

Our Continuing Search for Better Strawberry Varieties

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In this paper, we wish to simply report our findings from a strawberry variety and advanced selection trial at a location in Eastern, NC (Cottle Farms, Faison), over the most recent 2019-2020 season. Our primary purpose for doing this testing program is to identify new varieties and/or advanced selections from various public and private breeding programs in the U.S. that could provide strawberry growers in the Carolinas and other states in the mid-South with an opportunity to replace Chandler and/or Camarosa.

Background. Historically, the University of California public strawberry breeding program, founded in the 1930s, has been the leading source of commercially useful strawberry varieties for the mid-South over the last four decades. Chandler, released by the University of California in early 1980's, became the standard variety of the North Carolina strawberry industry from the mid-1980s through mid-1990s. Camarosa, a 1992 UC release, replaced Chandler to become North Carolina's dominant variety from the mid-1990s until the present. In more recent years, Albion, a day-neutral introduced in 2006, has been gaining some popularity in North Carolina and the Southeast. Also, a short day UC variety 'Merced' with excellent heat tolerance and large berries is showing some promise in our region.

Beginning in the fall of 2015, Cottle Farms of Faison, NC, in cooperation with Dr. Barclay Poling, former Small Fruit Extension Specialist, NC State (1980-2010), began testing a number of newer strawberry varieties (including Ruby June, Sweet Ann, Lucia and Scarlet), and advanced selections coming out of the private breeding program of Lassen Canyon Strawberry Nursery, Redding, CA. Of this group, Ruby June has shown the best adaptation to growing conditions in Eastern NC (Figure 1), as well as on several commercial farms in the piedmont. Ruby June is very high in fruit quality, and its marketable yields have compared favorably with Chandler and Camarosa in four (4) seasons of testing at Cottle Farm. In 2019, the University of California strawberry breeding program released four (4) new varieties (Royal Royce, Valiant, Victor and Warrior), which were included in our 2019-2020 trial (Figure 2).

Varieties Tested and Nursery Sources. We evaluated fifteen (15) varieties, including ten (10) from the University of California: Albion, Camarosa, Camino Real, Chandler, Merced, Royal Royce, San Andreas,



Fig. 1. Ruby June is a new short day strawberry from Lassen Canyon Breeding program (Redding, CA). Fig. 2. A new variety and advanced selection trial was planted in mid-October 2019 at Cottle Farms, and it consisted of 128 plots (20 plant plots) with newer varieties and advanced selections from several breeding programs, including Lassen Canyon Nursery, University of California and NC State University.

Varieties Tested and Nursery Sources (cont'd)

Valiant, Victor and Warrior (Figs. 3 & 4). The four (4) newly released UC varieties were grown as cutoff plants, and were sourced from Norcal Nursery, Turlock, CA. All other cutoff plants utilized in the trial were furnished by either Lassen Canyon Nursery (LCN), Redding, CA, or Westech Agriculture LTD, Alberton, PEI, Canada. Westech LTD also furnished runner tips for plugs that were propagated in either Buffalo Junction, VA (PEI-1), or Faison, NC (PEI-2). All plant material from Lassen Canyon Nursery, is designated 'LCN' in Table 1.



Fig. 3. (left) Royal Royce – a new day-neutral from the UC-Davis Strawberry Breeding Program that has shown in California trials significant marketable fruit yield advantage over commercial checks (Cabrillo, Monterey and San Andreas). Apparently, it produces significantly fewer runners during the berry season (a very serious problem in Monterey), and has excellent post-harvest and fruit quality characteristics (photo provided by UC- Davis). Fig. 4 (right) Valiant – a day-neutral that has shown excellent yields in the early season, and the plant has also performed well in organic culture (photo provided by UC- Davis).

We also tested two NC State releases, Rocco (NC10-156) and Liz (NC10-038). The plugs of both Rocco and Liz were grown by Aaron's Creek Farms, Buffalo Jct., VA. Rocco was described at the Varieties Breakout at the November 2019 Southeast Strawberry Expo by the panelists leading this discussion (Mark Hoffmann, Gina Fernandez and Rocco Schiavone) as follows:

Rocco – short-day. Early season. Medium-large, medium soft berry, excellent flavor! Very high yielder. Biggest observed problem: Seeds on surface at times, very early. Best for pick your own and on farm sales. Consider as Sweet Charlie alternative.

Liz – short-day. Mid-season. Medium-large, firm berry, good flavor. High yielder. Biggest observed problem: large canopy can make it hard to pick. Best for pick your own and short distance shipping. Consider as Camarosa alternative.

Lassen Canyon Nursery furnished cutoffs of two (2) varieties: Camila and Ruby June – these are both short day (SD) varieties. Fresh Forward of the Netherlands furnished the SD variety Calinda.

Planting dates, plot size and replication. The trial was transplanted on October 15, 2019. The only exceptions to this planting date were for Royal Royce, Valiant, Victor and Warrior – these were delayed in digging, and were not transplanted until October 24, 2019. Each plot consisted of twenty (20) plant plots and there were two (2) replications for all the variety/plant type treatments shown in Table 1, except for the new UC varieties (Royal Royce, Valiant, Victor and Warrior), which had four (4) replications. First year LCN Advanced Selections were planted in single replicates. Second year LCN Advanced Selections (repeaters) had from two (2) to four (4) reps.

Table 1. The top thirty-five (35) Advanced Selections and Variety Treatments for marketable yield, 2020.

Rank	CLONE/Plant	Mkt_lbs/plant	Tot_lbs/plant	Percent cull	Ave berry weight (g)	⁰ Brix	Flavor ^z
1	74X4 Cutoff LCN	2.83	3.38	16%	24.8	6.8	2.2
2	73X41 Cutoff LCN	2.62	3.23	19%	22.4	6.9	2.0
3	81X18 Cutoff LCN	2.60	3.03	14%	20.7	8.3	1.8
4	89T2 Cutoff LCN	2.48	2.90	14%	28.8	7.3	2.1
5	57U55 Cutoff LCN	2.47	2.79	12%	24.7	6.3	2.0
6	86U59 Cutoff LCN	2.45	2.88	15%	25.0	6.5	1.9
7	Camar. Cutoff LCN	2.39	2.75	13%	18.4	6.6	2.3
8	Camila Cutoff LCN	2.37	2.83	16%	24.5	7.4	2.2
9	Liz Plug NCSU	2.37	2.81	16%	16.9	7.8	2.3
10	12X40 Cutoff	2.30	2.89	20%	17.8	8.5	2.6
11	Camino Real plug	2.29	2.60	12%	21.1	7.5	1.9
12	UC Royce Cutoff	2.25	2.68	16%	27.9	6.7	1.5
13	152X15 Cutoff	2.23	2.56	13%	26.6	8.5	2.8
14	Ruby J Plug (PEI-1)	2.19	2.43	10%	20.0	8.4	3.3
15	Ruby J Cutoff (LCN)	2.17	2.45	12%	20.2	9.2	3.6
16	146T54 Cutoff LCN	2.16	2.36	9%	23.0	7.7	2.5
17	Camar. Plug (PEI-2)	2.11	2.59	19%	18.5	7.8	1.9
18	85U40 Cutoff LCN	2.08	2.62	21%	24.0	6.9	2.5
19	UC Valiant Cutoff	2.05	2.63	22%	28.6	6.0	1.7
20	84X27 Cutoff LCN	1.96	2.35	17%	21.7	7.6	2.7
21	Ruby J Plug (PEI-2)	1.92	2.17	11%	21.3	8.2	3.2
22	UC Victor Cutoff	1.85	2.73	32%	24.2	5.7	1.8
23	Chandler Plug (PEI)	1.85	2.15	14%	14.5	7.2	2.8
24	<i>Camar. Cutoff (PEI)</i>	1.84	2.16	15%	17.8	7.5	2.2
25	122X8 Cutoff LCN	1.84	2.26	18%	29.2	8.9	2.9
26	Rocco Plug NCSU	1.79	2.33	24%	13.4	8.4	2.5
27	Ruby J Cutoff (PEI)	1.73	1.95	12%	21.0	8.8	3.4
28	95X5 Cutoff LCN	1.71	2.18	21%	24.0	8.3	2.7
29	53X53 Cutoff LCN	1.63	1.98	18%	23.3	6.6	1.0
30	Merced Cutoff LCN	1.61	1.94	17%	23.2	6.0	2.2
31	Chand Cutoff (PEI)	1.58	1.91	17%	13.0	8	2.8
32	Merced Plug (PEI)	1.54	1.87	18%	19.7	6.9	2.6
33	143T35 Cutoff LCN	1.53	1.83	17%	20.9	9.9	4.0
34	UC Warrior Cutoff	1.43	1.97	27%	23.0	6.2	1.7
35	San Andreas plug	1.35	1.60	16%	18.3	5.9	2.0

^z Flavor rating: 4=excellent flavor; 3=good flavor; 2=fair flavor; and, 1=poor flavor

Results. The marketable yield (per plant), total yield (per plant), percentage cull fruit, average berry weight (grams per berry), °Brix, and Flavor (flavor rating: 4=excellent flavor; 3=good flavor; 2=fair flavor; and, 1=poor flavor) of the top thirty-five (35) advanced selections and variety treatments are shown in Table 1.

Marketable yield (MY). The relatively cool weather conditions that prevailed in April and May 2020 made conditions favorable for an exceptionally long harvest season, and seventeen (17) harvests were conducted from March 26 – June 8, 2020. The LCN Advanced Selection 74X4 (cutoff) had the highest marketable yield (MY) in the study of 2.83 lbs. per plant (see No. 1 Rank, Table 1), and Camarosa grown as a cutoff (see No. 7 Rank) had the highest MY of any named variety with 2.39 lbs. per plant, or approximately 35,550 lbs. per acre (assuming 15,000 plants per acre). Camila, Liz, Camino Real, and UC’s new variety, Royal Royce, all had marketable yields of more than 2.25 lbs. per plant. With Ruby June plugs, the MY was in the range of 1.92 to 2.19 lbs. per plant, depending on treatment (Table 1). Ruby June cutoffs ranged from 1.73 to 2.19 lbs. per acre (Nos. 27, and 15, respectively). Chandler had MY’s in the range of 1.54 to 1.85 lbs. per plant (Nos. 31 and 23, respectively).

Figure 5 shows the relatively “even” distribution of the entire crop over the first two (2) months of picking (March 26 to May 25), for Ruby June and the LCN Advanced Selection 146T54. Chandler had a much more variable yield pattern during this same two (2) month period (Figure 5). Having a more even production level each week during the season can be beneficial for planning harvest labor requirements throughout the season. Having a relatively consistent level of production each week of the season also lessens the likelihood of more catastrophic crop loss in the event heavy rains should coincide with a variety’s peak production period. In Figure 5 you can see that Chandler had twin production peaks – one in early April, and another in late April-early May. Ruby June did not have any ‘spikes’ in production comparable to Chandler; and, 146T54 had a single production peak around May 11, 2020.

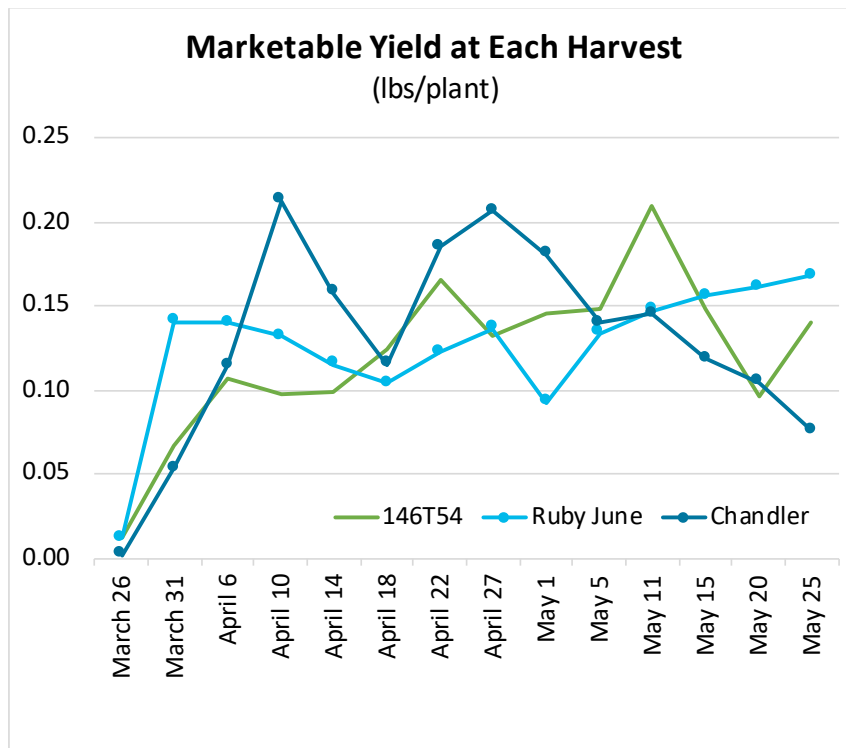


Fig. 5. The Lassen Canyon variety Ruby June (light blue line), and the LCN Advance Selection, 146T54 (light green line), stay in a narrower band of production from one harvest to the next by comparison to the industry standard Chandler.

Cull fruit. It is important to note that the spring 2020 strawberry season was characterized by very rainy conditions -- we only had two (2) of the seventeen (17) harvests that were unaffected by rainy conditions. Cull fruit data in this trial essentially reflect losses due to rain. The UC variety Victor had the worst rain tolerance with cull losses of 32% (No. 22), followed by UC's Warrior with 27% cull fruit (No. 34), and Valiant with 22% cull fruit (No. 19). Royal Royce had the best rain tolerance of the four (4) new UC varieties, with 16% cull fruit (No. 12). The industry standard in the mid-South for rain tolerance is Camino Real, and in this trial Camino Real had cull fruit losses of 12% (No. 11). For the full season, Ruby June had cull fruit losses in the range of 10 to 12% (see Nos. 14,15, 21 and 27). For the first fourteen (14) harvests of the 2020 season (from March 26 to May 25), Ruby June had only 5% cull losses, and the LCN Advanced Selection 146T54 had only 4% cull losses (Fig. 6). Because of 146T54's relatively low rain losses, Lassen Canyon Nursery is moving forward with naming 146T54 in 2021. This selection will also be tested in the 2020-2021 season by university researchers in Arkansas (Dr. Amanda McWhirt, Univ. of Arkansas), North Carolina (Dr. Gina Fernandez, NC State), and Virginia (Dr. Jayesh Samtani, Virginia Tech).

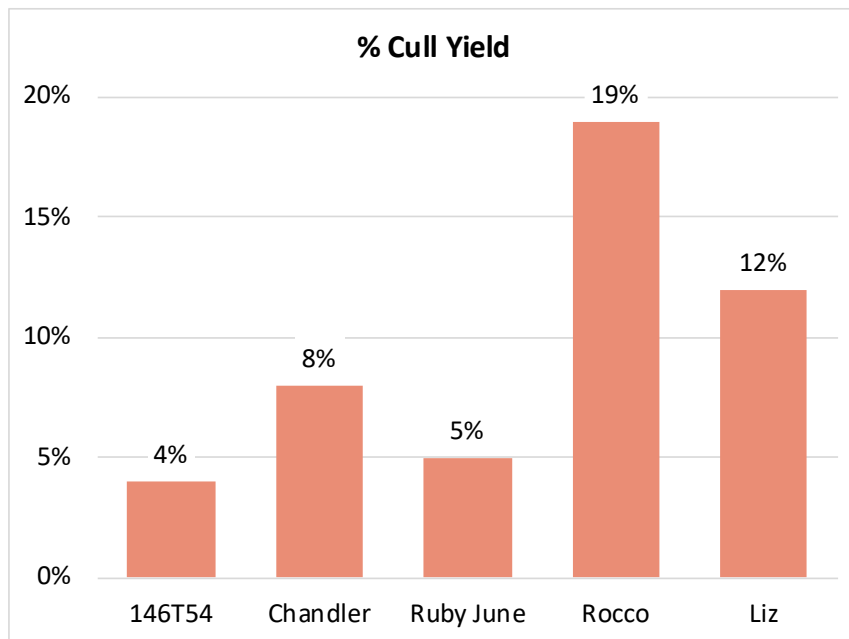


Fig. 6. The Lassen Canyon variety Ruby June had only 5% cull fruit losses for the fourteen (14) harvests from March 26 to May 25, 2020; Lassen will soon be naming 146T54 because of its excellent rain tolerance and overall good production characteristics.

Brix Readings and Flavor Scores. We did a minimum of three (3) Brix readings during the harvest season for each variety and advanced selection, and the Brix numbers and flavor scores shown in Table 1 represent the full season averages. Essentially, we found that all of the new UC varieties tested low for sugars. Royal Royce (No. 12), for example, had an average Brix of 6.7. By comparison, Ruby June treatments had average Brix readings in the range of 8.2 (No. 12) to 9.2 (No. 15).

Flavor scoring was subjective (done by Barclay Poling), and the average flavor score was only 1.5 for Royal Royce (4=excellent flavor; 3=good flavor; 2=fair flavor; and, 1=poor flavor). Flavor scores for Ruby June ranged from 3.2 (No. 21) to 3.6 (No. 15). Camarosa flavor scores typically fell into the range of 1.9 (No. 17) to 2.3 (No. 7). The average flavor score of for 146T54 (No. 16) was comparable to Camarosa (Nos. 7, 24). Table 2 shows a comparison of Brix and flavor scores for Camarosa and Ruby June for three (3) harvest dates. We were impressed not only by the higher seasonal Brix readings and flavor scores for

Ruby June treatments shown in Table 1 relative to the industry standard Camarosa, but we were also able to observe how consistently Ruby June maintained its flavor throughout the season (Table 2).

Table 2. Soluble Solids (Brix) and Flavor Ratings, Faison, NC, 2020

	March 31		April 15		May 12	
	Brix ^o	Flavor ^y	Brix ^o	Flavor ^y	Brix ^o	Flavor ^y
Camarosa	7.5	2.3	6.8	2.3	7.8	2.4
Ruby June	9.0	4.0	8.4	3.5	10.8	3.5

^y Flavor rating: 4=excellent flavor; 3=good flavor; 2=fair flavor; and, 1=poor flavor

Because of the heavy emphasis we place in this testing program on flavor, the top seven (7) Advance Selections shown in Table 1 were eliminated from further testing consideration due to their flavor scores below a minimum level of 2.3. On a more positive note, we did identify an advanced selection (No. 33, 143T35), with a seasonal Brix reading of 9.9 and an excellent flavor score of 4.0. Its main drawback is lower productivity in comparison to Camarosa or Ruby June, and in the 2020-2021 season it is being tested as a plug plant to see if this might boost its yield.

Berry size. With harvest labor becoming more expensive each year, it is that much more important for growers to select varieties with good “picking performance” characteristics. In this program we eliminate from further consideration any variety or advanced selection that does not meet a minimum berry size of 18 grams. The names of varieties and advanced selections that did not meet this minimum size requirement are italicized in Table 1. Chandler had an average berry size of 13.0 grams, which was the lowest of any variety or advanced selection tested (Table 1). Most of the Camarosa treatments were slightly above 18 grams in average berry size, with the exception of No. 24 (cutoff, PEI, 17.8 g). Contrary to the suggestion that Ruby June may only be good for “pick your own and short distance shipping” (SE Strawberry Expo, Variety Breakout Session, Nov. 2019), this variety does have more than acceptable average berry size for commercial harvest (see Nos. 14,15,21 and 27). Ruby June clamshell berry counts were in the range of 21-23 berries (1 lb. clamshell). By contrast, Camarosa had clamshell berry counts of approximately 25 berries. Ruby June also has very good shelf-life and is exceptionally easy to pick.

Summary. In our testing in Faison, NC (Coastal Plain) over the last five (5) strawberry seasons, we have not seen much difference in the overall performance of cutoff vs. plug plants. In 2019-2020, Ruby June, for example, produced an average of 2.05 lbs. per plant as a plug (average of two sources), and 1.95 lbs. per plant as a cutoff (average of two sources). In colder growing areas, however, the yield difference between plugs and cutoffs can be much greater, and plugs are generally recommended for regions with shorter fall growing seasons. The chief problem with cutoffs in colder growing regions is related to availability - typically this type of transplant is not available until early to mid-October from nurseries in California and Canada. In reference to transplant choice in colder growing areas, it is helpful to note that in a first year trial conducted in Maryland in the 2019-2020 season (Shlagel Farms, Waldorf, MD), that Ruby June plugs produced an average of 1.4 lbs. per plant and cutoffs had 1.3 lbs. per plant in marketable yield (<https://www.flavorfirst.com/preliminary-reports>).

In looking forward to the 2020-2021 season, we are carrying forward two (2) LCN Advanced Selections: 152X15 (No. 13), and 122X8 (No. 25). These selections had good flavor (range of 2.8-2.9), and 152X15 is a very attractive berry with excellent size (26.6 g). We are also excited about our growing network of research collaborators in AR, NC, and VA who will be evaluating 146T54 (rain tolerant) and 143T35 (high flavor) in the coming season. We also wish to acknowledge the special assistance we received in the 2019-2020 from Dr. Mark Hoffmann, NC State, and his research assistant, Emma Volk.