbance Prior to Bud Break, 2018–2020

Name	Kurtaklar soni			
	January 29	March 1	March 15	March 31
Flower	17	23	20	17
Non-flower	7	10	9	12
Umumiy kurtak	24	33	29	29

Note: *bud burst happened April 2, 2021.*

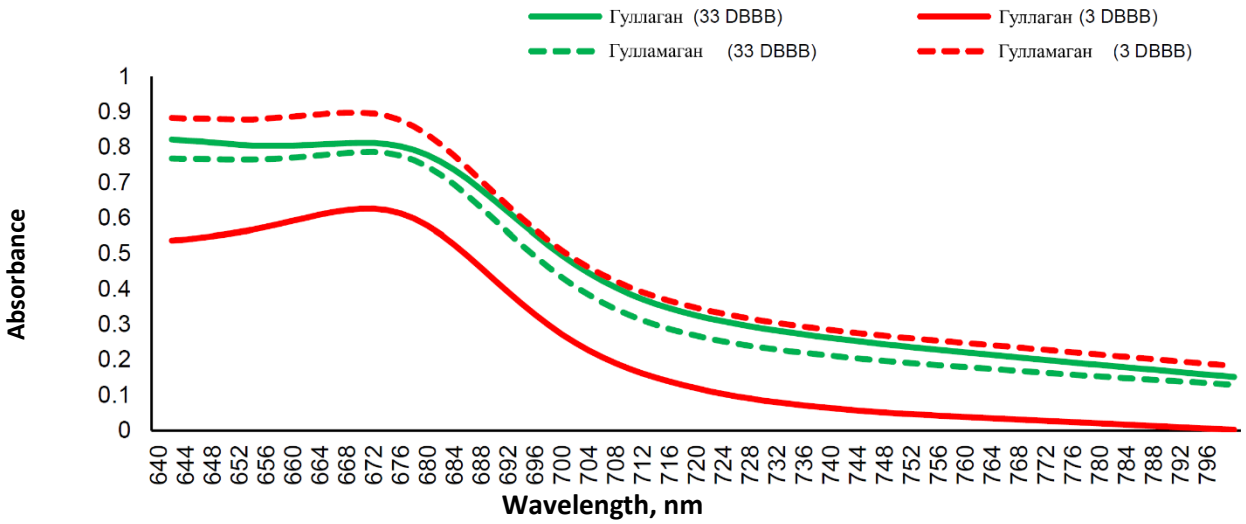

Figure 1. Spectral Absorbance of Visible Light in Flowering and Non-Flowering Buds of the 'Miyabi Fuji' Apple Cultivar; 33 and 3 Days Before Bud Break (DBBB).

In the visible spectrum, 33 days before bud break, the absorbance of non-flowering buds was observed to be lower compared to that of flowering buds (see Figure 2).

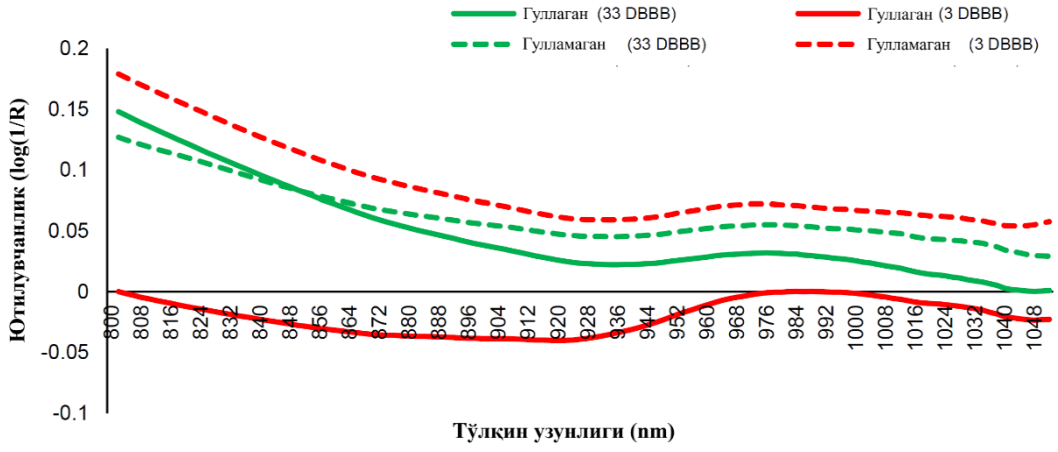

Figure 2. Near-Infrared Spectral Absorbance of Flowering and Non-Flowering Buds in the 'Miyabi Fuji' Apple Cultivar, 33 and 3 Days Before Bud Break (DBBB).

It was found that, in the near-infrared spectrum, the absorbance of flowering buds three days before bud break was lower than that observed 33 days prior.

In contrast, non-flowering buds exhibited higher absorbance three days before bud break compared to their absorbance 33 days earlier.

It was observed that, based on near-infrared spectral absorbance values, non-flowering buds exhibited higher light absorbance than flowering buds at both 33 and 3 days before bud break.

The classification results were obtained using 22 different machine learning algorithms, with 9 of them highlighted in the table below. Among these, the highest classification accuracy—75.9%—was achieved using the cubic K-Nearest Neighbors (KNN) algorithm. The medium KNN, cosine KNN, and weighted KNN algorithms each reached an accuracy of 72.4%.

In terms of sensitivity, the highest value was recorded with the cubic KNN algorithm (86%), followed by medium KNN, cosine KNN, and weighted KNN—each achieving a sensitivity of 80%.

Conclusion

This study demonstrated that VIS and NIR spectral absorbance data collected 33 and 3 days before bud break in 'Miyabi Fuji' apple trees are highly valuable for distinguishing between flowering and non-flowering buds. The cubic K-Nearest Neighbors (K-NN) algorithm successfully performed classification with an accuracy of 75.9% and a sensitivity of 86%, confirming the effectiveness of non-destructive methods based on spectrometry data.

These findings open new possibilities for agro-technical applications, particularly in bud status monitoring and flowering prediction. The current results also indicate that future advancements can be achieved by expanding the wavelength range, incorporating additional spectral analyses, and exploring alternative machine learning algorithms.

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