Grafted tomato propagation and production: relative seedling vigor, graft compatibility, and on-farm yield of 23 cultivars©

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INTRODUCTION

Rootstock (RS) and scion cultivar selection is the first step in preparing grafted plants. Propagators must consider the relative vigor of seedlings before they are grafted and RS-scion compatibility. Ultimately, cultivars are chosen based on their performance on farms. Grafted plants will be made and used more widely and effectively when research-based information on seedling vigor, cultivar compatibility and plant performance is more abundant and accessible.

The hypothesis was that seedling vigor, graft success and/or grafted plant performance (yield) on farms differed among RS and scion cultivars and their combinations.

We tested this hypothesis by documenting: (a) the growth rates of seedlings of 18 RS and 5 scion cultivars, (b) the percentage of healthy grafted plants representing all 90 RS-scion combinations, and (c) their performance on farms.

MATERIALS AND METHODS

Cultivar selection

Tomato RS and scion cultivars were selected based on grower nomination and experimenter assessment of cultivar traits. Communication with growers was facilitated by organic certifying agencies, grower associations, farmer groups, trade publications, and digital media. Selection was made from commercially available rootstocks (66 total) developed by 19 companies and contained approximately 24 disease resistance packages.

Eighteen RS cultivars were chosen representing grower interest, 12 companies, and 12 disease packages. Five scion cultivars were chosen representing hybrid and heirloom and round- and oblong-fruited types.

The greenhouse experiment was repeated twice February-April 2014 at the OARDC in Wooster, Ohio to monitor seedling vigor and graft compatibility. The on-farm evaluation was conducted in April-November 2014 on 31 cooperating farms.

Seedling vigor

Forty-eight seed of each cultivar were sown in a half 96-cell tray as a unit with three units as three replications. Four plant and two environmental variables were measured from 4 to 26 days after seeding. Emergence was recorded daily from day 4 to 14 and day 4 to 13 after sowing in run 1 and 2, respectively (beginning from the appearance of at least one hypocotyl hook and concluding when counts did not increase for two consecutive days for all cultivars). Three representative plants from each unit were destructively measured 18 days after sowing. Aboveground dry weight was measured by a MS3002S Precision Balance (Mettler Toledo, Greifensee, Switzerland) after drying at 50°C for 2 days (Fisher Scientific™ Isotemp™ oven). Stem diameter was measured at 1 cm below the cotyledon by a Traceable® digital caliper (Control Company, Friendswood, Texas). Leaf area was measured by a LI-3100C area meter (LI-COR Biosciences, Lincoln, NE). These parameters were used to calculate cultivar-specific vigor values.

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$$\text{Vigor} = \frac{[\text{above ground dry weight (mg)} \times \text{stem diameter (mm)} \times \text{leaf area (cm}^2)]}{(T_{90} \times \text{GDD} \times \text{PAR})} \times 10^7$$

where T_{90} = the number of days to 90% emergence, GDD = growing degree days (10°C Tmin, 27°C Tmax), and PAR = photosynthetically active radiation. GDD and PAR represent these variables accumulated by 18 days after sowing.

Compatibility (graft success)

Eight grafters were recruited and trained, and then their success with all RS-scion combinations and self-grafted plants as the common control was recorded each day. A total of 2,904 plants were grafted using the cleft grafting method on 10 days. Plant survival was evaluated 2 weeks after grafting; plants with a completely wilted scion were rated as dead and others as living.

Grafted plant performance on farms

Growers nominated their farms as study sites. More than 1,000 grafted plants representing all 90 RS-scion combinations were provided to 31 growers in 13 states. Growers provided subjective and objective information on grafted plant performance.

RESULTS

Seedling vigor

Vigor 18 days after sowing varied significantly among cultivars (Table 1).

Table 1. Vigor results for cultivars.

Cultivar (listed from least to most vigorous)	Aboveground dry weight (mg)	Stem diameter (mm)	Leaf area (cm^2)	Emergence (T_{90})	Vigor value
Trooper	20.4	1.1	10.9	9.4	23.2
Shield	31.4	1.6	16.2	6.9	103.0
Aiboh	36.1	1.6	15.0	6.5	117.8
Estamino	34.9	1.5	23.5	8.5	124.3
Supernatural	42.7	1.7	18.0	7.3	151.1
Aooni	43.2	1.6	21.2	8.6	151.1
• Cherokee Purple	36.0	1.7	16.9	5.7	154.4
• Brandywine	44.3	1.9	22.4	6.2	263.2
• Better Boy	53.7	1.7	21.6	6.4	269.7
• Celebrity	50.1	1.8	24.5	7.0	276.3
RST-105	49.2	1.8	28.5	7.9	279.8
Resistar	44.8	1.9	24.3	6.4	282.6
RST-106	54.3	1.9	26.7	6.4	383.1
Akaoni	61.1	1.9	26.9	6.6	405.4
Cheong Gang	58.0	1.8	27.5	5.8	437.8
BB	58.3	2.1	27.7	5.9	515.5
Armada	72.5	2.1	27.1	6.2	596.1
Stallone	71.1	1.9	30.6	5.6	635.6
Beaufort	66.5	1.9	28.6	4.2	772.3
• San Marzano 2	79.5	2.3	32.2	6.5	794.6
Arnold	82.4	2.0	35.8	4.0	1312.3
Maxifort	93.3	2.1	40.5	5.1	1343.4
Kaiser	110.4	2.0	49.1	4.9	1942.3

• Are scion cultivars; others are RS cultivars.

Graft success

All combinations registered 92-100% grafted plant survival. Survivorship averaged 97% among all RS-scion combinations.

On-farm performance

Qualitative and quantitative information from growers revealed that grafted plant performance varied among RS-scion combinations and farms. Of the seven growers able to compare grafted and ungrafted plants, six growers concluded that grafted plants out-performed their ungrafted counterparts while one grower concluded that the yields of grafted and ungrafted plants were similar. All growers expressed interest in additional research-based information regarding the performance and use of grafted plants.

CONCLUSIONS

Grafting operations should account for variation in seedling vigor and grafter performance. Seeding dates may need to be set by RS-scion combination (e.g., to produce a high percentage of plants with similar stem diameters).

With important exceptions, high rates of grafting success (compatibility) can be expected among the many thousands of possible RS-scion combinations.

Coordinated, local-regional evaluations of grafted plant performance and complementary educational resources are required to enhance the wider and more effective use of grafted plants, perhaps especially among small-midsize organic farms.

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