Effect of Fertilizer Source and Grafting on Quality of High Tunnel Grown Tomato

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Introduction:

Tomato is a major vegetable crop world-wide in general and specifically in high tunnel production. Vegetable grafting has been used for the last 60 years by commercial growers in Asia, and the last 20 years in Europe, for tomato grown in greenhouses, to increase plant vigor and improve plant production. This study investigated two fertilizer sources (commercial conventional blend vs. poultry manure plus urea) and the use of three rootstocks ('Estamino', 'Maxifort', 'DRO138TX') as well as non-grafted plants to determine if there were benefits for fruit quality of tomato cv. Panzer grown in high tunnels in northwest Washington.

Materials and Methods:

This study was conducted at Washington State University (WSU) Northwestern Washington Research and Extension Center (NWREC), Mount Vernon, WA (48°43'24" N, 122°39'09" W, elevation 6 m). The summer climate is cool and humid with 15 °C average daily temperature and 83% average relative humidity.

Experimental design:

The experiment used a randomized complete block split plot design with four replications.

Treatments:

Main plot treatment: Fertilizer

1) Commercial conventional fertilizer: a mixture of urea (46-0-0), monoammonium phosphate (11-52-0), potassium sulfate (0-0-50) and agricultural lime (36% Ca). Application rate: 112N-74P-47K kg·ha^{-1}

2) Poultry manure + urea: manure was provided by a local farm and applied at 2242 kg·ha^{-1}, urea fertilizer was added at 90 kg·ha^{-1} to provide balance for the N application rate. Application rate: 101N-58P-26K kg·ha^{-1}

Subplot treatments:

1) 'Panzer' grafted on 'Estamino'
2) 'Panzer' grafted on 'Maxifort'
3) 'Panzer' grafted on 'DRO138TX'
4) Non-grafted 'Panzer' (control)

'Panzer' was selected for this study as it has resistance to common greenhouse diseases and is recommended for high tunnel production systems (Reid et al., 2012)

Figure 1. Grafting 'Panzer' at WSU NWREC

Figure 2. Transplanting tomato in high tunnel plots at WSU NWREC

Figure 3. Pruning tomato in high tunnel plots at WSU NWREC

Marketable fruit quality data collection:

- Firmness (Newton)
- Juice content (%) SS
- Total soluble solids (TSS, measured as ^{0}Brix)
- pH
- Titratable acidity (% citric acid eq.)

Data analysis: JMP, Version 11.0 for Windows; SAS Institute, Cary, NC. Treatment means were compared using LSMeans Student's test at $\alpha = 0.05$. If no transformation satisfied the assumptions of normality and homogeneity of variance, a nonparametric analysis was applied using Wilcoxon/Kruskal-Wallis Tests (Rank Sums) test in JMP.

Figure 4 . Panzer tomato in the high tunnel on 21 July, 2015 (83 days after transplanting) at WSU NWREC

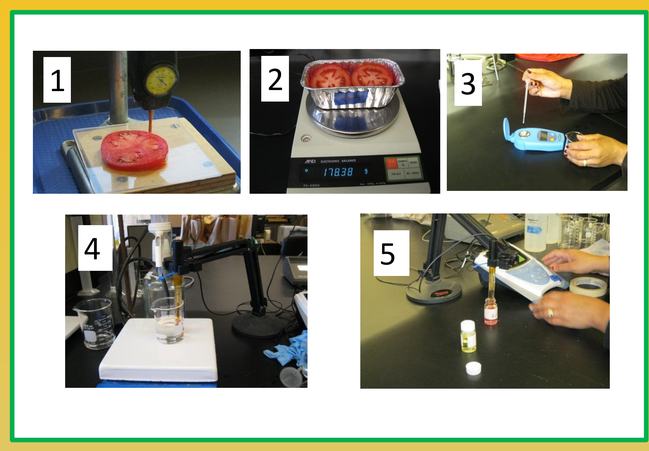

Figure 5. Fruit quality measurements in the Vegetable Horticulture lab at WSU NWREC: 1) Firmness (N), 2) Juice content (%), 3) Total soluble solid (°Brix), 4) pH, and 5) Titratable acidity (% CA eq.)

Table 1. Mean values for fruit quality parameters measured for 'Panzer' tomato grafted with three rootstock treatments and non-grafted in a high tunnel at WSU NWREC, on 4 dates (days after transplanting, DAT) 2015

Treatment	27 July (89 DAT)	3 Aug (95 DAT)	10 Aug (100 DAT)	17 Aug (117 DAT)
		Firmness (N)		
DRO 138	266	270	250	239
Estamino	231	251	237	278
Maxifort	231	241	211	272
Nongrafted	253	289	265	289
P-values	0.74	0.32	0.23	0.22
		Juice Content (%)		
DRO 138	93.4	93.1	93.6	93.5
Estamino	93.4	93.4	93.6	93.8
Maxifort	93.7	93.3	93.4	93.5
Nongrafted	93.1	92.7	93.1	93.2
P-values	0.09	0.1	0.005	0.009
		Total Soluble Solids(°Brix)		
DRO 138	5.2	5.3	4.5	5.2
Estamino	5.2	5.2	4.6	5.1
Maxifort	5.2	5.3	4.7	5.3
Nongrafted	5.2	5.4	4.7	5.4
P-values	0.91	0.26	0.87	0.08
		pH		
DRO 138	4.4	4.3	4.3	4.4
Estamino	4.3	4.3	4.4	4.4
Maxifort	4.3	4.3	4.3	4.4
Nongrafted	4.4	4.3	4.3	4.4
P-values	0.21	0.78	0.01	0.64
		Titratable Acidity (%CA eq.)		
DRO 138	0.33	0.35	0.35	0.33
Estamino	0.32	0.36	0.34	0.32
Maxifort	0.34	0.36	0.36	0.32
Nongrafted	0.48	0.38	0.35	0.31
P-values	0.37	0.6	0.73	0.57

Table 2. Mean values for fruit quality parameters measured for 'Panzer' tomato grown with two fertilizer treatments in a high tunnel at WSU NWREC, on 4 dates (days after transplanting, DAT) 2015

Treatment	27 July (89 DAT)	3 Aug (95 DAT)	10 Aug (100 DAT)	17 Aug (117 DAT)
		Firmness (N)		
Commercial	254	271	253	260
Poultry	235	255	228	280
P-values	0.44	0.42	0.18	0.24
		Juice Content (%)		
Commercial	93.5	93.1	93.4	93.5
Poultry	93.3	93.1	93.5	93.5
P-values	0.4	0.8	0.32	0.94
		Total Soluble Solids(°Brix)		
Commercial	0.39	0.37	0.35	0.33
Poultry	0.34	0.35	0.35	0.31
P-values	0.52	0.07	0.75	0.11
		pH		
Commercial	4.3	4.3	4.3	4.4
Poultry	4.3	4.3	4.3	4.4
P-values	0.43	0.22	0.7	0.39
		Titratable Acidity (%CA eq.)		
Commercial	0.39	0.37	0.35	0.33
Poultry	0.34	0.35	0.35	0.31
P-values	0.52	0.07	0.75	0.11

Results:

- Fruit from grafted plants had higher juice content (%) than non-grafted plants on 10 and 17 Aug (Table 1).
- There was no significant effect due to fertilizer source on the juice content of tomato fruit (Table 2).
- Fruit from plants grafted with 'Estamino' rootstock had a higher pH value than other grafted and non-grafted plants on 10 Aug (Table. 1).
- There were no significant effects due to fertilizer source and rootstock treatments on fruit firmness, TSS and titratable acidity (Table 1).

Conclusions:

- **Rootstock:** 'Panzer' grafted with three rootstock treatments resulted in higher juice content (%) at 100 and 117 DAT, and higher pH at 100 DAT than non-grafted plants.
- **Fertilizer:** There were no significant effects due to fertilizer source on quality parameters measured in this study.

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Reference:

- Reid, J., K. Klotzbach, and N. Hoover. 2012. 2011 High tunnel tomato variety trial. Cornell University Cooperative Extension Publication 8 (2): 3- 20.