In-Row Spacing of Grafted Seedless Watermelon Impacts Yield and Fruit Quality

Zheng Wang[1] (zzwwang@ucanr.edu) and Hande Saganak[2]

[1]University of California Cooperative Extension, 3800 Cornucopia Way, Modesto, CA 95358

[2]California MasterPlant Inc., 492 Durham Ferry Rd., Tracy, CA 95304

Introduction

As with other graftable vegetable commodities, watermelon grafting has its merits of soil-borne disease resistance and yield enhancement, but the increased cost and additional needs of field and greenhouse management remain the major concerns that block widespread adoption. For example, rootstock seed is sometimes four to five times the price of regular seed. In addition, almost doubled greenhouse space is required to produce grafted vegetable seedlings. Reducing the cost while maintaining fruit yield and quality is key to keep vegetable grafting as an attractive approach. Production cost can be potentially reduced at various stages, such as rootstock breeding, grafting (e.g., robotic grafter), and field stage. From the perspective of field production, using fewer grafted plants with wider in-row spacing may potentially reduce the production cost.

Our research trial was implemented in 2019 to evaluate the impact of planting population (in-row spacing) on grafted watermelon yield and fruit quality. The hypothesis is that growing fewer number of grafted watermelon plants will maintain comparable yield and marketable quality compared to grafted and non-grafted plants grown in the normal spacing.

Trial Setup

- The trial was conducted on a commercial watermelon field in Turlock, California.
- Two commercial seedless scions '7187' and 'Fascination' were grafted onto four rootstocks 'RS841', 'Flexifort', 'UG29A', and 'XSQ9901'.
- After grafting, plants were placed into the field at in-row spacings of 0.93, 1.23, and 1.83 m on April 24, 2019. The corresponding population is 5120, 3840, and 2560 plants/ha (Figure 1).
- The pollinizer 'Wild Card Plus' was placed after every three triploid plants, making a 3:1 ratio.

Experimental design

- The study was a split-split plot design with in-row spacing as the main factor, scion and rootstock serving as sub- and sub-sub factors.
- Non-grafted scions were used as the study controls.
- The entire set of treatments were replicated four times.
- Each treatment row is 9.3 m long containing 10, 7, or 5 triploid plants reflecting spacing variation.

Figure 1. Grafted and non-grafted plants were grown at the in-row spacing of 0.93, 1.23, and 1.83 m (left to right) in Turlock, California (photo on May 24, 2019).

Data Collection

1. Harvest: The field was harvested five times on July 24, August 7 and 23, September 11, and October 2.
2. Yield collection: Fruit yield and total number from each harvest were counted, weighed, and compared among treatments. Three fruit from each treatment in the first harvest were randomly selected for quality measurements.
3. Fruit was first measured for their length and width.
4. Hollow heart was rated based on the scales 1-5 after longitudinally cutting three fruit into halves (Guan et al. 2018).
5. After cutting, one spot of each half fruit (6 spots total per treatment) was scooped for sugar content measurement using a refractometer.
6. Flesh firmness was measured using a fruit penetrometer with a 11-mm diameter tip probe.
7. ANOVA was conducted using SAS 9.4 to test treatment effects. Multiple comparisons among treatments were performed using Fisher's least significant difference at P = 0.05.

Result-Fruit yield

Table 1. Comparisons of the main effects on fruit yield at each harvest and total yield (kg/plot).

	1st harvest	2nd + 3rd harvest	4th harvest	5th harvest	Total yield
0.93 m	291.0 A	33.1 A	24.5 B	128.5 A	477.1 A
1.23 m	295.6 A	26.5 B	28.4 A	125.6 A	476.1 A
1.83 m	273.3 A	34.4 A	25.2 B	120.0 A	452.9 A
7187	284.1 A	30.9 A	27.5 A	125.1 A	467.6 A
Fascination	289.2 A	31.8 A	24.6 B	124.3 A	469.9 A
Flexifort	283.3 AB	29.2 C	20.2 C	137.2 A	469.9 AB
RS841	294.2 A	24.6 D	16.7 D	131.8 AB	466.3 AB
UG29A	264.8 B	33.8 AB	16.9 D	125.8 B	441.3 B
XSQ9901	302.1 A	32.9 B	25.8 B	127.6 AB	488.4 A
Nongrafted	288.8 A	36.1 A	50.7 A	101.9 C	477.5 AB

Table 2. Comparisons of the main effects on average fruit weight (kg).

	1st harvest	2nd + 3rd harvest	4th harvest	5th harvest
0.93 m	9.4 A	7.3 B	6.4 B	4.9 A
1.23 m	9.7 A	8.6 A	7.2 A	4.9 A
1.83 m	9.8 A	8.8 A	7.4 A	5.0 A
7187	9.1 B	8.3 A	7.5 A	5.1 A
Fascination	10.3 A	8.3 A	6.5 B	4.8 A
Flexifort	9.6 A	8.9 A	7.0 B	4.9 A
RS841	10.1 A	7.6 C	6.9 B	5.1 A
UG29A	9.3 A	7.9 C	5.6 C	4.9 A
XSQ9901	9.8 A	8.1 BC	7.4 AB	4.8 A
Nongrafted	9.5 A	8.7 AB	8.1 A	5.1 A

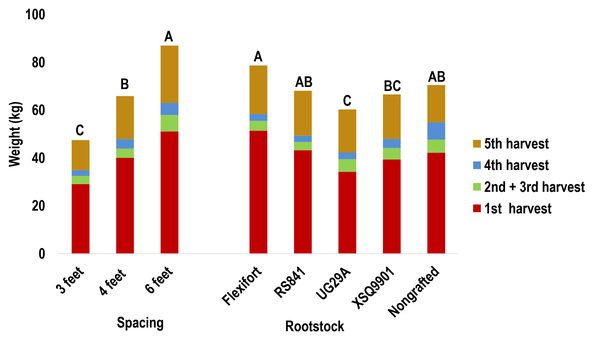

Figure 2. Single plant productivity (kg/plant) at each harvest sorted by spacing and rootstock.

Result-Fruit quality

Table 3. Comparisons of the main effects on fruit quality.

	Brix	Length (cm)	Width (cm)	Flesh firmness (kg/cm²)	Hollow heart
0.93 m	12.0	30.0	25.7	2.1	1.7
1.23 m	12.1	31.0	26.2	2.1	1.6
1.83 m	12.1	31.2	25.4	2.0	1.2
P ≤ 0.05					
7187	12.1	30.2	25.4	2.1	1.8
Fascination	12.0	31.2	25.9	1.9	1.2
P ≤ 0.05		√			√
Flexifort	12.0	31.2	25.7	2.2	1.1
RS841	12.1	31.0	25.9	2.1	1.3
UG29A	12.2	30.5	25.7	1.9	1.6
XSQ9901	11.8	31.2	25.7	2.3	1.4
Nongrafted	11.9	29.7	25.9	1.7	2.0
P ≤ 0.05		√		√	√

Figure 3. Grafting incompatibility showing declined fruit quality (hollow heart on grafted fruit).

Summary

- Spacing and rootstock effects on total yield were not observed except for UG29A with a negative effect (Table 1 and Figure 2).
- Fruit weight and size from larger-spacing plots did not increase in the first and fifth harvest (Tables 2 and 3).
- Grafting increased fruit length and firmness, decreased hollow heart, but did not increase weight in the first and fifth harvest (Tables 2 and 3).
- We did see grafting incompatibility showing that fruit quality declined after grafting onto certain rootstocks (See example in Figure 3).

Reference

Guan, Wenjing et al. (2018). 2018 Watermelon variety evaluation in Indiana. Midwest Vegetable Trial Report for 2018.

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