Effects of nitrogen application on flavor compounds of cherry tomato fruits

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Summary

A pot experiment was conducted to determine the effects of N application on volatile compounds, taste compounds, and firmness of fresh tomato fruits. Each pot was filled with 8 kg of clean sand. The experiment consisted of six nitrogen (N)-application rates with 0, 2.25, 4.50, 9.00, 18.00, and 36.00 mmol N L^{-1} in the nutrient solution. Volatile compounds, soluble sugars, soluble solids, titratable acidity, and firmness of fresh tomato fruits were measured. The results show that increasing N application increased the concentrations of 1-penten-3-one, hexanal, cis-3-hexenal, 2-methyl-4-pentenal, trans-2-hexenal, 6-methyl-5-hepten-2-one, titratable acidity, soluble sugars, and soluble solids. By contrast, increasing N supply decreased the concentration of phenylacetaldehyde and first increased and then decreased the concentrations of 2E–4E-hexadienal and the firmness of fresh tomato fruits. Close relationships between the concentration of various volatile compounds, titratable acidity, soluble sugars, and soluble solids were found. However, concentrations of these flavor compounds were very poorly correlated with fruit firmness. Based on contributions of these compounds to tomato flavor, we assume that moderate high N supply improves tomato flavor, whereas excessive N supply can deteriorate it.

Key words: fertilization / firmness / *L. esculentum var. carasiforme* / volatile compounds / soluble solids / taste

1 Introduction

Tomato is among the ten most important fruits and vegetables consumed in the world, and it is estimated that 99.4 million tons fresh tomato fruits are produced every year all over the world (*Maul*, 1999; *FAO*, 2002). Consumer's preference of fruits is strongly influenced by a characteristic sweet-sour tomato flavor (*Krumbein* et al., 2004; *Marsh* et al., 2006). However, recently concern has been expressed regarding poor flavor quality of fresh tomatoes available in consumer markets (*Bruhn* et al., 1991; *Baldwin* et al., 2000; *Maul*, 1999; *Berna* et al., 2004).

The desirable flavor of tomatoes is a result of a complex interaction between various aromatic volatiles and taste compounds present in the fruit (*Petro-Turza,* 1986; *Hobson*, 1988). To date, approximately 400 different volatile compounds have been identified in ripe tomato fruits, and 16 volatile compounds among them (cis-3-hexenal, β-ionone, hexanal, β-damascenone, trans-2-hexenal, 1-penten-3-one, 2+3-methylbutanal, 2-isobutylthiazole, 1-nitro-2-phenylethane, trans-2-heptenal, phenylacetaldehyde, 6-methyl-5-hepten-2-one, cis-3-hexenol, 2-phenylethanol, 3-methylbutanol, methyl salicylate) are considered to be important contributors of tomato flavor (*Buttery* et al., 1989; *Buttery*, 1993; *Buttery* and *Ling*, 1993a, b). The studies on effects of taste compounds on flavor focused on titratable acidity (TA), soluble sugars (SE), soluble solids (SS), and the ratios of SE to TA and SS to TA (*Stevens* et al., 1977; *Kader* et al., 1978; *Jones* and *Scott*, 1984). In fact, texture can also play an important role. A softer tomato may be perceived as more flavorful than a firm tomato, while a crispy and juicy apple will likely be perceived as more flavorful than a mealy one (*Baldwin* et al., 2000). Firmness is considered to be an important aspect of texture (*Pelayo*, 2003). However, fruit firmness does not directly impact flavor, but a change in firmness has some effect on the perception of flavor intensity in a psychophysical way, through a change in mouthfeel (*Weel* et al., 2002).

Researchers have proposed several reasons for the inferior flavor in fresh market tomatoes, and fertilization is believed to be a key factor affecting tomato flavor (*Stevens*, 1985). Effects of fertilization on flavor of some pungent vegetables were reported, and the flavor, in general, is estimated based on the concentrations of volatile compounds present in them. A volatile oil is regarded as a main component influencing ginger flavor. Increasing N application at a proper range of N application increased the concentrations of this volatile oil, whereas excessive N application decreased its concentrations (*Xu* et al., 2001). *Van Wassenhove* et al. (1990) demonstrated that excessive N decreased the concentrations of terpenes and phthalides, the characteristic volatile compounds of celery, which would affect celery flavor. However, effects of fertilization on fresh tomato flavor have rarely been studied. *Wright* and *Harris* (1985) pointed out that the proper combined application of N and K improved tomato flavor, and the concentrations of volatile and taste compounds increased with increasing rates of N and K application.

This study was conducted to determine effects of N application on volatile compounds, taste compounds, and firmness of fresh tomato fruits and to find out the relationships between these flavor parameters. This would provide a scientific basis for rational fertilization for preferred flavor and high-yield tomato production.

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