Soil fertility drives yield gains and losses of grafted tomatoes in Nebraska

Raihanah Hassim[1] , Sam E. Wortman[1] , Ashley A. Thompson[2] and Stacy Adams[1]
[1]University of Nebraska- Lincoln, [2]Oregon State University

Introduction

Grafting has been successfully used in vegetable production like tomato, pepper, eggplant, cucumber and watermelon. Other than its usefulness for managing soil-borne diseases, studies have shown that grafting tomatoes with rootstocks like 'Maxifort' and 'Estamino' can improve nutrient uptake and yield. Grafting creates a new plant with a combination of desirable above- and belowground attributes from selected scion and rootstock plants. However, only a few studies have assessed the effects of grafting and soil fertility management on yield of open field-grown tomatoes in the Midwest. Thus, there is a need to better document the effects of grafting heirloom and hybrid tomato cultivars onto hybrid tomato rootstocks on tomato yield and quality.

Objective

Improve fresh market tomato yield, nutrient uptake, drought tolerance, and disease resistance in Nebraska through the use of grafted rootstocks.




Methods

In 2017, the determinant heirloom tomato 'Nebraska Wedding' was grafted onto two rootstocks, 'Estamino' and 'Maxifort' (Table 1.). Non-grafted and self-grafted 'Nebraska Wedding' plants were controls. Plants were grown at two locations: high fertility soil in (1) Lincoln, NE, and low fertility soil in (2) Mead, NE as a strip-strip plot. Five tomato plant replicates of the four rootstock treatments received one of four fertilizer treatments (Table 3.).

Table 1. Grafting treatments

Rootstocks
Non-grafted (NG)
Self-grafted (SG)
Estamino (EST)
Maxifort (MAX)

Table 2. Soil physiochemical conditions were measured 0-20 cm prior to planting.

Location	NO_3-N (ppm)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	pH
Lincoln, NE	10.7	90	410	2720	343	6.2
Mead, NE	2.6	5	324	2010	384	5.7

Table 3. Fertilizer treatments and application rates

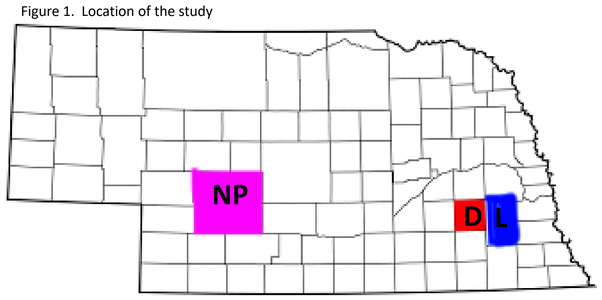
Fertilizer Treatment	Plant Available N (kg ha^{-1})
Control (CON)	0
$Ca(NO_3)_2$ Fertigation (N)	168
Yardwaste Compost (YW)	168
Integrated [yardwaste Compost + $Ca(NO_3)_2$] (YWN)	84 + 84

In 2018, two determinant fresh market tomatoes, 'Nebraska Wedding' and 'BHN-589,' were grafted onto two rootstocks, 'Estamino' and 'Maxifort' (Table 4). Non-grafted 'Nebraska Wedding' and 'BHN-589' plants were controls. Plants were grown at three different locations: high fertility soil in (1) Lincoln, NE, low fertility soil in(2) North Platte, NE, and high fertility soil in (3) Dwight, NE as a randomized complete block design. Five tomato plant replicates of the six grafting treatments received fertilizer treatments with recommended NPK rate.

Table 4. Grafting treatments

Rootstocks
Non-grafted Nebraska Wedding (NW-NON)
Non-grafted BHN-589 (BHN-NON)
Nebraska Wedding grafted to Estamino (NW-EST)
Nebraska Wedding grafted to Maxifort (NW-MAX)
BHN-589 grafted to Estamino (BHN-EST)
BHN-589 grafted to Maxifort (BHN-MAX)

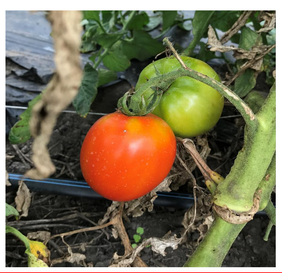
Figure 1. Location of the study



Data Collection:

- Tomatoes were harvested weekly and bi-weekly during later season at each location.
- Yield was determined by weighing all tomatoes from the five plants in each experimental unit.
- Data were analyzed for effects of grafting treatment, location, and their interaction.





Results 2017

- In high fertility soil, grafting to EST or MAX reduced yield by 41% and 48% relative to NG plants (Fig. 2.).
- Fertilizer treatments did not affect tomato yield in the high fertility soil, but did increase leaf nutrition (Fig. 3.).
- In low fertility soil, tomatoes grafted to EST had 20% greater yield than NG plants (Fig. 4.).
- MAX rootstocks did not increase yield compared to NG in low fertility soil (Fig. 4.).
- Fertilizing with $Ca(NO_3)_2$ alone and YWN increased tomato yield in the low fertility soil (Fig. 5.)

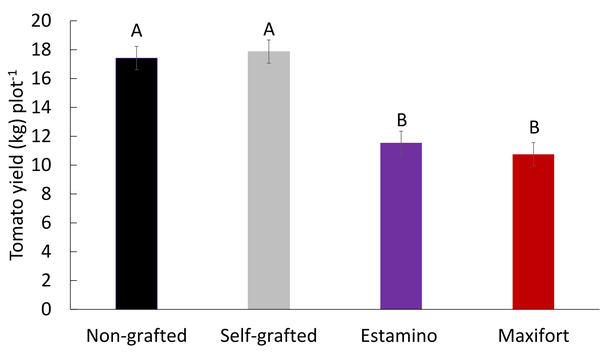


Figure 2. Tomato yield for each rootstock was determined by weighing all fruit in each 5 plant experimental unit harvested at the high soil fertility location in Lincoln, NE. Different letters indicate significantly different means using Tukey's HSD test. Error bars indicate the standard error.

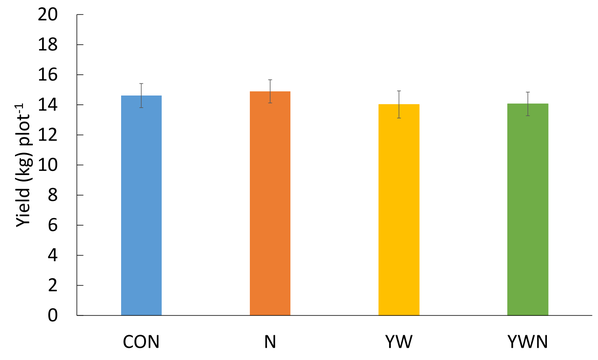


Figure 3. Tomato yield for each fertilizer was determined by weighing all fruit from each 5 plant experimental unit harvested at the high soil fertility location in Lincoln, NE. Error bars indicate the standard error.

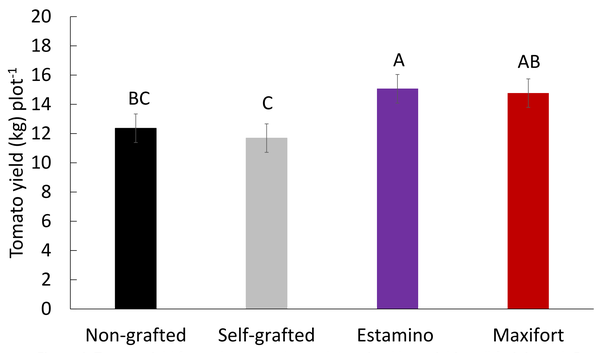


Figure 4. Tomato yield for each rootstock was determined by weighing all fruit in each 5 plant experimental unit harvested at the low soil fertility location near Mead, NE. Different letters indicate significantly different means using Tukey's HSD test. Error bars indicate the standard error.

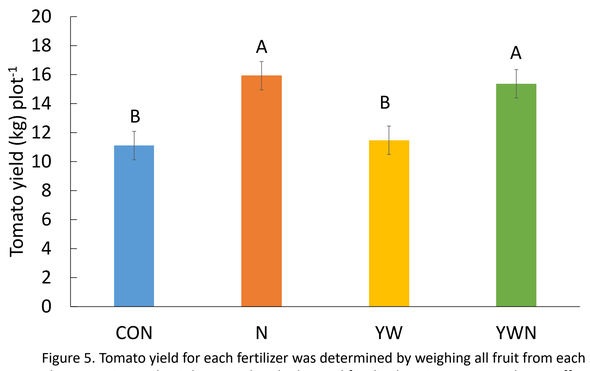


Figure 5. Tomato yield for each fertilizer was determined by weighing all fruit from each 5 plant experimental unit harvested at the low soil fertility location near Mead, NE. Different letters indicate significantly different means using Tukey's HSD test. Error bars indicate the standard error.

Results 2018

- In all 3 locations, 'BHN 589' yield was great than 'Nebraska Wedding'
- In **high fertility soil**, grafting NW to EST or MAX **reduced** yield relative to non-grafted plants (Fig. 6,7.).
- In **low fertility soil**, grafting NW to EST or MAX **increased** yield relative to non-grafted plants (Fig. 8.).
- Grafting BHN to EST or MAX increased yield relative to non-grafted plants in the lower fertility soil (Fig. 7,8.).

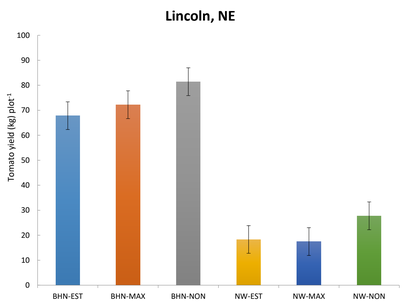


Figure 6. Tomato yield for each rootstock was determined by weighing all fruit in each 5 plant experimental unit harvested at the high soil fertility location in Lincoln, NE. Error bars indicate the standard error.

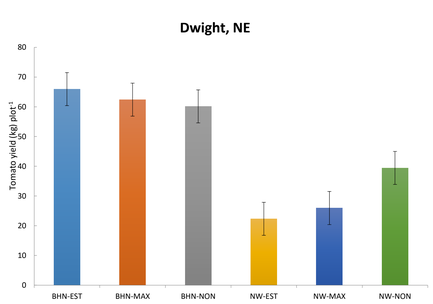


Figure 7. Tomato yield for each rootstock was determined by weighing all fruit in each 5 plant experimental unit harvested at the high soil fertility location in Dwight, NE. Error bars indicate the standard error.

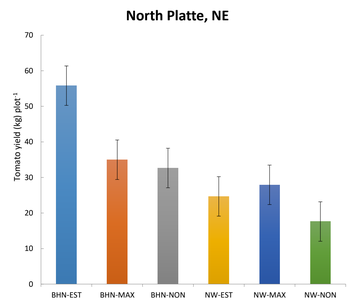


Figure 8. Tomato yield for each rootstock was determined by weighing all fruit in each 5 plant experimental unit harvested at the low soil fertility location in North Platte, NE. Error bars indicate the standard error.



Table 5. Location description

Location	NO_3-N (ppm)	OM %	CEC (me/100g)	Average Annual Precipitation (inches)	Soil Type	pH
Lincoln, NE	9.5	3.6	19.7	28.9	Silty Clay Loam	6.4
North Platte, NE	4.7	1.9	8.6	20.8	Cozad Silt Loam	6.8
Dwight, NE	23.7	3.2	18.6	29.0	Hasting Silt Loam	5.7

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