

Interim Report FNE03-452: Selecting Heirloom Tomato Varieties for Disease Resistance

Jeremy Barker Plotkin
22 Poole Rd.
Belchertown, MA 01007
(413) 323-9608; jbp@the-spa.com

Goals of Project:

I would like to breed resistance to *Alternaria* blight and *Septoria* leaf spot into some of the heirloom tomato varieties which I grow. I have a very good market for heirloom tomatoes, but disease pressure cuts my season very short. My plants are typically very productive in mid- to late-August, with declining productivity through the month of September. My market for tomatoes actually increases in September, and we often don't have frost until early October, so if I could reduce disease losses, I could greatly increase my yields and profitability. I typically put in a late planting for September, but we often have wet conditions in September and disease pressure is high even in the late plantings. I have observed variation between varieties in disease susceptibility, and would like to do some more targeted work to select and breed for disease resistance. My marketing strategy for heirlooms relies on having a full palette of colors, so the ideal scenario would be several resistant varieties in different colors.

My breeding strategy is working to develop what is known as horizontal resistance. This strategy is different from the standard technique, known as vertical resistance, which consists of finding single traits that code for resistance. Instead, a complex of several resistance traits is selected by growing plants under high disease pressure, and crossing the individual plants that are most resistant. Vertical resistance is typically short-lived, since a single mutation in the disease can overcome the resistance mechanism; horizontal resistance is a more robust type of resistance.

Farm Information

I rent an eleven-acre (4-5 tillable acres) parcel of land from the New England Small Farm Institute (NESFI) in Belchertown, MA. The land is part of a larger parcel of land that is owned by the Commonwealth of Massachusetts and managed by NESFI. 1999 was my first year of production; I had been working on vegetable farms or studying agronomy (I finished my M.S. in Plant, Soil and Environmental Science from the University of Maine in spring 2000) for seven years previous. I cultivated about 4 acres in 2002. The soil is a Woodbridge sandy loam soil which is excellent for vegetable production, particularly after several years of rock-picking and build-up of organic matter. My primary crops are mixed vegetables. I have been certified organic by NOFA/Mass since 2000. I manage a marketing cooperative of the farmers at NESFI; together we operate a farm stand on the site and go to the Amherst, MA and Cambridge, MA Farmer's Markets. In 2002, I increased production of heirloom tomatoes to meet two wholesale markets in addition to the retail markets I already served. The first wholesale market was the local Bread and Circus supermarket, and the second was the New American Farmer's Initiative, which brought Massachusetts produce to upscale restaurants in New York City. The tomatoes were very well-received by both markets.

In 2003, I maintained my production of heirlooms at the same level as in 2002. Production was good although a wet season and heavy disease pressure cut the season quite short.

Cooperators:

John Navasio, the technical director, has helped through phone consultation on plot design, evaluation and selection. Eli Kauffman has coordinated outreach through the Restroing Our Seed project. Lawrence Winship has provided winter greenhouse space at Hampshire College for grow-out and crossing of candidate strains. Ruth Hazzard has provided help in plot evaluation and will help to publish results at the end of the project.

2003 report

In 2003, I established a disease nursery plot which had been used in 2002 for tomato production and which had shown heavy disease pressure in that season. Six varieties of heirloom tomatoes were grown in the plot, along with resistant and susceptible varieties (for comparison), in a randomized block design with three repetitions. The plants were evaluated for foliar disease levels on three dates in August and September 2003. Ratings from 1 (least disease) to 9 (most disease) were assigned to each plant. For each variety, the block that had the highest average disease ratings was determined. Seed was saved from the best-performing plants in each of those blocks. This led to selection of 2-3 individuals from each variety. Seed from these individuals is being grown out this winter at the Hampshire College greenhouse. I will be making crosses by hand-pollination between individuals within the variety. Seed from the resulting tomatoes will be planted in the disease nursery in 2004.

Results

Following are the average disease ratings per variety, listed in descending order of performance.

<u>Variety</u>	<u>Disease Rating</u>
Aunt Ruby's German Green ("susceptible check")	4.96
Indian Moon	5.62
Nebraska Wedding	5.97
Pruden's Purple	5.98
Green Zebra	6.15
Carbon	7.08
Cherokee Purple	7.08
JTO-99197 ("resistant check")	8.41

Differences in disease levels were more readily apparent between varieties than between plants within a variety, but enough variation was found between plants to select the best individuals. The relative ranking based on foliar disease levels does not tell the whole story. Both *Alternaria* and *Septoria* progress more rapidly after fruiting commences, as the plant puts its energy into fruit production. The more determinate

varieties tended to fare the worst in foliar disease levels as they completely stopped producing leaves after fruiting. Indeterminate varieties did especially well because the plants put on a second flush of foliar growth in the later part of the season, after the extremely humid August weather was finished. The two opposite extremes are Aunt Ruby's, which produced immense quantities of lush green foliage and barely any fruit, and JTO-99197, which essentially died, and was loaded with sun-scalded, rotten fruit. Neither variety is useful under heavy disease pressure. The especially poor performance of JTO-99197, which is marketed as resistant to *Alternaria*, led me to believe that *Septoria* is the dominant disease. In the middle end of the spectrum is where the more interesting results lie. Indian Moon and Nebraska Wedding were both heavy producers of nice fruit, and showed moderately low foliar disease levels. Green Zebra was also a heavy late producer with moderate foliar disease. All three of these plants are indeterminate, and productive of both fruit and foliage. Pruden's Purple, on the other hand, received moderate foliar disease levels, but had a very low yields of marketable fruit (total fruit yields weren't low as with Aunt Ruby's, but most of the fruit was rotten). Pruden's showed the earliest onset of *Alternaria*, but the vines seemed to recover especially well and put on a second flush of foliage. Pruden's relatively good performance in spite of early *Alternaria* infection support the idea that *Septoria* is more dominant of the two diseases. Carbon and Cherokee Purple seemed to be more determinate, producing a heavy early fruit set (mostly rotten) on vines which died rapidly.

Plans for 2004

I will be eliminating Nebraska Wedding and Carbon from the trial because there was no appreciable difference between them and their counterparts (Indian Moon and Cherokee Purple, respectively). This will free up two spots in the trial—I haven't yet decided if I will use them to grow out more than one strain of some varieties or if I will add in some other varieties. I may also eliminate Indian Moon and/or Green Zebra, because they did so well, and may not need further improvement. One of my late-fall tomato problems is that I go to market with green and yellow tomatoes and the display just isn't as attractive as the full rainbow palette. Another change I will make is that I will substitute different varieties for the resistant and susceptible checks, since obviously neither fit those descriptions. I will also be performing some crosses between varieties, hopefully using Indian Moon and/or Green Zebra to introduce disease resistance into some of my other varieties. That is outside the scope of the present project, but could yield some interesting results. I may decide to run one such cross in the disease nursery to see how it performs.

Jeremy Barker Plotkin, February 28, 2004