Variety Trial Field Report: 2018 Northern Organic Vegetable Improvement Collaborative The Evergreen State College Olivia Raine, Dr. Angelos Katsanis, Dr. Sarah Williams

Organic Field Tomatoes: NOVIC Trial at The Evergreen Organic Farm

Abstract NOVIC (The Northern Organic Vegetable Improvement Collaborative) conducts research through researchers and farmers in different regions in the US. They collaborate with members to create a data driven system for organic farmers to choose varieties well adapted to their region. The Evergreen State College has been a member of this collaboration for two tomato trials (2017 & 2018) on The Evergreen Organic Farm. Seven varieties were chosen by NOVIC to be trialed and collect data on. Plant performance and fruit performance qualities were observed and data collected throughout the growing season. The resiliency to Late Blight (*Phytothora infestans*) was a plant performance quality that was of heightened interest due to tomato susceptibility to fungal pressures. A tasting workshop was conducted with a group of Evergreen students and all marketable fruit from the trial was sold by Practice of Organic Farming students at the weekly farm produce stand on campus. Variety trial results must always be viewed on the cautious side due to annual weather differences, soil types, farm microclimate, disease history and in the case of this trial, shaded areas. Varieties may have yielded well but have a lower quality than others, while others may have higher quality but lower yield. These are all factors each farmer will have to take into consideration.

Introduction

About NOVIC The Northern Organic Vegetable Improvement Collaborative (NOVIC) strives to bring together researchers and farms in the Northern USA to address the seed and variety breeding needs of organic farmers. The collaborative includes researchers and educators from Oregon State University, University of Wisconsin-Madison, Cornell University, Washington State University, Organic Seed Alliance, and the USDA. NOVIC collaborates with over 30 farmers to breed new varieties, identify the best performing varieties and educate farmers on seed production and the improvement of varieties. Trials are conducted on USDA organic certified land, research stations and farms. A mother-daughter trialing system is used, research farms utilize the mother component by running three repetitions of the variety blocks. Farmers take part by conducting daughter components by running a singular variety of each block. NOVIC focuses on five crops (sweet corn, red bell and roasting peppers, tomatoes, cabbage and winter squash) in their breeding program. An additional crop is chosen by farmers regionally. Results from NOVIC variety trials are published in the Organic Variety Trial Database which is maintained by collaborators at eOrganic. The overarching goal of NOVIC is to aid in the development of open-pollinated varieties which are specifically adapted to meet the needs of organic farmers through improvement of key traits to aid in market presence.

About this Trial This trial was conducted at the Evergreen Organic and was conducted as daughter trial; but two repetitions of each variety were grown and data was collected. The Evergreen Organic Farm hosted a NOVIC tomato trial during the ’17 summer season, this trial was conducted at a different location on the farm than the ’18 season trial. All protocols utilized in respect to data collection were provided by NOVIC. Caretaking protocols utilized were recommended by the Evergreen Organic Farm staff. Tomatoes are a common and high value crop grown by organic farmers for wholesale, CSA and direct market sales outlets. They are a somewhat finicky crop to grow, especially in regards to disease management in in the damp climate of Western Washington. This trial was focused on marketable yield and disease resiliency in an organic field trial for six salad/ slicer varieties (Crimson Sprinter, Marina, Marmande, Red Racer, Mt. Merit, Damsel) and one plum/paste variety (Plum Regal). The SURF (Summer Undergraduate Research Fellowship) program at The Evergreen State College made this project possible through funding and student support.

Methods & Materials The seeds for the trial were provided by NOVIC and were seeded by the Evergreen Organic Farm staff on April 4th The trial plants were transplanted in single-row beds on May 26th, with two replications in a complete randomized block design. They were transplanted into newly rototilled ground with a single line of drip irrigation per row. The beds had been freshly fertilized with 10lb of feather meal per 110 foot bed. The irrigation was run every two days for approximately three hours. Stirrup hoes were frequently used for weed control, especially in late spring and early summer. A basket weave trellising was utilized for all blocks. New support strings were added until the maximum size of the variety was reached or the top of the t-post was reached. Plants were monitored every 3 days to determine first fruit ripening. The first harvest was set for one week after first fruit ripening per block was observed. As each block began to ripen, they were added into the weekly harvest schedule, one week after ripening had been recorded. The weekly harvest was conducted over two days and all fruit at breaker stage (more orange/red on fruit than green) or more mature was harvested. Plant performance was measured through leaf curl, leaf cover, days to first harvest and disease resistance. Fruit performance was measured through marketable yield, total fruit, average fruit weight, average fruit length x width, average Brix, and picking ease.

Plant Performance Leaf curl analysis (Table 1) is an assessment of the severity of leaf curl/roll and was conducted as a whole block visual assessment. The data was collected 8/1/18 and timing of data collection and why a scale of 1-5 was used to grade the severity, with a grade of 1 conveying no or minimal leaf curl and a 5 conveying severe leaf curl. NOVIC protocols indicated that this evaluation should be conducted when the plants are in an early bloom stage. Individual ratings were given for each block and an average was calculated for the two blocks of each variety. Leaf cover analysis (Table 1) is an assessment of leaf protection of fruit and was conducted as a whole block visual assessment. The data was collected on 8/16/18 and a scale of 1-5 was used to grade the coverage, with a grade of 1 conveying minimal coverage and a 5 conveying heavy coverage. NOVIC protocols indicated that this evaluation should be conducted when fruit was nearing or at maturity. Disease and pest ratings were collected continuously throughout the trial and rated on a scale of 0-3, 0 conveying blocks without disease and/or pest, a rating of 3 conveying several disease and/or pest damage. Late Blight (*Phytopthora infestans)* was conducted as a whole block assessment and was rated on a 0-100% scale. The first symptoms of Late Blight where observed on 10/10 as irregularly shaped necrotic lesions. Harvest of all fruit concluded on 10/23.

Fruit Performance The fruit was qualitatively divided between marketable and unmarketable, and was then counted and weighed separately. Fruit was deemed unmarketable if the individual had any cracking, splitting, cat facing, zippering, lesions or was otherwise misshapen. For the single heirloom variety in the trial there was some leeway given for abnormal shapes. Picking ease was rated during the first harvest and fruit measurements were taken during week three of harvest. All fruit quality measurements were taken during the 3rd week of harvest for each variety. Samples for soluble solids analysis (Brix) were taken during the fifth harvest. Brix is a measurement of the sugar content of an aqueous solution and is taken using a Brix Refractometer. A tasting lab was conducted with an Evergreen program on 10/5/18 and the data is displayed in Table 2. A total of 33 individuals tasted each variety as raw slicers and judged each variety on five factors: appearance, sugar/acid balance, flavor, texture and skin thickness. They rated each factor on a scale of 1-5 (1= low/not enjoyable, 5=high/enjoyable). The scores were then averaged for an individual score per variety. All marketable fruit from this trial was sold at The Evergreen Organic Farm stand on campus twice a week. The fruit for the taste testing was set aside from the crop going to market.

Results

|  |  |
| --- | --- |
| Variety | Abbreviation |
| Crimson Sprinter | CS |
| Red Racer | RR |
| Plum Regal | PR |
| Marmande | Mar. |
| Marina | Marina |
| Mt. Merit | MM |
| Damsel | Damsel |

| Variety | Leaf Curl | Leaf Cover |
| --- | --- | --- |
| CS | 3 | 4 |
| Damsel | 3 | 4.5 |
| PR | 4 | 3 |
| Marina | 4 | 3 |
| Mar. | 3 | 3 |
| RR | 5 | 1 |
| MM | 3.5 | 2 |

Variety abbreviation index.

Table 1. Average results for Leaf Curl and Cover (fruit coverage by leaves) ratings. Curl ratings were conducted on a scale of 0-5, 0 = minimal or no leaf curl, 5 = extreme leaf curl. Cover ratings were in conducted on a scale of 0-5, 0 = minimal or no leaf cover, 5 = extreme leaf cover

| **Variety** | **Appearance** | **Flavor** | Balance  **(sugar + acid)** | **Texture** | **Skin Thickness** | **Overall** |
| --- | --- | --- | --- | --- | --- | --- |
| Red Racer | 3.12 | 2.96 | 2.86 | 2.93 | 3.34 | 3.04 |
| Damsel | 4.54 | 3.12 | 3.06 | 2.96 | 3.12 | 3.36 |
| Marmande | 3.5 | 2.93 | 3.04 | 2.81 | 3.28 | 3.11 |
| Mt. Merit | 2.72 | 3.01 | 3.00 | 3.15 | 3.01 | 2.97 |
| Plum Regal | 3.39 | 2.68 | 2.71 | 2.60 | 3.17 | 2.94 |
| Marina | 3.78 | 3.72 | 3.29 | 3.28 | 3.18 | 3.45 |
| Crimson  Sprinter | 3.90 | 3.98 | 3.45 | 3.31 | 3.06 | 3.54 |

Table 2. Fruit Tasting Table. 1 = low/ unenjoyable; 5 = high/ enjoyable.

| **Variety** | **Days to First Harvest** | **Picking ease**  **1 = difficult**  **3 = easy** | **Marketable yield**  **(lb.)** | | **Total fruit**  **(fruit count)** | **Marketable Fruit**  **(fruit count)** | **Percent Unusable**  **(%)** | **Disease and Pest Rank** | **Avg. Weight**  **(oz.)** | **Avg. WxL (in.)** | **Avg. Brix** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crimson Sprinter | 123 | 5 | 23.425 | 97 | | 56 | 42.3 | 2 | 7.36 | 2.39x2.715 | 5.3 |
| Damsel | 123 | 3 | 33.715 | 87.5 | | 55 | 37.1 | 1.5 | 9.36 | 3.05x2.625 | 5.55 |
| Plum Regal | 130.5 | 1 | 34.43 | 138.5 | | 127.5 | 7.9 | 1 | 4.16 | 2.03x2.95 | 4.1 |
| Marina | 117.5 | 3 | 39.205 | 287 | | 255 | 11.1 | 1 | 2.56 | 2.09x1.89 | 5.05 |
| Mar. | 120 | 2 | 39.675 | 150 | | 116.5 | 22.3 | 2 | 5.36 | 3x2.075 | 5.5 |
| Red Racer | 114.5 | 1 | 31.135 | 340.5 | | 300.5 | 11.7 | 2 | 2.16 | 1.975x1.915 | 5.1 |
| Mt. Merit | 117 | 3 | 11.570 | 46.5 | | 21.5 | 53.8 | 1 | 9.2 | 3.29x2.85 | 5.05 |

Table 3. Average results for fruit quality data.

| **Variety** | **10/17 (%)** | **10/24 (%)** | **10/30 (%)** |
| --- | --- | --- | --- |
| Marina N1 | 1 | 5 | 25 |
| Mar. N2 | 50 | 75 | 80 |
| PR N3 | 1 | 5 | 25 |
| CS N4 | 5 | 25 | 75 |
| PR N5 | 1 | 5 | 50 |
| CS N6 | 25 | 50 | 90 |
| RR N7 | 5 | 25 | 90 |
| Damsel S1 | 5 | 25 | 50 |
| Mt. Merit S2 | 25 | 50 | 75 |
| RR S3 | 5 | 50 | 75 |
| Damsel S4 | 5 | 25 | 50 |
| Mar. S5 | 75 | 75 | 90 |
| Mt. Merit S6 | 5 | 25 | 75 |
| Marina S7 | 50 | 75 | 100 |

Table 4. Late Blight (*Phytopthora infestans*) ratings for each block. Based on a scoring system of 0-100% infection.

Days Until First Ripe Fruit (Table 3.) Monitoring when the first ripe fruit per block appeared was necessary to determine the initial harvest date. Red Racer was the first variety to have ripe fruit (114 after seeding). Mt. Merit and Marina harvests began 117 days after seeding. Marmande produced ripe fruit 120 days after seeding, Crimson Sprinter and Damsel harvests began after 123 days. The last variety to be integrated into harvests was Plum Regal after 130 days.

Total Fruit (Table 3.) Total fruit removed from each variety block was widely varied between the varieties. This variable was counted on a whole block basis, the total amount for both blocks was averaged for a five week harvest cycle. Red Racer produced the most fruit with 340.5 averaged between the two blocks. The next highest producer was Marina, it is worth noting that these two varieties produced the most fruit, but the smallest fruit sizes of the varieties. Marmande produced 130 fruit, Plum Regal produced 138.5 fruit, Crimson Sprinter produced 97, Damsel 87.5. Mt. Merit was the lowest producing with a total of 46.5 fruit over the five weeks.

Marketable Fruit Yield and Count (Table 3.) Considering Marketable Fruit Count in comparison to Marketable Fruit Yield (lbs.) illustrates interesting variance in count to weight. Red Racer produced 300.5 individual marketable fruits weighing in at 31.135 lbs. Marina produced 255 marketable fruit weighing in at 39.205 lbs. Plum Regal produced 127.5 marketable fruit which weighed 34.430 lbs. Marmande produced 116.5 marketable fruits which weighed 39.675 lbs. Crimson Sprinter produced 56 marketable fruit which weighed 23.425 lbs, Damsel produced 55 marketable fruit which weighed in at 33.715 lbs. Mt. Merit was the lowest marketable fruit producer with 21.5 marketable fruit which weighed 11.570 lbs. While Red Racer had over 5x the individual marketable fruit count as Damsel, the marketable fruit yield of Damsel weighed more than Red Racer by 2 lbs. This can be attributed to the much larger fruit produced by Damsel.

Average Fruit Weight (Table 3.) The Average Fruit Weight data was collected from the fruit harvested during the third week of harvest. 10 representative fruit were measured and an average weight was calculated. Damsel was the heaviest at 9.36 oz., and Mt. Merit in as a close second at 9.2 oz. Crimson Sprinter weighed in at 7.36 oz., Marmande weighed in at 5.36 oz., Plum Regal weighed in at 4.16 oz., Marina fruit was an average of 2.56 oz. and Red Racer fruit weighed in at 2.16 oz.

Average Brix (Table 3.) Due to an incorrectly calibrated refractometer used for the week 3 harvest fruit data collection, the reported Brix scores were taken from the week 5 harvest. Brix scores did not have a wide spread. Damsel was measured to have a score of 5.55%, Marmande has 5.5%, Crimson Sprinter had 5.3%, Red Racer had 5.1%, Mt. Merit and Marina each scored 5.05%. Plum Regal was the lowest scoring with 4.1%.

Tasting Workshop (Table 2.) A class of 33 undergraduate students took part in the tasting workshop which took place in early October. Due to the time of season and the quality of tomatoes at the time, it can be assumed that the fruit was not at its highest possible quality. Students tasted each variety raw and scored using a scale of 1-5, (1 = unenjoyable, low; 5 = enjoyable, high). The results from the tasting workshop crowned Crimson Sprinter as the favorite with a 3.54/5. Plum Regal came in last place with a 2.94/5.

Late Blight Infection (Table 4.) Late Blight (*Phytopthora infestans*) was observed initially on 10/10/18 and the first round of scoring was conducted on 10/17/18. The scoring system used was 0-100% infected, 0% being completely unaffected, 100% being completely black and dead. Plum Regal performed the best and had the lowest infection scores for both blocks at the end of the three week scoring period. Damsel performed well and had some of the lowest infection scores for all the individual blocks. The two blocks of Marina performed quite differently after becoming infected, after the three week scoring period, the block in the “North” bed (N1) was only at a 25% infection score, the block in the “South” bed (S7) earned a 100% infection score. A possible explanation for this could be that the eastern portions of the beds received much more shade by the surrounding forest than the plants on the west side of the beds. N1 was located on the North-Western side and S7 was located on the South-Eastern side. Crimson Sprinter, Marmande and Red Racer performed poorly after becoming infected.

Interpretation Damsel was clearly a top contender in several ways; it produced the heaviest fruits, came third in the tasting workshop scoring and had a strong resistance to Late Blight (Table 4.). It did have a somewhat high Unusable Fruit Percentage and low Total Fruit Count (Table 3.). The plant itself was very heavy overall and required a fair amount of trellising support. It had a high Leaf Cover score (Table 1.) and was easy to pick (score of 3, Table 3.) but the fruit grew low to the ground. The fruit was striking to look at against the other tomatoes. It had a dark pink tinge to the coloration and large fruit sizes overall. Crimson Sprinter was a bright red, medium sized tomato and was the top performer in the tasting workshop (Table 2.). It did have a high Percent Unusable and low Total Fruit Count (Table 3.). It was easy to pick (score of 3, Table 3.) and had a heavy Average Weight (Table 3.). Plum Regal was the only plum variety involved in the trial and while it had a high Marketable Fruit, Total Fruit Count and a low Unusable Percent (Table 3.) the fruit never seemed to truly ripen. It was the lowest performing in the Taste Workshop (Table 2.) and had the lowest Brix rating (Table 3.) of all the varieties. The fruit was extremely hard to pick. Marmande was the only heirloom variety in the group and had the highest Marketable Yield despite having a somewhat high Unusable Percentage (Table 3.). This was the only variety that abnormal shape forgiveness was given and they produced a medium sized, bright red fruit. Mt. Merit was a disappointing variety, it had low Total Fruit Count, Marketable Yield and high Unusable Percentage (Table 3). A large number of the fruit had deep scars on the top of the fruit. It performed poorly in the Tasting Workshop (Table 2.) and once infected with Late Blight (Table 4.). Red Racer was the first variety to ripen and produced the highest Total Fruit count (Table 3.) but due to the small size of the fruit, not amongst the highest Marketable Yield varieties. It was in the middle of the pack in the Tasting Workshop (Table 2.) and performed poorly after becoming infected with Late Blight (Table 4.). The plants were the smallest in overall stature. Marina was the second highest Total Fruit count and second highest Marketable Yield (Table 3.). It was the second in the Tasting Workshop (Table 2.) and produced small/medium sized fruits. The plants grew tall, the fruit was easy to pick (Table 3.) and there were mixed results in the Late Blight resistance (Table 4.).

Conclusion This trial will be utilized to aid organic farmers in Western Washington make more informed decisions about which tomato varieties will grow well in their climate. The more seasons a NOVIC tomato trial is conducted at the Evergreen Organic Farm, the stronger and more helpful the data will be in the future. For farmers wanting to be among the first to market with tomato would do well to choose Red Racer as a variety a it was first to ripen fruit and high fruit count. For farmers wanting to be among the last at market with fresh tomatoes, they would do well to choose Damsel as it continued to produce well into the Fall and after Late Blight infection took hold. Damsel received the highest appearance rating from the tasting workshop and may do very well on a farmers market stand. A variety that did not perform well was Plum Regal, the only plum tomato variety, this variety had low plant and fruit performances. In the future, complete Mother trials would advance the strength and usefulness of this trial. A different block organization system would perhaps be more conducive to data collection over a complete randomized block system.

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