**Appendix C: Grafted Tomato Trial Report**

**Rationale**
In 2019, a trial comparing the performance of ‘Early Girl’ with ‘Early Girl’ grafted to ‘Fortamino’ rootstock indicated that grafting has the potential to improve dry farm tomato productivity and quality. Grafted ‘Early Girl’ tomatoes had higher yields and less blossom end rot, and were less drought-stressed than ungrafted ‘Early Girl’. However, it is likely that rootstocks differ in their potential to improve dry farm tomato fruit yield and quality. The goal of this study was identify rootstocks with the greatest potential to improve dry farm tomato yield and quality.

**SUMMARY OF Rootstocks**

**DRO141TX (F1) –** [**Johnny’s Seeds**](https://www.johnnyseeds.com/vegetables/tomatoes/dro141tx-f1-tomato-seed-3195.html?cgid=tomatoes)**\***

* Rootstock, F1 Hybrid, available as organic seed

**Emperador –** [**Log House Plants**](https://loghouseplants.com/plants/product-category/grafted-program/grafted-vegetables/grafted-tomatoes-all-varieties/)**\***

* Rootstock, F1 Hybrid, available as rootstock in organic transplants
* This is the sole rootstock used by Log House Plants in Cottage Grove, OR

**Fortamino –** [**High Mowing Organic Seeds\***](https://www.highmowingseeds.com/organic-non-gmo-fortamino-f1-root-tomato.html)

* Rootstock, F1 Hybrid, available as organic seed

**Maxifort –** [**Johnny’s Seeds**](https://www.johnnyseeds.com/vegetables/tomatoes/rootstock-tomatoes/maxifort-f1-tomato-seed-2700.html)**\***

* Rootstock, F1 Hybrid, available as organic seed

**Shin Cheong Gang –** [**Johnny’s Seeds**](https://www.johnnyseeds.com/vegetables/tomatoes/rootstock-tomatoes/shin-cheong-gang-f1-tomato-seed-4129.html)**\***

* Rootstock, F1 Hybrid, available as organic seed

**METHODS**

Transplant production

Scions: ‘BHN 871’, ‘Big Beef’, ‘Early Girl’, ‘Momotaro’, ‘New Girl’, and ‘Wisconsin 55’
Rootstocks: ‘Fortamino’, ‘DRO141TX’, ‘Maxifort’, and ‘Shin Cheong Gang’
Ungrafted scions were also included in the trials

Rootstocks were seeded into 3 inch pots on 28 February 2020 and scions were seeded into 200 cell trays on 2 March 2020. Scions and rootstocks were grafted on 20 March 2020 and 23 March 2020. They were moved into a healing chamber after grafting to allow the grafts to heal until 7 April 2020, when they were moved onto greenhouse benches. The combinations made and the number of seedlings planted in each trial are presented in Table 1. ‘Maxifort’ was grafted with only 2 scions: ‘Early Girl’ and ‘New Girl’. ‘Fortamino’ had a high level of mortality during the healing process, resulting in fewer seedlings. However, grafted plants were not randomized within the healing chamber, so high mortality may have been due to location rather than some property of the rootstock (personal communication, Paula House). Ungrafted scions were seeded on 19 March 2020 and 24 March 2020 (‘Big Beef’). Plants were grown in a greenhouse until planting. Seedlings received one fish emulsion fertigation prior to planting in the OSU vegetable research farm trial and two fertigations prior to planting in the on farm trial.

Table 1: Rootstock x Scion Combinations

|  |  |  |
| --- | --- | --- |
| Scion | Trial | Rootstock |
| DRO141TX | Fortamino | Maxifort | Shin Cheong Gang | None |
| BHN 871 | OSU | 5 | 5 | - | 5 | 5 |
| On Farm | 5 | 5 | - | 5 | 5 |
| Big Beef | OSU | 5 | 2 | - | 5 | 5 |
| On Farm | 5 | 0 | - | 5 | 5 |
| Early Girl | OSU | 5 | 5 | 5 | 5 | 5 |
| On Farm | 5 | 5 | 5 | 5 | 5 |
| Momotaro | OSU | 5 | 5 | - | 5 | 5 |
| On Farm | 5 | 0 | - | 5 | 5 |
| New Girl | OSU | 5 | 5 | 5 | 5 | 5 |
| On Farm | 5 | 5 | 5 | 5 | 5 |
| Wisconsin 55 | OSU | 5 | 3 | - | 5 | 5 |
| On Farm | 5 | 0 | - | 5 | 5 |

Two trials were conducted in 2020:

**Site 1) Oregon State University Vegetable Research Farm**
Soil:Chehalis silty clay loam with approximately 12 inches of available water holding capacity and no restrictive features to a depth of 5 feet.
Exposure: The site was exposed.
Soil preparation: A cover crop of common vetch, triticale, and fescue was seeded at a rate of 50 lb/acre on 15 September 2019 and terminated on 7 April 2020. Compost was applied at 4.5 wet tons/acre. On 20 April 2020 the field was fertilized with 1480 lbs/acre of Nutri-Rich (4-3-2; Stutzman Environmental Products, Inc., Canby, OR, USA) and 790 lbs/acre of Pro-Pell-It Feather Meal (12-0-0; Marion Ag. Service, Inc., Aurora, OR, USA).

Experimental design: The grafted tomato trial plots were randomly located in a larger variety trial. There was one plot per variety or scion/rootstock combination. Each 75 sq ft plot was planted to five seedlings (unless noted otherwise, see Table 1) on 8 May 2020 with 5’ between-row spacing and 3’ in-row spacing. The field was clean cultivated with hoes and an Allis-Chalmers G cultivating tractor equipped with knives.

**Site 2) On-farm trial, Philomath, OR**

Soil: Redbell silt loam with 11.8 inches of available water holding capacity and a root restrictive feature (firm soil consistency) starting at 3.75 feet.

Exposure: the site was partially shaded by large trees to the north and west of the plots.

Experimental design: The grafted tomato trial plots were planted in a completely randomized design on 14 May 2020. There was one plot per variety or scion/rootstock combination. Each 110 sqft plot was planted to five seedlings (unless noted otherwise, see Table 1) with 5.5’ between row spacing and 4’ in row spacing. Black plastic mulch was used for floor management.

Data collection and analysis

Harvests were conducted weekly. Ripe tomatoes were picked, weighed and counted. Harvested tomatoes were separated by type, with fruit either being unblemished, having light blossom end rot (BER light; just a few spots of blossom end rot), having heavy blossom end rot (BER heavy; large, shrunken spot on blossom end of fruit), and/or having other blemishes. Each category was then weighed and counted.

OSU trial: Tomatoes were harvested from 16 July 2020 to 29 September 2020. On 25 August 2020, the number of plants that were harvested was reduced from all plants to three. From 7 September 2020 to 22 September 2020 harvests were suspended due to wildfire smoke. Heavy rains (1.3”) on 17 September caused fruit to split, so blossom end rot data collection was discontinued and split tomatoes were counted and weighed on the 22 September and 29 September harvests.

On-farm trial: Tomatoes were harvested from 30 July 2020 to 8 October 2020. Fruit number and weight of all fruit and fruit with BER were taken for all plot plants on all harvest dates. From 3 September to 17 September 2020 tomato harvests were suspended due to wildfire smoke. Heavy rains on 17 September 2020 caused many fruit to split, and so splitting data was collected for the last three harvests.

Total yields and number of fruit were extrapolated to five plants/plot for each harvest. Total yield was divided by the total fruit count to determine average fruit size for each rootstock-scion combination for each trial. The proportion of fruit with BER, BER light, and BER heavy (from 30 July to 7 September for the research farm trial and for the whole period for the on-farm trial) was calculated, as was the proportion of fruit that split after the heavy rain (22 September – 29 September for research farm trial and 24 September to 8 October for the on-farm trial). Days to first harvest were determined to be the days between planting and first tomato harvest. Days of peak harvest were the number of days during which weekly tomato production was continuously above 1.5 lbs per plant.

**RESULTS**
DRO141TX, Fortamino, Emperador, and Maxifort improved scion productivity and reduced BER. Shin Cheong Gang had mixed results, and in some cases the grafted scions yielded worse and had more BER than the ungrafted controls (see Tables 1 and 2). Shin Cheong Gang reduced total yields for Big Beef and New Girl in the on farm trial and for Big Beef and Momotaro in the OSU vegetable research farm trial. Shin Cheong Gang also reduced average fruit size for BHN 871 and Big Beef in the on farm trial. Shin Cheong Gang increased incidence of BER for Early Girl and Momotaro in the on farm trial and for Big Beef and Wisconsin 55 in the OSU vegetable research farm trial.

Table 1: Fruit yield and quality, and days to first and peak fruit data (on-farm trial).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scion | Rootstock | Total yield (T/A)  | % increase in yield with grafting | Number of fruit (fruit/plot) | Average size (lbs) | % increase in fruit size with grafting | BER (%) | % decrease in BER with grafting | BER light (%) | BER Heavy (%) | Splitting (%) | Days to first fruit | Days of peak fruit production |
| BHN 871 | DRO141TX | 41.7 | 126 | 474 | 0.44 | 37 | 14.6 | -64 | 9.9 | 4.6 | 30.9 | 91 | 35 |
| BHN 871 | Fortamino | 33.0 | 79 | 441 | 0.38 | 16 | 4.8 | -88 | 3.4 | 1.4 | 16.8 | 85 | 28 |
| BHN 871 | None | 18.4 |  | 286 | 0.32 |  | 40.2 |  | 22.7 | 17.5 | 19.2 | 91 | 28 |
| BHN 871 | Shin Cheong Gang | 21.3 | 16 | 348 | 0.31 | -5 | 33.6 | -16 | 24.1 | 9.5 | 22.0 | 91 | 35 |
| Big Beef | DRO141TX | 43.2 | 99 | 560 | 0.39 | 37 | 5.5 | -86 | 3.0 | 2.5 | 42.3 | 91 | 28 |
| Big Beef | None | 21.7 |  | 385 | 0.29 |  | 38.4 |  | 26.2 | 12.2 | 24.5 | 85 | 28 |
| Big Beef | Shin Cheong Gang | 15.6 | -28 | 301 | 0.26 | -8 | 9.3 | -76 | 6.6 | 2.7 | 38.6 | 85 | 21 |
| Early Girl | DRO141TX | 26.6 | 53 | 571 | 0.24 | 63 | 6.7 | -86 | 5.8 | 0.9 | 18.9 | 91 | 28 |
| Early Girl | Emperador | 31.3 | 80 | 794 | 0.20 | 38 | 20.2 | -43 | 17.4 | 2.9 | 14.6 | 91 | 28 |
| Early Girl | Fortamino | 26.3 | 51 | 800 | 0.17 | 15 | 9.3 | -81 | 7.8 | 1.5 | 17.5 | 85 | 28 |
| Early Girl | Maxifort | 24.1 | 38 | 819 | 0.15 | 3 | 20.9 | -56 | 18.1 | 2.8 | 20.2 | 85 | 28 |
| Early Girl | None | 17.4 | - | 608 | 0.14 |  | 47.7 |  | 37.3 | 10.4 | 4.8 | 91 | 28 |
| Early Girl | Shin Cheong Gang | 19.2 | 10 | 674 | 0.14 | 0 | 68.1 | +43 | 51.6 | 16.5 | 9.0 | 91 | 28 |
| Momotaro | DRO141TX | 26.9 | 211 | 512 | 0.27 | 57 | 19.7 | -46 | 14.5 | 5.3 | 22.9 | 105 | 28 |
| Momotaro | None | 8.7 | - | 258 | 0.17 |  | 36.4 |  | 28.7 | 7.8 | 32.6 | 98 | 14 |
| Momotaro | Shin Cheong Gang | 17.4 | 101 | 455 | 0.19 | 14 | 48.8 | +34 | 32.1 | 16.7 | 33.7 | 91 | 28 |
| New Girl | DRO141TX | 31.8 | 69 | 939 | 0.17 | 32 | 6.7 | -87 | 6.3 | 0.4 | 8.9 | 77 | 21 |
| New Girl | Fortamino | 29.4 | 57 | 887 | 0.17 | 29 | 16.0 | -69 | 14.8 | 1.2 | 13.9 | 77 | 28 |
| New Girl | Maxifort | 30.8 | 64 | 996 | 0.16 | 21 | 13.0 | -75 | 10.8 | 2.1 | 14.3 | 77 | 21 |
| New Girl | None | 18.8 | - | 731 | 0.13 |  | 52.0 |  | 37.9 | 14.1 | 0 | 77 | 21 |
| New Girl | Shin Cheong Gang | 18.3 | -3 | 644 | 0.14 | 10 | 28.1 | -46 | 25.0 | 3.1 | 9.2 | 85 | 21 |
| Wisconsin 55 | DRO141TX | 34.3 | 176 | 639 | 0.27 | 37 | 1.7 | -90 | 1.3 | 0.5 | 44.2 | 91 | 28 |
| Wisconsin 55 | None | 12.4 |  | 317 | 0.20 |  | 18.0 |  | 13.6 | 4.4 | 41.3 | 105 | 21 |
| Wisconsin 55 | Shin Cheong Gang | 17.4 | 41 | 443 | 0.20 | 1 | 11.7 | -35 | 9.7 | 2.0 | 55.0 | 91 | 28 |

Table 2: Fruit yield and quality, and days to first and peak fruit data (OSU Vegetable Research Farm Trial)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scion | Rootstock | Total yield (T/A) | % increase in yield with grafting | Number of fruit (fruit/plot) | Average size (lbs) | % increase in size with grafting | BER (%) | % increase in BER with grafting | BER light (%) | BER Heavy (%) | Splitting (%) | Days to first fruit | Days of peak fruit production |
| BHN 871 | DRO141TX | 82.1 | 197 | 463 | 0.61 | 77 | 5.4 | -90 | 5.4 | 0 | 19.0 | 76 | 35 |
| BHN 871 | Fortamino | 66.2 | 140 | 470 | 0.48 | 41 | 2.8 | -95 | 2.2 | 0.6 | 58.7 | 94 | 28 |
| BHN 871 | None | 27.6 |  | 276 | 0.34 |  | 51.8 |  | 17.3 | 34.5 | 53.8 | 81 | 28 |
| BHN 871 | Shin Cheong Gang | 30.1 | 9 | 270 | 0.39 | 13 | 35.8 | -31 | 2.8 | 33.0 | 46.9 | 94 | 28 |
| Big Beef | DRO141TX | 83.4 | 119 | 539 | 0.53 | 25 | 3.4 | -88 | 2.1 | 1.3 | 61.1 | 69 | 43 |
| Big Beef | Fortamino | 97.8 | 157 | 424 | 0.80 | 84 | 1.7 | -94 | 1.7 | 0 | 63.6 | 69 | 43 |
| Big Beef | None | 38.1 |  | 308 | 0.42 |  | 27.5 |  | 12.6 | 15.0 | 59.2 | 88 | 43 |
| Big Beef | Shin Cheong Gang | 37.9 | -1 | 306 | 0.43 | 59 | 43.6 | +58 | 26.8 | 16.8 | 38.7 | 88 | 43 |
| Early Girl | DRO141TX | 49.5 | 102 | 728 | 0.23 | 51 | 36.4 | -49 | 32.2 | 4.3 | 31.5 | 81 | 43 |
| Early Girl | Emperador | 47.7 | 94 | 732 | 0.22 | 44 | 24.3 | -34 | 22.3 | 1.9 | 42 | 76 | 36 |
| Early Girl | Fortamino | 59.3 | 142 | 855 | 0.24 | 54 | 30.6 | -57 | 28.4 | 2.2 | 40.2 | 69 | 43 |
| Early Girl | Maxifort | 47.9 | 95 | 762 | 0.21 | 38 | 20.6 | -71 | 18.0 | 2.7 | 45.9 | 81 | 35 |
| Early Girl | None | 24.5 |  | 540 | 0.15 |  | 71.2 |  | 36.2 | 34.9 | 14.9 | 78 | 35 |
| Early Girl | Shin Cheong Gang | 32.1 | 31 | 644 | 0.17 | 11 | 61.1 | -14 | 43.4 | 17.8 | 40.0 | 76 | 43 |
| Momotaro | DRO141TX | 42.1 | 42 | 429 | 0.32 | 29 | 11.1 | -68 | 1.3 | 9.8 | 72.1 | 95 | 35 |
| Momotaro | Fortamino | 46.5 | 57 | 426 | 0.38 | 47 | 3.2 | -91 | 0 | 3.2 | 61.5 | 95 | 28 |
| Momotaro | None | 29.6 |  | 408 | 0.25 |  | 35.0 |  | 8.3 | 26.7 | 55.0 | 92 | 35 |
| Momotaro | Shin Cheong Gang | 30.4 | 3 | 288 | 0.34 | 37 | 27.2 | -22 | 15.0 | 12.2 | 70.5 | 81 | 42 |
| New Girl | DRO141TX | 56.9 | 178 | 903 | 0.21 | 92 | 13.3 | -76 | 11.5 | 1.8 | 32.5 | 69 | 42 |
| New Girl | Fortamino | 54.9 | 169 | 936 | 0.20 | 79 | 24.9 | -54 | 19.4 | 5.5 | 29.8 | 81 | 43 |
| New Girl | Maxifort | 60.4 | 196 | 1,040 | 0.20 | 77 | 25.2 | -54 | 19.0 | 6.2 | 43.8 | 76 | 56 |
| New Girl | None | 20.4 |  | 637 | 0.11 |  | 54.6 |  | 32.7 | 21.9 | 22.3 | 73 | 42 |
| New Girl | Shin Cheong Gang | 30.1 | 47 | 752 | 0.14 | 22 | 49.4 | -10 | 26.8 | 22.6 | 4.1 | 76 | 43 |

Table 2 continued: Fruit yield and quality, and days to first and peak fruit data (OSU Vegetable Research Farm Trial)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scion | Rootstock | Total yield (T/A) | % increase in yield with grafting | Number of fruit (fruit/plot) | Average size (lbs) | % increase in size with grafting | BER (%) | % increase in BER with grafting | BER light (%) | BER Heavy (%) | Splitting (%) | Days to first fruit | Days of peak fruit production |
| Wisconsin 55 | DRO141TX | 60.5 | 151 | 662 | 0.31 | 34 | 0 | - | 0 | 0 | 78.7 | 88 | 36 |
| Wisconsin 55 | Fortamino | 42.8 | 77 | 452 | 0.32 | 39 | 1.3 | - | 0.6 | 0.6 | 83.7 | 88 | 36 |
| Wisconsin 55 | None | 24.1 |  | 351 | 0.23 |  | 0 | - | 0 | 0 | 85.2 | 78 | 35 |
| Wisconsin 55 | Shin Cheong Gang | 33.5 | 39 | 400 | 0.28 | 23 | 6.0 | - | 4.8 | 1.2 | 86.4 | 88 | 35 |