QUALITY EVALUATION OF FRUIT OF A RANGE OF APPLE CULTIVARS/CLONES GROWN IN IRELAND

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ABSTRACT

Overall quality of 20 apple cultivars/clones grown in Ireland was evaluated based on husbandry factors and fruit composition, colour, texture, flavour and aroma. Samples were tested on 7 occasions over a period of 4 seasons. Results showed that fruit of the cultivars/clones Golden Delicious, GD Smoothee, Crispin, Gala and GDC 446 was of good overall quality; that of Gloster 69, Idared, GD 88, GD 85, GD Stark, Karmijn and Moss's Seedling was intermediate while fruit of Jonathan, Kent, Suntan, Ivette, Sinta, GD 4E 23-10, Goldjon and GD Stark was of poor overall quality. The data show that fruit of Golden Delicious and its clones is well represented in the "good overall quality" category.

INTRODUCTION

The main apple cultivar grown in Ireland is Golden Delicious. While this cultivar yields well under Irish conditions, organoleptic quality can vary considerably from season to season (1-3) with high soluble solids (SS) levels in warm seasons but low SS values and a green colour in cool seasons. Orchard location also influences quality (3). More recently the Irish apple industry has been severely hit by imports of Golden Delicious from France and while the Irish grown fruit is of equal quality to the French in most seasons (2, 4) consumers consider the French fruit of superior quality and are prepared to pay more for it (4).

For this reason it is important to have alternative cultivars to Golden Delicious and this paper presents results of a quality assessment of 19 cultivars/clones in addition to Golden Delicious tested on 7 different occasions over 4 seasons. Tests were carried out for SS, acidity, skin and flesh colour, firmness, and for flavour and aroma using taste and sniff panels respectively. A husbandry index is also provided as an indication of cropping performance, fruit size, tree growth, ease of management, disease resistance and other factors in respect of each cultivar/clone.

The results presented are averaged over the 7 testing dates. It is recognised that it is not possible to have fruit of every cultivar/clone at its optimum for testing on the
same date; nevertheless useful information relating to overall relative quality can be obtained by averaging over the testing dates especially as the purpose of the study is to identify cultivars/clones whose fruit retain their good characteristics over a relatively long storage period.

EXPERIMENTAL

Testing schedule
Fruit from four seasons (1975, 1976, 1977, 1978) was tested on 7 occasions as follows: 1975 fruit in February, 1976; 1976 fruit in November, 1976 and January, 1977; 1977 fruit in December, 1977; 1978 fruit in October, 1978, December, 1978 and January, 1979. These dates are referred to as testing dates 1-7 respectively in this experiment. The list of cultivars/clones tested and the frequency of testing is given in Table 1.

<table>
<thead>
<tr>
<th>Cultivar/clone</th>
<th>Frequency</th>
<th>Cultivar/clone</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malling Suntan</td>
<td>7</td>
<td>Gala</td>
<td>6</td>
</tr>
<tr>
<td>Malling Kent</td>
<td>7</td>
<td>GDC 446</td>
<td>7</td>
</tr>
<tr>
<td>Gloster 69</td>
<td>7</td>
<td>Moe’s Seedling</td>
<td>5</td>
</tr>
<tr>
<td>GD Smoothie</td>
<td>7</td>
<td>Sinta</td>
<td>7</td>
</tr>
<tr>
<td>Crispin</td>
<td>7</td>
<td>GD 88</td>
<td>6</td>
</tr>
<tr>
<td>Idared</td>
<td>6</td>
<td>GD 85</td>
<td>7</td>
</tr>
<tr>
<td>Karmijn de Sonnaville</td>
<td>7</td>
<td>GD 4E 23-10</td>
<td>5</td>
</tr>
<tr>
<td>Ivette</td>
<td>5</td>
<td>GD Stark</td>
<td>6</td>
</tr>
<tr>
<td>Red Jonathan</td>
<td>6</td>
<td>Goldjon</td>
<td>7</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>7</td>
<td>Starkspur</td>
<td>7</td>
</tr>
</tbody>
</table>

Testing procedures
Spot samples of each cultivar/clone were stored at 2°C in air after harvesting until tested. Five fruit of each sample were tested on each occasion for SS, acidity, firmness (shear press) and skin colour (Hunter Colour Difference Meter, blush side) as described by Gormley et al (1). Internal colour was determined on a Hunter Colour Difference Meter with a 5 cm aperture using five apples from each sample. A sample representing about one third of each apple was removed and the internal colour (Hunter 'b' value - yellowish) was measured on the resulting flat surface of the remaining two thirds of each fruit immediately after the fruit was sliced.

Flavour preference was tested using rank type taste panels (5) with 10 tasters and 5 or 6 samples per panel. Panelists were also asked to comment on the flavour of each sample. Fruit of Golden Delicious was included as a hidden standard sample in each panel as it is a well known cultivar with reasonably good fruit quality. Samples of other cultivars/clones could then be compared against it. The tasters were chosen from research, technical and secretarial staff at Kinsealy Research Centre. All were experienced at tasting apples and the composition of the panel was generally 5 males
and 5 females. While it is recognised that such a panel cannot fully represent consumer opinion it should broadly classify samples as having, or not having, potential from a flavour point by view. Fruit was peeled, cored, sliced and was presented to the panel within 10 min. Fruit of all cultivars/clones was evaluated by taste panels at each of the testing dates and the same set of 5 or 6 cultivars/clones were compared against each other on each occasion.

Aroma was measured on two occasions only (December 1978, January, 1979) using a saucepan/cone system (6). Ten panelists were used in each 'sniff panel' with the same set of cultivars/clones being evaluated each time as was used for the flavour evaluation above.

Husbandry index

There is little point in determining quality of apple fruit in isolation from husbandry considerations. A husbandry index is given therefore for each cultivar/clone as a component of overall quality. The index is based on the performance of cultivars/clones in terms of cropping performance, fruit size, tree growth, ease of management and disease resistance and was assigned by an experienced pomologist. Obviously if any of these factors was limiting the cultivar/clone would receive a low index value. A five point numerical scale is used with (+2) indicating an excellent cultivar/clone in relation to the above factors; (+1) indicating good, (0) indicating average, (-1) below average and (-2) well below average. Golden Delicious was given the top score of (+2) in view of its good performance in relation to the factors above and indices for the other cultivars/clones were assigned relative to this.

Analysis of results

Since no replicates were tested (spot samples only) for the various cultivars/clones in any season the 7 testing dates are used to obtain an error term to find differences between cultivars/clones and vice versa. It is not possible therefore to analyse for interactions. However, the data has been examined visually and the rank position for any factor for a given cultivar/clone which differs by more than 10 rank placings from season to season is reported. For convenience these are referred to as rank difference interactions (RD interactions).

Overall quality is based on a combination of firmness (1), composition, flavour, aroma and husbandry index. Data for firmness, acidity and SS for the different cultivars/clones are ranked from 1 (highest value) to 20 (lowest value). The three sets of ranks are added to give rank sums which are then re-ranked to give the relative merits of the cultivars/clones for these factors. This rank order is referred to as the FAS (firmness, acidity, SS) rank order in this experiment. Good overall quality is based on a sample having a reasonable FAS value (in the top 12) coupled with the absence of a negative value for husbandry index, flavour or aroma.
RESULTS AND DISCUSSION

Firmness, acidity, soluble solids

Mean data over the seven testing dates for firmness, acidity and SS are presented in Table 2. Significant differences were found for each of these factors for the cultivars/clones. Fruit of Kent, I'dared and GD Smoothee was firmest and that of Sinta and Karmijn was softest. In the case of acidity, fruit of the cultivars/clones Suntan, Karmijn and Gloster 69 was most acid while that of Gala, Goldjon and Starkspur had the lowest acidity. Soluble solids levels were highest for fruit of Karmijn and Suntan and lowest for Moss’s Seedling and Goldjon. The firmness, acidity and SS data were ranked in order of magnitude for the cultivars/clones (Table 2) to give the FAS rank order. This procedure indicated that fruit of Suntan, Kent and Gloster 69 was best and that of Starkspur, Goldjon and GD Stark worst in terms of firmness and composition. Fruit of Golden Delicious was ranked in position 10 out of the 20 cultivars/clones tested. It is considered that FAS ranking gives a good indication of the storage potential, and flavour of the cultivars/clones; for reasons of marketing and for consumer acceptance it is essential that apples retain firmness with accompanying high levels of acidity and solids over a considerable period of time.

Table 2: Firmness and composition of apple cultivars/clones grown in Ireland

<table>
<thead>
<tr>
<th>Cultivar/clone</th>
<th>Firmness (kg)</th>
<th>Titratable acidity meq/100 ml</th>
<th>Soluble solids (%)</th>
<th>Rank sums</th>
<th>FAS rank order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suntan</td>
<td>136 (5)</td>
<td>12.4 (1)</td>
<td>13.7 (2)</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Kent</td>
<td>188 (1)</td>
<td>8.2 (8)</td>
<td>13.0 (3.5)</td>
<td>12.5</td>
<td>2</td>
</tr>
<tr>
<td>Gloster 69</td>
<td>133 (6)</td>
<td>11.3 (3)</td>
<td>12.7 (5.5)</td>
<td>14.5</td>
<td>3</td>
</tr>
<tr>
<td>GD Smoothee</td>
<td>141 (3)</td>
<td>8.0 (9)</td>
<td>13.0 (3.5)</td>
<td>15.5</td>
<td>4</td>
</tr>
<tr>
<td>Crispin</td>
<td>138 (4)</td>
<td>8.3 (7)</td>
<td>12.3 (7.5)</td>
<td>18.5</td>
<td>5</td>
</tr>
<tr>
<td>I'dared</td>
<td>161 (2)</td>
<td>10.6 (4.5)</td>
<td>11.7 (15.5)</td>
<td>22</td>
<td>6.5</td>
</tr>
<tr>
<td>Karmijn</td>
<td>110 (19)</td>
<td>12.2 (2)</td>
<td>14.1 (1)</td>
<td>22</td>
<td>6.5</td>
</tr>
<tr>
<td>Ivette</td>
<td>128 (8)</td>
<td>10.6 (4.5)</td>
<td>12.2 (10)</td>
<td>22.5</td>
<td>8</td>
</tr>
<tr>
<td>Jonathan</td>
<td>126 (10)</td>
<td>10.1 (6)</td>
<td>12.5 (7.5)</td>
<td>23.5</td>
<td>9</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>121 (12)</td>
<td>7.5 (10.5)</td>
<td>12.7 (5.5)</td>
<td>28</td>
<td>10</td>
</tr>
<tr>
<td>Gala</td>
<td>132 (7)</td>
<td>5.8 (20)</td>
<td>12.1 (11)</td>
<td>38</td>
<td>11.5</td>
</tr>
<tr>
<td>GDC 446</td>
<td>127 (9)</td>
<td>6.9 (16)</td>
<td>11.9 (13)</td>
<td>38</td>
<td>11.5</td>
</tr>
<tr>
<td>Moss’s Seedling</td>
<td>119 (13)</td>
<td>7.5 (10.5)</td>
<td>11.1 (19.5)</td>
<td>43</td>
<td>13.5</td>
</tr>
<tr>
<td>Sinta</td>
<td>80 (20)</td>
<td>7.1 (14)</td>
<td>12.3 (9)</td>
<td>43</td>
<td>13.5</td>
</tr>
<tr>
<td>GD 88</td>
<td>114 (17.5)</td>
<td>7.4 (12)</td>
<td>11.8 (14)</td>
<td>43.5</td>
<td>15</td>
</tr>
<tr>
<td>GD 85</td>
<td>118 (14.5)</td>
<td>7.2 (13)</td>
<td>11.6 (17)</td>
<td>44.5</td>
<td>16</td>
</tr>
<tr>
<td>GD 4E-23-10</td>
<td>114 (17.5)</td>
<td>6.9 (16)</td>
<td>12.0 (12)</td>
<td>45.5</td>
<td>17</td>
</tr>
<tr>
<td>GD Stark</td>
<td>118 (14.5)</td>
<td>6.9 (16)</td>
<td>11.7 (15.5)</td>
<td>46</td>
<td>18</td>
</tr>
<tr>
<td>Goldjon</td>
<td>122 (11)</td>
<td>5.9 (19)</td>
<td>11.1 (19.5)</td>
<td>49.5</td>
<td>19</td>
</tr>
<tr>
<td>Starkspur</td>
<td>117 (16)</td>
<td>6.8 (18)</td>
<td>11.3 (18)</td>
<td>52</td>
<td>20</td>
</tr>
<tr>
<td>F-test</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>SE</td>
<td>7.60</td>
<td>0.40</td>
<td>0.28</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

a rank order
b Obtained by ranking rank sums; FAS refers to the rank order based on firmness, acidity and soluble solids
It should be noted (Table 2) that fruit of Karmijn, Idared and Gala each received widely different rank positions for firmness, acidity and SS. Karmijn was ranked 19th for firmness but was ranked 1st and 2nd for SS and acidity respectively. Idared had firm fruit (ranked 2nd) but SS level was low and was ranked 15.5. Fruit of Gala had the lowest acidity of the cultivars/clones tested but was firm and had an intermediate SS level.

There was a number of RD interactions for cultivars/clones between testing dates and the tests for firmness, acidity and SS. In the case of firmness the following was found; GD 88 ranked 7th on date 3 and 18th on date 5; GD Smoothee ranked 1st, 2nd, 2nd, 16th, 4th, 17th and 8.5 on the testing dates 1 to 7; for acidity fruit of GD Smoothee was ranked 9th, 7th, 5th, 17th, 8th, 12th and 12th on the 7 dates. RD interactions were found for 8 cultivars/clones in the case of SS. Fruit of Crispin was ranked 1st on date 7 and 11th on date 6; Gloster 69, 3rd on date 7 and 15th on date 6; Golden Delicious 2nd on date 4 and 15th on date 3; GD4E-23-10 5th on date 6 and 16th on date 4; Idared 8th on date 1 and 19th on date 5; Sinta 6th on date 2 and 18th on date 6; Starkspur 5th on date 4 and 20th on date 6.

**Fruit colour**

Data for skin and flesh colour of the apples, averaged over all assessments, are presented in Table 3. There were significant differences between the cultivars in each case. The skin colour only serves to indicate whether fruit of a given cultivar/clone is red, yellow or green. Goldjon, Gloster 69 and Gala had the reddest fruit; that of GD Smoothee, Moss’s Seedling and Sinta was uniformly yellow while Crispin, Starkspur, GDC446 and GD85 had green fruit. It should be noted that colour was measured on the blush or most ripe side.

Fruit of Suntan, Goldjon and Gala had the yellowest flesh colour while Idared, Moss’s Seedling, Kent and Jonathan fruit were white fleshed.

There were RD interactions for cultivars/clones between testing dates and fruit colour; Crispin fruit were more yellow than usual on date 7 as was fruit of GDC446 on date 3; fruit of Ivette was greener than usual on dates 6 and 7. In the case of flesh colour fruit of Ivette was yellower than usual at testing date 2.

**Flavour and aroma**

Data for panel response to flavour and aroma for fruit of the different cultivars/clones are presented in Table 4. Results are only given for samples that received a significantly better or worse ranking than other samples in each panel as this identifies superior or inferior samples, especially if fruit of a given cultivar/clone is found consistently better or worse over a number of panels. Gaps in the table indicate that the particular samples did not receive significantly better or worse ratings relative to other samples in their respective panels.

It should be noted that Golden Delicious fruit which was included in each panel did not receive any significantly different rankings (Table 4); it was found to have an average flavour which was consistent over time based on comments made by panelists on the score sheets. The results also show that there are well-flavoured...
Table 3: Skin and flesh colour of apple cultivars/clones grown in Ireland

<table>
<thead>
<tr>
<th>Cultivar/clone</th>
<th>Skin colour&lt;sup&gt;a&lt;/sup&gt; (Hunter 'a')</th>
<th>Flesh colour&lt;sup&gt;b&lt;/sup&gt; (Hunter 'b')</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suntan</td>
<td>+14.4 (8)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>30 (2)</td>
</tr>
<tr>
<td>Kent</td>
<td>+18.3 (5)</td>
<td>25 (17.5)</td>
</tr>
<tr>
<td>Gloster 69</td>
<td>+23.7 (2)</td>
<td>26 (15.5)</td>
</tr>
<tr>
<td>GD Smoothee</td>
<td>0.0 (10)</td>
<td>29 (5.5)</td>
</tr>
<tr>
<td>Crispin</td>
<td>-8.2 (20)</td>
<td>27 (12.5)</td>
</tr>
<tr>
<td>Idared</td>
<td>+17.9 (6)</td>
<td>22 (20)</td>
</tr>
<tr>
<td>Karmijn</td>
<td>+16.6 (7)</td>
<td>29 (5.5)</td>
</tr>
<tr>
<td>Ivette</td>
<td>-1.4 (12)</td>
<td>26 (15.5)</td>
</tr>
<tr>
<td>Jonathan</td>
<td>+20.3 (4)</td>
<td>25 (17.5)</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>-4.1 (16)</td>
<td>28 (9)</td>
</tr>
<tr>
<td>Gala</td>
<td>+23.3 (3)</td>
<td>30 (2)</td>
</tr>
<tr>
<td>GDC 446</td>
<td>-4.9 (17.5)</td>
<td>28 (9)</td>
</tr>
<tr>
<td>Moss's Seedling</td>
<td>+0.9 (9)</td>
<td>24 (19)</td>
</tr>
<tr>
<td>Sinta</td>
<td>-0.6 (11)</td>
<td>29 (5.5)</td>
</tr>
<tr>
<td>GD 88</td>
<td>-3.8 (15)</td>
<td>27 (12.5)</td>
</tr>
<tr>
<td>GD 85</td>
<td>-4.9 (17.5)</td>
<td>28 (9)</td>
</tr>
<tr>
<td>GD 4E-23-10</td>
<td>-2.6 (13)</td>
<td>27 (12.5)</td>
</tr>
<tr>
<td>GD Stark</td>
<td>-3.5 (14)</td>
<td>29 (5.5)</td>
</tr>
<tr>
<td>Goldjon</td>
<td>+27.1 (1)</td>
<td>30 (2)</td>
</tr>
<tr>
<td>Starkspur</td>
<td>-7.9 (19)</td>
<td>27 (12.5)</td>
</tr>
<tr>
<td>F-test</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>SE</td>
<td>1.88</td>
<td>0.39</td>
</tr>
</tbody>
</table>

<sup>a</sup><sup>+</sup> = red, (0) = yellow, (-) = green
<sup>b</sup> yellowness values
<sup>c</sup> rank order

cultivars/clones which could be used as alternatives to Golden Delicious in the market place, assuming that they yield well and are easily managed. Fruit of GD Smoothee and Gala were well flavoured and received good flavour rankings in 3 panels (Table 4). Fruit of Crispin and Karmijn also got good flavour ratings. In contrast fruit of Gloster 69, Jonathan, Sinta, Goldjon and Starkspur had a relatively poor flavour. Differences in aroma were not so outstanding, and Jonathan fruit got good aroma ranking relative to that of Idared (Table 4).

**Husbandry index**

Only 10 out of 20 cultivars/clones received a good husbandry index rating (Table 5) with GD Smoothee, Golden Delicious, GD88, GD85 and GD Stark best followed by Gloster 69, Idared, Gala, GDC 446 and Starkspur; Kent and Jonathan were worst in this respect. It is important to note that most of the samples with high ratings were Golden Delicious clones.

**Overall quality**

An indication of overall quality can be obtained from the data in Table 4. It could be argued that rank data are being used here in an absolute sense. However, in the large number of samples being tested it is most likely that there will be a large spread in
Table 4: Quality factors for apple cultivars/clones grown in Ireland

<table>
<thead>
<tr>
<th>Cultivar/clone</th>
<th>FAS rank order(^a)</th>
<th>Taste panels(^b)</th>
<th>Aroma panels(^c)</th>
<th>Husbandry index(^d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suntan</td>
<td>1</td>
<td>1/2</td>
<td>-</td>
<td>-1</td>
</tr>
<tr>
<td>Kent</td>
<td>2</td>
<td>-</td>
<td>1/2</td>
<td>-2</td>
</tr>
<tr>
<td>Closter 69</td>
<td>3</td>
<td>3/7</td>
<td>-</td>
<td>+1</td>
</tr>
<tr>
<td>GD Smonthee</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>+2</td>
</tr>
<tr>
<td>Crispin</td>
<td>5</td>
<td>2/7</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Idared</td>
<td>6.5</td>
<td>1/6</td>
<td>2/2</td>
<td>+1</td>
</tr>
<tr>
<td>Gloster 69</td>
<td>6.5</td>
<td>-</td>
<td>-</td>
<td>-1</td>
</tr>
<tr>
<td>Idared</td>
<td>8</td>
<td>1/5</td>
<td>1/2</td>
<td>-1</td>
</tr>
<tr>
<td>Jonathan</td>
<td>9</td>
<td>3/6</td>
<td>2/2</td>
<td>-2</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>+2</td>
</tr>
<tr>
<td>Gala</td>
<td>11.5</td>
<td>-</td>
<td>-</td>
<td>+1</td>
</tr>
<tr>
<td>GD 446</td>
<td>11.5</td>
<td>-</td>
<td>-</td>
<td>+1</td>
</tr>
<tr>
<td>Moss's Seedling</td>
<td>13.5</td>
<td>1/5</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Sinta</td>
<td>13.5</td>
<td>2/7</td>
<td>1/2</td>
<td>-1</td>
</tr>
<tr>
<td>GD 88</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>+2</td>
</tr>
<tr>
<td>GD 85</td>
<td>16</td>
<td>-</td>
<td>1/2</td>
<td>-1</td>
</tr>
<tr>
<td>GD 4E-23-10</td>
<td>17</td>
<td>1/5</td>
<td>1/6</td>
<td>+2</td>
</tr>
<tr>
<td>GD Stark</td>
<td>18</td>
<td>1/6</td>
<td>1/6</td>
<td>0</td>
</tr>
<tr>
<td>Goldjon</td>
<td>19</td>
<td>2/7</td>
<td>-</td>
<td>+1</td>
</tr>
<tr>
<td>Starkspur</td>
<td>20</td>
<td>2/7</td>
<td>1/2</td>
<td>+1</td>
</tr>
</tbody>
</table>

\(^a\)see Table 2

\(^b\)ratio of the number of panels where samples received a statistically better (positive) or worse (negative) flavour rating to the total number of panels

\(^c\)as for b except for aroma only

\(^d\)see Table 5

quality in which case ranking procedures will show true differences — especially when the ranks for a number of different factors are added to give an indication of quality. Many of the cultivars/clones that received good FAS values got a bad rating for husbandry index and in some cases flavour and aroma. GD Smonthee had the best overall quality with a high FAS rank order value, a good flavour and a good husbandry index. Other cultivars/clones coming out relatively well include Crispin, Golden Delicious, Gala and GD 446.

Closter 69 and Idared fruit had poor flavour but high FAS rank order and husbandry index values. GD88, GD85 and GD Stark also had high husbandry index values and also good flavour but low FAS rank order values. Moss's Seedling had a poorish FAS rank order but was average for flavour and husbandry index while Karmijn fruit had a good flavour and FAS rank order value but was below average for husbandry index. This group of 7 cultivars/clones was classified as 'intermediate' for overall quality. Fruit of Jonathan, Kent and GD 4E-23-10 received poor overall ratings. On the basis of the data in Table 4, therefore, the cultivars/clones can be divided broadly into three groups for overall quality, i.e. good, intermediate and poor (Table 6). It is important to recognise that this form of classification is the best that can be achieved within the limits of the experiment.
Table 5: Husbandry index* for apple cultivars/clones

<table>
<thead>
<tr>
<th>Cultivar/clone</th>
<th>Husbandry index</th>
<th>Most limiting factor</th>
<th>General comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suntan</td>
<td>-1</td>
<td>Internal fruit problems</td>
<td>A triploid, seems of no great value commercially in Ireland</td>
</tr>
<tr>
<td>Kent</td>
<td>-2</td>
<td>Rough stem finish</td>
<td></td>
</tr>
<tr>
<td>Clove 69</td>
<td>+1</td>
<td>Erect tree habit</td>
<td>Useful cultivar, if growth can be controlled</td>
</tr>
<tr>
<td>GD Smoothie</td>
<td>+2</td>
<td>Slower to crop than GD</td>
<td>Slightly rounder fruit than GD</td>
</tr>
<tr>
<td>Crispin</td>
<td>0</td>
<td>Tree vigour and overlarge fruit</td>
<td>Need heavy crops to reduce fruit size</td>
</tr>
<tr>
<td>Idared</td>
<td>+1</td>
<td>Lack of flavour</td>
<td>Crops as heavily as GD</td>
</tr>
<tr>
<td>Karmijn</td>
<td>-1</td>
<td>Fruit too large</td>
<td>Vigorous grower</td>
</tr>
<tr>
<td>Ivette</td>
<td>-1</td>
<td>Fruit too small</td>
<td>Crops well, fruit green</td>
</tr>
<tr>
<td>Jonathan</td>
<td>-2</td>
<td>Fruit too small</td>
<td>Susceptible to severe mildew</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>+2</td>
<td>Market resistance</td>
<td>Very good grower's apple</td>
</tr>
<tr>
<td>Gala</td>
<td>+1</td>
<td>Must be virus-free</td>
<td>Insufficient experience with virus-free tree</td>
</tr>
<tr>
<td>GDC 446</td>
<td>+1</td>
<td>Slow cropper</td>
<td></td>
</tr>
<tr>
<td>Moss’s Seedling</td>
<td>0</td>
<td>Green colour of fruit</td>
<td>Heavy cropper</td>
</tr>
<tr>
<td>Sinta</td>
<td>-1</td>
<td>Light cropping</td>
<td>Vigorous tree</td>
</tr>
<tr>
<td>GD 88</td>
<td>+2</td>
<td>Market resistance</td>
<td></td>
</tr>
<tr>
<td>GD 85</td>
<td>+2</td>
<td>Market resistance</td>
<td></td>
</tr>
<tr>
<td>GD 4E-23-10</td>
<td>-1</td>
<td>Low early cropping</td>
<td>Fruit size inadequate</td>
</tr>
<tr>
<td>GD Stark</td>
<td>+2</td>
<td>As for GD</td>
<td></td>
</tr>
<tr>
<td>Goldjon</td>
<td>0</td>
<td>Fruit too small</td>
<td></td>
</tr>
<tr>
<td>Starkspur</td>
<td>+1</td>
<td>Fruit smaller than GD</td>
<td>Very compact tree</td>
</tr>
</tbody>
</table>

*from (+2) best, (0) average, (-2) worst

bearing in mind that all fruit is not at its optimum for testing at every date; it should also be noted that only large differences in overall quality between cultivars/clones are of practical significance and this broad classification provides the necessary information.

Quality of apples in 4 seasons

The mean values for firmness, composition and colour of the apples (averaged over cultivars/clones) on each testing date (in 4 seasons) are given in Table 7. As expected the samples tested closest to time of harvest (testing date 5 October '78) were firmest; samples tested on date 1 (February 1976) were also quite firm, especially in view of the length of time in storage (air, 2°C). Similarly, samples from date 5 also had the highest acidity and the greenest fruit. Mean values for SS were much higher for the first three testing dates due presumably to the warm dry summers of 1975 and 1976. This effect was also reflected in that fruit had redder skin and yellower flesh colour in these seasons. Inspection of the data in Tables 2 and 7 suggest that seasonal storage variation may be as important in some instances as cultivar/clone variation.
Table 6: Overall quality of 20 apple cultivars/clones grown in Ireland

<table>
<thead>
<tr>
<th>Good</th>
<th>Intermediate</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>GD Smoothee</td>
<td>Gloster 69</td>
<td>Jonathan</td>
</tr>
<tr>
<td>Crispin</td>
<td>Idared</td>
<td>Kent</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>GD88</td>
<td>Suntan</td>
</tr>
<tr>
<td>Gala</td>
<td>GD85</td>
<td>Ivette</td>
</tr>
<tr>
<td>GDC446</td>
<td>GD Stark</td>
<td>Sinta</td>
</tr>
<tr>
<td></td>
<td>Karmijn</td>
<td>GD 4E-23-10</td>
</tr>
<tr>
<td></td>
<td>Moss’s Seedling</td>
<td>Goldjon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Starkspur</td>
</tr>
</tbody>
</table>

*based on data in Table 4

Table 7: Firmness, composition and colour of apples grown in Ireland in four seasons

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Firmness (kg)</td>
<td>135</td>
<td>110</td>
<td>111</td>
<td>121</td>
</tr>
<tr>
<td>Acidity (meq/100 ml)</td>
<td>7.2</td>
<td>9.7</td>
<td>7.5</td>
<td>12.1</td>
</tr>
<tr>
<td>Soluble solids (%)</td>
<td>13.4</td>
<td>13.7</td>
<td>12.8</td>
<td>11.7</td>
</tr>
<tr>
<td>Skin colour (Hunter ‘a’)</td>
<td>+10.8</td>
<td>+11.3</td>
<td>+3.6</td>
<td>+2.4</td>
</tr>
<tr>
<td>Flesh colour (Hunter ‘b’)</td>
<td>29.2</td>
<td>28.7</td>
<td>27.6</td>
<td>25.9</td>
</tr>
</tbody>
</table>

*mean values averaged over 20 cultivars/clones
*100 = red, 0 = yellow, - = green
*yellowness values
ACKNOWLEDGEMENTS

We acknowledge Messrs. P. E. Walshe, S. Egan and L. O'Sullivan for technical assistance.

REFERENCES


*Received July 30, 1980.*