The Growth Characteristics of Pear Trees of the Cultivar ‘Packham’s Triumph’ on Different Rootstocks in the Pelotas Region, RS, Brazil

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Abstract
The aim of this research was to evaluate the growth and development of pear trees of the cultivar ‘Packham’s Triumph’ grafted on six different quince rootstock cultivars, ‘Adams’, ‘Alongado’, ‘D’Angers’, ‘EMC’, ‘Portugal’ and ‘Smyrna’, and one Pyrus calleryana. The experiment was carried out at the experimental field of the Federal University of Pelotas (FAEM/UFPel), Palma Agricultural Center, Capão do Leão, Pelotas RS, Brazil. In August 2002, the pear trees were planted at 5 x 1 m (2000 trees ha⁻¹) and trained as slender spindles on a three-wire support. A drip irrigation system was set for four hours each day (2 L/h/tree). The experimental design was a complete randomized block with three replications of four trees each. Data collected were trunk diameter, tree height, canopy volume, leaf area and fresh and dry leaf weight. In general, ‘EMC’ supported less plant development (vigour) of ‘Packham’s Triumph’, followed by ‘Portugal’. However, ‘Smyrna’, and to a slightly lesser extent, ‘Alongado’, had the better (more vigorous) plant development. The reduction in tree height, when grafted on ‘EMC’ rootstock, was 49.33% in relation to the more vigorous rootstock, ‘Smyrna’. ‘EMC’ had the largest difference among the rootstocks in trunk diameter and showed a reduced diameter of its trunk in comparison to the cultivar (0.37 mm). Moreover, ‘EMC’ induced a lesser leaf area (54.16 cm²), fresh (0.01 N) and dry weight (0.01 N) in the scion, whereas ‘Smyrna’ induced greater averages of leaf area (92.13 cm²), fresh (0.03 N) and dry weight (0.02 N). Some yields were obtained by using quinces rootstocks cultivars ‘D’Angers’ and ‘Smyrna’.

INTRODUCTION
The European pear tree was introduced to Brazil by the first Italian and German immigrants. The cultivars adopted were of commercially low quality and currently there has been little progress on the culture mainly due to low field production (Faoro, 1999).

Currently, pear production is around 21.000 tons per year, whereas the national consumption of pears reaches 150.000 tons per year (FAO, 2007). Consequently, Brazil has become the fourth world’s largest importer of pear fruits, and the fruit takes the first place in the priorities of imported fruits, most of these imports come from Argentina (80% of total) (Nakasu, 1999; FAO, 2007).

Considering the present demand for pear fruit in Brazil it is estimated that the culture of pears offers great potential for expansion. However, according to Silva et al. (1997), there are some constraints caused as by the lack of cultivars adapted for different regions and the lack of research and indetermination of suitable adapted rootstocks.

Traditionally, pear trees grown in large world’s production centers are raised on quinces (Cydonia oblonga Mill.) or on Pyrus communis and occasionally on P. calleryana or P. betulaefolia (Strydom, 1998).

Loreti and Massai (1998) stated that in the selection of rootstocks the following are essential: graft compatibility with commercial cultivars, ease of propagation, tree vigor control, induction of large fruits, adaptation to various soils and climatic conditions, resistance/tolerance to pathogens and nematodes, root asphyxia resistance (soil flooding tolerance).
According to Loreti (1994), the widespread use of quince as rootstocks has made possible the production of pear trees in areas previously thought to be unsuitable for the particular crop. Nevertheless, this has caused further problems of graft affinity with some cultivars, i.e., cultivar ‘Kaiser’.

This research aimed to assess the agronomical influence of different quince rootstocks and *Pyrus calleryana* on the growth and development of pear trees of the cultivar ‘Packham’s Triumph’.

**MATERIALS AND METHODS**

The research was carried out at the experimental field of Palma Agricultural Center and at the laboratory of Federal University of Pelotas (FAEM/UFPEL), Capão do Leão, RS, Brazil. It is located at latitude 31°52’00” S, longitude 52°21’24” W Greenwich and altitude of 13.24 m during July 2005 and July 2006. The soil belongs to the ‘Camaquã’ mapping unity and it is classed as Red-Yellow Podozolic (Brasil, 1973).

In August 2002, the pear trees were planted at 5 x 1 m (2000 trees/ha) and grown in a slender spindle system, trained on three-wire supports. A drip irrigation system was set to apply water for four hours each day (2 L/hr/tree).

The materials assessed were pear trees of the cultivar ‘Packham’s Triumph’ grafted on six different quince rootstocks cultivars ‘Adams’, ‘Alongado’, ‘D’Angers’, ‘EMC’, ‘Portugal’ and ‘Smyrna’, and also on *Pyrus calleryana*, the plants being used, free of disease.

The experimental design utilized was a complete randomized block with three replications of four trees each.

Data collected were: 1) development of trunk diameter – a digital paquimeter was used at 10 cm above and below the grafting point and the difference between scion and rootstocks was taken; 2) tree height – measured from the ground to the top of the tree (cm); 3) canopy volume – by multiplication of height, width and canopy thickness (m³); 4) average area of leaves – the sample consisted of 10 leaves per tree and the leaf area was determined by using a leaf area measurer (cm²); 5) fresh and dry leaf weight – after assessment of leaf area, the leaves were weighed to determine the fresh matter. Then, they were taken into the oven to dry out during 15 min to determine dry matter (g).

The data were submitted to analyses of variance F-test and the comparison of means between treatments was applied when differences were significant. The mean differences were separated with Duncan test at 5% level of significance. The statistical analyses were performed by using WinStat program (Machado and Conceição, 2002).

**RESULTS AND DISCUSSION**

In regards to trunk diameter, the quince rootstocks ‘EMC’ and ‘Portugal’ induced lesser growth of the rootstock as well as of the scion of the cultivar ‘Packham’s Triumph’ (10.77 mm and 13.02 mm, 11.28 mm and 19.94 mm, respectively). In contrast, the largest trunk development of rootstock was observed when using the quince cv. Smyrna (26.57 mm); however, it did not differ from ‘Alongado’ and ‘D’Angers’. ‘Packham’s Triumph’ produced its greatest trunk development when grafted on the quince rootstocks ‘Smyrna’ and ‘D’Angers’, which did not differ whether grafted on ‘Alongado’ or *Pyrus calleryana*. When observing the diameter relationships between both scion and rootstock, ‘EMC’ showed initially a reduced diameter (Table 1).

Sansavini et al. (1997), in their studies on different rootstocks for the cultivars ‘William’s’ and ‘Abate Fétel’ found similar results. Moreover, it was observed that clonal pear rootstocks, besides providing vigorous vegetative development, were shown to be poor in inducing precocious cropping.

The tree height showed a similar trend to trunk diameter. ‘EMC’, which was among the lower vigor group, reduced tree height of ‘Packham’s Triumph’ (45.63 cm), differing from ‘Smyrna’ and ‘Alongado’. ‘Smyrna’ rootstocks produced more vigorous trees; 95.50 cm (Table 1). The observed data agree with Colombo (2003), who describes quince ‘EMC’ as the only rootstock with dwarfing effect, allowing medium/high density
planting.

When observing the canopy volume of ‘Packham’s Triumph’ raised on different rootstocks, the quince rootstock ‘Smyrna’ produced the largest trees (0.046 m³) and was significantly different from trees on ‘Adams’, ‘Portugal’ and ‘EMC’. Although, these three rootstock types were not statistically different, they produced reduced tree volume (Table 1). The vigor difference among rootstocks is explained by Baldini (1986) as being related to the anatomic structure of roots and trunks. In particular, the lesser vigorous rootstocks comprise a better-developed root epidermis than the more vigorous rootstocks.

Concerning the pruning weights, the rootstocks, which produced highest tree vigor of ‘Packham’s Triumph’, also showed higher weights of pruned branches. The trees on the rootstocks ‘Smyrna’ and ‘Alongado’ had greater pruning weights (20.64 g and 22.28 g, respectively), than trees on ‘Portugal’, which did not need pruning. Therefore, the more vigorous rootstocks the more intense the pruning may need to be (Table 1).

Similar results are backed up by Marangoni and Malaguti (2002) and Fachinello (2004) with pear rootstocks grown under Italian conditions. They observed that the rootstocks which had higher transversal sections of the trunk also showed increased tree vigor, and consequently the pruning requirements were higher.

For the leaf area results of ‘Packham’s Triumph’, the rootstocks ‘Smyrna’ produced, as with the other variables, the highest values for leaf average area (92.18 cm²) differing only from ‘Adams’ and ‘EMC’. The rootstock ‘EMC’ induced less development of the average area of leaves (54.16 cm²) (Table 2).

There was little variation in leaf fresh and dry weight rates (Table 2). Regarding the fresh weight, ‘Packham’s Triumph’ had lesser weight of leaves when grafted on quinces rootstocks ‘EMC’ and ‘Adams’ (1.20 g and 1.38 g, respectively), being statistically different. The use of ‘Smyrna’ as rootstocks increased dry leaf weight (1.72 g), although it did not differ from ‘Alongado’ and ‘D’Angers’.

In regards to production aspects, some yields were obtained by using the quince rootstocks ‘D’Angers’ and ‘Smyrna’ (1.45 and 0.90 t/ha, respectively). The other rootstocks did not show yield production up to the fourth year of growth (data not shown).

In general, the rootstocks that increased the vigour of ‘Packham’s Triumph’, also provided higher field production in the first years.

Different results were found by Sansavini et al. (1997) and Loreti et al. (2002) with regard to the rootstock ‘EMC’, which showed in their trials precocious cropping and higher yield efficiency. Since ‘EMC’ was inferior in all the variables analyzed here, this difference may be related to soil type and climate conditions of South of Brazil, where the winter has only 350 hours of winter cold temperatures (above or equal to 7.2°C).

Faust (1989) reported similar results for leaf area by associating the development of leaf area with the plant growth characteristics, such as height, canopy volume and trunk diameter. The same occurred with fresh and dry weight, where according to Salisbury and Ross (1994), it can be considered as a parameter of plant development. Due to variability of water content in the plant, the dry weight rate corresponds to the plant growth. Thus, the dry weight is considered more accurate than fresh weight for the estimation of plant growth. This agrees with the results found in this research, where the cultivars which showed higher dry weight rates and, in general, higher relationships between fresh and dry weights made better plant development for the cultivar ‘Packham’s Triumph’.

CONCLUSION
1. Rootstocks showing large trunk diameters provided trees with large canopy volume and higher height;
2. The rootstock ‘Smyrna’ proved to be the most vigorous of those tested for ‘Packham’s Triumph’;
3. ‘Packham’s Triumph’ had less vigor on the rootstocks ‘EMC’ and ‘Adams’ (51.39 and 50.00%, respectively) when compared to ‘Smyrna’;
4. Some yields were obtained by using the quince rootstocks ‘D’Angers’ and ‘Smyrna’.

**Literature Cited**


Table 1. Rootstock and scion trunk diameter, diameter differences, tree height, canopy volume and pruning weight of pear trees of the cultivar ‘Packham’s Triumph’ grafted on different rootstocks. FAEM/UFPel. Pelotas, 2007.

<table>
<thead>
<tr>
<th>Rootstocks</th>
<th>Diameter (mm)</th>
<th>TDD(^2) (mm)</th>
<th>Tree height (cm)</th>
<th>Canopy volume (m(^3))</th>
<th>Pruning weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rootstock</td>
<td>Scion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smyrna</td>
<td>26.57(^a)</td>
<td>22.68a</td>
<td>3.89a</td>
<td>92.50a</td>
<td>0.0403a</td>
</tr>
<tr>
<td>Alongado</td>
<td>22.43ab</td>
<td>18.18ab</td>
<td>4.24a</td>
<td>84.42ab</td>
<td>0.0375ab</td>
</tr>
<tr>
<td>D’Angers</td>
<td>21.40ab</td>
<td>20.74a</td>
<td>0.66bc</td>
<td>79.08abc</td>
<td>0.0272ab</td>
</tr>
<tr>
<td>Pyrus calleryana</td>
<td>16.87bc</td>
<td>15.96abc</td>
<td>1.20abc</td>
<td>79.62abc</td>
<td>0.0078ab</td>
</tr>
<tr>
<td>Adams</td>
<td>16.67bc</td>
<td>11.99bc</td>
<td>3.28ab</td>
<td>63.29abc</td>
<td>0.0006b</td>
</tr>
<tr>
<td>Portugal</td>
<td>13.02c</td>
<td>10.94c</td>
<td>1.22abc</td>
<td>48.00bc</td>
<td>0.0004b</td>
</tr>
<tr>
<td>EMC</td>
<td>10.77c</td>
<td>11.28c</td>
<td>-0.37c</td>
<td>45.63c</td>
<td>0.0002b</td>
</tr>
</tbody>
</table>

\(^1\)Means with the same letter are not significantly different by Duncan test (\(\alpha = 0.05\)).
\(^2\)TDD – Difference between trunk and scion diameter.

Table 2. Leaf area and fresh and dry matter of pear trees of the cultivar ‘Packham’s Triumph’ grafted on different rootstocks. FAEM/UFPel. Pelotas, 2007.

<table>
<thead>
<tr>
<th>Rootstocks</th>
<th>Leaf area (cm(^2))</th>
<th>Fresh leaf weight (g)</th>
<th>Dry leaf weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smyrna</td>
<td>92.18(^a)</td>
<td>2.67</td>
<td>1.72</td>
</tr>
<tr>
<td>Alongado</td>
<td>82.40ab</td>
<td>2.49</td>
<td>1.23ab</td>
</tr>
<tr>
<td>D’Angers</td>
<td>78.21abc</td>
<td>2.25</td>
<td>1.23ab</td>
</tr>
<tr>
<td>Pyrus calleryana</td>
<td>72.37abc</td>
<td>2.10</td>
<td>1.10b</td>
</tr>
<tr>
<td>Adams</td>
<td>58.28bc</td>
<td>1.38</td>
<td>0.80b</td>
</tr>
<tr>
<td>Portugal</td>
<td>83.40ab</td>
<td>2.24</td>
<td>1.06b</td>
</tr>
<tr>
<td>EMC</td>
<td>54.16d</td>
<td>1.20</td>
<td>0.77b</td>
</tr>
</tbody>
</table>

\(^1\)Means with the same letter are not significantly different by Duncan test (\(\alpha = 0.05\)).