

Work package A3.1.: Ingredients and product quality of vegetables

Effects of reduced water supply on ingredients of radish in the Geisenheimer FACE site

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Introduction

Our work package focuses on the effects of elevated carbon dioxide concentrations (eCO₂) and limited water supply (H₂O) on the product quality of vegetables in the FACE experimental site for special crops in Geisenheim (Germany). Spinach (*Spinacia oleracea* L.), radish (*Raphanus sativus* var. *sativus* L.) and cucumber (*Cucumis sativus* L.) were cultivated and analyzed regarding their primary and secondary compounds that determine the crops' nutritional value. Preliminary univariate tests with the split-plot factor H₂O inside the six different plots (FACE system not running) served two goals: (1) to determine the effect of moderately reduced H₂O supply on various plant metabolites, and (2) to obtain initial information about the data variability gained from the experimental site. Hence, data of radish grown in 2015 inside the FACE ring system was analyzed.

Present results

Analytical results are plotted in the Principal Component Analysis (PCA) on the first two axes, which account for more than 50% of variability (Fig. 1). The first axis mainly describes the effects of several minerals such as P, Ca, Mg, Na, total anthocyanins and indol glucosinolates for example. The second axis represents the effect of anions like sulfate, phosphate and nitrate as well as total phenols. Univariate analysis of the H₂O effect revealed significant reductions of malic acid, phosphor and iron based on dry matter (Fig. 2A-2C). The content of inositol, which represents the most abundant sugar alcohol in radish, increased with limited water supply (Fig. 2D). Also, most of the single anthocyanins in radish peel, which are all pelargonidin-derivates, increased due to the moderate reduction in the water supply (Fig. 4A-4D).

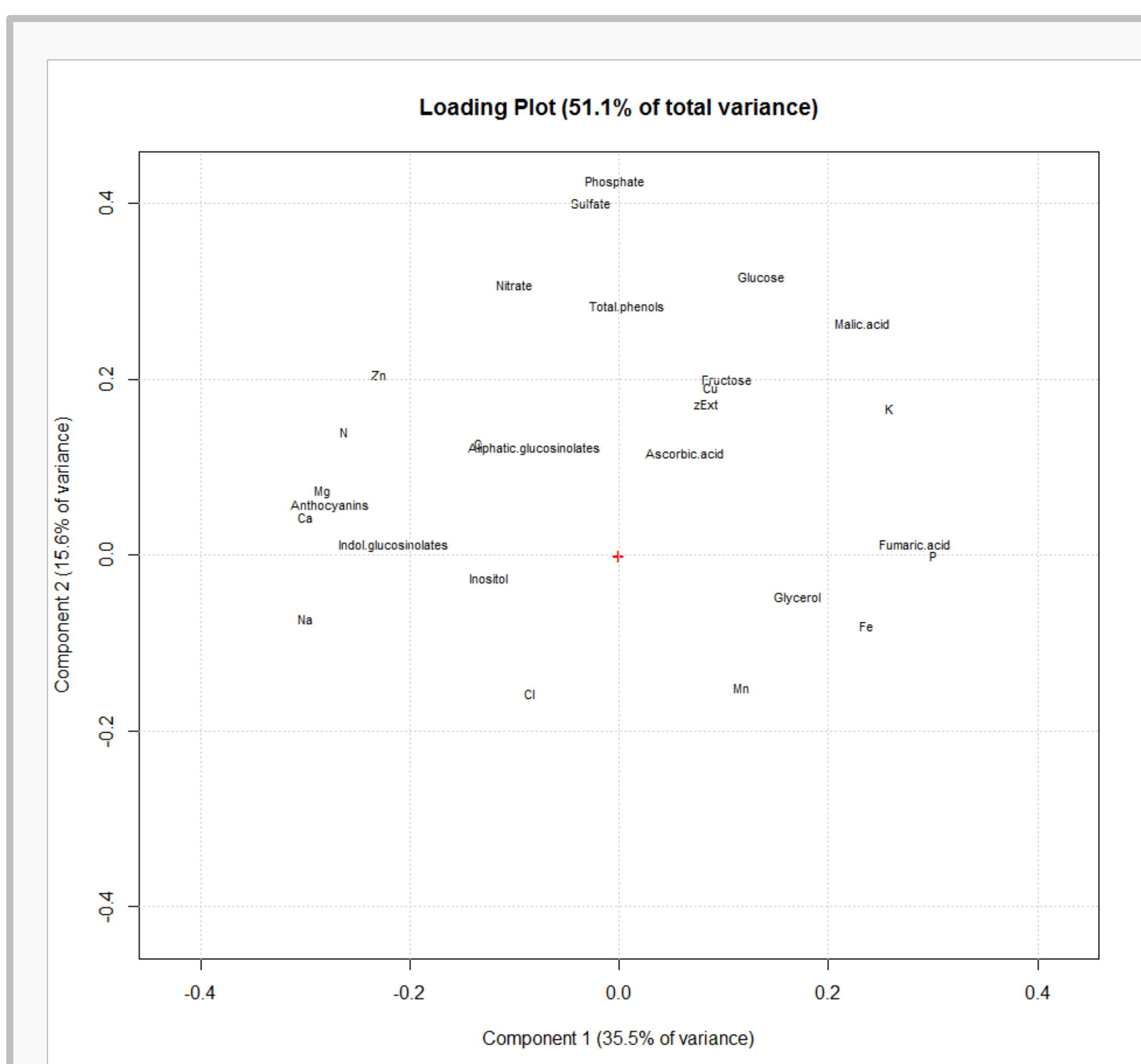


Fig. 1: PCA loading plot of the first two dimensions

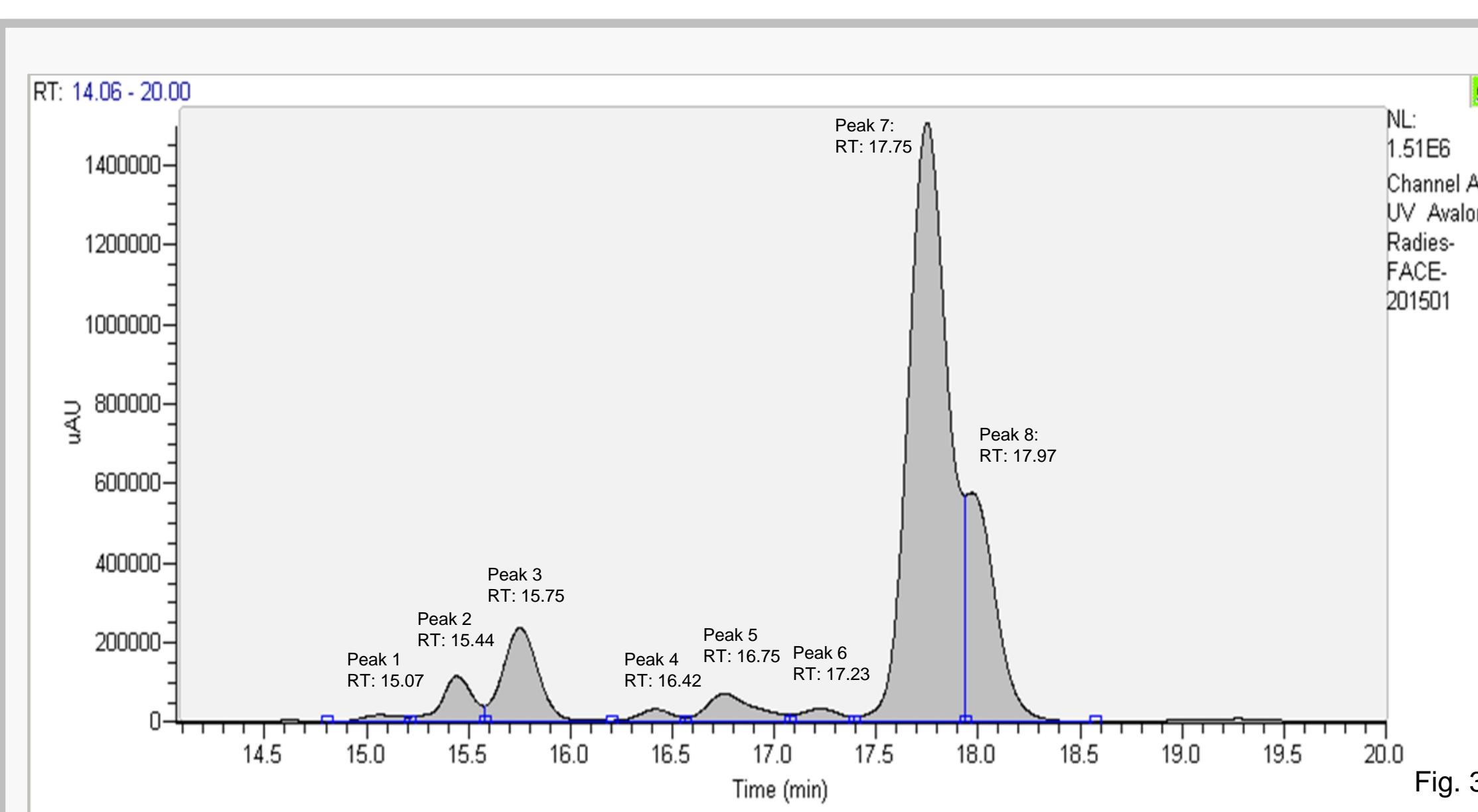


Figure 3: Chromatogram of single anthocyanins in radish analyzed by LC-MS, (RP-Reprosil-Pur 120 ODS-3 column, 125 x 2 mm)

Figure 4: Effects of reduced water supply on single (Fig. 4A-4C) and total anthocyanins (Fig. 4D) in radish peel; well-irrigated (100%) = dark blue, reduced water supply (85%) = light blue.

P-values for single plots:
0.0457 (peak no. 1), 0.0640 (peak no. 3),
0.0014 (peak no. 5),
0.1463 (total anthocyanins)

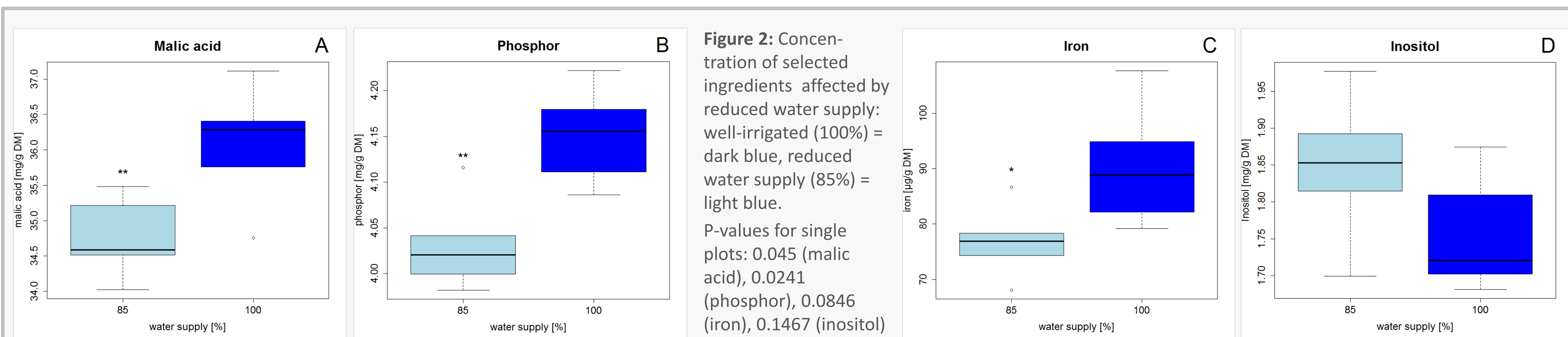
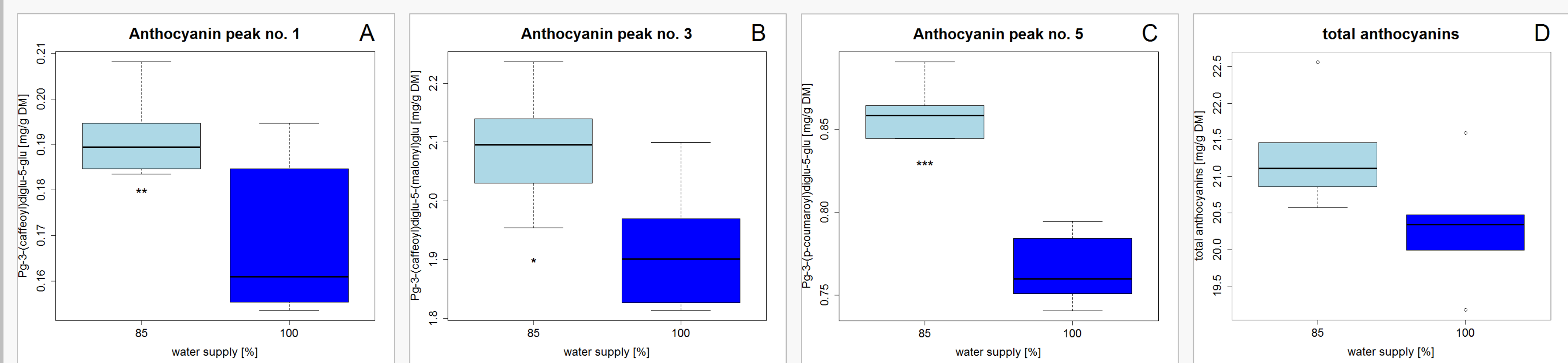


Figure 2: Concentration of selected ingredients affected by reduced water supply: well-irrigated (100%) = dark blue, reduced water supply (85%) = light blue. P-values for single plots: 0.045 (malic acid), 0.0241 (phosphor), 0.0846 (iron), 0.1467 (inositol)

Material & Methods

Radish was cultivated at two different irrigation levels inside the FACE experimental ring plots. Drip irrigation was initiated when soil tension fell below -20 kPa. Compared to the well-irrigated treatment, subplots of reduced water supply obtained 15% lower water amounts in total (irrigation plus precipitation). After freeze-drying, an aliquot of each sample was analyzed for a wide range of primary and secondary compounds. Results are based on the dry matter content to exclude the effect due to different water contents. Statistical analysis included descriptive multivariate PCA as well as univariate ANOVA (alpha=5%) with boxplot presentation of treatment effects. Datasets presented in the figures were corrected by the random effect of the ring plots.

Conclusion and Outlook

The results show that even a small reduction in the water supply leads to significant differences in the concentrations of selected ingredients of radish. Considering future product quality even a moderate water stress may affect their nutritional composition.

Furthermore the results show that the research site is well suited to investigate effects of environmental factors on different ingredients of vegetable crops. Based on this findings as well as the completed establishment of methods we are confident that future effects of eCO₂ can be well traced within the FACE system for vegetable crops.