EFAO HORTICULTURE 2019: Tomato grafting in high tunnels

Do grafted tomatoes pay off in high tunnels in Ontario?

MULTI-FARM

DISEASE & PEST CONTROL

SEED PRODUCTION & BREEDING

Farmer-Researchers

Eric Barnhorst
Eva Mae Farm - East

Jenny Cook
Knuckle Down Farm - East

Sarah Judd
Meadow Lynn Market - West

Nathan Klassen
Nith Valley Organics - West

Project timeline:
Winter 2019 - Fall 2019

IN A NUTSHELL

Grafting is a proven way to incorporate disease resistance into tomato transplants. However adoption of this practice to high tunnel production is relatively new, so these four growers were curious about the economic viability of grafting tomatoes for production in high tunnels in southern Ontario.

Key Findings

- Grafted tomatoes had greater total marketable yield regardless of scion variety.
- Grafted tomatoes had greater overall plant health.
- Grafted tomatoes had higher net returns on average but the degree of economic benefit varied by farm.
- Yield advantage for grafting likely depends on scion variety and scion and rootstock compatibility.

BACKGROUND

Specialized tomato rootstock are used in greenhouses to confer resistance to soilborne disease and provide improved longevity and total marketable yield. Even when soilborne disease isn't a problem, specialized rootstock can provide a yield advantage - especially for heirlooms (1). Growing grafted tomatoes in high tunnels is relatively new but may also prove advantageous (2).

METHODS

Grafting - *See page 2*
Experimental Design - *See page 2*

Table 1

Experimental design for the multi-farm tomato grafting trial (G = grafted; U = ungrafted).

Farmer, Farm	Design	Replicate	Scion Variety	Rootstock for grafted plants*	In-row or in-section arrangement and # plants per section
Eric, Eva Mae Farm	5 rows randomly assigned a scion; each half row randomly assigned to grafted rootstock or ungrafted control; transplanted April 29	Row 1	Margold (F1)	Estamino	12G + 12U
		Row 2	Tomimaru Muchoo (F1)	Estamino	12U + 12G
		Row 3	Moskvich (heirloom)	Estamino	8G + 8U
		Row 4	Black Prince (heirloom)	Estamino	8G + 8U
		Row 5	Marbonne (F1)	Estamino	2U + 12G
Jenny, Knuckle Down Farm	1 row with 3 blocks of 2 sections each; each block randomly assigned a scion; each half section randomly assigned to grafted rootstock or ungrafted control; transplanted May 11	Block 1	Moskvich (heirloom)	Estamino	8G + 8U
		Block 2	Margold (F1)	Estamino	8G + 8U
		Block 3	Marbonne (F1)	Estamino	8U + 8G
Sarah, Meadow Lynn Market	2 rows; each half row randomly assigned to grafted rootstock or ungrafted control; transplanted June 4	Row 1	Arbason (F1)	Estamino	19G + 20U
		Row 2	Arbason (F1)	Estamino	22U + 20G
Nathan, Nith Valley Organics	2 greenhouses; greenhouse 1 transplanted on May 29 and greenhouse 2 transplanted on May 15	Greenhouse 1	Caiman (F1)	Maxifort	24G + 18U
		Greenhouse 2	Caiman (F1)	Estamino	32G + 12U
		Greenhouse 2	Caiman (F1)	Maxifort	88G + 12U

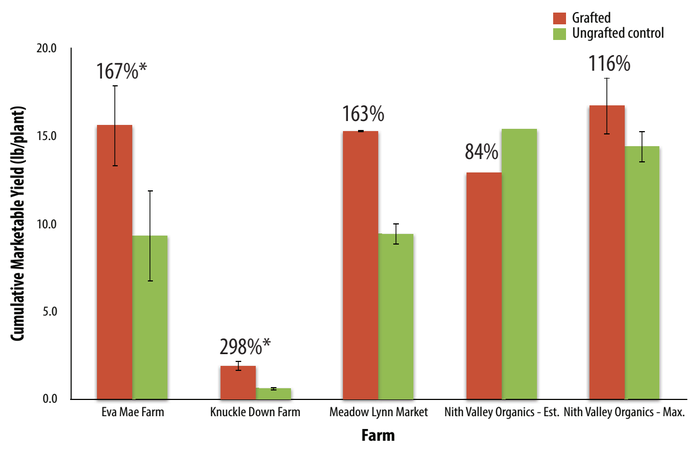
*Estamino and Maxifort rootstock were sourced from Johnny's

RESULTS

Yield

Figure 1

Total marketable yield of grafted and ungrafted tomatoes from each farm. Bars are means (+/- standard error). % yield advantage is above the grafted bars. Est. = Estamino; Max. = Maxifort.



*P-values < 0.05 for individual farms; P<0.002 for all farms combined.

Note that individual statistics for Meadow Lynn Market and Nith Valley Organics were not possible because of too few replicates.

For Sarah's trial, grafted seedlings (started at Nith Valley Organics) were ready to be transplanted 2 weeks before the ungrafted seedlings (started at Meadow Lynn Market). For this reason grafted plants were taller and a little greener, but more spindly and needed to be supported. However, grafted and ungrafted plants looked very similar a few weeks after transplanting.

Total marketable yield at Knuckle Down Farm was much lower than the other farms. T he bed where the trial was planted had been used for several years and Jenny suspects it was not adequately amended prior to planting.

For each harvest day throughout the season, the growers weighed tomatoes from every section separately (!!). They added up all weights from harvest dates for total marketable yield per plant.

Grafting did not necessarily extend production length (*Table 2 on page 2*), but grafted tomatoes produced more marketable tomatoes than the ungrafted control plants (P<0.002). This yield advantage was seen across different scion varieties and farms (Figure 1).

Photo. Vigour difference between grafted (*left*) and ungrafted (*right*) Margold tomatoes at Eva Mae Farm on July 17, 2019.

Estamino performed well, and 10/11 comparisons on 6 scion varieties produced greater total marketable yield compared to ungrafted plants (P<0.003). This is consistent with other studies (5, 6).

There was not enough data from **Maxifort** rootstock to draw conclusions but two comparisons suggest that it may also be a good choice for the region, which is also consistent with other studies (5).

Caiman (Nith Valley Organics) had the highest yield for ungrafted plants. It also showed the lowest yield advantage on Maxifort and no yield advantage on Estamino. This may be because Caiman, as a greenhouse variety, already has a good disease package and good overall vigour.

Plant Health - *See page 2*
Net Return - *See Table 3 on page 2*

Because of a large yield advantage, it was economical for Eric and Sarah to graft tomatoes.

For example: Eric estimates his extra cost to produce grafted seedlings is $4.47 /plant. His average yield advantage is 6.3 lb/plant, so the extra cost to produce the grafted seedling is ($4.47/plant) / (6.3 lb/plant) = $0.71.

Nathan was interested to see if Caiman, a greenhouse variety with good disease package and good overall vigour, would benefit enough from grafting to be economical. This data show that grafting Caiman on Maxifort was not economical at his retail price of $2.08/lb but was economical at Eric' retail price of $3.25/lb.

Because Jenny's yields were low in general (see note in Yield section), it was not economical for her to graft tomatoes.

TAKE HOME MESSAGE

Multi-farm trials are a powerful way for growers to gain robust answers to their research questions. In this study, four farmer-researchers showed that grafting tomatoes for production in high tunnels in southern Ontario can be profitable.

Estamino rootstock performed well in the region and across different scions. Preliminary data suggest that the exception to Estamino's performance is with Caiman - an already vigorous greenhouse variety. There was an indication that Maxifort might be a good choice for Caimin.

This data shows that in order to take advantage of grafting tomatoes for high tunnel production you should have generally good yields, use a scion that will benefit enough to make grafting worthwhile, pair scion and rootstock for compatibility; and, finally, use cost of production to compare the advantage for your farm.

[Continued on page 2]

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2. Lang and Nair. 2019. https://doi.org/10.21273/HORTSCI13874-19
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5. Nair and Lang. 2019. https://www.iastatedigitalpress.com/farmreports/article/id/468/
6. Bitter and Gao. 2017. https://projects.sare.org/project-reports/os13-083/

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METHODS continued

Grafting

The healing chamber is critical to grafting success. A good chamber provides darkness, misting for humidity, and temperature control. To graft, Eric modified the method from reference 3. Briefly, he found rootstock-scion pairs of similar diameter, placed the seedlings in the dark for 1 hour to halt photosynthesis, performed the grafts on a bench next to the healing chamber and immediately placed them into the chamber that was prepared at ~26°C and high humidity. Grafts remained in complete darkness for 48-72 hours and then progressively experienced lower humidity and temperature and higher light for about 1 week. Survival was around 80%. Nathan modified his healing chamber and water timing based on reference 4. He also ran a propagation controller to provide mist during initial stages of healing. His grafting technique was similar to Eric's, although the seedlings were not placed in the dark for an hour before grafting.

Eric grafted and grew grafted and control seedlings for himself and Jenny. He seeded rootstock and scion varieties on Feb 12, more scion on Feb 18, and control varieties on Feb 25; and he grafted on multiple sessions between March 4-16. Nathan grafted and grew grafted seedlings for himself and Sarah, and they grew control seedlings for themselves. Eric transplanted on April 29, Jenny on May 11, Sarah on June 4 and Nathan on May 15 in greenhouse 2 and May 29 in greenhouse 1.

Experimental Design continued

Each farmer compared replicate pairs of grafted and ungrafted tomatoes, following the design in Table 1, for a total of 13 replicate comparisons. The growers used two rootstocks and 7 scion varieties, such that we can not draw conclusions about individual scion varieties or one rootstock.

Eric's design: 5 rows randomly assigned a scion; each half row randomly assigned to grafted rootstock or ungrafted control (5 replicate pairs).

Jenny's design: 1 row with 3 blocks of 2 sections each; each block randomly assigned a scion; each half section randomly assigned to grafted rootstock or ungrafted control (3 replicate pairs).

Sarah's design: 2 rows; each half row randomly assigned to grafted rootstock or ungrafted control (2 replicate pairs).

Nathan's design: 2 greenhouses; each greenhouse with 1 comparison of Maxifort (2 replicate pairs) and an additional comparison of Extamino in greenhouse 2 (1 replicate pair).

RESULTS continued

Yield continued

Table 2

Production statistics for grafted and ungrafted tomatoes at the four farms. G = grafted; U = ungrafted.

Farmer, Farm	First Harvest	Last Harvest	Production (weeks)*
Eric, Eva Mae Farm	U, Jul 26 G, Jul 19	Oct 18	U, 12 G, 12
Jenny, Knuckle Down Farm	Jul 3	Sep 30	12.5
Sarah, Meadow Lynn Market	U, Aug 6 G, Aug 12	Oct 28	U, 12 G, 11
Nathan, Nith Valley Organics	U, Jul 15 G, Jul 13	Oct 14*	U, 13 G, 12

*Nith Valley Organics heated their greenhouse and extended harvest to October 28. All data used in this report is from the unheated greenhouse but conclusions did not change when data from the heated greenhouse was used.

Plant Health

For plant health, the growers observed differences but no data was recorded. Compared to ungrafted plants, they consistently reported that the grafted plants had:

- Higher quality fruit (bigger, lower % culls)
- Even ripening, better colour (less yellow shoulders)
- Larger, more robust plants
- Less susceptibility to cracking
- More disease resistance against soil borne disease (*Septoria* leaf spot at Eric's)
- More disease resistance against airborne disease, even though the rootstock only confers soilborne disease resistance (*Botrytis* on Tomimaru and Marbonne at Eric's)

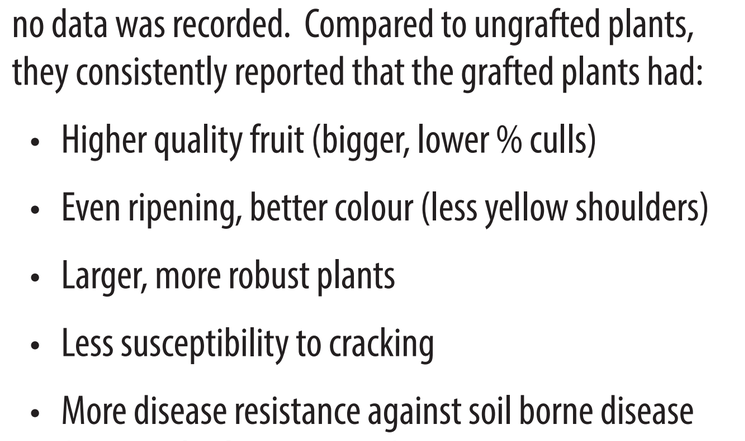

Photo: Healing chamber at Nith Valley Organics.

Photo: Vigour difference between grafted (*left*) and ungrafted (*right*) tomatoes growing at Meadow Lynn Market.

Table 3

Estimated minimum retail price needed to see a net return on grafting based on two estimates of cost of production for ungrafted tomato seedlings.

Farm	Cost to produce to yield advantage from grafted plants	
	Scenario 1 - Eva Mae Farm seedling cost of production: $6.47 grafting cost - $1.80 standard seedling cost = **$4.47/seedling extra cost to graft**	**Scenario 2 - Nith Valley seedling cost of production:** $6.47 grafting cost - $1.20 standard seedling cost = **$5.27/seedling extra cost to graft**
Eva Mae Farm	$0.71 /lb	$0.81 /lb
Knuckle Down Farm	$3.55 /lb	$4.03 /lb
Meadow Lynn Market	$0.76 /b	$0.86 /lb
Nith Valley Organics - Estamino	No yield advantage	No yield advantage
Nith Valley Organics - Maxifort	$2.12 /lb	$2.40 /lb
All farms combined Estamino and Maxifort combined Estamino only	 **$1.26 /lb** **$1.09 /lb**	 **$1.43 /lb** **$1.24 /lb**

Eric's retail price for tomatoes was $3.25/lb and Nathan's was $2.08/lb.

Acknowledgements

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