Shelf Life of Cluster Tomatoes (Lycopersicum esculentum) Stored at a Non-chilling Temperature and Different Relative Humidity Levels

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Optimum temperature and relative humidity (RH) during storage are crucial to the marketable quality of fruits and vegetables and have a major impact on their shelf life. Cluster tomatoes were harvested at the light red color stage twice from a commercial greenhouse in Florida and were stored during 16–22 days at a non-chilling temperature (15 °C) and five RH levels (41%, 52%, 79%, 88%, and 92%). Visual and instrumental color, firmness, shriveling, stem freshness, decay incidence, slicing characteristics, and compositional quality were evaluated every 2 days. The objectives of this study were to obtain quality curves at low and recommended RH levels and identify for each RH which quality attributes limit cluster tomato shelf life and marketability. The results showed that RH had a significant effect on the shelf life and quality of cluster tomatoes. Tomatoes stored at RH lower than 88% had higher weight loss, were softer, more shriveled, and stems became wilted and dry. When stored below 88% RH cluster tomatoes also had lower acidity, soluble solids, and ascorbic acid contents, and more decay incidence than tomatoes stored at higher RH. Overall, the quality attributes that limited the shelf life of cluster tomatoes varied depending on the RH and included: stem freshness and slicing at 41% and 52% RH; firmness, slicing, and stem freshness at 79% RH; color and firmness at 88% and 92% RH. Maximum shelf life and best overall quality were obtained when cluster tomatoes were stored at 92% RH.

Tomato is one of the horticultural crops most consumed worldwide. Nowadays, we can find in the fresh market a large variety of tomatoes with different shapes, colors, and sizes. The round red-fleshed tomato types are still the most popular, but the yellow and orange round types, as well as cluster (i.e., ripened on-the-vine and sold in a bunch with the stem still attached), plum, and the small sized red types such as cherry, grape, and mini-pear are also available in the fresh-market and gaining popularity (Sargent and Moretti, 2004).

The quality of fresh tomato fruit is determined by various attributes such as appearance, firmness, flavor, and nutritional value. Because consumers purchase tomatoes largely based on appearance, fruit should be well formed, have a uniform orange-red to deep red color with no green shoulders, and should have a smooth appearance (Kader et al., 1978). In the particular case of cluster tomatoes, which are sold ripe and with stems attached, one of the main causes of rejection at the retail level seems to result from the objectionable appearance of the stem, which becomes dry and brownish while the appearance of the fruit may still be acceptable. The loss of stem freshness is most likely related to the loss of moisture content during handling and display at the retail store. As tomatoes ripen, changes in color and texture, such as development of a deep red color and softening of the tissues, are also important quality attributes as they affect tomato sensory quality and determine the end of shelf life.

When loss of moisture reaches a certain threshold, numerous changes occur such as decrease in turgidity and firmness, shriveling, and decline in nutritional value. Several studies reported that a reduction in water content between 2% and 7% can result in unacceptable tomato quality (Hruschka, 1977; Nunes and Emond, 2007; Robinson et al., 1975). In addition, the loss of water results in reduction of fresh weight of the harvested commodity, which when sold by weight represents a loss of economic profit. For a maximum shelf life and to reduce water loss and desiccation, it is recommended to keep ripe tomatoes at 13 °C and 90% to 95% RH (Chomchalow et al., 2002; Maul et al., 2000; Sargent and Moretti, 2004; Toor and Savage, 2005).

Although many studies have been conducted on the effects of temperature on the quality of tomatoes, to our knowledge no data have yet been published on the impact of relative humidity (RH) on the quality attributes and shelf life of cluster tomatoes. The objectives of this study were to: 1) obtain quality curves for cluster tomatoes stored at a non-chilling temperature, and different RH levels; and 2) identify for each RH which quality attributes limit cluster tomato shelf life and marketability.

Materials and Methods

Plant Material and Storage Conditions. Cluster tomatoes (cv. Success) were harvested at the light red color stage on 11 May and 27 May 2009 from a commercial greenhouse operation in Wellborn, FL. Tomatoes were transported to the laboratory within 1 h of harvest. Upon arrival, the clusters of fruit were selected based on uniformity of color, size, and freedom from defects and distributed in five RH-controlled chambers (Forma Environmental Chambers Model 3940 Series, Thermo Electron.)

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Corporation, Marietta, OH) at 41%, 52%, 79%, 88%, and 92% RH. Temperature of the chambers was maintained at 15 °C in order to reduce the risk of chilling injury. Six tomatoes from three cardboard flats containing approximately 20 clusters each were used for initial sensory quality evaluations and firmness measurements, and immediately frozen to be later used for compositional analysis. A total of 10 clusters containing six tomatoes each were distributed among the five RH-controlled chambers and reevaluated daily for non-destructive quality evaluations (two clusters containing six fruit each per RH). For daily destructive quality evaluations, 165 tomato fruit (three fruit from 11 clusters per RH) were sampled from the five RH-controlled chambers. However, each day three more fruit per cluster were removed from their respective RH, firmness measured and immediately frozen, to be later used for compositional analysis. The total amount of tomato clusters and fruit was calculated based on a 22-d storage period; however, storage was ended when the quality of the fruit was considered unacceptable for sale or consumption. Therefore storage times varied from 16 to 22 d for the first and second harvest, respectively.

Temperature and relative humidity monitoring. Temperature and relative humidity (RH) were monitored throughout storage using battery-powered data loggers (Hobo® U10 Temp/RH data logger, Onset Computer Corporation, Pocasset, MA.).

Sensory quality. Sensory quality of cluster tomatoes was evaluated every 2 d always by the same trained person. Surface color, shriveling, stem freshness, and decay severity were determined subjectively using a 1 to 5 visual rating scale, and firmness was determined subjectively based on the whole tomato resistance to slight applied finger pressure and recorded using a 1 to 5 rating scale. To determine the slicing characteristics (i.e., loss of locule gel and seeds), tomatoes were first cut in halves, then each half sliced twice, and release of locule gel and seeds was immediately evaluated using a 1 to 5 rating scale (Table 1). A score of 3 was considered to be the limit of acceptability for retail or wholesale.

Instrumental color (L*a*b*). Two surface color measurements were taken at the equatorial part on each individual tomato fruit with a hand-held tristimulus reflectance colorimeter (Model CR-300, Minolta Co., Ltd., Osaka, Japan) equipped with a glass light-protection tube with a 8 mm aperture (CR-A33a, Minolta Co., Ltd.) using standard illuminant D65. Color was recorded using the CIE-L*a*b* uniform color space (CIE-Lab), L* (lightness), a* (redness), and b* (yellowness) values. Numerical values of a* and b* were converted into hue angle and chroma using the Minolta Color Management Software (1996–1999 Cyber Soft Spectra Match/QC software version 3.3, Cyber Chrome, Inc., Stone Ridge, NY).

Texture analysis. Firmness of each individual tomato fruit was measured using a TA.XT plus Texture Analyzer (Texture Technologies Corp., Scarsdale, NY) fitted with a 76.2-mm-diameter compression plate, and equipped with a 50-kg load cell. Each tomato fruit was placed on the flat surface of the texture analyzer with the stem-end down, so the pressure was applied on the blossom-end part of the fruit. The probe was then driven with a crosshead speed of 1 mm∙s⁻¹, and the compression force was recorded at 10.0 mm deformation.

Weight loss. Weight loss was calculated from the initial weight of each tomato cluster and after every 2 d during the storage period. Concentrations of chemical constituents were expressed in terms of dry weight in order to show the differences between the RH treatments that might be obscured by differences in water

| Table 1. Visual quality rating scores and descriptors for greenhouse-grown cluster tomatoes. |
|------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|
| Scores and description                   | 1                                        | 2                                        | 3                                        | 4                                        |
| Color                                    | Very dark red, overripe                  | Dark red                                 | Red                                      | Light red                                 |
|                                         |                                            |                                          |                                          | Very light red with no trace of green     |
| Firmness*                                | Extra-soft, overripe, fruit yields very   | Soft, fruit yields readily to slight     | Firm, fruit yields slightly to            | Hard, fruit yields only slightly to       |
|                                         | readily to slight pressure               | pressure                                 | moderate pressure                        | considerable pressure                     |
| Slicing characteristics                   | Most of the locule gel and seeds are lost | Some locule gel and/or seeds may be     | A few drops of locule gel, and/or seeds   | Very minor loss of locule gel or          |
|                                         | when sliced, overripe fruit              | be lost when sliced                      | may be lost when sliced                  | seeds when sliced                         |
| Shriveling                                | Extremely shriveled and dry, fruit       | Severe shriveling                        | Shriveling evident, but not serious      | Field fresh, no signs of shriveling       |
|                                         | appears old and deteriorated             |                                          |                                          |                                            |
| Stem freshness                           | Stem is completely dry and dark-brownish green | Stem is dry, wilted and brownish-green | Signs of dryness are evident but not      | Stem appears slightly less green and less   |
|                                         |                                            |                                          | objectionable                            | turgid                                    |
| Decay severity                           | Severe to extreme decay, the fruit is    | Moderate to severe decay (51–75%)       | Slight to moderate decay, spots with     | Probable decay, brownish/sunken minor     |
|                                         | either partial or completely rotten (76–100%) |                                            | decay and some mycelium growth (26–50%)  | spots (1–25%)                             |

*Score of 3 was considered to be the minimum acceptable quality before cluster tomatoes are considered unacceptable for retail or wholesale.

*Artés et al., 1999
content. The following formula was used for water loss corrections: [chemical components (fresh weight)\(\times\)100 g/5.5 g (tomato average dry weight) + weight loss during storage (g)]. Tomato dry weight was determined by drying three weighed aliquots of homogenized tomato tissue at 80 °C, and until weight stabilized.

**pH and titratable acidity.** Chopped tomatoes were homogenized in laboratory blenders at high speed for 1 min. The homogenates were centrifuged at 800 \(\times\)g for 30 min, filtered through cheesecloth and the pH of the juice was determined using a pH meter (Accumet Model 15, Fisher Scientific, Arvada, CO) that had been previously standardized to pH 4 and pH 7. Aliquots (6.0 g) of the juice were diluted with 50 mL distilled water and the titratable acidity determined by titration with 0.1 N NaOH to an end point of pH 8.1 with an automatic titrimeter (Titroline 96, Schott-Geräte GmbH, Mainz, Germany). The results were converted to percent of citric acid, using the following formula: \[
\text{[(mL NaOH}\times\text{0.1 N}\times\text{0.064 meq}\times\text{6.00 g}\times\text{Juice}]}\)\times\text{100]. Titratable acidity was expressed in terms of dry weight.

**Soluble solids content.** The soluble solids content (SSC) of the resulting clear juice samples (see above) was measured with a digital refractometer (Palette PR-101, 0–45 °Brix, Atago Co., Ltd., Tokyo) and was expressed as a percentage in terms of dry weight.

**Total ascorbic acid.** For total ascorbic acid (AA) analysis, 2 g of freshly homogenized tomato tissue was combined with 20 mL of a 6% metaphosphoric acid and 2 N acetic acid mixture. The tomato–acid mixture was centrifuged for 20 min at 5,000 \(\times\)g and then filtered (0.22-\(\mu\)m syringe filter) prior to HPLC analysis. AA analysis was conducted using a Hitachi LaChroma Ultra UHPLC system with a diode array detector and a LaChroma Ultra C18 2-\(\mu\)m column (2 \(\times\) 50 mm) (Hitachi, Ltd., Tokyo). The analysis was performed under isocratic mode at a flow rate of 0.5 mL/min \(^{-1}\) with detection at 254 nm. Sample injection volume was 5 \(\mu\)L. The mobile phase was buffered potassium phosphate monobasic (\(\text{KH}_2\text{PO}_4\), 0.5%, w/v) at pH 2.5, with metaphosphoric acid (\(\text{HPO}_3\text{O}_4\), 0.1%, w/v). The retention time of AA peak was 0.35 min. After comparison of retention time with the AA standard, the peak was identified. The amount of total AA was quantified using calibration curves obtained from different concentrations of AA standards. Three samples were used for each retention time with duplicate HPLC injections.

**Limiting quality factor.** For each RH, a limiting quality factor was established considering the rating value of 3 as the minimum acceptable quality before the whole cluster (i.e., stem and fruit) becomes unmarketable. More specifically, for each RH, the factor that limited the product marketability was identified from the quality curves.

**Statistical analysis.** The Statistical Analysis System (SAS) computer package was used for the analysis of the data. The data from the two harvests were analyzed separately and treated by two-way analysis of variance (ANOVA), with RH and storage time as factors. In order to determine the primary limiting factor(s), the quality attributes for each temperature were compared using the least significant difference (LSD) at the 5% significance level. Pearson’s correlation coefficient (r) was calculated between weight loss and stem freshness.

**Results and Discussion**

**Sensory quality.** Color is one of the most important quality factors that affect tomato appearance and is determined by skin and flesh pigmentation (Brandt et al., 2006). As tomatoes ripen, color changes from green in mature, unripe fruit to dark red in fully ripe fruit. In this study, the visual color of the cluster tomatoes changed during storage, regardless of the RH, from light red to a very dark red by the end of the storage period (Figs. 1 and 2). However, there was not a significant difference between the changes that occurred in the color of tomatoes during storage at different RH levels. The color of the tomatoes from the first harvest reached the limit of acceptability (i.e., fruit appeared very dark red) after 6 d when fruit were stored at 41% or 88% RH and after 8 d when stored at 52%, 79%, or 92% RH. Similarly, the color of tomato fruit from the second harvest reached the limit of acceptability after approximately 8 d for all RH levels. These results suggest that the storage temperature (15 °C) might have had a greater impact on tomato color development than exposure of the fruit to different RH levels.

Tomato firmness is also an important quality decisive factor because it is associated with good eating quality and longer post-harvest life. As tomatoes ripen firmness decreases, and ripe fruit are much softer than mature-green fruit (Wann, 1996). In the current study, the firmness of the tomatoes significantly decreased during storage for all RH levels (Figs. 1 and 2). There was, however, a slightly faster decrease in the firmness of fruit stored at RH levels below 88%. Therefore, after 6 d, firmness of fruit from the first harvest stored at 41%, 79%, or 88% RH declined to the limit of acceptability; after approximately 8 d for fruit stored at 52% RH; and after approximately 10 d for fruit stored at 92% RH. Results were similar for the second harvest, with firmness reaching the limit of acceptability after 8 d for tomatoes stored at 41%, 52%, or 79% RH and after 10 d for fruit stored at 88% or 92% RH.

Slicing characteristics are related to the amount of locule gel released by the tomato fruit when sliced. In general, tomatoes used for salads are preferred to be firm and easy to slice with slight loss of juice when cut, whereas tomatoes for processing or cooking may be riper and juicier. In this study, when tomatoes were sliced, loss of juice and seeds increased from minor loss of juice at harvest to most of the juice lost as the fruit became riper (Figs. 1 and 2). However, changes were faster and reached the limit of acceptability sooner in fruit stored at 41%, 52%, or 79% RH (within 6 to 10 d depending on the RH and harvest) than in tomatoes stored at 88% or 92% RH (after 12 and 14 d for the first and second harvest, respectively). Shriveling developed after 4 to 8 d of storage in tomatoes from the first harvest and after 8 to 20 d in tomatoes from the second harvest, depending on the RH (Figs. 1 and 2). After that period, fruit shriveling started to increase, becoming objectionable in fruit from the first harvest stored at 41% or 52% RH after 6 or 8 d, respectively. After 12 d, fruit stored at 79% or 88% RH showed objectionable shriveling; and after approximately 13 d shriveling was also evident in tomatoes stored at 92% RH. Development of shriveling in fruit from the second harvest was much slower and never reached the limit of acceptability. For example, tomatoes stored at 92% developed only minor signs of shriveling after 20 d of storage while for tomatoes stored at lower RH, shriveling was slightly apparent but not objectionable after 8 to 15 d of storage, depending on the RH. In a previous study, greenhouse-grown ‘Trust’ tomatoes showed objectionable softening and overripe appearance after 11 d of storage, and although the fruit were completely soft and unacceptable for sale after 14 d of storage at 20 °C and 95% RH, shriveling was not yet visible (Nunes and Emond, 2007).

Appearance of the stem started to change from the beginning of the storage period with the color shifting from very bright green and turgid (rating 5) to completely dry and dark brownish-
green (rating 1) by the end of the storage period (Figs. 1 and 2). Although changes in the stem freshness of clusters from the first harvest were faster and less obvious between RH levels, in clusters from the second harvest there was a gradual decrease in stem freshness but a marked difference between RH levels.

In clusters from the first harvest, stem freshness declined to the limit of acceptability after only 4 d at 41% RH, after 6 at 52% or 79% RH, and after approximately 10 d at 88% or 92% RH. But in clusters from the second harvest, stem freshness reached the limit of acceptability after approximately 6, 8, 10, 14 and 16 d in
clusters stored at 41%, 52%, 79%, 88%, or 92% RH, respectively.

Development of decay was not evident, regardless of the RH, until after approximately 8 d of storage for tomatoes from the first harvest and, until after 10 d for the second harvest (Figs. 1 and 2). For fruit from the first harvest, decay developed rapidly and reached the limit of acceptability after approximately 12 d for fruit stored at all RH levels. For fruit from the second harvest, decay never reached the limit of acceptability during the storage period evaluated. However, tomatoes stored at higher RH levels developed less decay than those stored at lower RH, possibly because the use of higher RH levels resulted in healthier fruit and thus with more resistance to decay.

**Instrumental color.** L* values measured on the tomato skin significantly decreased during storage regardless of the RH (Fig. 3). In addition, there was not a significant difference in the L* value of the tomato fruit between RH treatments. As storage progressed the tomato color changed from a light red (higher L* values) to a darker red (lower L* values) in fruit stored at all RH levels. In another study, when tomato fruit were stored at 20 °C, a gradual decrease in L* value was also observed from the turning stage to the red stage, indicating darkening of the tomato skin (Nussinovitch et al., 1996). Auerswald et al. (1999) also reported a decrease in L* value of tomatoes after storage for 7 d at 20 °C.

Chroma values slightly increased during storage, particularly for tomatoes from the first harvest (Fig. 3). Although there were no major difference between chroma values of tomatoes stored at different RH, fruit from the first harvest stored at 88% or 92% RH tended to be slightly more vivid (higher chroma values) than those stored at lower RH.

Hue values of tomatoes from the first harvest initially tended to decrease (after 2 to 4 d of storage) but thereafter remained quite unchanged throughout the storage period, whereas in fruit from the second harvest hue values significantly decreased (Fig. 4). Overall, hue values of tomatoes stored at 41%, 52%, or 79% RH were not significantly different while the same trend was found for hue of tomatoes stored at 88% or 92% RH. Hue of tomatoes stored at lower RH tended to be slightly lower (less red) compared to that of fruit stored at RH higher than 88%.

Results obtained from instrumental color evaluation are in agreement with those obtained from visual color evaluation where color of tomatoes was not significantly different between RH levels (Figs. 1 and 2).
FIG. 3. Changes in the color (L*, chroma, and hue angle) of ‘Success’ greenhouse-grown cluster tomatoes from two harvests during storage at 15 °C and different RH levels.

Texture. Firmness has been considered a major factor in the price premium paid for tomatoes (Resurreccion and Shewfelt, 1985). In this study, the firmness of tomatoes decreased during storage, regardless of the RH (Fig. 4). Although by the end of the storage period tomato fruit stored at higher RH levels (88% and 92%) were firmer than fruit stored at lower RH levels, there was no significant difference in the firmness of the fruit stored at RH levels lower than 79%. Overall, cluster tomatoes stored at 92% RH better maintained their firmness compared with fruit stored at lower RH levels. In a similar study, Nunes et al. (2011) also found that firmness of green bell peppers (cv. Revolution) decreased as RH in the storage environment was lowered from 95% to 40%.
Weight loss. Weight loss increased during storage regardless of the RH level (Fig. 4). However, tomatoes stored at 41% or 52% RH experienced the highest weight loss compared with fruit stored at 88% or 92% RH, with tomatoes stored at 79% having intermediate weight loss. Weight loss of fruit stored at 88% or 92% RH was the lowest and not much different between the two RH levels. After 16 d, weight loss in tomatoes from the first harvest was approximately 9% for fruit stored at 41% or 52% RH, 7% for fruit stored at 78% RH, and 4% in fruit stored at 88% or 92% RH. After 16 d, tomatoes from the second harvest stored at 41% or 52% RH had lost approximately 8% and 7% of their weight, respectively, followed by a 7% loss in tomatoes stored at 79% RH, and by approximately 3% loss in tomatoes stored at 88% or 92% RH. In a previous study, Syamal (1990) reported that when tomato fruit were stored at 20 °C and 65% RH weight loss attained a maximum of approximately 15% after 12 d, whereas Bhowmik and Pan (1992) reported that tomatoes stored for 4 weeks at 12 °C and 85% RH lost about 9.8% weight and, after 3 weeks, the appearance of the fruit started to deteriorate due to development of wrinkles, shrinkage of the skin, and loss of brightness. In another study, Javanmardi and Kubota (2006) measured a weight loss rate of 0.49% per day for tomatoes stored at 12 °C.

Stem freshness was negatively correlated with weight loss (P < 0.001). Therefore, as weight loss increased stem freshness decreased. After 16 d of storage at 41% RH, maximum weight loss of 9.3% and 7.8% was obtained for cluster tomatoes from the first and second harvests, respectively. At this level of weight loss a rating of 1.0 for stem freshness (stem is completely dry and dark-brownish green) was obtained whereas a weight loss of 2.6% (16 d at 92% RH, second harvest) corresponded to a stem freshness rating of 3.0 (signs of dryness are evident but not objectionable).

pH and titratable acidity. The pH of tomatoes from the second harvest significantly increased regardless of the storage RH (Fig. 5). Although there was not a significant difference in the pH of tomatoes during storage at different RH levels, by the end of the storage period the pH of tomatoes stored at RH higher than 79% tended to be higher than that of tomato fruit stored at lower RH levels.

Acidity decreased during storage regardless of the storage RH or time of harvest, as the tomato fruit became less acid (Fig. 5). Overall, acidity was the lowest in tomatoes stored at lower RH levels (41%, 52%, and 79% RH) and the highest in tomatoes stored at 88% or 92% RH, particularly in fruit from the second harvest.
Green bell peppers (cv. Revolution) stored at or higher than 90% RH also tended to have higher acidity than fruit stored at lower RH levels (Nunes et al., 2011). Soluble solids content (SSC) decreased regardless of the RH and harvest time (Fig. 6). However, by the end of the storage period fruit stored at 88% or 92% RH had lost less SSC than fruit stored in other RH levels. Tomato fruit stored at 79% RH had SSC intermediate between that of tomatoes stored at higher and lower RH levels. So, fruit stored at 41%, 52%, or 79% RH lost on average 65%, 59%, and 54% of their initial SSC after 16 d of storage whereas cluster tomatoes stored at 88% or 92% RH lost on average 44% of their initial SSC after the same period of time. Similarly, SSC content of green bell peppers (cv. Revolution) was significantly lower in fruit stored at RH lower than 90% (Nunes et al., 2011).

The total ascorbic acid (AA) content of tomatoes from the second harvest was initially higher than that of fruit from the first harvest, during storage the AA content of the tomato fruit significantly decreased regardless of the RH level (Fig. 6). However, the decrease in AA content was higher in tomatoes stored at 41% or 52% RH compared with that of tomatoes stored at 88% or 92% RH. Overall, by the end of the storage period, tomatoes stored at 41% RH had the lowest AA content and fruit stored at 92% RH the highest AA content. After 16 d of storage, there was a significant difference in the AA content of fruit stored at lower RH compared with that of fruit stored at 92% RH. Thus, after 16 d of storage cluster tomatoes stored at 41%, 52%, 79%, or 88% RH lost on average 47%, 38%, 35%, and 30% of their initial AA content while for fruit stored at 92% RH for the same period of time AA losses were on average only 3%. In a similar study, Nunes et al. (2011) also found that the AA content of green bell peppers (cv. Revolution) was significantly lower in fruit stored at RH lower than 90% or 95% RH. Another study reported that the AA values also decreased over storage time in vine-ripened tomatoes stored at 20 °C (Giovanelli et. al., 1999).

Limiting quality factors. For cluster tomatoes from the first harvest the quality attributes to first reach the limit of acceptability for sale (rating of 3) reduced the shelf life of the fruit to 6 d at 41% RH, 8 d at 52% and 88% RH, and 10 d at 92% RH. Those quality attributes were loss of stem freshness, changes in color, loss of firmness, and increased locule gel liquefaction and seed release upon slicing (Figs. 1 and 2). The shelf life of cluster tomatoes stored at 79% RH was limited to 8 d due to loss of firmness and stem freshness, and changes in color (Fig. 1). Softening, loss

Fig. 5. Changes in pH and titratable acidity of ‘Success’ greenhouse-grown cluster tomatoes from two harvests during storage at 15 °C and different RH levels.
of stem freshness, and changes in color were the primary quality attributes to reach the minimum acceptable rating in cluster tomatoes from the second harvest stored at 41% RH, and those quality attributes limited the fruit shelf life to 8 d (Fig. 1). Color changes, softening, loss of stem freshness, and increased locule gel liquefaction and seed release upon cutting limited the shelf life of cluster tomatoes stored at 52%, 79%, or 88% RH to 8, 10, and 12 d, respectively (Figs. 1 and 2). For fruit stored at 92% RH changes in color and softening were the primary quality attributes to reach the limit of acceptability and those reduced the fruit shelf life to 14 d (Fig. 2). Similarly, for 'Trust' tomatoes stored at 15 °C and 95% RH over development of color was the primary limiting quality factor and loss of firmness the second most important limiting quality factor (Proulx et al., 2001).

Conclusions

Storage RH had a significant effect on the shelf life and overall sensory and compositional quality of cluster tomatoes. In general, the lower the RH the faster the deterioration of tomato fruit quality. Cluster tomatoes stored at RH lower than 88% were softer, with stems that appeared to be less fresh; they lost more liquid when sliced, were more shriveled, and had higher weight loss and lower acidity, SSC, and AA content than those stored at higher RH levels. Overall, higher RH levels during storage contributed to cluster tomatoes that maintained better visual and textural quality and higher ascorbic acid content compared with those exposed to lower RH levels. Maximum shelf life (10 to 14 d) and best quality were obtained when cluster tomatoes were stored at 92%. Finally, the quality curves obtained from quality evaluations for each RH level showed that a single quality attribute cannot be used to express quality loss of cluster tomatoes stored over a range of RH levels.

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