Evaluation of Grafted and Non-grafted Hybrid and Heirloom Tomatoes in a Midwest High Tunnel Production System

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Introduction & Hypothesis

High tunnels have emerged as a tool for Iowa vegetable growers to extend the growing season, increase crop production, and improve quality of the produce, but tomato (*Solanum lycopersicum*) production in this system does not come without challenges. Continuous cropping of tomatoes in a high tunnel gives rise to recurring soil-borne and foliar diseases; pest pressure; and issues with soil fertility and salinity.

We hypothesized that grafted tomatoes would overcome challenges outlined above through increased plant vigor conferred by a proven, disease-resistant rootstock. The goal of this study was to evaluate hybrid and heirloom tomatoes grafted to a commercially available rootstock as a primary means to overcome production challenges while increasing marketable yield, fruit and nutritional quality, and profitability.

Objectives

- *Compare marketable yields of grafted and non-grafted hybrid and heirloom tomatoes*
- *Determine if fruit quality and nutritional differences exist between each treatment*
- *Measure differences in plant vigor as a response to grafting*

Materials and Methods

Field trials were conducted in 2015 and 2016 at the Iowa State University Horticulture Research Station in Ames, IA.

Cherokee Purple Heirloom Variety (Indeterminate)
- Grafted to RST-04-106-T Rootstock
- Non-grafted

Mountain Fresh Plus Hybrid Cultivar (Determinate)
- Grafted to RST-04-106-T Rootstock
- Non-grafted

Tomato transplants were grafted three weeks after seeding using the splice grafting method (Figure 1). On May 7, 2015 and April 29, 2016 the transplants were planted in a 30' x 96' ClearSpan™ high tunnel. Mountain Fresh Plus tomatoes were grown using a stake and weave system. The Cherokee Purple tomatoes were grown as a single leader using the lower and lean trellis technique. Tomatoes were planted in a randomized complete block design with 10 plants per plot replicated four times.

Figure 1. Transplants immediately after splice grafting was completed.

Results

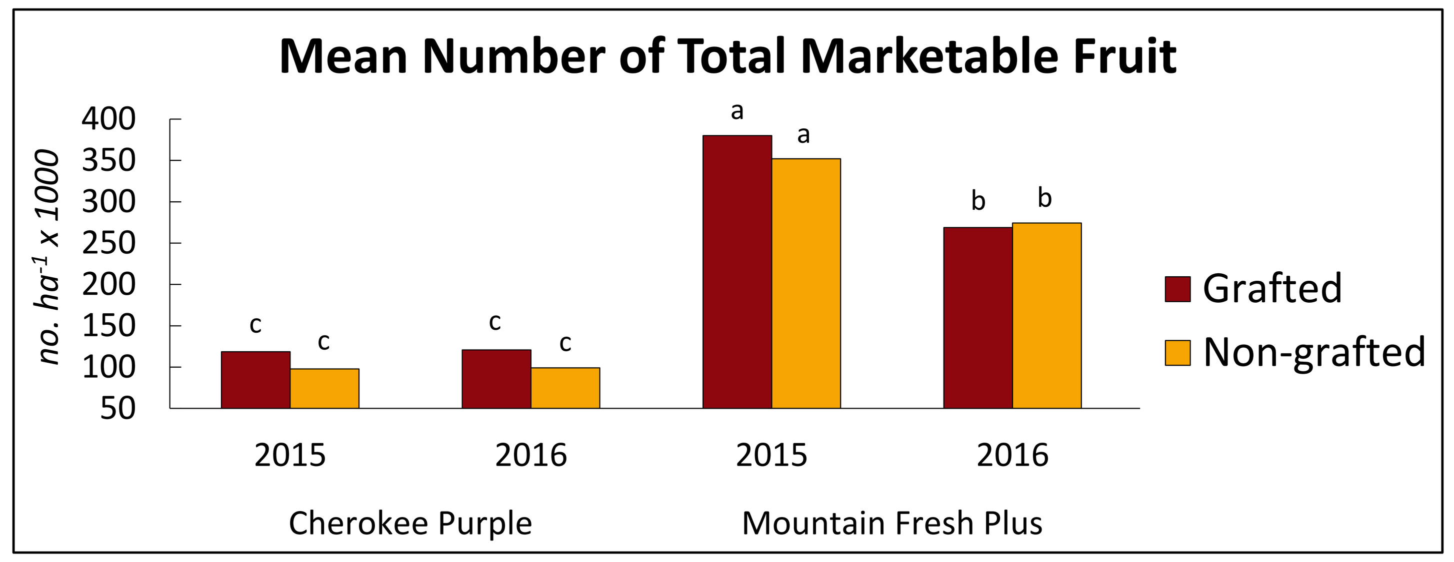

Figure 2. Mean number of total marketable fruit July 22 – October 12, 2015 and July 6 – October 3, 2016 seasons. Marketable fruit for Mountain Fresh Plus includes USDA Grade 1, 2, and 3 tomatoes. Marketable fruit for Cherokee Purple includes all tomatoes that were free from disease, insect damage, and severe cracking and other physiological disorders. All mean separations in Figures 2, 5, and 6 are based on LSD at $P \leq 0.05$ analyzed using PROC GLIMMIX in SAS Version 9.4. Values with the same letter are not significantly different from one another.

Figures 3 & 4. Marketable Mountain Fresh Plus tomatoes from grafted (left) and non-grafted (right) plants. Fruit was harvested on September 5, 2016 from the same replication.

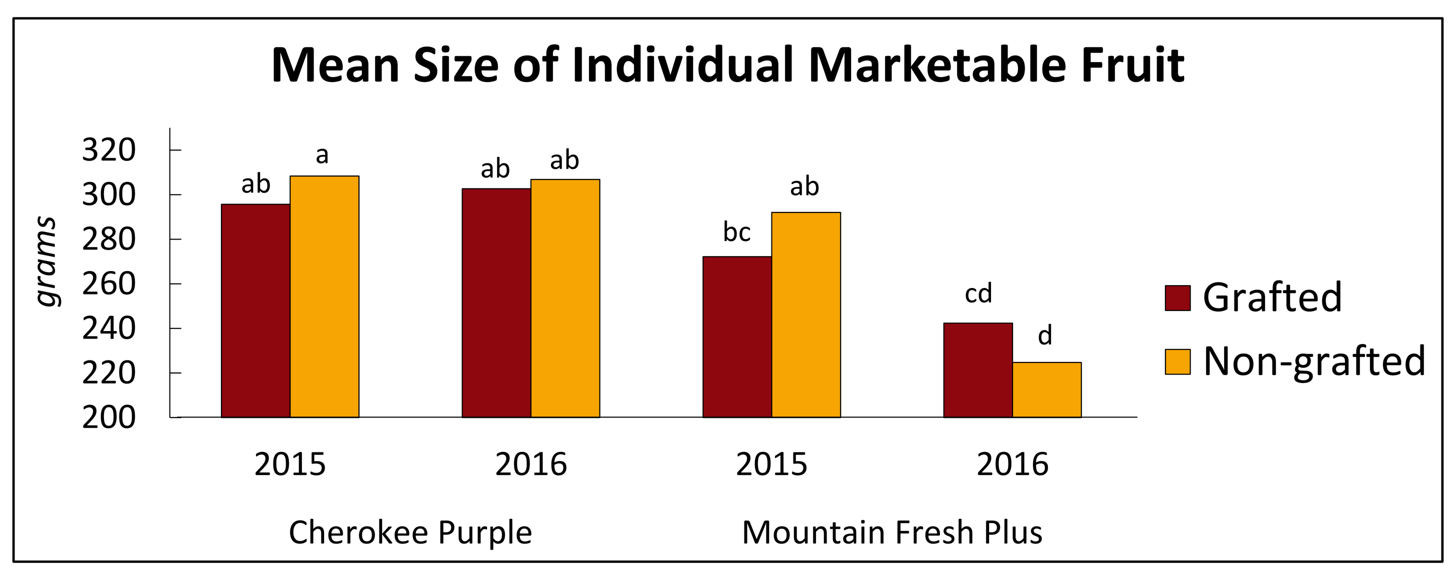

Figure 5. The mean size of individual marketable fruit as determined by the ratio of total marketable harvest weight to total marketable harvest number of fruit.

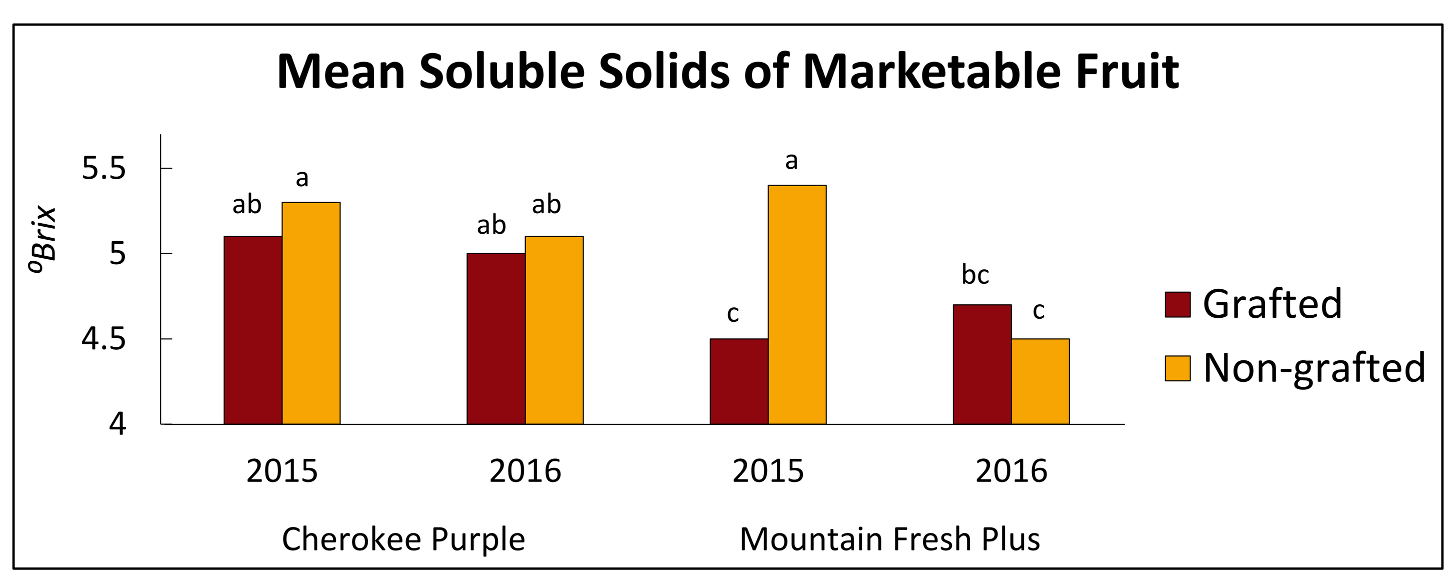

Figure 6. Soluble solids were measured using marketable fruit at the same stage of ripeness collected from a mid-season harvest. Higher values indicate a higher sugar content within fruit samples.

Results Continued

Table 1. Plant vigor indicators [Dry plant biomass, stem diameter, and SPAD (leaf chlorophyll content)]. Data are an average of 10 plants for SPAD and stem diameter and 3 plants for biomass. SPAD readings were collected at mid-season and stem diameter and biomass were measured at the end of each growing season. Values followed by the same letter within a column are not significantly different from one another at $P \leq 0.05$.

Cultivar	Graft	Shoot Biomass (g/plant)	Root Biomass (g/plant)	Stem Diameter (mm)	SPAD
			2015		
Cherokee Purple	Grafted	111.7 b	5.8 c	15.4 a	44.4 cd
	Non-grafted	115.58 b	5.8 c	14.7 ab	43.4 cd
Mountain Fresh Plus	Grafted	339.8 a	14.9 a	15.2 ab	45.7 bc
	Non-grafted	346.2 a	12.9 ab	14.3 b	47.0 b
			2016		
Cherokee Purple	Grafted	154.62 b	8.0 c	15.1 ab	44.0 cd
	Non-grafted	145.20 b	7.5 c	14.4 ab	42.8 d
Mountain Fresh Plus	Grafted	338.8 a	11.6 b	15.2 ab	47.9 ab
	Non-grafted	334.0 a	10.9 b	14.3 ab	49.45 a

Conclusions

- The main effect of grafting increased the number of marketable fruit by an average of 16,200 fruits per hectare as compared to non-grafted plants ($P = 0.040$ based on the F test) (Figure 2). However, within each year there were not any differences in the number of marketable fruit by cultivar.
- The size of individual marketable fruit harvested from grafted plants was not different from fruit of non-grafted plants (Figure 5).
- Fruit from grafted plants had a lower concentration of soluble solids ($P = 0.036$)(Figure 6).
- The use of the rootstock, RST-04-106-T, did not increase plant shoot or root biomass (Table 1). Stem diameter was larger for the grafted plants ($P = 0.005$), which may increase the overall durability of plant stems.
- There was not an effect of the grafted rootstock on the chlorophyll leaf content; however, there was an interaction between the main effects of cultivar and grafting.

While grafting shows promise to increase marketable tomato yields for Midwest farmers using high tunnels, the trade-off of fruit quality must be considered. Additional, localized trials of alternative hybrid rootstocks should be utilized to drive decisions leading To the adoption of large-scale grafted tomato production.

Figure 7. Farmers at the 2016 Fruit and Vegetable Field Day examine grafted and non-grafted tomatoes in the high tunnel.

Acknowledgements

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