Grafted Watermelon Plants: Why, Where, and How We Use Them

Pick TN Conference
Franklin, TN; Feb 18, 2022

Matt Kleinhenz
Horticulture and Crop Science

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES















Why

Vegetable Grafting Economics

- ROI and factors influencing it

Big Picture

Common Challenges

- diseases
- nematodes
- insects
- weeds
- abiotic stress

Common Resources

- genes
- material inputs
- practices, tactics

- grafted watermelon plants are used because their genes (traits) replace or supplement other tools in overcoming production challenges

  … grafted plants are production tools


94
13
11
DICKERSON
69
FORRISTALL
87
27
88

- **grafted watermelon plants are used primarily because they often maintain yield potential in the presence of specific, *serious nematodes and soilborne diseases***

Disease, Nematode Resistances Targeted for Inclusion in Watermelon and other Cucurbit Rootstock (RS) Varieties

- Melon Necrotic Spot Virus (MNSV)
- Bacterial Wilt (Rs)
- Fusarium Wilt (Foc/Fom/ Fon:1-3)
- Fusarium Crown and Root Rot (For)
- Rhizoctonia Root Rot (Rs)
- Verticillium wilt (Va:1/Vd:1)
- Root-knot Nematode (Ma, Mi, Mj)

• Individual RS varieties usually include one or more resistances (can be very specific)

Fusarium **effects on grafted and ungrafted plants in Wooster, OH in 2021.**

Fusarium effects on grafted and ungrafted plants in Wooster, OH in 2021. No fruit harvested from ungrafted plots. Marketable yield averaged 58.4 ton (7,484 fruit) per acre in grafted plots (9 plants + 6 pollenizers).

Widespread Testing on Research Stations and Farms

- resistance may be incomplete but it often results in yield greater than from ungrafted plants of the same scion

Disease, Nematode Resistances Targeted for Inclusion in Watermelon and other Cucurbit Rootstock (RS) Varieties

- Melon Necrotic Spot Virus
- Fusarium Wilt
- Rhizoctonia Root Rot
- Root-knot Nematode
- Bacterial Wilt
- Fusarium Crown and Root Rot
- Verticillium wilt

• Individual RS varieties usually include one or more resistances (can be very specific)

RS breeding targets widespread, very damaging disease, nematode issues for which control measures are weak or costly and/or breeding can be effective.

Disease, Nematode Resistances Targeted for Inclusion in Watermelon and other Cucurbit Rootstock (RS) Varieties

- Melon Necrotic Spot Virus
- Fusarium Wilt
- Rhizoctonia Root Rot
- Root-knot Nematode
- Bacterial Wilt
- Fusarium Crown and Root Rot
- Verticillium wilt

• Individual RS varieties usually include one or more resistances (can be very specific)

RS breeding targets widespread, very

Stay tuned; work is ongoing.

which control measures are weak or

costly and/or breeding can be effective.

- **grafted watermelon plants are also used because they may* maintain yield potential in the presence of *abiotic stresses (e.g., salinity, temp., drought and flood)***

*** less well proven than soilborne disease and nematode resistance**

- an additional benefit of using grafted watermelon plants is that fruit they produce can be **superior in grower and consumer quality** than fruit from standard plants

- an additional benefit of using grafted watermelon plants is that fruit they produce can be superior in grower and consumer quality than fruit from standard plants

+

- rind thickness
- flesh color, firmness, soluble solids
- hold quality in field longer

- an additional benefit of using grafted watermelon plants is that fruit they produce can be superior in grower and consumer quality than fruit from standard plants

+

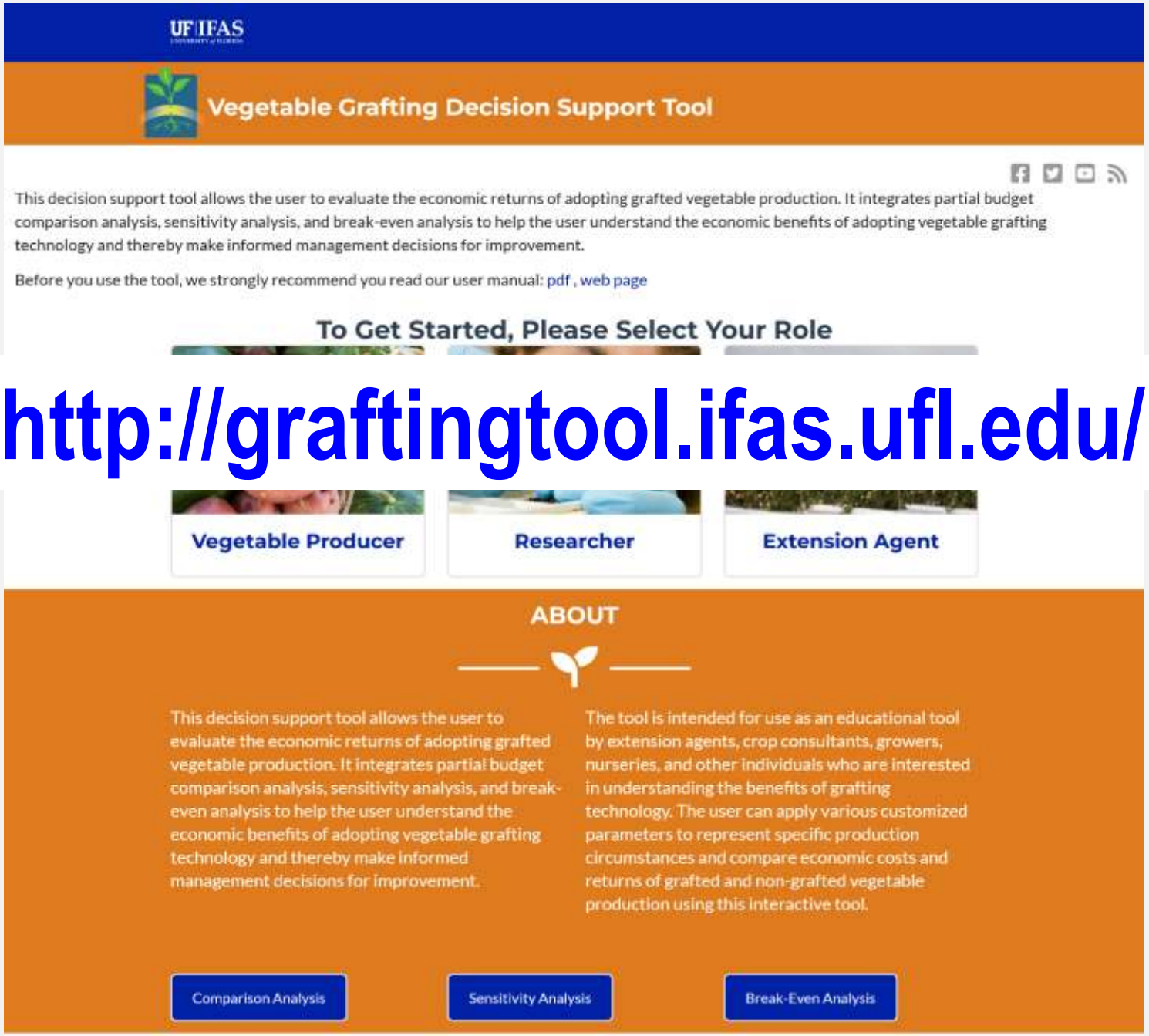
- rind thickness
- flesh color, firmness, soluble solids
- hold quality in field longer

-

- larger
- reach peak quality later

- grafted watermelon plants are used primarily because they often or may maintain yield potential in the presence of specific, serious nematodes and soilborne diseases and/or abiotic stresses and fruit they produce can be superior in grower and consumer quality than fruit from standard plants

$$1 + 1 + 1 = 4$$


UF IFAS
Vegetable Grafting Decision Support Tool
This decision support tool allows the user to evaluate the economic returns of adopting grafted vegetable production. It integrates partial budget comparison analysis, sensitivity analysis, and break-even analysis to help the user understand the economic benefits of adopting vegetable grafting technology and thereby make informed management decisions for improvement.
Before you use the tool, we strongly recommend you read our user manual: pdf , web page
To Get Started, Please Select Your Role
http://graftingtool.ifas.ufl.edu/
Vegetable Producer
Researcher
Extension Agent
ABOUT
This decision support tool allows the user to evaluate the economic returns of adopting grafted vegetable production. It integrates partial budget comparison analysis, sensitivity analysis, and break-even analysis to help the user understand the economic benefits of adopting vegetable grafting technology and thereby make informed management decisions for improvement.
The tool is intended for use as an educational tool by extension agents, crop consultants, growers, nurseries, and other individuals who are interested in understanding the benefits of grafting technology. The user can apply various customized parameters to represent specific production circumstances and compare economic costs and returns of grafted and non-grafted vegetable production using this interactive tool.
Comparison Analysis
Sensitivity Analysis
Break-Even Analysis

Where

Big Picture of Grafted Watermelon Plants

- expected to occupy at least 30% of watermelon acreage by 2030 based on industry and research evidence
- currently occupy >90% of watermelon acreage in at least five other countries

Big Picture of Grafted Watermelon Plants

- # farms, acres in watermelon
- distribution, prevalence of soilborne disease, other challenges
- lack of viable control options
- access to grafted plants

Big Picture of Grafted Watermelon Plants

https://www.theledger.com/story/business/agricultural/2021/09/21/2-newly-identified-viruses-florida-could-impact-watermelon-growers/5801048001/

https://ncfieldfamily.org/farm/how-n-c-melons-go-from-farm-to-table/

Farms in other states ranging in:

- **size**
- **market**

Big Picture of Grafted Watermelon Plants for Your Farm

- **Test! Help is available.**
  - **disease, nematode issue(s)?**
  - **consider production, harvest factors**

How

Grafted Watermelon Plants

Primary Positive (+)

Proven production potential, especially when soilborne disease, nematode issues exist

Grafted Watermelon Plants

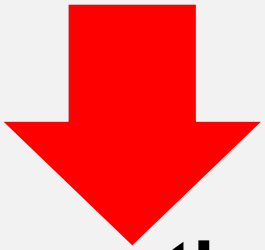
Key Negatives (-)

1. Expensive
2. Underlying genetics may require them to be managed differently (core cultural practices). Learning curve calling for updated research-based recs.

Grafted Watermelon Plants

Partial Solution

1. Expensive
2. Underlying genetics may require them to be managed differently (core cultural practices).
   Learning curve calling for updated research-based recs.



Testing, improving common practices may reduce costs and/or enhance current ROI values.

Support and Collaboration

"Growing New Roots: Grafting to Enhance Resiliency in U.S. Vegetable Industries"
(USDA-NIFA Specialty Crops Research Initiative
Award Number 2016-51181-25404)

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

TRI HISHTIL

Sonia Walker
B.S.

Nicole Wright
MPHM

Mark Spigos
B.A.

Experiments by Year

	2018	2019		2020		2021
expt(s)	D	D	F	D	F	D
scions	Fascination Jade Star					Fascination Sweet Dawn
RSs	own/ungrafted Carnivor					own/ungrafted Carnivor Pelops RZ

D = plant density; F = fertility (total seasonal N rate)

Density Treatments

(in-row spacing)

1. 1.22 m
2. 1.52 m

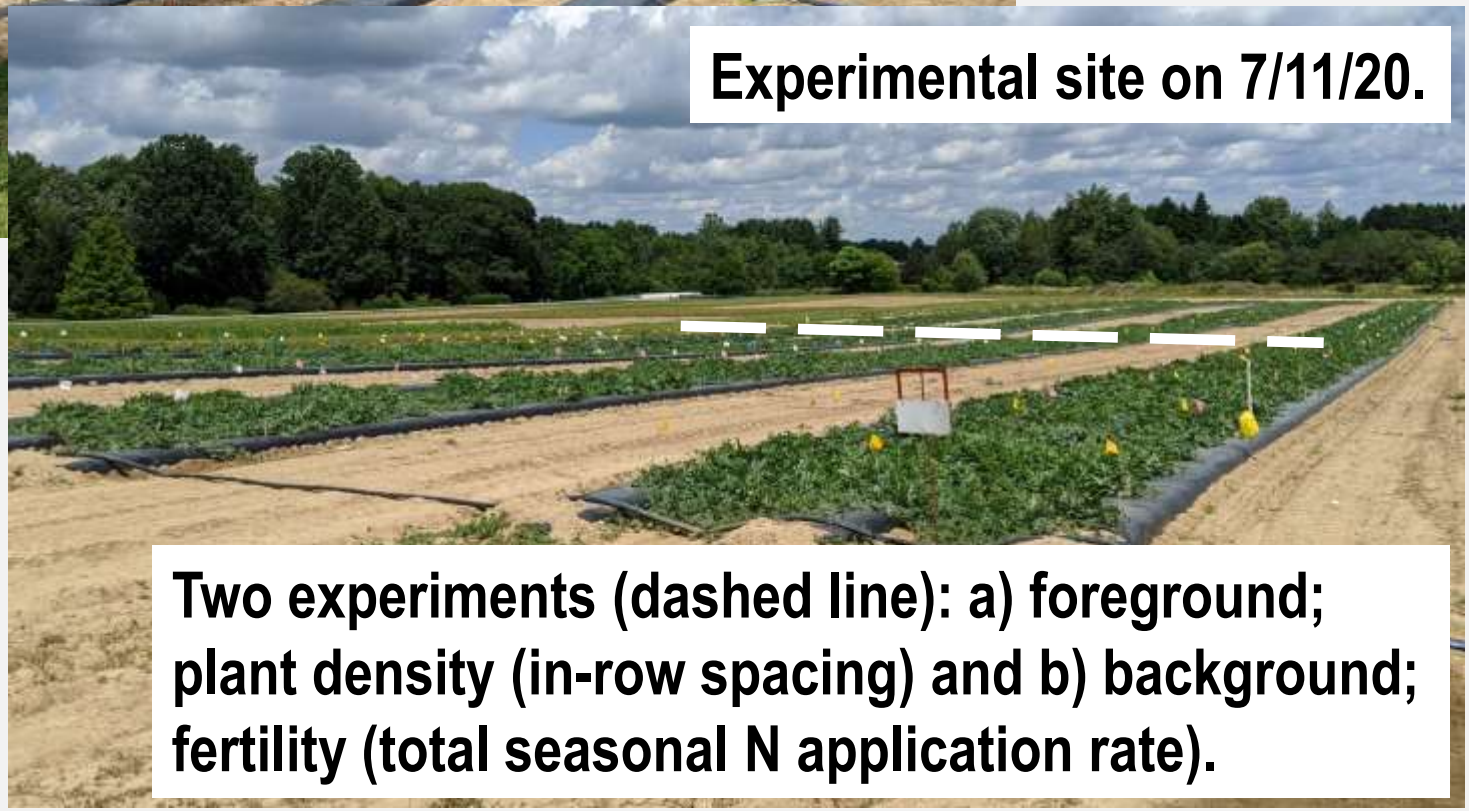
20% difference with various implications (e.g., number of plants/acre - grafted plant costs)

between-spacing constant at 1.83 m

TRI HISHTIL

TRI HISHTIL

12 beds (≈ 600 ft each)



RCB design with 4 reps in each study

Experimental site at transplanting on 6/10/21.

12 beds
(≈ 250 ft each)

RCB
design with
4 reps

Experimental site on 7/1/21.

in-row spacing
1.22 m in
Fertility Study

plot structure

3.05-m
spray alley

1.83 m b/t beds

1.22 or
1.52 m
b/t plants

'SP-6' ('18-'20)
or 'SP-7' ('21)
pollinizers
separate plots
in-row

3 x 3 treatment plant arrangement

pollination

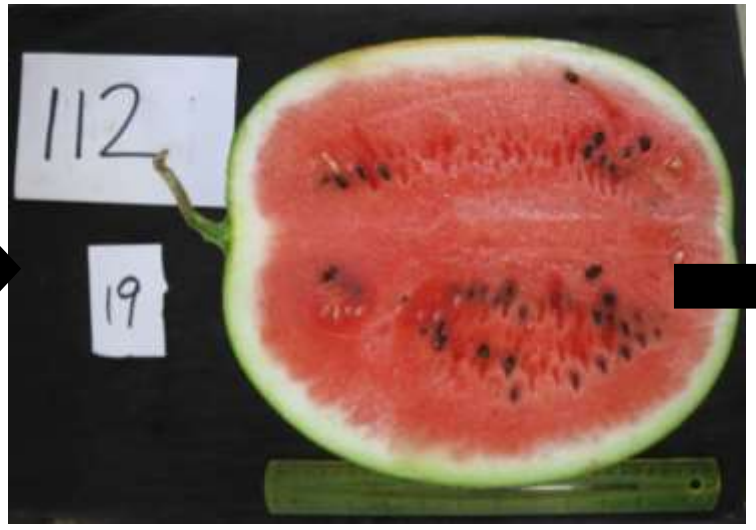
Dr. Reed Johnson
OSU Entomology

vine training

all fruit meeting maturity criteria

fruit size, weight, external appearance (fruit, plot basis)

Fruit Quality Assessment



Visual Assessment of Internal Flesh

1. Score stringiness and redness using 15 cm line

not at all stringy — extremely stringy

not at all red — extremely red

measure distance from left endpoint

2. Score for presence of internal cavities

on-farm evaluations of same plant stock (and tomato)

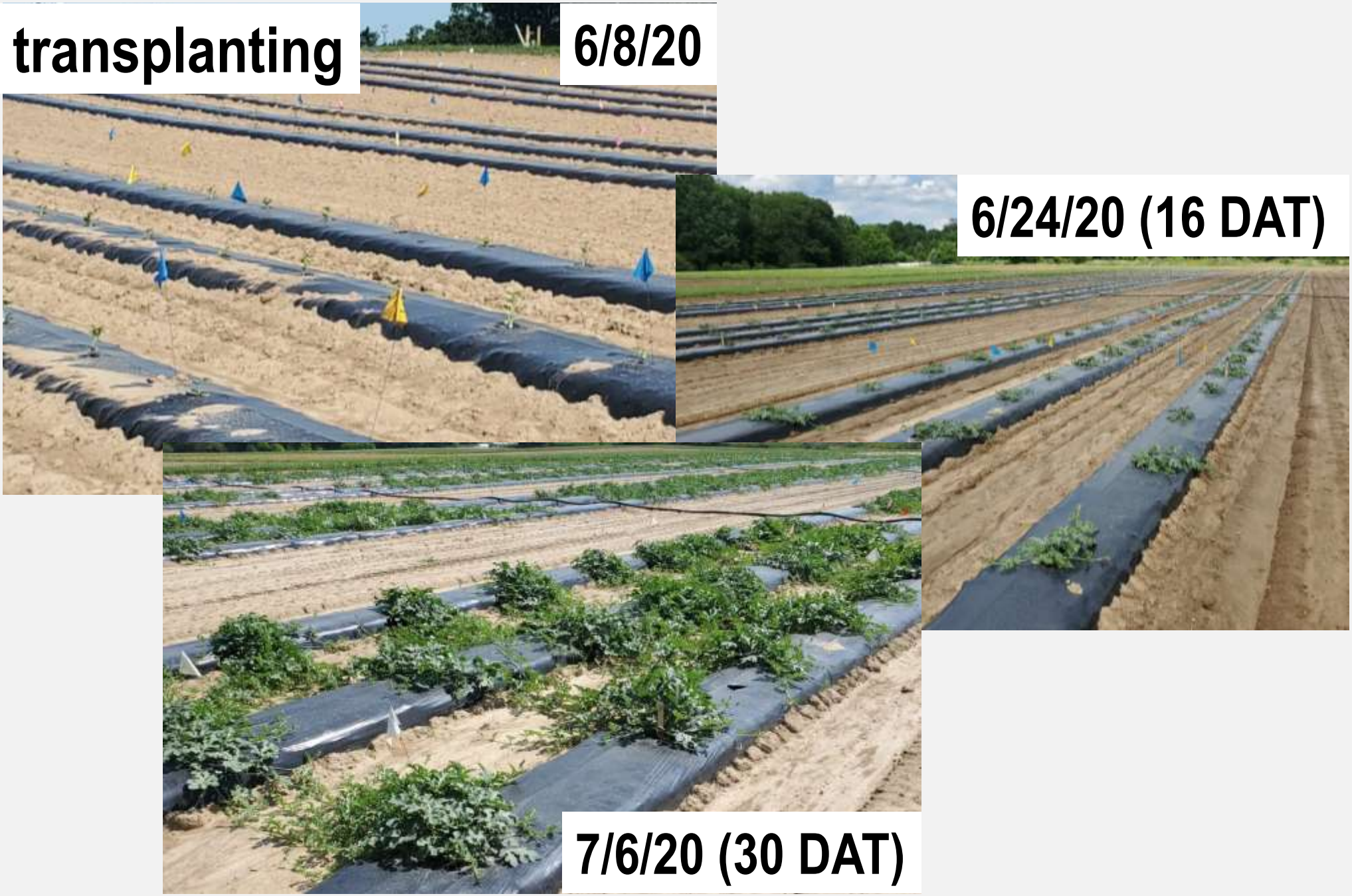
RESULTS

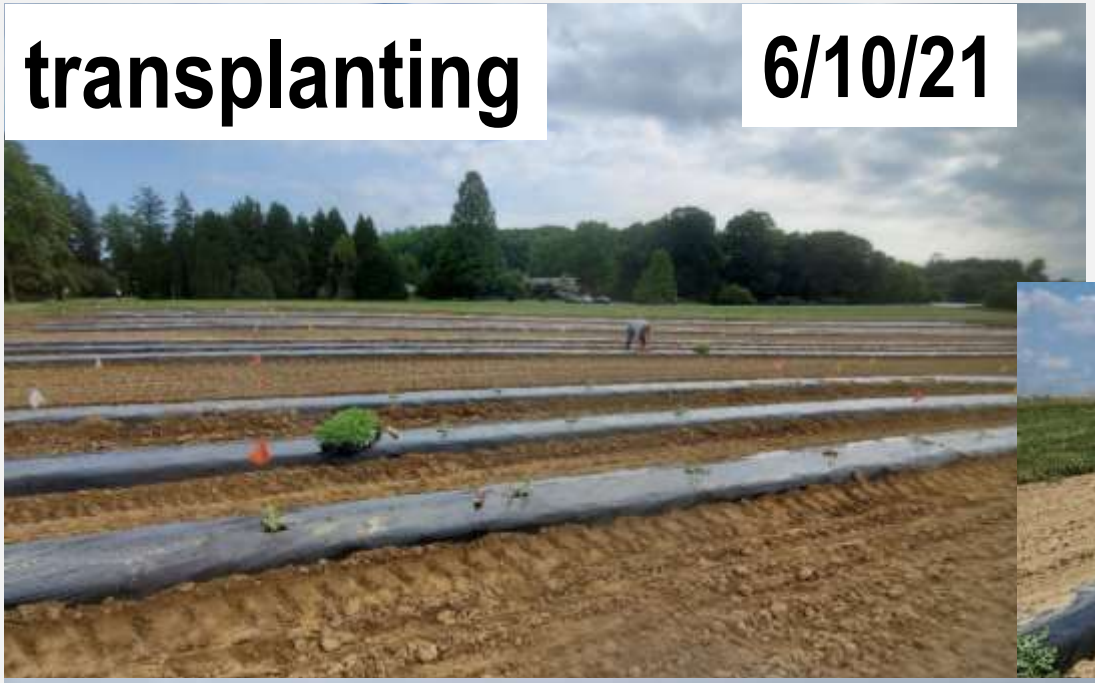
transplanting

6/3/19

6/26/19 (23 days after transplanting, DAT)

7/30/19 (57 DAT)

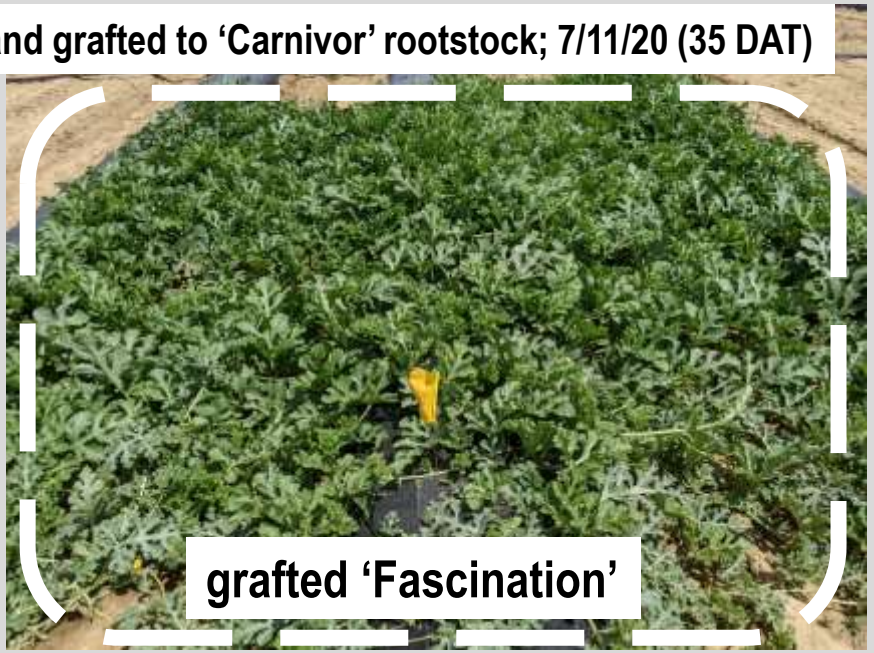

transplanting
6/8/20
6/24/20 (16 DAT)
7/6/20 (30 DAT)


transplanting
6/10/21


6/28/21 (18 DAT)


7/16/21 (36 DAT)

‘Fascination’ and ‘Jade Star’ watermelon ungrafted and grafted to ‘Carnivor’ rootstock; 7/11/20 (35 DAT)



‘Fascination’ and ‘Jade Star’ watermelon ungrafted and grafted to ‘Carnivor’ rootstock; 6/29/20 (21 DAT); Wooster, OH)

ungrafted ‘Fascination’

grafted ‘Fascination’

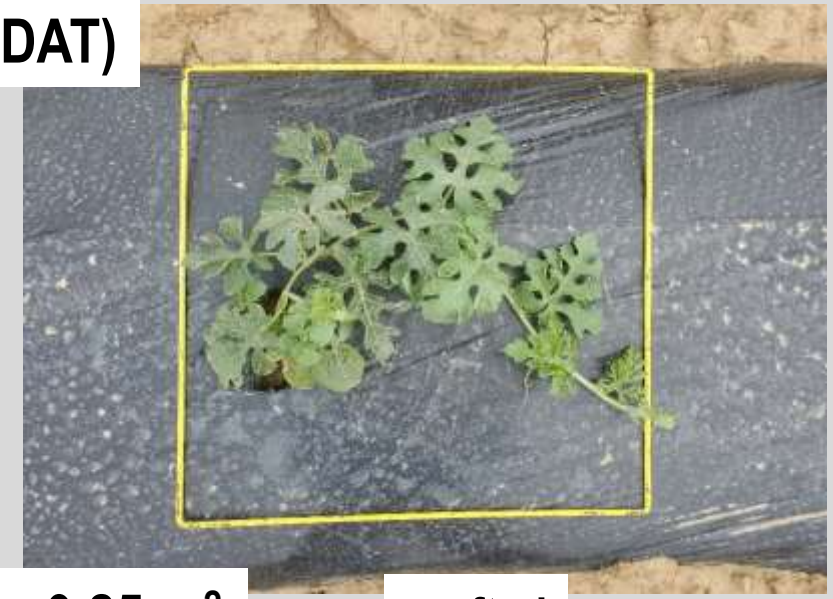
yellow squares = 0.25 m^2

ungrafted ‘Jade Star’

grafted ‘Jade Star’

‘Fascination’ watermelon ungrafted and grafted to ‘Carnivor’ rootstock; Wooster, OH)

6/25/21 (15 DAT)



ungrafted

yellow squares = 0.25 m^2

grafted

*same plants after 1 week

7/2/21 (22 DAT)

ANOVA (p values) for the effects of scion, grafting, and in-row spacing on the total number of fruit per plot: a) meeting maturity criteria and b) meeting maturity criteria and weighing ≥ 3.4 kg. Data across two harvests in 2019 and three harvests in 2020.

	meeting maturity criteria	
Factor		+ weighing ≥ 3.4 kg
scion (S)	<0.0001	<0.0001
grafting (G)	<0.0001	<0.0001
in-row spacing (IRS)	0.0005	0.0012
S x G	0.0081	0.0071
S x IRS	0.5968	0.9168
G x IRS	0.0377	0.0612

ANOVA (p values) for the effects of scion, grafting, and in-row spacing on the total weight of fruit per plot: a) meeting maturity criteria and b) meeting maturity criteria and weighing ≥ 3.4 kg. Data across three harvests in 2020.

	meeting maturity criteria	
Factor		+ weighing ≥ 3.4 kg
scion (S)	<0.0001	<0.0001
grafting (G)	<0.0001	<0.0001
in-row spacing (IRS)	0.0107	0.0103
S x G	0.0015	0.0008
S x IRS	0.5554	0.4530
G x IRS	0.1010	0.1157

In-row spacing effects on the total number of fruit per plot (9 plants): a) meeting maturity criteria and b) meeting maturity criteria and weighing ≥ 3.4 kg. Data across two harvests in 2019 and three harvests in 2020.

	meeting maturity criteria	
Factor		+ weighing ≥ 3.4 kg
Density/IRS	p < 0.0001	p < 0.0001
1.22 m	29.5 b	27.3 b
1.52 m	35.2 a	32.4 a
LSD (0.05)	4.0	3.8
	1.19x	**1.19x**

Grafting effects on the total number of fruit per plot (9 plants): a) meeting maturity criteria and b) meeting maturity criteria and weighing ≥ 3.4 kg. Data across two harvests in 2019 and three harvests in 2020.

	meeting maturity criteria	
Factor		**+ weighing ≥ 3.4 kg**
Density/IRS	**p < 0.0001**	**p < 0.0001**
non-grafted	**21.9 b**	**20.0 b**
grafted	**42.8 a**	**39.7 a**
LSD (0.05)	**3.1**	**3.0**
	1.95x	**1.99x**

‘Jade Star’ watermelon ungrafted and grafted to ‘Carnivor’ rootstock; Wooster, OH)

H1 (8/19/20)

H2 (9/10/20)

H3 (9/24/20)

Grafting effects on the total weight (kg) of fruit per plot (9 plants): a) meeting maturity criteria and b) meeting maturity criteria and weighing ≥ 3.4 kg. Data across three harvests in 2020.

	meeting maturity criteria	
Factor		**+ weighing ≥ 3.4 kg**
Density/IRS	p < 0.0001	p < 0.0001
non-grafted	121.72 b	114.39 b
grafted	278.80 a	270.98 a
LSD (0.05)	31.45	30.69
	2.29x	**2.37x**

ANOVA (p values) for the effects of scion, grafting, and in-row spacing on four components of fruit size meeting maturity criteria and weighing ≥ 3.4 kg at harvest. Data across two harvests in 2019 and three harvests in 2020.

Factor	weight	length	width	density
scion (S)	0.0699	<0.0001	0.0189	<0.0001
grafting (G)	0.0047	0.0157	0.0136	0.1494
in-row spacing (IRS)	0.6788	0.6652	0.5320	0.6967

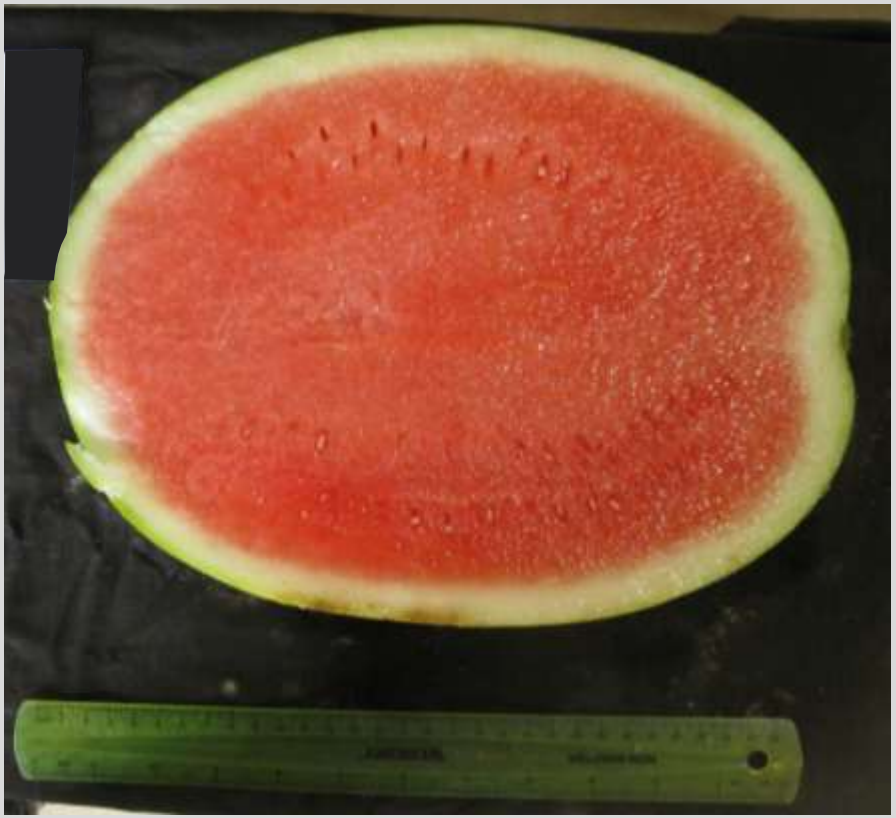
ANOVA (p values) for the effects of scion, grafting, and in-row spacing on five components of the market quality of fruit meeting maturity criteria and weighing ≥ 3.4 kg at harvest. Data across two harvests in 2019 and three harvests in 2020.

Factor	redness	stringiness	internal cavities	rind thickness	°Brix
scion (S)	0.2083	0.0009	0.0006	<0.0001	0.8377
grafting (G)	0.0645	0.0056	0.3952	<0.0001	0.4831
in-row spacing (IRS)	0.6927	0.9491	0.6846	0.2047	0.3028

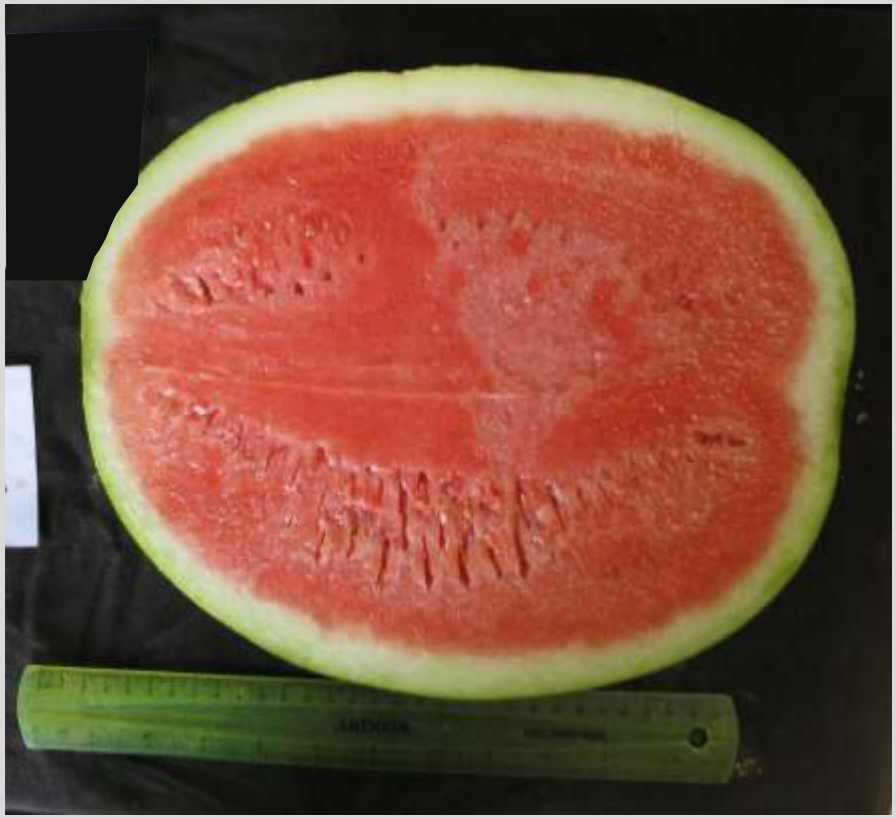
ºBrix: S x G interaction significant ($p \leq 0.0170$).

‘Fascination’ watermelon ungrafted and grafted to ‘Carnivor’ rootstock; Wooster, OH
Harvested 8/26/2020, Internal quality 8/27/2020

ungrafted



grafted



Grafting effects on four components of the fruit size meeting maturity criteria and weighing ≥ 3.4 kg at harvest. Data across two harvests in 2019 and three harvests in 2020.

Factor	weight (kg)	length (cm)	width (cm)	density (g/cm^2)
Density/IRS	p<0.0524	p<0.0001	p<0.0245	p<0.0026
ungrafted	6.71 b	25.31 b	22.30 b	0.98 a
grafted	7.20 a	26.03 a	22.72 a	0.99 a
LSD (0.05)	0.33	0.54	0.35	0.01

Grafting effects on five components of the market quality of fruit meeting maturity criteria and weighing ≥ 3.4 kg at harvest. Data across two harvests in 2019 and three harvests in 2020.

Factor	redness (0-15 scale)	stringiness (0-15 scale)	rind thickness (mm)	internal cavities (0=no, 1=yes)	°Brix
Density/IRS	p<0.3049	p<0.0031	p<0.0001	p<0.0119	p<0.2716
ungrafted	12.6 a	6.70 b	13.99 b	0.10 a	11.77 a
grafted	11.7 a	8.23 a	16.07 a	0.08 a	11.64 a
LSD (0.05)	0.65	1.10	0.72	0.05	0.42

Grower Observations

- optimistic about potential benefit of using grafted plants
- want further, larger evaluation
- some have proactively, independently sourced grafted plants (tomato, watermelon)

SUMMARY

There are compelling reasons to be curious about and experiment with grafted plants … to be optimistic but purposeful in evaluating the potential role of grafted (watermelon) plants on your farm. Help is available.

THANK-YOU and GOOD LUCK!

QUESTIONS?

Dr. Matt Kleinhenz
Professor, Extension Vegetable Specialist
Dept. of Horticulture and Crop Science
The OSU-OARDC

Phone: 330-263-3810
E-mail: kleinhenz.1@osu.edu
Web: http://u.osu.edu/vegprolab/
YouTube: https://go.osu.edu/vegeprosystemslab
Facebook: www.facebook.com/osuvpslab

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES