at Geneva while fully dormant in Jan., shipped to Winchester and there compared to dormant scions collected locally from ‘Golden Delicious’/‘Malling Merton 106’ trees.

Adult pine voles caught from orchards in the vicinity of Winchester were placed singly in standard laboratory cages with 7 mm stainless steel wire bottoms. Animals were offered water and commercial rat food continuously throughout all experiments. Each cage was fitted with a metal partition to separate the bedding and feeding areas. Burlap strips were provided for bedding. The animal room was kept on a 16-hr day, 8-hr night, 20°C ± 2°C, and a relative humidity of 50 ± 10%.

Each singly caged vole represented 1 replicate. Two stems of a rootstock or other candidate were challenged with 2 ‘Golden Delicious’ stems in each of 24 cages (24 replicates). Stems were placed vertically in the cage with the lower part in about 1.5 cm of water. All stems were about 7 mm diam and 15–17 cm long taken from 1-year-old growth. About 13 cm of each stem remained inside the cage. After 24 hr the stem pieces were removed and rated as follows: 0 = no damage; 1 = less than ½ girdled; 2 = ½ girdled or more; 3 = completely girdled; and 4 = cut into at least two pieces. The damage rating of the two stem pieces of each rootstock was averaged and a t-test was performed on each clone vs. ‘Golden Delicious’. Paired comparisons between clones were not performed so those listed in Table 1 cannot be compared directly.

Results and Discussion

Since peach scions were not as susceptible to damage as apple scions (3), peach stems provided a useful standard with which to check the various vole lots. In 1975 and 1976, ‘Golden Delicious’ stems were challenged against ‘Golden Delicious’ to determine the validity of the test procedure (Table 1). These comparisons resulted in a non-significant t-test at 5% when ‘Golden Delicious’ were challenged with ‘Golden Delicious’ and a significant test, 5% or 1%, with ‘Glohaven’ peach scions.

A Japanese rootstock, M. × sublobata PI 286613 was rejected by the voles in all 3 years (2 trials were made in 1976). Selections from the cross (Malling 9 × PI 286613) tested in 1975 and 1976 indicated at least 1 clone (7OM963-41) was resistant; however, the inconsistent results between the 2 years could not be explained. These trees bore a crop in 1976, but not in 1975 and physiologically they could have been different. The Canadian rootstock, M. × robusta ‘RS’, was less consistently rejected in 4 tests; limited testing of ‘RS’ open-pollinated seedlings was inconclusive. Also, ‘Ivory’s Double Vigour’ showed resistance in 2 of 3 years.

Two prairie crabapples, M. coronaria ‘Charlotte’ and M. ioens ‘Hucker No. 1’ were attacked but lightly in 1975 and 1976. Two flowering crab derived from crosses between common apple and Oriental crabs, ‘N. Y. 11928’ and ‘Sissipuk’, appeared resistant.

An indication of resistance to pine vole was not detected in ‘Virginia Crab’ or ‘Stayman’.

Literature Cited

Table 1. Description of classes used in evaluating ‘Honey Dew’ melon development and ripening.

<table>
<thead>
<tr>
<th>Developmental class</th>
<th>Approximate days after anthesis</th>
<th>Class name</th>
<th>Class description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 10</td>
<td>Very early</td>
<td>Growing rapidly in length, 5-cm long; uniformly light green in color; hard, hairy.</td>
<td></td>
</tr>
<tr>
<td>B 20</td>
<td>Early growth</td>
<td>Growing rapidly in length, 10-15 cm long; differentiation between opaque ground color and translucent areas appearing as shades of green; hard, hairy.</td>
<td></td>
</tr>
<tr>
<td>C 25</td>
<td>Early immature</td>
<td>Growing slowly in length, rapidly in diameter, 15-20 cm long, translucent green color evenly dispersed in lighter ground color; hard, prickly or hairy.</td>
<td></td>
</tr>
<tr>
<td>0 30</td>
<td>Immature</td>
<td>Growing slowly, still undersized, still rough or ribby, not well filled out; ground color still greenish; blossom end still hard; no aroma; no waxy skin coating; skin probably still prickly or hairy; will not ripen regardless of treatment; occasionally harvested commercially by mistake.</td>
<td></td>
</tr>
<tr>
<td>1 35</td>
<td>Minimum horticultural maturity but unripe</td>
<td>Well filled out and of normal size; ground color white but with greenish aspect, due to translucent greenish speckles; blossom end hard to firm; no aroma; no waxy skin coating; may feel prickly or hairy; not likely to ripen without ethylene treatment; minimum commercial harvest maturity.</td>
<td></td>
</tr>
<tr>
<td>1:2 39</td>
<td>Fully mature</td>
<td>Color definitely white, no more than a trace of translucent green color; blossom end hard to slightly springy; no aroma; very little wax; ethylene treatment essential for uniform ripening of a shipment; good commercial harvest maturity.</td>
<td></td>
</tr>
<tr>
<td>2 45</td>
<td>Ripening initiated</td>
<td>Color mainly white; blossom end slightly springy; slight aroma; slightly waxy; minimum eating ripeness; will continue to ripen without ethylene treatment but ethylene treatment will speed ripening; occasionally harvested commercially for local shipment.</td>
<td></td>
</tr>
<tr>
<td>3 50</td>
<td>Ripe</td>
<td>Color white to creamy white; blossom end springy to soft; pronounced and typical ‘Honey Dew’ aroma; waxy coating of skin very evident; ideal eating ripeness.</td>
<td></td>
</tr>
<tr>
<td>4 55</td>
<td>Overripe</td>
<td>Color creamy white to pale yellow; blossom end soft; strong aroma; abundance of skin wax; maximum eating ripeness.</td>
<td></td>
</tr>
<tr>
<td>5 60</td>
<td>Senescent</td>
<td>Color yellow; melon generally soft; very strong aroma; skin very waxy to greasy; unfit to eat.</td>
<td></td>
</tr>
</tbody>
</table>

The goals of this study were to determine the time course of various aspects of growth, maturation, and ripening, and to identify possible cause and effect relationships among these processes, especially those which might determine the eating quality of ‘Honey Dew’ muskmelons. Over several years we have run storage and shipping tests with fruits obtained from local packing sheds. In the course of these and other studies, class descriptions for stages of development, maturation, and ripening were developed (Table 1). The usual stage for good commercial harvest has been score “1,” but the best commercial operators are now harvesting at score “1:2.” Melons of lower maturity than score “1” will not have the required soluble solids content and will not ripen in response to ethylene treatment. Score “1” fruits are unlikely to ripen without ethylene treatment, even after prolonged storage at a warm temp (20—25°C). Because of this curious behavior, we originally thought this cultivar might be genetically variable with respect to ripening ability. Our first effort was to see if all melons would eventually ripen if left attached to the plant in the field and to check the ripening behavior of melons harvested at various times and matched as well as possible by appearance. Subsequently, a full investigation of flowering and fruit development was undertaken to see if the observed ripening phenomena could be explained on the basis of the true age of individual ‘Honey Dew’ fruits, since the growth patterns of individual cantaloupe fruits (‘PMR-45’) are quite uniform, and chronological ages (days after anthesis) provide a satisfactory basis for sampling fruits of different stages of development (13).
Materials and Methods

'Honey Dew' melons were grown on the Univ. of California farm at Davis. Seeds were planted at about 3-week intervals beginning about April 15. Spacing was usually 2 to 3 m between rows and 0.3 to 1 m between plants in the row; otherwise the cultural practices of irrigation, fertilization, pest control, and pollination (beehives provided nearby) were typical of well-managed commercial plantings in the area.

For most studies, all newly opened perfect flowers were tagged each day for at least 2 weeks after the first flowers appeared in each planting. Flowering usually continued for several weeks, resulting in secondary and tertiary peaks of fruit setting, but these fruits were usually too variable for our purposes. For some purposes, fruitlets were tagged about 7 days after anthesis. About 2 weeks after the cessation of tagging the set fruits were counted. For the most critical experiments, the fruits set during the 3 peak days of a planting were generally used; they were harvested at the desired age by reference to the dated tags and were selected from an even distribution over the field. Growth rates were determined by measuring circumferences of individual fruits at regular intervals, estimating volumes, and weighing all harvested samples. Fruits were usually harvested in mid-morning when flesh temperature approximated that of the laboratory (20°C). The fruits were rinsed with tap water, weighed, and the cut stem surfaces dusted with sulfanilamide. The melons were placed individually in respirometers consisting of 25 cm O.D. cylindrical battery jars sealed with bolted lids and rubber gaskets. Air at 9 to 12 liters/hr-kg fresh wt was supplied using calibrated capillary flow meters. The air was not humidified, in order to avoid superficial mold growth, but weight loss was less than 1% in 2 weeks.

The rate of CO₂ evolution was determined by a colorimetric method, and ethylene production by means of flame-ionization gas chromatography using an aluminum oxide column. In relatively short-term experiments, internal ethylene concn was determined by withdrawing 1.0 ml of air from the placental cavity with a syringe; no wound responses or decay appeared as a result of this procedure. However, for prolonged experiments, internal concn was estimated from the rate of ethylene production and the concn within each fruit was determined. To calibrate this method of estimation, melons of several ages were covered in the field with small multilayered burlap shelters to insulate them from direct solar radiation, thus preventing sharp gradients or rapid changes in temp. Thermometers were inserted into 5 of the melons at 0800 when the pulp temp averaged about 18°C. By 1300 the pulp temp had risen to 22°C, giving a mean temp of 20°C during the 5 hr period. At this time 1 ml samples of air were drawn from the placental cavities of the 12 remaining shaded fruits and analyzed for ethylene. The same melons were then harvested and placed in respirometers at 20°C. Samples of internal air were again taken 24 and 48 hr after harvest. There was no discontinuity in the trend of internal ethylene concn in these fruits.

Soluble solids, texture, and dry wt of pericarp tissue were measured in tissue samples obtained by cutting a 5.0 cm wide equatorial slice through the melon and then cutting radially to obtain wedges and cuboid pieces. Soluble solids content of the juice (calibrated as sucrose) was obtained by hand refractometer. The % dry wt was obtained by lyophilizing small wedges of tissue. Texture (firmness) was determined with two 5 x 5 cm cuboid slices of pericarp tissue from each melon, placed skin side down in the test cell of an Alto-Kramer Shear Press (Model SP-12 with Model C-15 standard Shear-Compression Test cell and Model R-1 M 3000 lb Electronic Proving Ring) operated at the 300 and 100 lb settings with an 8.9 cm stroke in 30 sec. The numerical value at any point along the resulting recorded peak, when divided by the cross sectional area of the slice, represents the shear compression force. Values of the mean force were calculated from the area under the peak by cutting and weighing the chart paper (sample error was less than 2%).

Results

Flowering and fruit set. The relationship between the no. of flowers opening each day and the percentage of those which set fruit was observed for several years. The first perfect flowers generally appeared about 1 week after the first staminate flowers. The no. of perfect flowers opening per plant increased...
rapidly for 5 or 6 days (Fig. 3) and then leveled off or increased more gradually for several weeks. Newly formed fruits which were destined to abort stopped growing, lost color, and abscised from the plant within 2 to 7 days after anthesis. While the patterns of flower formation was similar from year to year, the patterns of fruit set varied (Fig. 3, 4, 7). The percentage of those flowers which set fruit usually rose to a peak of about 15% for 3 or 4 days and then declined to near zero, resulting in a "crown set" of about 5 fruits per plant in widely spaced plantings. The percentage of fruit set fluctuated thereafter, leading to varied secondary and tertiary peaks (as in Fig. 4 and 7). These results are comparable to those with cantaloupe (13). Closely spaced plants, as in usual commercial plantings, generally set only 1 or 2 fruits, and the second and third cycles were much reduced or eliminated.

In 3 plantings seeded about 3 weeks apart during 2 different growing seasons, a well-defined peak set occurred in the first planting each year (Fig. 4; see also Fig. 3). Depending upon the weather, flowering and fruit set of the second planting closely followed or overlapped that of the first (Fig. 4A), but peak rate of setting was lower and fewer fruits were produced per plant. Sometimes the rate of set was appreciably lower over extended periods (Fig. 4B). Visual observations of the plantings suggest that trends in fruit set (Fig. 4) may be related to vine size and leaf area. First plantings have a large total leaf area by the time of flower initiation. Third plantings have a relatively small leaf area when flowering and fruit set are initiated but later achieve larger leaf areas which support the patterns of fruit set. However, these later fruits seldom attain the size of those in the first plantings and, as noted below, not all mature and ripen. Second plantings were often intermediate in behavior with a moderate but steady rate of fruit set.

**Fruit growth.** Although the absolute rates of growth in volume and final fruit sizes varied, the patterns of growth in different plantings were very consistent (Fig. 5) as indicated by the time required to achieve half the final volumes (Fig. 5A). Curves based on weight (Fig. 5B) closely approximate the volume curves, and mean rates of growth in terms of both volume and weight per day can also be compared (Fig. 5A and B). The apparent density of the fruit (compare liters in Fig. 5A with kilograms in Fig. 5B) decreases as the percentage of the fruit's volume represented by the central cavity increases.

**Accumulation of dry wt constituents.** During the early, rapid phases of growth the rates of solute uptake, solute incorporation into insoluble products, and cell expansion are apparently balanced, maintaining a relatively constant concn (4.0 ± 0.8%) of soluble solids (compare Fig. 6A and B). After about 20 days, when the fruits have reached half of their final size, another phase of growth begins in which the rate of growth steadily decreases (Fig. 5B), accompanied by a rapid accumulation of solids (Fig. 5A, 6A and B). There are therefore, 2 peaks in the rate of total solids accumulation (Fig. 6B), one coinciding with the most rapid rate of growth (Fig. 5A and B), and the second with the period of rapid accumulation of sugars (Fig. 6). The rate of accumulation and the final concn of soluble solids vary from year to year, but the length of time required for the fruit to reach one-half of the final net increase in soluble solids (Fig. 6A) is relatively constant at about 35 days after anthesis.

Under midsummer growing conditions at Davis, melons
Fig. 6. Soluble solids (A) and mean dry wt (B) during growth and development of melons during several seasons. In A, stars show when half of the final increase in soluble solids was attained, using the 14-day concn as the initial value. In B, the dry wt accumulation is the resultant of rate of total dry wt production less respiration loss.

judged to be good to excellent eating quality usually contained 13 to 17% soluble solids. Mature melons which had accumulated no more than 10 to 12% soluble solids were only fair quality. The differences in eating quality between those fruits which have not accumulated high sugars when vine ripe and those which have the same low sugar content by virtue of earlier harvest have not been studied.

Field ripening. All fruits which set on 50 vines planted on May 4 were observed until all had ripened on the vine or until the vines declined in vigor and died at the end of the season.

Melons set in 3 distinct cycles with peaks about 12 days apart (Fig. 7). All those set during the first cycle, and most of those set during the second, ripened normally on the vine. However, a few of the second cycle and most of those of the third failed to ripen. Most of these late-set melons did not grow to a satisfactory size, probably due to loss of vigor of the vines near the end of the season; only the first-set fruits would usually be harvested commercially.

Postharvest ripening of fruit samples classified by appearance. To determine whether fruits selected by superficial appearance (as in commercial practice) would ripen off the plant, 15 vines were selected at random each week from the same planting as the vines studied for field ripening (above). All melons over 12.5 cm diam were harvested and classified into development stages (Table 1). The fruits of each stage were further sorted into 2 matched lots which were held at 25°C. One of these lots was treated for 24 hr with 1000 ppm ethylene, approximating a commercial treatment. Thereafter the fruits were examined frequently and scored for ripening. Soluble solids were measured as the fruits ripened or, in the unripened fruits, when the experiment was terminated in late Sept. Harvested melons of high apparent maturity (score "1:2" and "2") ripened readily whether or not they were treated with ethylene (Table 2). Melons of very low maturity ("C" and "O") failed to ripen, although superficial appearance changed somewhat following ethylene treatment (small increase in arbitrary ripeness score). Although ethylene had some effect on appearance in all samples, soluble solids were not affected. Some melons harvested in the "0 to 1" range failed to ripen, even when treated with ethylene; this group fell just below the California legal requirement for average soluble solids content, proving

Table 3. Variation in some characteristics of 'Honey Dew' melons harvested at score "0 to 1" and held at 25°C.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Avg soluble solids (%)</th>
<th>Avg ripeness score</th>
<th>Avg days to softening or discard</th>
</tr>
</thead>
<tbody>
<tr>
<td>All melons</td>
<td>9.4 ± 1.6</td>
<td>11.7 ± 2.1</td>
<td>25.2 ± 13.8</td>
</tr>
<tr>
<td>Melons which ripened</td>
<td>10.1 ± 1.0</td>
<td>11.0 ± 2.4</td>
<td>18.9 ± 3.5</td>
</tr>
<tr>
<td>Melons failing to ripen</td>
<td>8.4 ± 1.7</td>
<td>8.1 ± 2.3</td>
<td>33.4 ± 12.7</td>
</tr>
</tbody>
</table>

2 Melons of Table 2; summation of all "0 to 1" fruits, whether treated with ethylene or not.

3See Table 2.
Comparative behavior of individual fruits. The climacteric respiratory patterns shown by individual melons of the same age group varied in time, amplitude, and duration (Fig. 8B and C). Therefore, the mean respiratory behavior of a number of fruits (roughly equivalent to the behavior of a multifruit sample) shows a broader and lower respiratory peak (Fig. 8A) than that of most individuals. The same is true for patterns of ethylene production (Fig. 8D, E, and F). Hence, respiration and ethylene production are best studied in individual fruits.

In 2 of the 28-day melons there was a noticeable but delayed increase in ethylene production to about 0.6 μl/kg-hr. This increase was accompanied by a small irregular peak of respiratory activity. The remaining 8 fruits were kept until 75 days after anthesis with no sign of a respiratory climacteric. In 2 of the 35-day melons the peak of ethylene production (at the normal time) was lower than the minimum inductive level, and there was no distinct increase in respiration (e.g., melon 35-c, Fig. 8B). The climacteric pattern of the 8 remaining fruits ranged between the amplitude of melons 35-b and 35-a. In this population the 47-day fruits were apparently fully mature, since they ripened to approximately the same eating quality as those left on the plants. All individuals produced sufficient ethylene to induce a climacteric peak of respiration, but there was a considerable range in the magnitudes of these phenomena (Fig. 8C and F). Indeed, many individual melons in the 47- and 51-day groups failed to produce enough ethylene to induce a maximum climacteric rate response (e.g., Fig. 8C and F). In none of the 60 individuals studied over a 3-year period was a pronounced climacteric pattern seen if ethylene production was less than 0.43 μl/kg-hr (1.5 ppm internal concentration). The rate was normally between 0.6 and 1.0 μl/kg-hr (3.0 ± 1.0 ppm internally) at the onset of the climacteric. Furthermore there is an obvious correlation between the magnitudes of the ethylene and the climacteric peaks. Our estimate of the ethylene production required for a maximal respiratory response is shown by the upper shaded band of Fig. 8.

Texture changes. Firmness of the pericarp tissue declined sharply beginning about 40 days after anthesis (Fig. 9). This is the earliest response following the upsurge of ethylene production, preceding the induction of the climacteric and other observable aspects of ripening by approximately 7 days. Wang and Mellenthin (27) made a similar observation with 'Anjou' pears.

Discussion

Fig. 9 summarizes important changes and their interrelationships during growth, maturation, and ripening of 'Honey Dew' melons. The data are derived from several seasons, including those presented in detail above. Note that minimal horticultural maturity is attained at 35 to 37 days and a good
state of ripeness at about 50 days. The failure of harvested melons to reach an acceptable level of ripeness or quality is clearly not due to an inherent qualitative characteristic of this cv. The field observations of ripening indicated that melons failed to ripen only when maturation was prevented by death or senescence of the vine. Poor ripening response in commercial practice is probably due to physiological immaturity of the harvested fruit. A critical developmental stage occurs during which 'Honey Dew' melons undergo a maturation process unaccompanied by obvious external signs permitting accurate judgment of maturity, so fruits picked in this developmental stage may or may not ripen acceptably. Fruits of this classification that do ripen probably would still be of fairly low quality.

To illustrate these points let us compare 37- and 47-day fruits (Fig. 9). Growth had slowed but the fruits had attained about 87% of their final size by 37 days; soluble solids would have reached the legal minimum of 10% and a score of “1” would be assigned (Table 1), but the fruits would be hard and cucumber-like in flavor. If stored through the normal ripening period, ethylene production would show a minimal peak, resulting in minimal changes in texture, color, or flavor. If treated with ethylene, they would undergo the same degree of softening as a fully mature melon, but there would be no change in sugar content, and some cucumber-like flavor might be retained. On the other hand, 47-day fruit would have 12 to 16% soluble solids, and after storage at room temp for a few days their ethylene production, softening, color, and flavor development would be essentially the same as in those ripening on the vine during the same time span. They might not, however, produce the amount of ethylene required for induction of the maximum respiratory peak rate (19).

Of the phenomena we studied only two, the respiratory climacteric and the reduction in firmness, appear to be directly related to increasing ethylene concn. Conversely, decreasing growth rate and increasing soluble solids are important physiological changes that clearly precede accelerated ethylene production. Since melons do not store starch, ethylene cannot affect soluble solids content by increasing starch hydrolysis as in banana or pear. In our opinion, relatively immature melons harvested at low sugar content (10 to 12%) do not develop the best flavor, even with ethylene treatment. However, the roles of maturity and ethylene production in the development of flavor volatiles in this cultivar remain in question. For example, do the various components of ripening have the same ethylene concn requirements for maximum response as the respiratory climacteric? If they do, then many melons may not reach maximum eating quality in response to endogenous ethylene alone.

Ethylene treatment may compensate not only for the range of maturities harvested because of similar superficial appearance but also for an inherent range in ability of mature melons to produce ethylene. Maximal eating quality may require not only that the fruit be fully mature at harvest, but also that it be given a supplemental treatment with ethylene.

Since truly mature melons ripened rapidly and acceptably, commercial quality would be greatly enhanced if the fruit were as mature as possible when harvested, but an ethylene ripening treatment would still provide insurance against sorting errors. Sorting errors are almost inevitable because of the long time span between attainment of horticultural maturity and ripening. However, this time span permits fewer harvests, providing an adequate ethylene treatment is given. Treating the more mature fruits, which would ripen normally anyhow, will cause no harm and assures the uniformity of ripening of a large lot, but ethylene treatment is no substitute for adequate maturity.

Literature Cited

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Quality and Condition of ‘Delicious’ Apples after Storage at 0°C and Display at Warmer Temperatures

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Abstract. Apples (Malus domestica Borkh.) were examined after 0, 2, 4, and 6 months' storage and after simulated retail display for 1 and 2 weeks at 4.4°, 13°, and 21°C. Apples displayed or marketed at 4.4° for 1 week developed less decay and scald than apples held at 21°, and were crispier, brighter, and about 0.55 kg (1.2 lb.) firmer. Apples softened much faster at 21° soon after harvest than after 4 or 6 months' storage at 0°C. The sonic firmness index decreased significantly with both storage time and with increases in display temp. Weight losses from bulk apples during 1 week of display at 4.4°, 13°, and 21° averaged 0.2, 0.4, and 1.8%, respectively. The greatest loss of acidity was also at the warmest display temp. Apples displayed at 13° were of a quality and condition intermediate to those held at 4.4° and 21°. Apples stored in CA for 6 months and then displayed 2 weeks at 21° were firmer and more acid, and had a lower respiration rate than those stored in air. Refrigerated display of 'Delicious' apples is strongly recommended to retard deterioration and preserve their good quality and shelf life.

Apples are rarely adequately refrigerated in supermarkets. The dessert quality and shelf life of fruit consumers take home are greatly reduced when previous handlers have neglected refrigeration. Many investigators have studied the changes in quality of 'Delicious' apples during storage and ripening (3, 9, 12, 15, 20, 21, 22). Few studies have been done recently to compare various simulated retailing temp on apple quality maintenance. Lewis (13, 14) reported that refrigerated 'Delicious' apples retained an attractive appearance and crisp texture longer than apples held at room temp. Haut (10) and Senn and Scott (19) evaluated post-storage temp for 'Richared Delicious' and concluded that apples should be kept below 10°C if the time between storage and consumption exceeds 6-9 days.

A 1960 study (11) showed that apples displayed under simulated retail refrigeration (10°C) lost less weight and showed less decay than similar apples displayed at room temp. Scald was reduced during marketing when fruit was displayed at 10°C or lower (5). Certainly both time and temp are involved in deterioration rate. Mattus et al (16, 17) surveyed the rapidity of sale of apples in Virginia supermarkets. An average of 2.7 days was required to sell 50% of the bulk or loose apples on display and 8.5 days to sell 95%. Only 25% of the bagged apples were in refrigerated displays. Recently a USDA task force studying apple marketing (4) listed many industry problems, including the holding of apples with poor keeping qualities or under poor conditions.

Chain store executives continue to ask for further information on the value of refrigeration for short retailing periods. This research was initiated to determine progressive quality changes of 'Delicious' apples during storage and during 1 and 2 weeks of subsequent display at 4.4°, 13°, and 21°C (40°, 55°, and 70°F). These temp were presumed to represent good, fair and poor retail display conditions, respectively.

Materials and Methods

Fruit source and preparation. The study was conducted in the fall and winter months of 1974-75 in experimental storage rooms at Beltsville, Md. Three lots of 'Delicious' apples were obtained from commercial orchards in Virginia, West Virginia and Pennsylvania within 6 days of harvest. All were size 100 tray packed and graded as Combination U.S. Extra Fancy and Fancy, sports 'Richared', 'Starking', and 'Red Spur' harvested at approx optimum maturity in Sept. Each lot was composited separately and dipped in 2,700 ppm ethoxyquin for scald control. Fruit was then replaced in tray-packed cartons for storage.

Storage and display. Storage was at 0°C with 85-92% relative humidity for 0, 2, 4, and 6 months in air and for 6 months in experimental CA chambers (1% O₂ with <1% CO₂) with and without the ethylene absorbent "Purafil." The initial or 0 storage examination was made when fruit had been at 0°C for 6 months and then displayed 2 weeks at 21°.