FINAL REPORT

High Tunnel Production of High Lycopene Tomatoes Using a New Disease Resistant Rootstock

David Trinklein
Associate Professor
Division of Plant Sciences
University of Missouri

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BACKGROUND

The demand for locally-grown produce in Missouri has never been greater. Concerns over the safety, quality and nutritional content of produce imported from other states and/or countries have made vegetables an attractive alternative cash crop for Missouri farmers.

Accordingly, high tunnel production of tomatoes in Missouri is rapidly increasing as producers obtain premium prices for high quality, early season tomatoes. Tomatoes can be produced in tunnels for several years, but ultimately, soil-borne diseases, including root-knot nematodes, can become problematic. For sustained productivity, grafted tomato plants on a disease and nematode-resistant rootstock may be a necessity. While the production of grafted tomatoes is widespread in Asia, it is relatively new in the United States.

'Trooper' (*Solanum lycopersicon* x *S. hirsutum*) is new tomato rootstock introduced to North America in 2010. It carries resistance to tomato mosaic virus, *Fusarium* and *Verticillium* wilt, *Fusarium* crown and root rot, corky root rot, and nematodes.

Plant geneticists have identified a recessive gene (named 'crimson') which, when present in the homozygous state, imparts a deeper red color resulting from a lycopene content 50 percent higher than regular tomato fruit. Recent research has shown lycopene to be a potent anti-oxidant associated with decreased incidence of certain cancers, coronary heart disease, and cataracts. Tomato is the primary source of lycopene in the human diet.

'Health Kick' is a relatively new tomato cultivar that carries the crimson gene. It is a large saladette tomato that has an intense red flesh color along with a high lycopene content. While 'Health Kick' has many attributes, it is susceptible to certain diseases, which limit yield. However, production may be enhanced by grafting 'Health Kick' onto 'Trooper' rootstock.

The objective of this study was to investigate the influence of grafting 'Health Kick' tomato onto 'Trooper' rootstock on the production of high-lycopene tomatoes under high tunnel production conditions.

PROJECT APPROACH

On March 20, 2012 seeds of the tomato rootstock 'Trooper' were sown in plastic bedding plant trays using ProMix BX (Premier Peat Company) as a germination medium. Following seeding, the trays were placed in a controlled environmental chamber where they were exposed to a temperature of 26ºC (79ºF), 80% relative humidity and a 12 hour photoperiod. On March 23, 2012, the same procedure was followed using 'Health Kick' tomato seeds. The difference in sowing date reflects the difference in germination time between the two varieties determined in trials conducted earlier.

On March 28, 2012, seedlings of both 'Health Kick' and 'Trooper' were transplanted into plastic bedding plant packs filled with ProMix BX. Packs contained four cells measuring 5.1 cm. (2 in.) by 5.7 cm. (2.25 in.) each. When seedling stems of both cultivars approximated 2 mm in diameter, 40 'Health Kick' seedlings were grafted onto 'Trooper' rootstock using silicone tubular grafting clips (Seedway Seed Co.). Additionally, 40 'Health Kick' seedlings were allowed to develop on their own rootstock to serve as a control. All seedlings remained in the plant growth chamber whose environmental conditions were described in the previous paragraph until the establishment of graft unions on those seedlings that were grafted.

Following that, all seedlings were moved to a greenhouse at the University's Ashland Road research facility to grow to transplantable size. There, they were exposed to temperatures of 26ºC (78ºF) day and 18ºC (65ºF) night and fed (continuous liquid feed) a nutrient solution

containing 250 ppm N, 62 ppm P_2O_5 and 238 ppm K_2O derived from Peters Excel 20-5-19 fertilizer (Scotts Miracle-Gro Company).

On April 30, 2012 both grafted seedlings and those growing on their own rootstock were transplanted into a high tunnel located at the University of Missouri's Bradford Research and Extension Center. Five replications each containing seven replicate plants of the two treatments (grafted and un-grafted) were planted on 24 inch centers in rows spaced 36 inches apart in a randomized complete block design. Prior analysis of the soil (see Appendix) revealed adequate-to-high levels of nutrients; therefore a pre-plant fertilizer was not applied. Immediately after transplanting, all plants received approximately 200 cc of a nutrient solution derived from Peters 9-45-15 (Scotts Miracle-Gro Company) mixed at the rate of 540 ppm N, 2700 ppm P_2O_5 and 900 ppm K_2O. Beginning on June 25, 2012 and continuing on a weekly basis throughout the life of the crop, greenhouse grade calcium nitrate (Viking Ship Brand) was applied via drip irrigation at the rate of 130 grams fertilizer per 30.5 meters of row.

Plants were supported using the short-stake weave system. Water was supplied via drip irrigation; the amount supplied varied according to the age of the crop. Values ranged from 2.5 l./plant/week early in the crop to 15.5 l./plant/week when plants were mature and fruit set was heavy. The presence of disease was monitored visually on a weekly basis. Tomatoes were harvested July 9, 16, 23, 26, 30, August 3, 6, 10, 14, 20 and 29, 2012. Number and total weight of fruit were recorded at each harvest date.

OUTCOMES

Table 1 clearly indicates that 'Health Kick' plants grafted onto 'Trooper' rootstocks out-performed non-grafted plants numerically in the three parameters used to measure yield: fruit

number, total yield and average fruit weight. All data represents performance on a per-plant basis.

Table 1. Influence of grafting on fruit number, total yield and average fruit weight.

Treatment	Fruit Number	Total Yield (kg.)	Ave. Fruit Wgt. (g.)
Non-grafted	62.7	6.2 (13.7 lb.)	99.3 (3.5 oz.)
Grafted	72.6	7.7 (17.0 lb.)	105.1 (3.7 oz.)
	5.0*	0.70*	2.9*

*Standard error mean

The same result of superior performance of grafted over non-grafted plants held true for early yield (Table 2). Early yield was defined as data collected on the first two harvest dates.

Table 2. Influence of grafting on fruit number, early yield and average early fruit weight.

Treatment	Fruit Number*	Early Yield (kg.)*	Ave. Fruit Wgt. (g.)*
Non-grafted	57.8	1.6 (3.5 lb.)	99.4 (3.5 oz.)
Grafted	97.0	2.8 (6.2 lb.)	107.9 (3.8 oz.)
	19.6**	0.6**	4.3**

*First two harvests. ** Standard error

As stated earlier, the rootstock 'Trooper' carries resistance to tomato mosaic virus, *Fusarium* and *Verticillium* wilt, *Fusarium* crown and root rot, corky root rot, and nematodes. Indeed, an objective of this study was to determine if that resistance imparted any affect on the productivity of grafted plants. Weekly observations failed to identify any incidence of the above diseases, either on grafted or non-grafted plants. Therefore there was no data to collect or differences between treatments to analyze.

BENEFICIARIES

All current and future tomato producers should benefit from the results of this study. The fact that grafted tomato plants produced greater yield (both early and total) should enhance the profitability of the nearly 700 tomato production operations in Missouri. The use of grafted disease resistant rootstocks should benefit organic growers and has the potential of reducing or eliminating the use of fungicides for non-organic growers. High-lycopene tomatoes have the potential of commanding higher prices at the market and greater return to the grower because of their phyto-nutrient content. Also, consumers would enjoy the nutritional and other health benefits of high quality, locally produced, high-lycopene tomatoes

LESSONS LEARNED

High tunnels provide a more ideal environment for tomato production compared with outdoor production. Highly amended soil along with warmer soil temperatures often prompt varieties growing on their own rootstocks to produce more vigorous root systems than when growing outdoors. This has caused some to question the need to bear the expense of grafting a more vigorous rootstock onto a hybrid scion. This study demonstrated that, even under more favorable conditions for root growth, grafted tomatoes out-yielded non-grafted. The latter fact should cause all growers to consider seriously tomato grafting as a standard, "best management practice".

This study also was designed to determine the influence of tomato grafting on disease severity. The fact that there appeared to be little if any selection pressure for the common tomato diseases made any assumptions concerning the benefit of grafting on disease incidence impossible to make.

CONTACT PERSON

Dr. David Trinklein
Associate Professor Plant Sciences
University of Missouri
Columbia, MO 65211
573-882-9631
trinkleind@missouri.edu

APPENDIX

University Extension
University of Missouri
Columbia

Soil Test Report

----------MU Laboratories----------

23 Mumford Hall
Columbia, MO
(573) 882-0623

or

P.O. Box 160
Portageville, MO
(573) 379-5431

Serial No.	County	Region
G87813H-2	Boone	3

Submitted	Processed
3/26/2012	3/28/2012

http://www.soiltest.psu.missouri.edu/

Sample ID: HOOP-WEST

Lab No: C1210600

This report is for:

DAVE TRINKLEIN
1-87 AG BLDG
COLUMBIA MO 65211
trinkleind@missouri.edu

Last Limed: unknown

Submitted by:
Firm No. 80 Outlet: 998
soiltestingservices@missouri.edu
573-882-0623

SOIL TESTING LAB-RESEARCH
23 MUMFORD HALL
UNIVERSITY OF MISSOURI

COLUMBIA, MO 65211

SOIL TEST RESULTS			RATING					
			Very low	Low	Medium	High	Very high	Excess
pHs	7.7		**********					
Phosphorus (P)	550	lbs/a						**********
Potassium (K)	368	lbs/a			**********			
Calcium (Ca)	5621	lbs/a					**********	
Magnesium (Mg)	1052	lbs/a					**********	
Organic Matter:	5.7 %		Neutr. Acidity: 0.0 meq				CEC: 18.9 meq	

Fertilizer & Limestone Recommendations (lbs/1000 sq ft)

Crop	Nitrogen (N):	Phosphorus(P_2O_5)	Potash (K_2O)	Zinc(Zn)	Sulfur(S)	LIME
1 vegetables	0.0	0.0	0.0		22.0	0
						0
						0