Grafting of Tomatoes for Soil-based Production in Greenhouse and High Tunnels

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Introduction

Soil based greenhouse and high tunnel production of tomatoes has risen dramatically in the Northeast in the last decade. A recent USDA report indicates that the adoption of hoop house technology has allowed states such as New York to become leaders in season extension[1]. This season extension technology offers farmers an opportunity to target market price peaks and capitalize on the rising demand for locally grown produce. Tomatoes from these protected culture systems have proven profitable in wholesale auction settings as well as farmer's markets and CSA's.

However, as production continues in the same soil, risk of root-zone diseases, nematodes and soil nutrient deficiencies increase. Grafting, the combination of two separate cultivars into one plant, is one management approach to these challenges.

Materials and Methods

On February 21, 2012 seeds of tomato scion varieties Big Dena and Panzer; and rootstock varieties Maxifort and Arnold were sown in a soilless potting mix (Promix, Premier Horticulture) at a cooperating greenhouse in Penn Yan, NY. Seeds of rootstock variety Colossus were sown on February 22. All varieties were transplanted to 50-cell flats at first true leaf stage, on March 6. On March 23 grafts were made with the three root stock varieties and two scions, for a total of 6 combinations, 40 finished plants per combination. Cuts were made with a double-edged razor blade on a 45º-angle across the stem of both varieties, immediately above the cotyledons, the union was then joined with 2 mm silicon grafting clips. Grafted plants in 50-cell trays were placed immediately in a darkened healing-chamber with 100% relative humidity and temperature of 80-84 ºF. Grafted plants were gradually re-acclimated to greenhouse bench conditions, with increasing intervals of time out of the healing chamber, until complete acclimation, approximately 12 days post-grafting. Grafted plants were transplanted into an unheated high tunnel with a Lima Silt Loam soil on April 18. Fertilization was carried out per grower standards, detailed in the attached appendix. Plants were grown on a vertical trellised and pruned to a single growing point.

Graft survival was recorded with viable plants available on April 18. Number of fruit per block and total weight per block was recorded at each harvest, beginning June 6 and ending October 30. Data were analyzed using statistical software Analysis of Variance (ANOVA) procedure, and treatment means were separated using Fisher's Least Significant Difference ($p \leq 0.05$).

Results

[1] Winter Farmers Markets Expand, Now More than 1,200 Locations for Fresh Local Foods. (2011). www.usda.gov

Survival of grafted plants was highest with Colossus rootstock, with an average of 94%, followed by Maxifort with 84% and Arnold 73% (Chart1). When examining graft survival based on scion, Big Dena had an average 86% survival across the two rootstocks and Panzer 79%.

Grafting significantly increased yield of both scion cultivars (Table 1). The highest yielding combination as measured by pounds per plant was Big Dena X Maxifort with a value of 30.6. Panzer X Maxifort followed with 29.16 lbs per plant.

Discussion

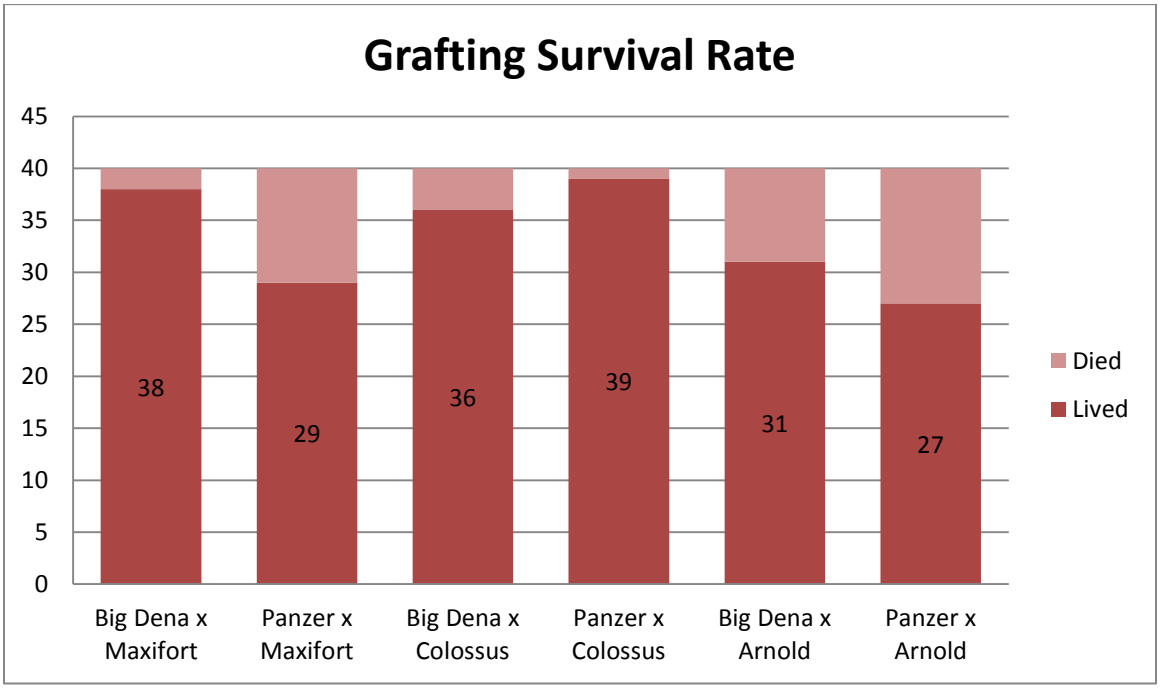

Chart 1. Survival rates out of 40 plants per six rootstock/scion combinations.

Table 1. Yield measures of two tomato varieties ungrafted, and grafted to three different rootstocks.

	Mean Fruit Weight (lbs)	Total Fruit per Plant	Mean Plant Yield (lbs)
Big Dena	0.64 bc	38.31 c	24.54 cd
Big Dena x Maxifort	0.70 a	43.69 ab	30.60 a
Big Dena x Colossus	0.68 ab	39.69 bc	26.80 bcd

Big Dena x Arnold	0.72 a	37.56 c	26.85 bc
Panzer	0.55 e	44.58 a	24.42 d
Panzer x Maxifort	0.62 cd	47.19 a	29.16 ab
Panzer x Colossus	0.60 cde	47.00 a	28.11 b
Panzer x Arnold	0.58 de	47.88 a	27.61 b
p-Value	***0.0000***	***0.0001***	***0.0003***

*Means with different letters (grouping) differ significantly according to Fishers's Protected LSD ($P<0.05$).

Discussion

Graft survival rate is not likely related to cultivar compatibility. Two of the authors conducted the grafting process and differences in technique may account for variability in survival. It is critical however, to match the scion stem diameter as best as possible to root stock stem diameter. Vigorous scions such as Panzer could be started several days after all of the root stock used here.

Grafting of Panzer scions onto all rootstock trialed here offered significantly higher production than the ungrafted controls. Big Dena yield was higher on all rootstock, but only significantly separate from ungrafted when grafted to Maxifort. It should be noted this trial took place in 'fresh' tunnel soil that had not seen vegetable production for several years. In other work by the Cornell Vegetable Program it has been noted that yield response to grafting is greater at sites that have a recent history of intensive tomato production.

Yield as measured by pounds per plant, is perhaps the most important metric in this trial, however it is not the only one needed for selecting a scion/rootstock combination. The grower noted a preference for Panzer fruit, based on color and shape. The three rootstock X Big Dena combinations gave the significantly heaviest fruit weight, creating their own grouping. Fruit size may be an important attribute for some markets.

Yield precocity is also important for tomato marketing, as a price differential exists for early season fruit.

Conclusions

Economics of grafting is favorable based on the yield increase in this trial. The estimated cost of a Maxifort X Panzer is 1.50/plant vs. ungrafted panzer at 0.36/plant. With a mean increase of 4.7 lbs per plant, the break-even price required is 0.24 per lb. It should also be noted that this trial site had not been cropped in several years. As many tunnels have soil further compromised than this site, yield differences between grafted and non-grafted will likely be higher.

Figure 1. Successful grafts of Big Dena onto Maxifort.

Figure 2. Grafted tomato trial in an unheated high tunnel.