The International Planting Systems Trial

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The International Planting Systems Trial, a collaborative experiment, was initiated as a result of discussions within the High Density Planting Working Group of the Fruit Section of the International Society for Horticultural Science.

In the course of meetings of this group, it became clear that high-density, single-row orchards on the dwarfing M.9 rootstock were rapidly becoming the preferred planting system in western Europe and that there was considerable interest in even more intensive multirow systems. Results of numerous experiments and of commercial experience with orchard systems of different types have been analyzed in terms of science-based production factors and economic performance. There has been considerable progress also in computer modeling of orchard system productivity and profitability to enable generalizations and predictions as to system performance (1–3). An internationally coordinated group of field experiments was judged to be the best way in which a number of promising new systems could be generally evaluated and the data necessary to the application of computer models over sites with different environmental conditions obtained.

Detailed aims

The main aims of the experiments were to a) compare growth, cropping, and fruit quality of the same planting systems at different geographical sites; b) obtain an insight into the possibilities of a number of intensive systems and tree shapes of current interest when grown at a range of sites but with management practices supervised by relevant scientists from the country in which the particular system had been invented; c) provide an estimate of productivity in the different locations throughout Europe, free from confounding with differences in cultivar, spacing, or pruning; and d) provide standard material for basic physiological studies at leading research centers in each of the participating countries.

MATERIALS AND METHODS

Planting systems

Planting systems consisted of the following a) Slender spindle-

bushes on M.9 in single rows with a spacing of 3 × 1.25 m for ‘Golden Delicious’ (2667 trees/ha) and 3.5 × 1.5 m for ‘Gloster’ (2051 trees/ha). This system is now considered as the conventional high-density system in western Europe (7). b) Zig-zag double-rows on M.9 with spacings of 3.0 + 1.45 × 1.68 m for ‘Golden Delicious’ (2675 trees/ha) and 3.2 + 1.7 × 1.96 m for ‘Gloster’ (2061 trees/ha). This system has a similar number of trees/ha as the first system, but arranged so as to give a more even spacing over the orchard surface. It is described by Parry (5) and Jackson et al. (4). c) North-Holland spindles in three-row beds with spacings of 3.0 + (2 × 0.9) × 1.75 m for ‘Golden Delicious’ (3571 trees/ha) and 3.25 + (2 × 1.1) × 2.0 m for ‘Gloster’ (2755 trees/ha). This system is described by Wertheim et al. (8). d) Mini-bush trees (6) and slender spindles on M.27 grown as full-field systems at spacings of 1.5 × 0.75 m for ‘Golden Delicious’ (8889 trees/ha) and 1.75 × 1.0 m for ‘Gloster’ (5714 trees/ha). e) Single-row systems on either M.9, M.26, or MM.106 to represent either the current commercial system in the particular country or a system of particular research interest to the scientists concerned.

In all of the systems, rows were oriented north–south. All trees were grown with 2.5-m-high stakes driven 0.5 to 0.6 m into the ground, except for the mini-bush trees, which were supported by wires attached to short stakes at intervals down the rows.

Cultivars

‘Golden Delicious’ was chosen as a universally grown cultivar suited to high-density systems. ‘Gloster’ was chosen as a red-colored cultivar, suitable for all the sites in the trial, which could be used to identify any adverse effect of system of growing on fruit color.

Experimental design

There are four replicates at each site, so that the trial at each site can enable a reasonable assessment of the performance of the different systems, with separate randomization for each site so that an overall pooled analysis can be made.

Sites

Trials were planted in Winter 1980–81 at East Malling (United Kingdom), Wilhelminadorp (Netherlands), Bavendorf and Sarstedt (Federal Republic of Germany), Bologna (Italy), Blangstedgaard...
Table 1. The International Planting Systems Trial.

<table>
<thead>
<tr>
<th>System</th>
<th>Bologna</th>
<th>Total yield, 1982–1985 inclusive (t·ha⁻¹)</th>
<th>East Malling</th>
<th>Sarstedt</th>
<th>Wilhelminadorn</th>
<th>Bavendorf</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Golden Delicious</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Single row/M.9</td>
<td>125</td>
<td>171</td>
<td>94</td>
<td>151</td>
<td>57</td>
<td>109</td>
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<tr>
<td>Double row/M.9</td>
<td>130</td>
<td>153</td>
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<td>137</td>
<td>53</td>
<td>109</td>
</tr>
<tr>
<td>Triple row/M.9</td>
<td>159</td>
<td>162</td>
<td>147</td>
<td>149</td>
<td>64</td>
<td>109</td>
</tr>
<tr>
<td>Spindles/M.27</td>
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<td>247</td>
<td>144</td>
<td>172</td>
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<td>109</td>
</tr>
<tr>
<td>Mini-bush/M.27</td>
<td>178</td>
<td>223</td>
<td>127</td>
<td>146</td>
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<tr>
<td></td>
<td></td>
<td>Gloster</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single row/M.9</td>
<td>139</td>
<td>109</td>
<td>114</td>
<td>141</td>
<td>71</td>
<td>109</td>
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<tr>
<td>Double row/M.9</td>
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<tr>
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<td>127</td>
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</tr>
<tr>
<td>Mini-bush/M.27</td>
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<td>150</td>
<td>120</td>
<td>119</td>
<td>79</td>
<td>109</td>
</tr>
</tbody>
</table>

(Deutschland), and Skiermiewice (Poland). At all sites except Skiermiewice the planting material came from a nursery in the Netherlands (to which M.27 rootstocks had been supplied by East Malling Research Station).

Management

Trees were planted with the union 15 cm above soil level. All systems had annual overall herbicide management, and pruning was carried out following annual exchanges of photographs and instructions between the originating center for the particular system and the other sites. Irrigation, fertilizer treatment, fruit thinning, and crop protection measures followed good local practice. The scientists concerned have visited each other’s plots at times but it would have been much better if we had been able to have a formal program of exchanges and, in particular, regular visits to each site by the expert on each of the pruning systems used.

Observations

Trunk girths at 25 cm above the union, shoot numbers and lengths, pruning weights, and tree heights and spreads have been measured regularly, and also leaf area at some times. Flower cluster numbers, date of full bloom, an index of fruit set, the date of picking, and the number and weight of fruits picked have been recorded annually. Fruit size, color (for 'Gloster'), and russet (for 'Golden Delicious') have been recorded according to European Economic Community (European Common Market) standards.

RESULTS

Owing to severe winter-freeze killing at the site in Denmark and the different starting material in Poland, results from five sites only are considered here. It is clearly not possible to evaluate all of the results from this series of trials in a brief paper, but the following points are important.

Site effects. a) Growth of 'Golden Delicious' was generally more vigorous at East Malling than at the other sites, whereas growth of "Gloster" was most vigorous at Bologna; b) yields over the first four cropping seasons were highest at East Malling for 'Golden Delicious' and (marginally) at Wilhelminadorp for 'Gloster' (Table 1); and c) fruit were much larger at Bologna than at the other sites, especially for 'Golden Delicious'.

System effects. As expected, systems with high densities gave the most yield in the first cropping years and the highest accumulated yield over 1982–1985 (Table 1), although with some site-to-site variation. By 1985, the effect of planting density and tree arrangement for the plots on M.9 was relatively small. At most of the sites, high yield levels (50 t·ha⁻¹ or more) were achieved for 'Golden Delicious' in 1983 in either the three-row bed system on M.9 or one of the full field systems on M.27.

DISCUSSION

To date, this trial has proved extremely successful in two of its primary aims: It has facilitated the evaluation of a number of intensive systems over a wide environmental range and has provided a unique set of standard experimental orchards as a basis for comparative studies.

It also has been most stimulating in bringing research workers from different countries into close practical contact. This contact has led to a useful standardization of recording procedures (even such a basic parameter as date of blossoming was hitherto recorded according to different criteria in the United Kingdom and the Netherlands, as well as to greatly increased collaboration in areas other than that of this particular trial.

The major weakness to date has been inadequate financial provision for longer-term visits and exchanges. It would have been particularly helpful to have all the pruning for each system done by the same person, an expert from the country of origin, rather than by advice based on exchange of photographs and instructions.

Results will be presented in detail in subsequent papers. Perhaps the most important point that will be established is the extent to which it is possible to generalize about overall orchard production system cropping efficiency, as well as about the performance of different components of system productivity, over a wide range of environments. Results to date suggest that the major European centers of production have much more in common in these respects than might have been thought from a study of their recent commercial practices.

Literature Cited