maximum root length did not vary significantly among cultivars during either year, and increased from 3.7 cm 30 DAT in 1986 to 9.9 cm 110 DAT in 1987. Root mass was similar for all cultivars, ranging from an average low of 0.35 g/plug 30 DAT in 1986 to 3.44 g/plug 40 DAT in 1987. Unlike root production, differences were noted in the number and mass of rhizomes produced by Kentucky bluegrass cultivars during 1986 (Table 2). In particular 'Adelphi' produced more rhizomes and a greater mass than other cultivars on two of the first three observations. Although 'Adelphi' exhibited superior rhizome production capacity through the 131 DAT (1986) observation date, rhizome production and growth of other cultivars increased with time, so that no significant differences among cultivars were observed 209 DAT in 1986 or during 1987 (data not presented). Our results indicate that pendimethalin can be used on these cultivars without concern for foliar injury or restricted root and rhizome production. Concurrent work by Bhowmik (1988) revealed that pendimethalin applied to 'Baron' Kentucky bluegrass at 1.7 or 3.4 kg·ha⁻¹ did not inhibit either rhizome growth or tiller formation when measured 4, 8, and 12 WAT. Although some root length inhibition occurred immediately after the 1986 pendimethalin application in this study, it was short-lived and did not affect quality or subsequent root growth.

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Changes in Guavas of Three Maturity Stages in Response to Temperature and Relative Humidity

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Abstract. Maturity at harvest influenced storage life of guava (*Psidium guajava* L.) fruit kept at 3.5, 7, or 11C and 80% or 88% RH. Quality characteristics considered were firmness, pH, titratable acidity, ascorbic acid and soluble solids concentrations, and weight loss. Chilling injury was observed only in guavas harvested at the mature-green stage and kept at 3.5 or 7C. The storage life of fruit kept at 11C was reduced due to fungal attack. The best results were obtained with guavas harvested at the color-turning stage followed by storage at 7C and 80% RH for 3 weeks. These fruits had good appearance 5 days after removal from storage.

Guavas are highly perishable fruits, with production for the fresh market generally limited to a few weeks. Studies to increase the storage life of these fruits are scarce (Wilson, 1980). Both ethylene absorbers (Ahlawat et al., 1980) and morphactins (Gupta and Mukherjee, 1980) have been tried to slow ripening, without success. High CO₂ concentration was also not very effective in increasing storage life (Ahlawat et al., 1978). In general, refrigeration is the preferred and more convenient method (Pantastico, 1975; Ryan and Pentzer, 1974; and Singh and Mathur, 1954) for storage of these climacteric fruits (Akamine and Goo, 1979). The present study was designed to evaluate the effect of temperature and relative humidity on the postharvest storage life of mature guavas harvested at different stages of ripeness.

Guava fruits were obtained from a commercial orchard at Calvillo, Aguascalientes, Mexico. After harvest, they were quickly transported (during the night) to Chapingo, where the experiments were performed. Fruits were picked at the following three stages of ripeness: mature-green (Stage I), when maximum growth of the fruits had been attained and their skin was dark to light green; turning (Stage II), when the skin was light green to yellow (this is the usual commercial harvest stage); and fully ripe (Stage III), when the fruits are completely yellow and ready to eat.

Fruits of the same size with no bruising were chosen. After washing with water and weighing, the fruits (15 fruits per treatment, with three replicates) were placed in trays and covered with perforated polyethylene film. Desired humidities were obtained by using saturated solutions of (NH₄)₂SO₄ for

80% RH and KCl for 88% RH (Winston and Bates, 1960). Small air pumps were used to circulate the air over the trays. Refrigerated rooms held at 3.5, 7, and 11C were used. Control fruits, at each temperature, were not covered and were exposed to ambient relative humidity (55%). In addition, a general control at ambient temperature (≈20C) was used.

Fruits were analyzed before and after storage. Firmness (as penetration force) was determined on opposite sides of fruit with an Effegi penetrometer fitted with an 8-mm-diameter tip. Soluble solids content (SSC) was determined with a Zeiss (New York) manual refractometer. The pH was measured on undiluted juice extracted from the fruit at 20C. Titratable acidity was determined by titrating filtered juice samples obtained from 10 g of material with 0.1 N NaOH to an end-point pH of 8.1 using a pH meter. Data are expressed as percent of citric acid. Ascorbic acid was determined according to Jacobs (1962) using metaphosphoric acid extraction and 2,6-dichlorophenolindolephenol dye reduction. Weight loss was the difference between the initial weight of each lot and the weight after the storage period, which ranged from 2 to 4 weeks, according to stage of ripeness. After an additional 5 days in air at 20C, subsamples from each storage treatment were visually assessed for general appearance. The experiment was analyzed using a completely randomized factorial analysis.

Mature-green fruits (Stage I) could be stored up to 4 weeks. Fruits stored at 11C (80% and 88% RH) or at 7C (88% RH) began to show fungal development after 2 weeks. Ripe fruits (Stage III) had a storage life of 2 weeks; 1 week more than was cited by Ryan and Pentzer (1974) for very ripe guavas. Control fruits at ambient temperature had a very limited storage life. Data shown in Table 1 for these fruits were taken after 4 days of storage, when the fruits already were very soft.

Mature-green fruits stored at 3.5 or 7C, irrespective of the relative humidity showed symptoms of chilling injury (CI). The symp-

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Table 1. Effects of temperature, relative humidity, and maturity at harvest on guava fruits^{xy} stored 3 weeks under conditions indicated plus 5 days at 20C.

Variable	Firmness (N)	Weight loss (%)	pH	Titrateable acidity (% citric acid)	Soluble solids concn (%)	Ascorbic acid (mg/100 g of fresh wt)
Initial	25 a	...	4.0 a	0.6 a	12.5 b	16.5 a
Temperature (°C)						
Ambient (20)	3 c	34.4 a	3.9 ab	0.7 a	13.8 a	28 b
3-4	7b	18.0 c	3.7 b	0.7 a	12.3 b	179 a
7	8b	17.7 c	3.7 b	0.6 a	12.7 b	90 ab
11	6b	23.3 b	3.4 c	0.7 a	12.8 b	75 b
Relative humidity (%)						
Ambient (55)	5 a	32.1 a	3.8 a	0.7 a	13.6 a	56 b
80	8b	14.6 b	3.6 b	0.6 b	12.2 b	145 a
88	9b	13.1 b	3.4 c	0.6 b	12.1 b	131 a
Maturity at harvest ^z						
Stage I	7b	21.1 a	3.5 b	0.7 b	12.1 b	132 a
Stage II	11 a	17.3 b	3.5 b	0.6 b	13.2 a	163 a
Stage III	5 c	10.8 c	3.8 a	0.5 c	11.9 b	82 b

^xData are means of 15 fruits per treatment and three replicates per treatment.

^yMean separation in a column within treatments by Tukey's HSD, $P = 0.05$.

^zStages I, II, III = mature-green, turning, fully ripe, respectively.

toms included pitting and failure to ripen properly after storage. These symptoms were not observed in fruits harvested at the color-turning or full-ripe stages. This result is in agreement with those mentioned by Pantastico (1975), who noted that maturity and ripeness are factors that influence susceptibility to CI.

During storage, firmness of the guavas decreased, as is observed with most other fruits (Pantastico, 1975), and about equally at all three temperatures (Table 1). Firmness decreased less rapidly in fruits harvested in the color-turning stage than at the other stages (Table 1).

Fruits kept at 80% or 88% RH lost about the same amount of weight and about half as much as fruit kept at $\approx 55\%$ RH (Table 1).

The pH of ripe fruits (Stage III) was higher than that of fruits picked at the other two stages (Table 1). Titrateable acidity of harvested fruits tended to decrease significantly during their ripening from Stage I to Stage III. There were no statistical differences in titrateable acidity among fruits held at different temperatures.

SSC did not differ significantly between guavas harvested at Stages I and III, but was higher at the color-turning stage (Stage II). Control fruits in general showed a slight in-

crease compared with the guavas kept at 80% and 88% RH, which most likely was due to the larger water loss by the control fruit (Ta-

The ascorbic acid content was higher in fruit harvested at Stages I and II than at Stage III. According to Mapson (1970), ascorbic acid content can be affected by several environmental factors. The values for ascorbic acid tended to be higher at lower temperatures in the three stages considered, which is similar to the results found by Manzano et al. (1984) for tomatoes.

After the additional 5 days in air at 20C to simulate commercial marketing, only fruit initially at Stage II and kept at 3.5 or 7C and 80% or 88% RH had a good appearance and were of acceptable eating quality. Particularly, fruit at 7C and 80% RH had higher firmness and soluble solids concentration, and less change in titrateable acidity.

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