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The effect of potassium fertilization on the metabolite profile of tomato fruits

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The macronutrient potassium (K) is essential for several physiological functions in plants like translocation of assimilates, activation of enzymes, maintenance of turgescence, and stomata regulation [1]. Consequently, K supply has also a major impact on the concentrations of metabolites in plant tissues, for example amino acids, amines and organic acids [2, 3]. However, the impact of K supply on tomato fruit metabolite profile – and thus fruit quality - has not been investigated so far.

The cocktail tomato cultivars Primavera, Resi and Yellow Submarine were grown in an outdoor pot experiment and fertilized with 5 increasing K doses. Ripe fruits were sampled in the mid-harvest season and by combining whole-fruit segments to pooled samples. After freeze-drying, grinding, methanol extraction and derivatisation, an untargeted metabolome analysis was conducted using GC×GC-MS [4]. Mineral contents of the fruits were determined with ICP-OES.

As shown by ICP-OES analysis, K levels in fruits increased in a dose-dependent manner due to increasing K supply while concentrations of other minerals, for example calcium, were not or only slightly affected. On the basis of 244 consistently detected and reproducibly quantified metabolites, the untargeted metabolome analysis revealed a substantial K effect in the metabolite profiles of Primavera and Yellow Submarine (about 60 metabolites significantly changed). In contrast, the levels of only 11 metabolites were changed in the cultivar Resi. Despite these general cultivar-specific differences, especially citric acid and α-ketoglutaric acid were consistently upregulated by K fertilization in all cultivars. In case of most other compounds like succinic, threonic and quinic acid, uridine, putrescine, isopentylamine and phosphorylethanolamine, asparagine, phenylalanine, methionine, lysine and several sugars, however, the profile of the response to K fertilization was cultivar-specific: Differences were observed either concerning the direction of concentration change (increase or decrease) or the profile of the metabolic response (linear, dose-dependent change or non-linear changes with an intermediate minimum or maximum). In summary, although we could confirm that K fertilization has a consistent and dose-dependent effect on TCA cycle, K influences also several other metabolic pathways in a complex and cultivar-specific way.

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