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Exploiting natural factors in greenhouses to stimulate plants' defences and the concentration in bioactive compounds of fruits and vegetables

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Many secondary metabolites, such as carotenoids, flavonoids, glucosinolates, contribute to the health benefits of fruits and vegetables. It has been repeatedly observed that environmental factors can be used as a powerful lever, besides genetic factors, to increase the concentrations in bioactive compounds of fruits and vegetables. More specifically, it has been observed in a large range of vegetables, including lettuce, pepper, tomato, and strawberry, that high light intensity, red and UV light, high electrical conductivity of the nutrient solution, elevated CO₂, may substantially enhance concentrations in phenolic compounds (much more than 100 % in several cases). Ecological, deterministic theories, such as the Growth Differentiation Balance Hypothesis, as well as the physiological insight we have gained in the role played by stress and nitrogen deprivation on flux-determining enzymes of the synthetic pathway of phenolic compounds, such as phenylammonium lyase and chalcone synthase, provide the scientific basis for the observed effects. Interestingly, numerous secondary metabolites, many of them phenolic compounds, which contribute to the health benefits of fruits and vegetables, are also involved in plants' defences. Stressing conditions and nitrogen deprivation represent the two most important factors that can be easily and currently exploited by growers in greenhouses and soilless systems to stimulate synthesis and accumulation of phenolic compounds, thus plants natural defences and quality of production. Modelling tools may be required to define the right amount of stress or nitrogen deprivation that stimulates effectively plants defences (and enhances quality of production), while sparing commercial yield. So far, mild stress seems generally more effective than severe stress. While it seems tempting to manipulate the greenhouse environment not only to reduce the pressure of pests and diseases, but also to stimulate plants natural defences, it must be remembered that in greenhouses, glass and current plastic covering materials deprive plants from UV radiations, one of the most powerful natural factor controlling synthesis of phenolic compounds. We thus advocate moreover for the use of specific plastic covering materials which do not stop UV radiations in greenhouses.

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