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Late Blight Resistant Tomato Variety Evaluation Conducted with Organic Production Practices — 2014

Margaret T. McGrath
Cornell University

Karen LaMarsh
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Tomato is an important crop that is routinely affected by diseases. It is important for both organic and conventional diversified vegetable growers, which are common in the northeastern United States. Fresh local tomatoes are one of the most popular items during summer, therefore they are grown by many organic and conventional growers.

There are several foliar disease affecting tomatoes, including Septoria leaf spot, early blight, bacterial speck and spot, late blight, powdery mildew, and leaf mold. Foliar diseases are a common occurrence wherever tomatoes are grown. All plantings are affected, even those grown under protection (greenhouses and high tunnels) and in small home gardens. Resistant varieties would be a valuable tool for managing these diseases, particularly late blight because it occurs sporadically and can be difficult to control with fungicide applications started after onset. Organic growers on Long Island have identified tomato as a high priority for research.

The goals of this experiment, which is part of a multi-year project, were to evaluate new tomato varieties and experimental hybrids with resistance to late blight in terms of 1). susceptibility to naturally-occurring foliar diseases, and 2). yield and fruit quality.

Materials and Methods

The experiment was conducted at the Long Island Horticultural Research and Extension Center (LIHREC) in Riverhead, NY, in a field with Haven loam soil that has been dedicated to research on organically produced crops since 2001. Organic fertilizer at 105 lb/A N was spread over rows to be planted, then incorporated. Three products were used each at 700 lb/A: Pro-Grow 5-3-4, Cheep Cheep 4-3-3, and 6-0-6 Cotton seed blend. Next, drip tape was laid as the rows were covered with black plastic mulch. A combination of annual ryegrass and clover were planted between rows of plastic mulch to establish a living mulch by broadcasting seed with a hand-operated spreader, then lightly raking to incorporate. The ryegrass plus weeds that grew were mowed routinely. Some weeds were removed by hand.

Tomato seed were sown in an organic seeding mix in the greenhouse on May 10. Seedlings were transplanted by hand on June 17 into holes opened in the plastic mulch by a waterwheel transplanter that also placed in the holes a starter fertilizer, Neptune's Harvest Benefits of Fish (2-4-1 N-P-K). Drench applications of this fertilizer to the base of plants were made on August 8, 15, and 29, and September 5 and 12.

A completely randomized block design with four replications was used. Plots consisted of 10 plants in a single row with 24-in. plant spacing and 68-in. row spacing. A yellow cherry-type tomato plant (cv. Sungold) separated plots within rows. This variety was also planted in a spreader row between the second and third replications. Plots for each of the four replications were in three adjacent rows. Following standard procedure for fresh-market tomato production on Long Island, plants were staked and trellised as they grew using the Florida weave trellising

system with 4-ft stakes placed between plants. Water was provided as needed through drip tape laid beneath the plastic mulch.

Thrips, tomato fruitworms, and other insect pests were managed by applying Entrust (8 oz/A) on July 17 and 25, August 4, and September 2. The application was made using a tractor-mounted boom sprayer equipped with twinjet (TJ60-11004VS) nozzles spaced 17 in. apart that delivered 63 gal/A at 65 psi.

Leaves were examined for symptoms of any foliar disease sixteen times from July 16 to October 8. Late blight and other diseases observed were assessed by estimating the percentage of leaves in each plot with symptoms (incidence) and the severity of symptoms on these affected leaves. Canopy severity was calculated by multiplying these values. Area Under Disease Progress Curve (AUDPC) was calculated for late blight severity from September 17 through October 8. All diseases occurring developed naturally; inoculum was not introduced.

Ripe fruit were harvested on August 26, September 8, 15, 23, and 30, and October 8. Green fruit were also harvested on October 8. Fruit quality attributes assessed included taste rated on a 1-5 scale with 5 being excellent.

Average monthly high and low temperatures (°F) were 79/60 in June, 82/67 in July, 81/64 in August, 77/61 in September, and 66/53 in October. Rainfall (inches) was 2.47, 2.24, 2.42, 1.86, and 5.43 for these months, respectively.

Results and Discussion

Late blight was first observed on June 20 on Long Island, NY, in 2014. Very few symptoms were found that day in a commercial potato crop in Suffolk County located about 5 miles from the research field for this experiment. Source of inoculum for this crop could not be determined. Symptoms were found in three additional crops before being found in this experiment on August 15. US-23 was the only genotype of *Phytophthora infestans* found in the region, including at LIHREC.

Late blight became moderately severe in this experiment on the late blight-susceptible variety (Mountain Fresh Plus), reaching 52% leaves with symptoms and 46% canopy severity on September 22. Subsequently many leaves died. Defoliation was 94% on October 8. All varieties evaluated were significantly and substantially less severely affected by late blight than Mountain Fresh Plus, including Pruden's Purple and Wapsipinicon Peach, which were not bred to be resistant (Table 1). Observations by others of less severe late blight on these relative to other varieties prompted their inclusion in this experiment. No symptoms of late blight were found on plants of Mountain Merit (red slicer type fruit) or Mountain Magic (campari type), which are both heterozygous for *Ph2* and *Ph3* major genes for resistance. Plum Regal is homozygous for *Ph3*. Powdery mildew and Septoria leaf spot were both most severe on Wapsipinicon Peach and least severe on Mountain Magic. JTO 1175 exhibited the least defoliation on September 29, but this was only significantly different from Pruden's Purple and Wapsipinicon Peach. Late blight symptoms were also not found in the nonreplicated plantings (single plots) of four varieties from a local grower-breeder who felt they had resistance from her observations.

Significant differences in yield were detected among varieties examined (Table 2). Quantity of fruit produced was primarily determined by fruit type, with the greatest number produced by Mountain Magic, the variety with the smallest fruit (campari aka cocktail type fruit). Mountain

Fresh Plus and Mountain Merit produce red slicer type fruit. JTO 1175 produces red plum type fruit.

Acknowledgments

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Table 1. Severity of late blight and other naturally occurring foliar diseases on tomato varieties, Riverhead, New York, 2014.

Entry Name	Disease Severity (% canopy affected)[z]						Defoliation (%)[z]
	Late Blight		Powdery Mildew		Septoria Leaf Spot		
	17 Sep.	AUDPC[y]	17 Sep.	AUDPC[y]	29 Sep.	AUDPC[y]	29 Sep.
Mountain Fresh Plus	33.4 a	377.3 a	8.4 c	383.2 bc	2.8	7.6 ab	46.3 ab
Pruden's Purple	1.2 b	10.1 b	14.6 bc	248.9 cd	1.4	1.9 bc	50.0 a
Wapsipinicon Peach	0.8 b	1.8 b	64.0 a	1,499.6 a	1.6	2.6 a	50.0 a
JTO 1175	1.0 b	9.2 b	1.7 c	255.2 cd	0.6	0.4 b	5.5 b
Plum Regal	0.4 b	1.5 b	2.6 c	257.6 cd	2.1	4.3 ab	17.8 ab
Mountain Merit	0.0 b	0.0 b	45.5 ab	934.8 ab	2.6	6.9 ab	38.8 ab
Mountain Magic	0.0 b	0.0 b	0.2 c	23.8 d	0.1	0.0 c	15.0 ab
P-value (treatment)	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.6601*	*0.0001*	*0.0069*
Clackamas Blueberry[x]	0.0	0.0	1.0	25.8	0.0	14.9	*20.0*
Fahrenheit Blues[x]	0.0	0.0	30.0	40.4	0.0	9.5	*5.0*
Blue Pitts[x]	0.0	0.0	0.3	9.5	0.0	11.6	*5.0*
Stripe of Yore[x]	0.0	0.0	4.0	28.1	0.0	11.2	*5.0*

[z]Numbers in each column with a letter in common are not significantly different from each other (Tukey's HSD, P=0.05).

[y]AUDPC values for replicated plots were square root transformed before analysis. Table contains detransformed values.

[x]Data not statistically analyzed because these were single observational plots.

Table 2. Yield of tomato varieties, Riverhead, New York, 2014.

Variety	Seed Source[w]	Yield (# fruit/plant)[z]				
		Marketable[y]			Total[x]	
		30 Sep.	8 Oct.	All[v]	8 Oct.	All[v]
Mountain Fresh Plus	BE	1.0 b	0.8 b	4.7 cd	7.8 d	18.7 cd
Mountain Merit	BE	0.8 b	0.4 b	4.0 cd	10.5 cd	17.9 cd
Plum Regal	BE	1.9 b	1.1 b	8.2 bcd	36.5 b	48.8 b
JTO 1175	JS	2.4 b	1.8 b	10.0 bc	35.4 bc	47.3 b
Wapsipinicon Peach	TT	3.1 b	2.0 b	13.0 b	25.8 bcd	40.6 bc
Pruden's Purple	JS	0.5 b	0.1 b	2.7 d	2.0 d	9.3 d
Mountain Magic	BE	8.3 a	9.3 a	45.9 a	106.4 a	148.4 a
P-value (treatment)		*0.0012*	*0.0001*	*0.0001*	*0.0001*	*0.0001*
Clackamas Blueberry	G	0.8	0.6	1.4	30.0	101.1
Fahrenheit Blues	G	0.0	2.4	2.4	23.6	116.5
Blue Pitts	G	14.1	20.5	34.6	27.4	136.4
Stripe of Yore	G	1.4	2.1	3.5	6.5	25.6

[z]Numbers in each column with a letter in common are not significantly different from each other (Tukey's HSD, P=0.05).

[y]AUDPC values were square root transformed before analysis. Table contains detransformed values.

[x]'Total' represents marketable and unmarketable fruit, which included those that had rotted, split, or were damaged by insect feeding plus unripe fruit present at last harvest on October 8.

[w]BE= Bejo Seeds, G=Grower (Tom Wagner, seed procured by Invincible Summer Farms), JS=Johnny's Selected Seeds, and TT= Totally Tomato

[v]'All' is the summation of fruit harvested on 6 days (August 26, September 8, 15, 23, and 30, and October 8).