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Tomato on rootstocks with resistance to corky root rot - effects on plant growth and fruit yield

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## **Tomato on rootstocks with resistance to corky root rot - effects on plant growth and fruit yield**

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### **1. Introduction, Knowledge, Objectives**

Corky root rot is a soil-borne fungal disease, leading to reduced numbers of secondary roots and corky primary roots (Ekengren 2008). Consequently the uptake of water and nutrients is limited which can result in reduced fruit yield in tomato production. At present, it is not possible to combat this disease. To overcome this problem for soil cultivation, tomato plants are grafted onto rootstocks with resistance to corky root rot. While several studies have dealt with effects on fruit yield and quality (e.g. Kell & Jaksch 2014), little data are available for growth, especially at the early phase of plant establishment. Thus, we investigated the effects of grafting three tomato varieties onto two rootstocks on plant growth parameters and fruit yield. Moreover, it was tested whether it is possible to predict the incidence of corky root rot by regular ratings of plant growth parameters.

### **2. Material and Methods**

The tomato varieties 'Vanessa' (agri-Saaten GmbH, Bad Essen, D), 'Hamlet' (HILD samen GmbH, Marbach am Neckar, D) and 'Lyterno' (Rijk Zwaan B.V., De Lier, NL) were grown without grafting and grafted onto the rootstocks 'Emperador' (Rijk Zwaan B.V.) or 'Spirit' (Dürr Samen, Reutlingen, D) which possess intermediate resistance against the corky root rot disease. The experiment was conducted in a greenhouse in 2014. Each combination of the factors variety and grafting had four replications (10 plants each) which were arranged in blocks. Sowing dates were April, 14/15 2014 for the rootstocks and April, 17 2014 for the scions. On April, 28 2014, the scions were grafted onto the rootstocks. The seedlings were planted in soil in late May 2014. Water and fertilizer was supplied according to demand by drip irrigation. Plant height, the numbers of leaves and flowers were weekly assessed on two plants per plot (N=8 plants per treatment) in the first month after planting. Number of leaves indicates unfolded leaves while numbers of flowers represent inflorescences with at least one open flower. On day 72 after planting, plant height was assessed again. Harvest of single fruits took place from July to September 2014. In September 2014, the incidence of corky root rot (self-defined scale from 0 to 2: 0 = non-existent, 1 = weak, 2 = very strong) was rated on those plants used to assess the growth parameters, and their total above-ground biomass (except ripe fruits) was determined. Plant growth parameters were tested for significant differences by Kruskal-Wallis test. When significant differences ( $\alpha=0.05$ ) were obtained, Nemenyi tests at  $\alpha=0.01$  were run (R Development Core Team 2011). The incidence of corky root rot symptoms, the final above-ground biomass and the total fruit yield were analyzed by Kruskal-Wallis tests followed by Mann-Whitney pairwise comparisons (with Bonferroni-corrected p values) using the PAST 3.04 software (Hammer

et al. 2001). Correlation analyses between the incidence of corky root rot and plant growth parameters were performed (PAST 3.04) in order to obtain Spearman's  $r_s$  value. These were used to calculate coefficients of correlation ( $R^2$ ).

### 3. Results

On days 1 and 8 after planting, the non-grafted 'Hamlet' plants were taller than those grafted onto 'Spirit'. However, on days 22, 29 and 72 after planting, no more differences between the grafting treatments were observed. Instead, for both 'Hamlet' and 'Vanessa', the plants on 'Emperador' were tallest on day 72. For numbers of leaves, no differences between grafting treatments were observed (Fig. 1). The number of flowers did not differ significantly for the grafting treatments of 'Lyterno' and 'Vanessa'. However, non-grafted 'Hamlet' plants had more inflorescences at 15 and 22 days after planting than grafted scions (Fig. 1).

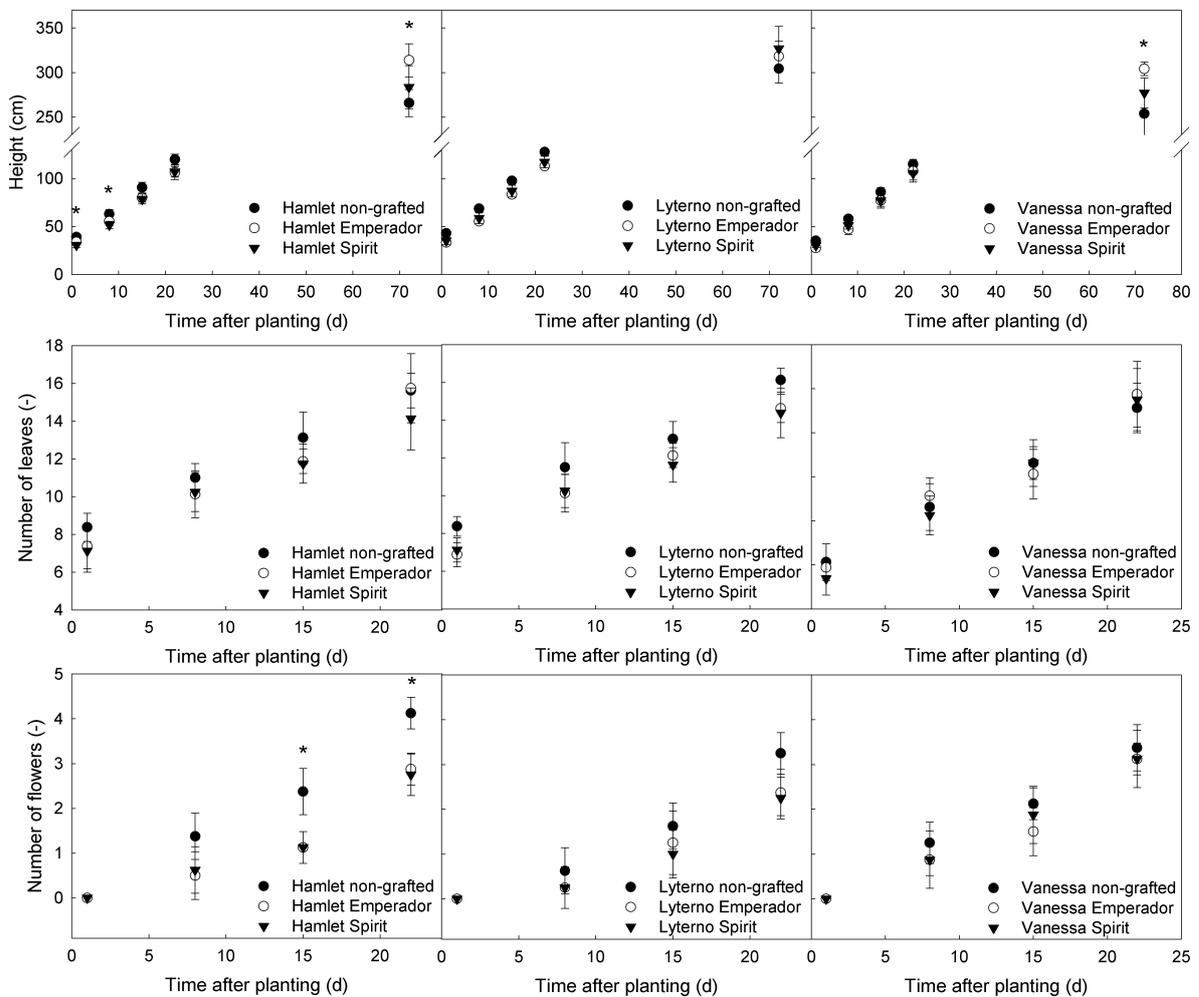


Fig. 1: Development of plant height, number of leaves and flowers over time in 'Hamlet', 'Lyterno' and 'Vanessa' grown either non-grafted or grafted onto 'Emperador' or 'Spirit'. Asterisks indicate differences between treatments for single time points at  $\alpha=0.05$  (plant height on day 72) or  $\alpha=0.01$  (other data).  $N=8$ . Data points are averages  $\pm$  SD.

The incidence of corky root rot was affected by grafting treatment, with ‘Hamlet’ (by trend) and ‘Lyterno’ on ‘Emperador’ being least infected (Fig. 2A). ‘Hamlet’ and ‘Vanessa’ grafted on ‘Emperador’ reached higher final above-ground biomass at the end of the cultivation period than non-grafted plants (Fig. 2B). However, the total fruit yield was not affected by grafting treatment (Fig. 2C).

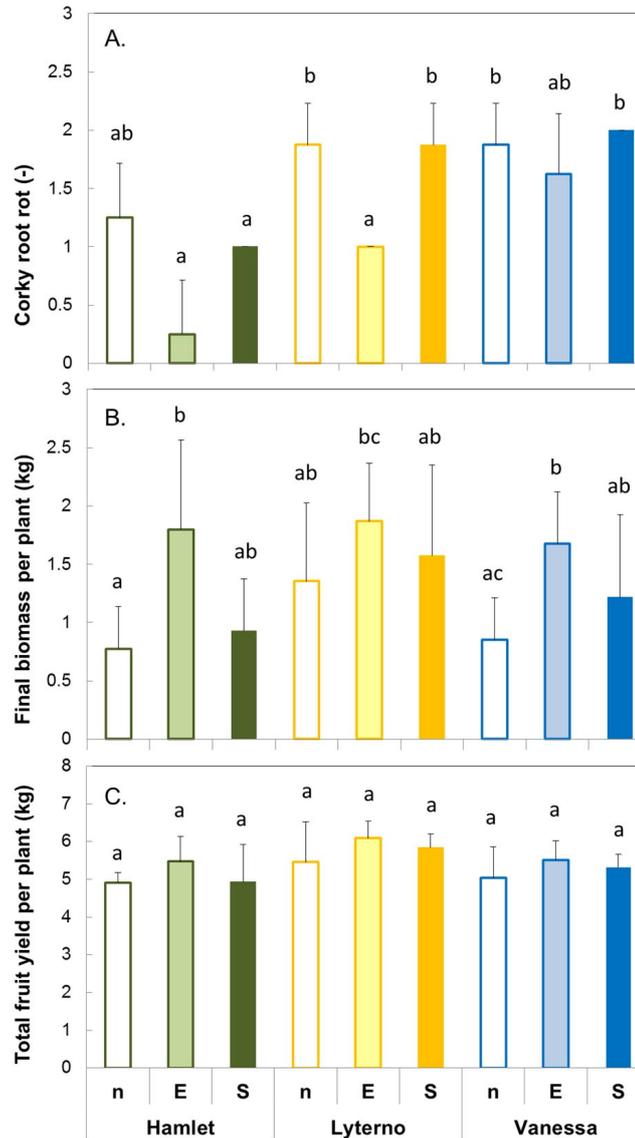


Fig. 2: Incidence of corky root rot symptoms (A), total above-ground biomass (B) and total fruit yield (C) of three varieties of tomato (‘Hamlet’, ‘Lyterno’ and ‘Vanessa’) grown without grafting (n) or grafted on the rootstocks ‘Emperador’ (E) or ‘Spirit’ (S). N=8 for (A) and (B) and N=4 for (C). Bars are averages  $\pm$  SD. Different letters indicate significant differences between the treatments at  $\alpha=0.05$ .

The incidence of corky root rot was neither correlated to plant height, numbers of leaves and flowers, increase in plant height nor to fruit yield and final above-ground biomass (Table 1).

Table 1: Coefficients of correlation ( $R^2$ ) of the incidence of corky root rot and plant growth parameters. For plant height, numbers of leaves and flowers the highest  $R^2$  is shown.

Parameter	Days after planting	Correlation with incidence of corky root rot ( $R^2$ )
Plant height	1, 8, 15, 22	0.057
Plant height	72	0.013
Height increase	22	0.057
Number of leaves	1, 8, 15, 22	0.061
Number of flowers	8, 15, 22	0.121
Final biomass	133	0.007
Total marketable yield	62-132	0.011
Total non-marketable yield	62-132	0.174

#### 4. Discussion

The height of the tomato plants did not differ during the first three weeks after planting into the greenhouse, with exception of ‘Hamlet’ scions grafted on ‘Spirit’ being smaller than non-grafted plants (Fig. 1). Grafting thus seems to inhibit height growth of the scions after planting. Later, this pattern was reversed since both ‘Hamlet’ and ‘Vanessa’ on ‘Emperador’ were tallest (Fig. 1). In contrast, numbers of leaves did not differ between grafting treatments for the three tomato varieties (Fig. 1). The number of inflorescences was larger for the non-grafted ‘Hamlet’ plants as compared to both grafting treatments (Fig. 1).

Interestingly, the number of leaves of young plants is not reflected by the final above-ground biomass (Fig. 2B). However, the number of flowers (inflorescences) is highly relevant for tomato producers as this determines the number of potentially developing fruits. In our experiment, significant differences between grafting treatments were obtained but they did not impact the fruit yield (Fig. 2C). Even as they had different incidences in corky root rot disease (Fig. 2A) and biomass development (Fig. 2B), neither grafting on ‘Emperador’ nor on ‘Spirit’ was advantageous for tomato fruit production which was earlier shown for the variety ‘Encore’ as well (Kell & Jaksch 2007, Kell & Jaksch 2014).

Height growth and the number of leaves are of minor importance for tomato producers albeit they are crucial for photosynthetic processes and thus assimilate availability to the fruits. In case of soil cultivation, they might be used as indicators for infection pressure by corky root rot. However, in our study, the prediction of the incidence of corky root rot infection by regular assessment of plant growth parameters was not possible (Table 1).

#### 5. Conclusions

When growing tomato in soil infested with corky root rot disease, neither the rootstock ‘Emperador’ nor ‘Spirit’ can be recommended since they did not increase the fruit yield under our cultivation conditions. Furthermore, it proved not to be possible to predict the incidence of corky root rot on single plants by regular ratings of several plant growth

parameters at the early phase of establishment.

## **6. Literature**

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