Grafting Cucumbers for Yield and Cold Hardiness in High Tunnels
a Cornell Vegetable Program challenge grant
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Introduction

Soil based greenhouse and high tunnel production of vegetables has risen dramatically in New York recently. This season extension technology offers farmers an opportunity to target market price peaks and capitalize on rising demand for locally grown produce. Considerable attention has been given, justifiably, to tomatoes in these settings. Trials by the Cornell Vegetable Program confirm that cucumbers can also be grown at a profit in tunnels.

As production continues in the same soil beds, risk of root-zone diseases and soil nutrient deficiencies increase. Grafting, the combination of two separate cultivars into one plant, could be a solution to these challenges. Evaluations of grafted tomato by the Cornell Vegetable Program revealed several advantages. This project endeavored to graft cucumbers onto a fig leaf gourd (*Cucurbita ficifolia*) for increased yields and cold hardiness.

Materials and Methods

On March 2, 2010 seeds of cucumber varieties Diva (Johnny's Selected Seeds) and Manar (DeRuiter) were sown in a commercial potting mix (Promix, Premier Horticulture, Quebec) at a cooperating Yates County greenhouse (Guyanoga Greenhouse). Rootstock 'Triumph (F1)' (Johnny's Selected Seeds) was also planted, all seeds into 48-cell flats. On March 13 grafts were made using the cleft-method (Figure 1) of 38 Manar and 38 Diva; each onto Triumph rootstock. The grafted plants were then placed in a grower-constructed healing chamber with an air temperature of 80°F, 100% relative humidity (RH) and darkness for 3 days. The grower then began a gradual acclimatization process toward full sun and greenhouse ambient RH and temperature. Of the 76 grafts 1 successfully healed after 1 week. The other 75 plants wilted or exhibited a soft-rot.

On March 15 seeds of Manar and Diva were planted in 48-cell flats to be used in ungrafted control plots. Seeding on the same date as the grafted plants would create too great a size difference at the final transplant date.

Using the original lot of March 2 seeded plants another attempt at grafting was made March 20 using a slant graft removing 1 cotyledon of the rootstock and both of the scions' (Figure 2). Thirty seven of each variety, Diva and Manar, were grafted to Triumph. Healing temperature was lowered to 72°F with 100% RH, darkness for 3 days, then very low light levels and multiple returns to healing chamber until they were placed under greenhouse benches at 7 days, then on top at 9 days. This process required additional misting compared to other graft trials. On April 5 there were 8 surviving plants of each of the scions Diva and Manar (16 total).

Blocks of 8 plants each grafted Manar, ungrafted Manar, grafted Diva, ungrafted Diva were transplanted at a cooperating high tunnel farm on April 5, 2010 into a Lima fine sandy loam soil. 1 Diva grafted plant broke during transplant (7 left). Blocks were arranged in an alternating in-row pattern of a double staggered row with 12" in-row spacing, with 8 plants per block, with the exception of grafted Divas (Figure 3); all on black plastic mulch. Number of fruit per block and total weight per block was recorded at each harvest, beginning May 25 and ending July 9. By the time data collection began there remained 1 grafted plant per variety due to stem breaks and undetermined factors causing wilt. Thus data was restricted to calculating average yields without statistical analysis. The trial was terminated on July 9 due to high levels of Two Spotted Spider Mites.

Temperature sensors connected to a data logger (Watchdog Model 400, Spectrum Technologies Plainfield, IL) were placed in the soil at approximately one inch deep, both in the tunnel, under the black row plastic, and outside of the tunnel. Sensors were also used to measure air temperature in and out of the tunnel at approximately three feet above ground level. The air sensors were placed in a vented radiation shield. The data logger was programmed to record temperature in degrees Fahrenheit at 15 minutes intervals, beginning March 23. Average temperatures were calculated for each sensor location. Aberrant readings (± 50F) were replaced with previous valid readings for 7 data points on April 9.

Results

Grafted plants of both varieties Manar and Diva out-yielded their ungrafted counterparts as measured by pounds per plant and number of fruit per plant (Charts 1 and 2). Grafted Diva plants yielded 6.4 lbs more per plant than ungrafted Diva and grafted Manar out-yielded ungrafted Manar by 0.9 lbs. Grafted plants gave more fruit; 6.5 more per plant in the case of Diva and 4.1 fruit in the case of Manar.

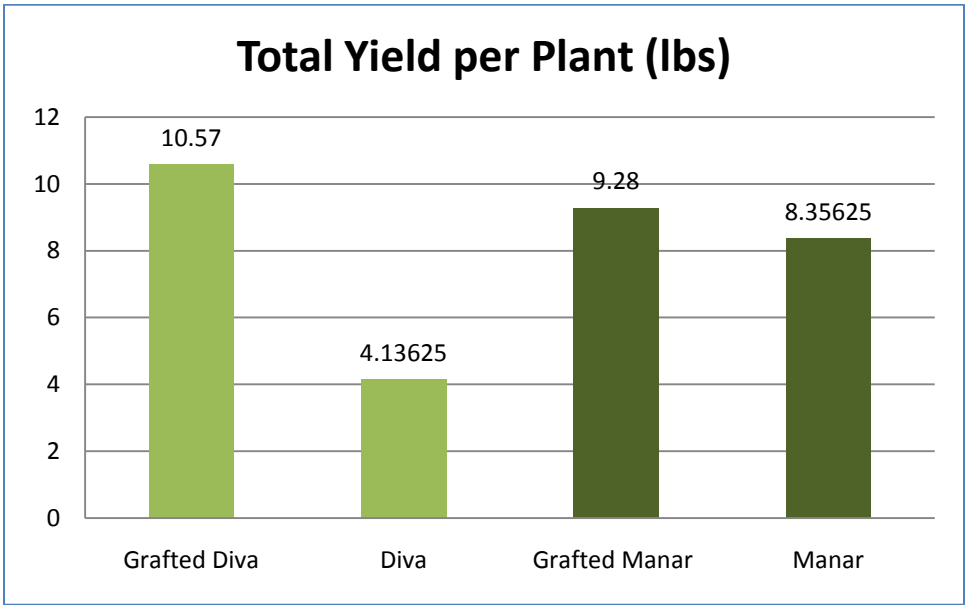

Chart 1. Yield per plant in pounds.

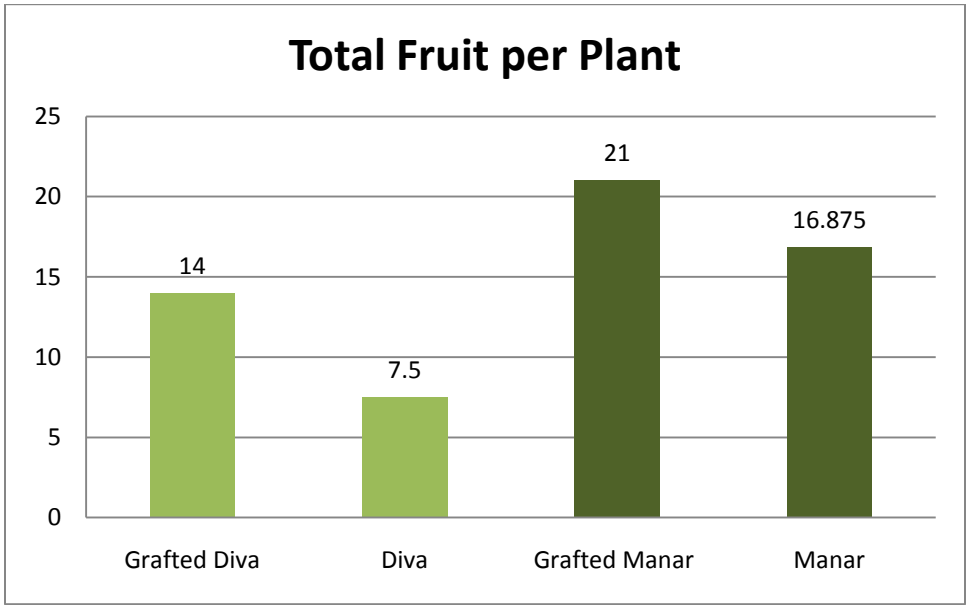

Chart 2. Yield per plant in fruit number.

Discussion

One goal of this project was to increase cucumber vigor, and hence precocity of yield. The gourd rootstock is reportedly tolerant of soil temperatures much lower than that of the cucumber. This was most apparent with the variety Diva, which when grafted yielded earlier in cold soils (Chart 3) then ungrafted. Soil temperature in the tunnel was higher than outside, particularly in the months of April and May (Table 1). Thus by combining the technologies of grafting with plastic mulch/high tunnels, growers can begin harvesting cucumbers when they would otherwise be planting with little to no additional heat inputs.

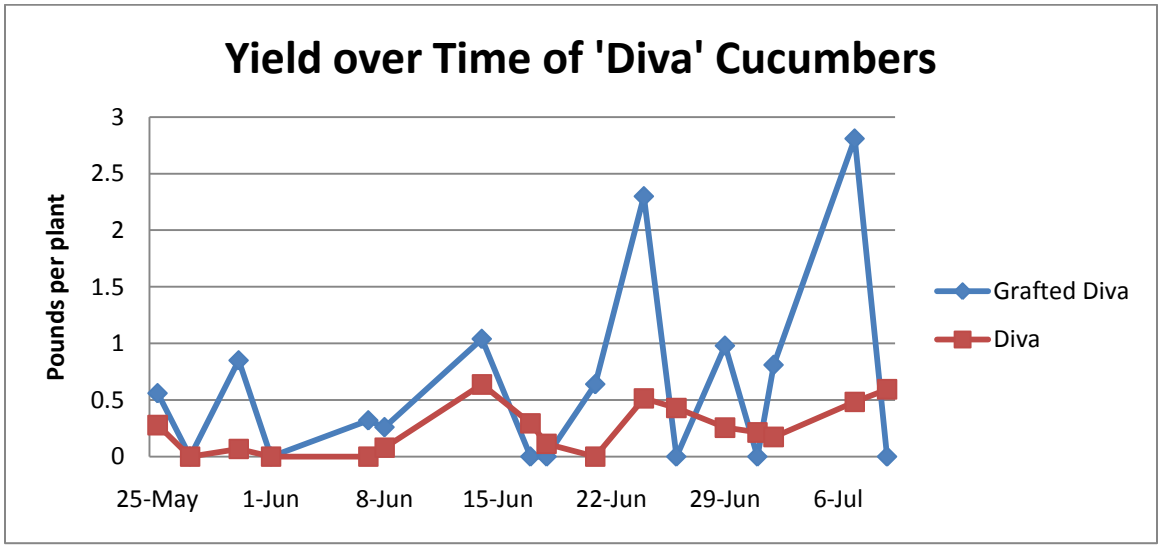

Chart 3. Grafted Diva cucumber yielded earlier than ungrafted.

Table 1. Average temperatures for soil and air, inside and out of the tunnel.

Dates	Avg Tunnel Air° F	Avg Outdoor Air° F	Avg Tunnel Soil ° F	Avg Outdoor Soil ° F
3/23-4/15	**61.8**	**47**	**55.2**	**48.5**
4/16-5/15	**67.3**	**53.3**	**59.8**	**52.1**
5/16-6/15	**73.8**	**65.4**	**70.6**	**67.6**

Recommendations

Although this trial gave promising data, there were many challenges. Low survival of grafted plants must be overcome for this to be feasible on a commercial level. The rootstock had uneven germination. Thus we recommend soaking seeds in water for 24 hours to achieve more uniform germination. As the rootstock stems have wider circumference than the scions (when seeded on the same date) we also recommend that Triumph should be sown 3-5 days later than scion. Future work could examine other rootstocks with smaller stem diameters. Secondary shoots from the rootstock also may have competed with the scion for water. These should be pruned regularly.

Gratitude is expressed to the Cornell Vegetable Program for their support of this project as well as our farmer cooperators.

Figure 1. Cleft grafts had low survival rates in this trial

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Figure 2. Successful slant graft at cotyledon.