Achieving sustainable production of and high nutritional content in horticultural crops – Tomato as a model crop

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Sustainability and enhancement of the nutritional content of horticultural produce is the need of the times, particularly in light of the perishability of horticulture crops and the growing human population in the world. To achieve these objectives, horticulture production systems need to be redesigned by incorporating legume-based cover crops, designing modern genetic tools - including genetic engineering technologies, and focusing on the nutrition-providing secondary metabolism. Plant foods contain a range of bioactive compounds that have the potential of preventing chronic diseases. But these bioactive nutrients are often present at marginal concentrations or are absent in edible horticultural produce. It has become clear that crop genetics is the most important factor determining crop nutritional content. Also, biofortified crops can increase delivery of vitamins and minerals in plants. To increase sustainability of field-grown tomato production, a hairy vetch cover crop production system was developed to reduce the need for synthetic fertilizer inputs such as N, reduce soil erosion, and increase soil water holding capacity. Physiological cues released from the decomposing cover crop, other than N, were found to have beneficial impacts on tomato plants. The source and composition of N fertilizer influences gene expression in tomato and other crops. Such an agroecosystem environment also impacts the metabolome of transgenic tomato lines that were constructed to vary in the abundance of the plant growth regulators ethylene, methyl jasmonate, and polyamines (spermidine, spermine). The metabolite relationships in the tomato fruit metabolome were genotype (hormone) and environment specific, suggesting that the fruit primary metabolome is highly plastic in nature. Therefore, production of sustainable production systems may provide opportunities to further enhance nutritional quality of food beyond that provided by advanced crop germplasm. However, analysis of the impact of crop agroecosystem and crop genotype (in this case, variation in hormone levels) on the tomato metabolite profile indicates that genotype, agroecosystem, and agroecosystem x crop genotype interactions influence tomato metabolites. There is, therefore, a serious need to thoroughly test newly generated crop cultivars in different cropping systems and, likewise, the impact of newly developed cropping systems on crop cultivars regarding nutritional quality of the resulting foods. Robust crop cultivars are needed that consistently express traits across agroecosystems and environments. Likewise, techniques and ideas that result in increased robustness of crop genotype need to be developed and tested.

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