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Role of Intermittent Warming in Reducing Chilling Injury in Tomato

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Abstract

Tomatoes (*Solanum lycopersicum* L.) are an important crop commercially and nutritionally. Tomatoes are often harvested at the mature-green stage and handled at low temperature to facilitate postharvest storage. However, long term storage at low temperature (below 13 °C) is challenging as mature-green tomatoes are susceptible to chilling injury (CI). Chilling injury, therefore, limits the advantage of using low temperature to maintain quality of fresh tomatoes during long term storage.

Failure to develop red colour, uneven blotchy red colouration, excessive softening, and increased susceptibility to decay were found to be main CI symptoms. Different low temperature ranges affected tomatoes differentially. For a given storage duration, storage at 8 °C delayed but did not perturb red colour development, fruit held at 6 °C showed uneven blotchy red colouration and those at 2.5 °C showed a complete failure to develop red colouration and severe decay. It was suggested that there was a series of critical temperature thresholds at which different CI symptoms were induced.

An increased rate of electrolyte leakage is often considered as an indicator of chilling damage to cell membranes. This can be confused with ripening-related increase in electrolyte leakage. This study indicated that electrolyte leakage in mature-green tomatoes increased with chilling either in stored discs or fresh discs cut from stored fruit independently of ripening during long term storage.

Interruption of low temperature storage with one or more short periods of warm temperature for various periods of time (intermittent warming, IW) has been shown to reduce CI and improve keeping quality of several horticultural crops. While IW was effective in reducing CI, the responses were highly dependent on production conditions and cultivar and different symptoms of CI had independent responses to IW. The present study was undertaken to elucidate a basic mechanism (physiological response) by which IW reduces CI in tomato. IW stimulated ethylene production and reduced CI. It was suggested that IW-stimulated ethylene was required to reduce CI in tomato as also reported in some other climacteric fruit. However, blocking ethylene response of IW fruit by 1-methylcyclopropene (1-MCP) reduced chilling-induced decay indicating that reduction of CI symptoms by IW was not solely attributable to ethylene action. IW possibly has some metabolic benefit independent of ethylene.

As adoption of IW in commercial situation is logistically challenging, one objective of the current study was to determine if intermittent ethylene (IE) supply during low temperature storage could be used as an alternative to IW for alleviating CI in tomato. Results suggested that IE supply was effective in reducing CI, although effectiveness was dependent on storage temperature and nature of CI symptoms. Additionally, treating tomatoes with 1-MCP in the absence of IW enhanced decay susceptibility, consistent with ethylene involvement in reducing decay during cool storage. While 1-MCP was found to reduce CI and extend storage life in many crops, our results indicated that 1-MCP may not be considered for commercial use in mature-green tomatoes before cool storage.

Overall, the positive results of ethylene application may assist the tomato industry to store tomatoes for longer periods at chilling temperatures and hence enable sea freight of tomatoes to new markets. While ethylene showed promise as a tool to reduce CI and allow fruit to develop red colour after cool storage, further research is required to determine optimum concentration, time and frequency of application, and efficiency when applied at a range of temperatures in order to derive a successful treatment that may have significant commercial applications. Additionally, while the findings are positive for a possible industry application, the magnitude of the positive effect in reducing CI needs to be determined for other tomato cultivars and fruit from other growing locations. More importantly, if the recommendation of IE application is commercially adopted, in future it will be important to investigate the effect of IE on sensory perceptions of tomato quality.

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“In God we trust, the rest must come with data.”

Narayana Murthy, Infosys Chairman

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